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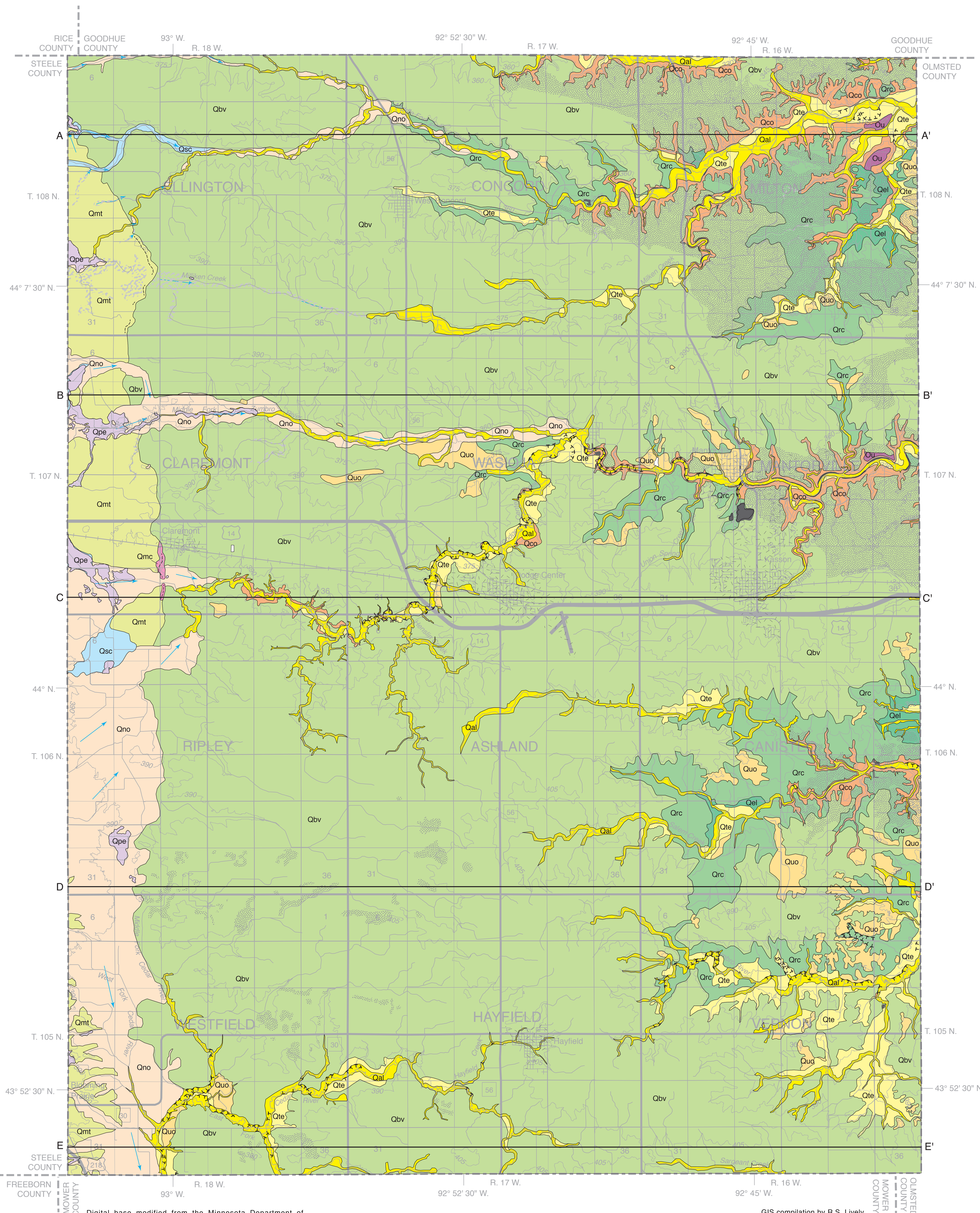

Digital base modified from the Minnesota Department of Transportation BaseMap data; digital base annotation by Corey J. Betchwars.
Elevation contours were derived from the U.S. Geological Survey 30-meter Digital Elevation Model (DEM) by the Minnesota Geological Survey.
Universal Transverse Mercator Projection, grid zone 15
1983 North American Datum

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

SCALE 1:100 000

CONTOUR INTERVAL 15 METERS

LOCATION DIAGRAM

SURFICIAL GEOLOGY

By

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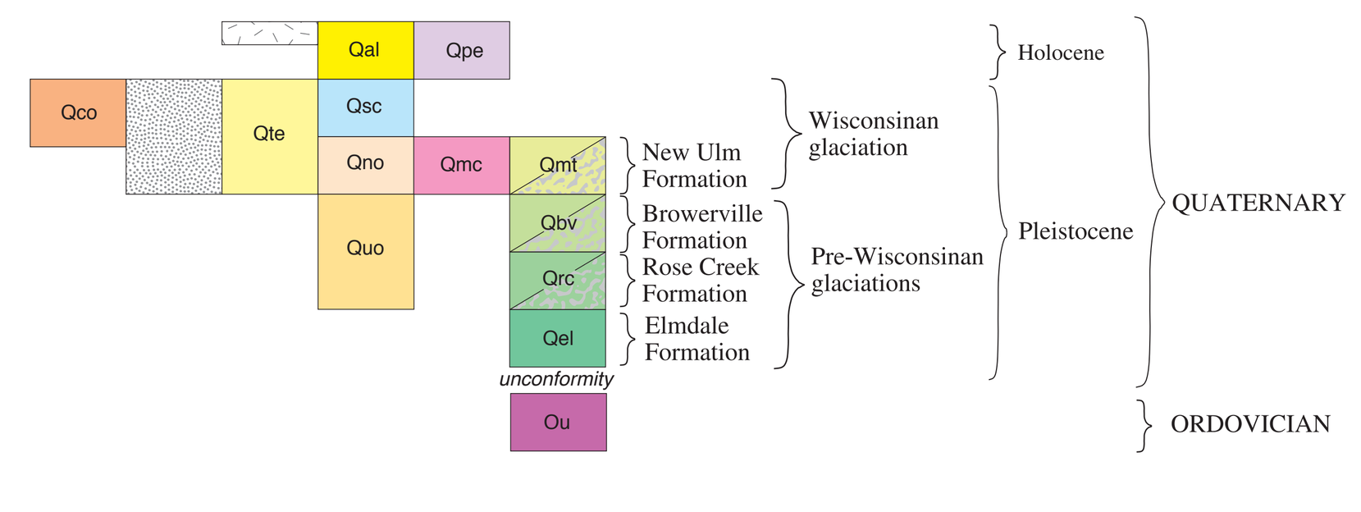
2019

CORRELATION OF MAP UNITS



MAP SYMBOLS

Geologic contact—Approximately located.

Stream-cut scarp—Erosional scarp formed by fluvial processes. Hachures point down scarp.

General flow direction of glacial meltwater—Arrow points downstream in the direction of glacial meltwater flow. Direction of flow is based on elevation data from lidar.

Moraine ridge—Indicates a small ridge constructed by the Des Moines lobe during the Moland phase. Moraine ridge is not continuous. Ridge can be up to 15 feet (5 meters) high but is typically between 5 and 8 feet (1.5 to 2.4 meters).

Washed—Pattern indicates where glacial till (units Qmt, Qbv, Qrc) has been washed by water. These areas may have a thin layer of sand and gravel overlying the till.

Bedrock outcrop.

INTRODUCTION

This map displays the surface distribution of Quaternary sediments and areas where these sediments are thin or absent in Dodge County, Minnesota. The depiction of landform distribution was based on 1-meter resolution lidar elevation imagery collected in 2008 (available from the Minnesota Geospatial Commons <https://gisdata.mn.gov>). This map was compiled using descriptions and samples collected from exposures, gravel pits, road cuts, water-well cuttings, six rotary-sonic cores, and 93 soil-auger borings. Auger borings were drilled to an average depth of 24 feet (7 meters) and were collected during the 2016 field season. Over 700 samples collected from auger borings and exposures were analyzed for texture and lithology for this plate and for Plate 4, *Quaternary Stratigraphy* (Tables 1, 2). Data from previous mapping projects in and adjacent to Dodge County (see Mapping Index) were also used to interpret map units. This was supplemented by the soil map of Dodge County (Natural Resources Conservation Service, 2014), the Minnesota Department of Natural Resources Aggregate Resources map (Anderson, 2002), well logs from the County Well Index (CWI), and the Minnesota Geological Survey Quaternary Data Index (QDI), an internal working database that includes Minnesota Department of Transportation bridge borings.

Map units are distinguished from each other by texture, very coarse-grained sand grain (1-2 millimeters) lithology, stratigraphic position, and landscape position. Most of the Quaternary deposits are assigned to the lithostratigraphic units defined in Johnson and others (2016).

GLACIAL HISTORY

The surficial geology of Dodge County is dominated by sediments deposited during the Quaternary Period. This period, which began about 2.6 million years ago and extends to the present, is characterized by repeated advances of the Laurentide ice sheet, a continental glacier, into Minnesota. During these glacial advances, ice flowed into the state from four different source areas, the central-northwest Winnipeg provenance, the northwest Riding Mountain provenance, the central-northeast Rainy provenance and the northeast Superior provenance (Fig. 1). As ice advanced from these source areas, it incorporated different types of rocks and deposited glacial sediments with distinct lithologic compositions, which are indicative of the provenance from where the ice originated. However, by the time it reached southeastern Minnesota, ice from the four source areas had flowed along similar paths for hundreds of miles. As the ice flowed, it incorporated additional rocks that diluted the distinct lithologic composition of the provenance from where it originated (Fig. 2). Therefore, glacial deposits in southeastern Minnesota tend to have less diagnostic lithologic compositions than deposits in central or northern Minnesota (Meyer, 2000).

Pre-Wisconsinan glaciation

The oldest glacial material preserved at the land surface in Dodge County is Elmdale Formation till (unit Qel) of Winnipeg provenance (Fig. 1). This unit is at lower elevations along valleys in eastern Dodge County, where the overlying Rose Creek and Browerville Formations have been eroded. Till of the Elmdale Formation is texturally similar to that of the Browerville Formation, but generally has fewer Paleozoic carbonate clasts (see Plate 4, Table 1). The Rose Creek Formation, also exposed in eastern Dodge County through erosion, is interpreted to have been deposited by Rainy-provenance ice as it advanced from the northeast (Fig. 1). Till of the formation (unit Qrc) is distinguished by an absence of Cretaceous material within the very coarse-grained sand (1-2 millimeter) fraction, and the matrix is typically more sand-rich than that of other tills in Dodge County (Table 1).

Following deposition of the Rose Creek Formation till, ice retreated from Dodge County. In the absence of ice cover, a boreal forest developed (Meyer, 2000). Eventually, Winnipeg-provenance ice buried this forest, and in places, a soil horizon was preserved as part of the Bennington Member of the Rose Creek Formation. The Bennington Member also includes silty sediments that have been interpreted to be remobilized loess and pond sediment (Meyer and Knaeble, 1998; Meyer, 2000). The Bennington Member was encountered in six soil-auger borings and in two rotary-sonic cores primarily in southern Dodge County.

Winnipeg-provenance ice deposited the Browerville Formation above the Bennington Member. Although this formation is present across much of Minnesota, in most areas it is buried beneath younger, Wisconsinan-age glacial sediments. Till from this formation contains Cretaceous limestone, *Inoceramus sp.* shell fragments, and trace amounts of gray and speckled shale within the 1-2 millimeter sand fraction (Table 1). In Dodge County, Browerville Formation till (unit Qbv) is the most widespread surficial unit. Glacial landforms of the Browerville Formation have been subdued by extensive wind and water erosion, and likely periglacial activity during the Wisconsinan glaciation. As a result, the Browerville Formation forms a relatively low-relief landscape across Dodge County.

Radiocarbon and uranium/thorium dating have been used to determine the age of the Browerville Formation. Wood collected from Browerville Formation till at a gravel pit in Stearns County was older than about 48,000 cal YBP (Table 3; Meyer and Knaeble, 1996; Johnson and others, 2016). Two calcite samples were collected from marl deposits in lacustrine sediment on top of Browerville Formation till in a rotary-sonic core drilled in central Minnesota. These samples had a uranium/thorium disequilibrium minimum date of 200,000 years before present (Knaeble and Meyer, 2007) and imply that the Browerville Formation is pre-Wisconsinan and probably pre-Illinoian in age.

In places, till of the Browerville, Rose Creek, and Elmdale Formations are overlain by highly leached and oxidized deposits of sand and gravel (unit Quo; Table 2). The sand and gravel clasts are typically coated by a thin layer of reddish clay and they break apart easily due to extensive chemical weathering. This unit includes sediment deposited over an extended time period, following deposition of the Elmdale Formation, by either meltwater or non-glacial streams. These deposits are interpreted to be largely exhumed by subsequent erosion (see cross sections on Plate 4), but in places likely include sediment laid down during periods of slope instability following the glaciation in which the Browerville Formation was deposited.

Wisconsinan glaciation

The most recent glacial event to deposit sediments in Dodge County occurred near the end of the Pleistocene Epoch, during the Wisconsinan glaciation (75,000 to 11,700 years ago). During the Moland phase, the Des Moines lobe advanced from the northwest (Fig. 1), reaching what is now the town of Moland in Rice County (Fig. 3), giving the phase its name (Patterson and Hobbs, 1995; Meyer, 2000). As it advanced, the Des Moines lobe deposited loamy till of the Moland Member of the New Ulm Formation (unit Qmt; Johnson and others, 2016). This till is of Riding Mountain provenance and is distinguishable from the pre-Wisconsinan tills in Dodge County by the presence of Cretaceous shale within the 1-2 millimeter sand fraction (Table 1). Wood from bedded sediment below Moland Member till in Blue Earth County was radiocarbon dated at about 23,000 YBP (27,500 cal YBP; Meyer and others, 2012), setting a maximum age for the Moland phase.

During the Moland phase, the Des Moines lobe advanced into Dodge County and stopped just west of the city of Claremont (Fig. 3). In this position, Des Moines-lobe ice constructed a subtle north–south-trending moraine across northwest Dodge County (see map symbols) and an ice-contact ridge composed of poorly sorted sand and gravel (unit Qmc; Table 2). Additionally, meltwater flowed from the ice, carving valleys and depositing outwash (unit Qno; Table 2). In northern Dodge County, meltwater flowed eastward through the several valleys of the Middle Fork of the Zumbro River and the valley of Milliken Creek. In southern Dodge County, meltwater flowed south, draining into the Cedar River valley.

Meyer (2000) concluded that the Moland-phase deposits of the New Ulm Formation in adjacent Mower County correlate to the Sheldon Creek Formation of north-central Iowa (Bettis and others, 1996; Bettis 1997). The Moland Member may also be time correlative with the Verdi Member of the New Ulm Formation in southwestern Minnesota because these two tills were both deposited by the Des Moines lobe prior to the formation of the Bemis moraine (Gowan, in press).

Following the Moland phase, the Des Moines lobe advanced again during the Bemis phase, radiocarbon dated at about 14,000 years ago (about 17,250 cal YBP; Bettis and others, 1996; Johnson and others, 2016). During this advance, the Des Moines lobe constructed the Bemis moraine (Fig. 3), which extends in an arc from northeastern South Dakota through southwestern Minnesota, northern Iowa, and into southeastern Minnesota (Fig. 4). Although glacial ice did not enter Dodge County at this time, meltwater flowed from the Bemis moraine into Dodge County and deposited outwash. Because it is not possible to distinguish outwash from the Bemis phase versus the Moland phase by lithology or elevation, outwash from both phases are mapped together (unit Qno). Areas where meltwater deposited thin (less than 3 feet [1 meter]) layers of sand and gravel over till are mapped as washed (see map symbols). At the same time, non-glacial streams deposited sand and gravel (unit Qte; Table 2) across Dodge County. Because meltwater eventually flowed into valleys occupied by non-glacial streams, it is likely that this sand and gravel unit (unit Qte) also contains materials deposited by glacial meltwater.

Des Moines-lobe ice eventually stagnated and melted in Dodge and adjacent Steele Counties, causing new drainage patterns to develop. Areas where high-energy meltwater once flowed were now covered by slow moving or stagnant water, where silt and clay accumulated in lakes and on floodplains (unit Qsc; Table 2). These deposits locally cover New Ulm Formation sand and gravel in the western part of the county.

Most of Dodge County was not covered by ice or glacial meltwater during the Wisconsinan glaciation. This ice-free landscape, due to the harsh climate, remained sparsely vegetated and was exposed to the elements. When strong winds came off the ice sheet from the northwest, they swept across the land surface, mobilizing and depositing fine-grained sediment from pre-Wisconsinan glacial deposits (Mason and others, 1994; Zanner, 1998). This formed a unit of fine-grained sand and silt called the Peoria Formation loess (stippled pattern; unit Qlo on Plate 4; Table 2). The thickness of this loess is highly variable, but overall it increases to the east within Dodge County. Along the eastern margin, loess deposits are as much as 12 feet (4 meters) thick. Basal radiocarbon ages from organic material buried by loess in east-central Iowa range from about 33,200 to 22,000 cal YBP (Table 3; Ruhe and others, 1968). This indicates the beginning of loess deposition. Organics buried in the upper section of Peoria Formation loess range from about 17,900 to 17,300 cal YBP (Table 3), implying loess deposition ended around that time in Iowa (Ruhe and others, 1968).

Periglacial conditions, including permafrost, contributed to a major mass-wasting episode during the Wisconsinan glaciation. Materials from the uplands mixed with bedrock along steep slopes, forming a poorly sorted mix of sediment and angular bedrock clasts called colluvium (unit Qco; Table 2). Radiocarbon dating of organic matter collected from colluvium deposits in southeastern Minnesota indicates that deposition occurred around 19,900 to 13,900 cal YBP (Table 3; Mason and Knox, 1997).

Holocene

The Holocene Epoch began around 11,700 years ago and marks the end of the ice age in Minnesota. As the ice melted and the climate warmed, vegetation returned to the area. The reestablishment of vegetation halted significant wind erosion and stabilized slopes in southeastern Minnesota. Drainage from glacially dammed lakes far to the northwest of Dodge County eroded and deepened the Mississippi River valley. This caused local tributary streams to down cut their valleys, dissecting and preserving older alluvium (unit Qte) as terraces above the newly established floodplain. Following drainage of the glacial lakes, sediment-carrying capacity waned and the tributaries began to fill with floodplain alluvium (unit Qal; Hobbs, 1995). Also during this time, organic-rich deposits formed in low-lying areas (unit Qpe). More recently, large-scale movement of sediment by industrial machinery redistributed surface sediments and created fill (slash pattern; unit Qfi on Plate 4) in urban areas and landfills.

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DESCRIPTION OF MAP UNITS

QUATERNARY

Holocene

Fill—Formed by large-scale movement of sediment by industrial machinery. Present in urban areas, gravel pits, quarries, and landfills. Materials vary depending on land use. *Fill.*

Qal **Sand and gravel, sandy loam to silt loam**—Generally coarse-grained sediment (sand and gravel) in channels, and finer-grained sediment (fine-grained sand and silt) on floodplains; coarsens with depth. Locally capped and/or interbedded with organic-rich layers. Areas of low elevation are typically filled with thick silty to clayey sediment. Generally, sediment along smaller streams is finer-grained. Deposited by modern streams in channels and on floodplains. *Floodplain alluvium.*

Qpe **Decomposed organic matter**—Partially to fully decomposed organic matter. Unit was developed and is maintained in a non-glacial environment. Distribution of this unit has been obtained from the Natural Resources Conservation Service (2014). *Peat.*

Pleistocene

Wisconsinan

Qsc **Silt and clay**—Bedded; gravel is rare to absent; clay increases with depth. Oxidized color is 2.5Y 5/4 and unoxidized is 5Y 5/2. Material is calcareous and can be 15 feet (5 meters) thick. Consists of fine-grained sediment deposited by water in a post-glacial lake or by slackwater in a meltwater-carved channel. Deposited over Des Moines-lobe materials. *Lake and floodplain sediment.*

Qco **Loam, locally includes silt to boulders**—Hillslope deposits associated with steep slopes. Derived from bedrock and reworked Quaternary deposits. The unit is thin upslope and thickens downslope. Upslope, the unit is finer-grained and consists of reworked loess, soil, or diamicton. Downslope, the unit is generally poorly sorted and rocky, containing angular clasts of the local bedrock in a silty to sandy matrix. Bedrock exposures are common. *Colluvium.*

Qte **Gravelly sand to sandy loam**—Poorly sorted. May be capped by loamy fine-grained sand. Present as terraces above modern river valleys. Deposited during higher stages of flow. *Terrace alluvium.*

Peoria Formation—Sediment deposited by northwesterly wind during the late Wisconsinan glaciation (Johnson and others, 2016).

Silty loam—Uniform, massive silt mixed with some clay and fine-grained sand. Present as loamy sand in places in the southwestern portion of the county. Silty loam is generally yellowish-brown (10YR 5/6) to light yellowish-brown (10YR 6/4) where oxidized and is rarely unoxidized. The gravel component is due to mixing of this unit during sampling with an erosive gravel lag at its base. Thickness is highly variable. Deposit may have been removed by road building or construction in places where mapped. In places, overlies an erosional gravel lag. Shown as a stipple pattern where thicker than 3 feet (1 meter). Pattern omitted where overlying colluvium. *Loess.*

New Ulm Formation—undifferentiated—Sediment deposited by ice of the Riding Mountain-provenance Des Moines lobe (Johnson and others, 2016).

Qno ***Sand to gravelly sand***—Poorly sorted. Includes finer-grained stratified sediments in some areas. Deposited by glacial meltwater issuing from the Des Moines lobe during the Moland and Bemis phases. *Glaciofluvial outwash.*

New Ulm Formation—Moland Member

Qmc ***Gravelly sand to sandy loam***—Poorly sorted. Sediment is collapsed due to melting of ice blocks. Deposited in contact with melting Des Moines-lobe ice at the Des Moines-lobe margin during the Moland phase. Can be up to 25 feet (8 meters) in relief. *Glacial ice contact.*

Qmt ***Loam diamicton***—Unsorted sediment; contains pebbles and scattered cobbles suspended in a loam matrix. This unit contains lenses of silt, clay, and fine-grained sand that formed during ice stagnation and melt out. Diamicton is generally light olive-brown (2.5Y 5/4) to gray-brown (2.5 Y 5/2) where oxidized. Average composition of the very coarse-grained sand fraction is shown in Table 1. The diagnostic feature of New Ulm Formation materials is gray shale fragments, derived from the Cretaceous Pierre Shale located in northern North Dakota and southwestern Manitoba. Pattern indicates areas where till was washed by meltwater and may be overlain by a thin layer of sand and gravel (see map symbols). *Glacial till.*

Pre-Wisconsinan

Quo **Sand to gravelly sand with minor beds of silt and clay**—Weathered, oxidized, and leached, usually to depths of 15 feet (5 meters). Clasts are typically coated by a reddish clay in the upper part of the deposit. This unit is patchy and discontinuous throughout the county. Occupies an upland position above the elevation of modern floodplains. Deposited either by meltwater or non-glacial rivers. *Undifferentiated outwash or alluvium.*

Browerville Formation—Sediment deposited by Winnipeg-provenance ice (Johnson and others, 2016).

Qbv ***Loam diamicton***—Unsorted sediment; contains pebbles and scattered cobbles suspended in a loam matrix. Generally yellowish-brown (10YR 5/6) where oxidized and very dark gray (5Y 3/1) to dark olive-gray (5Y 3/2) where unoxidized. Sand lenses are common in the upper 6 feet (2 meters). Depth of carbonate leaching varies locally but is on average 2 feet (0.6 meter). Average composition of the very coarse-grained sand fraction is shown in Table 1. Contains Cretaceous limestone, fragments of *Inoceramus* shells, and trace amounts of gray shale. Pattern indicates areas where till was washed by water and may be overlain by a thin layer of sand and gravel (see map symbols). *Glacial till.*

Rose Creek Formation—Sediment deposited by Rainy-provenance ice (Johnson and others, 2016).

Qrc ***Loam diamicton***—Unsorted sediment; contains pebbles and scattered cobbles suspended in a loam matrix. Generally yellowish-brown (10YR 5/6) to brownish-yellow (10YR 6/6) where oxidized and gray (5Y 6/1) where unoxidized. Depth of carbonate leaching varies. This unit is typically encountered beneath the Browerville Formation, but is exposed where the land surface is highly dissected, implying erosion of the overlying Browerville till. Average composition of the very coarse-grained sand fraction is shown in Table 1. This unit contains fewer Cretaceous grains and is somewhat coarser-textured than till of the Browerville and Elmdale Formations. The Bennington Member, consisting of peat over leached silty sediment, is part of the Rose Creek Formation. Where preserved, it occurs on top of Rose Creek Formation till and below the Browerville Formation. A pattern indicates areas where till was washed by water and may be overlain by a thin layer of sand and gravel (see map symbols). *Glacial till.*

Elmdale Formation—Sediment deposited by Winnipeg-provenance ice (Johnson and others, 2016).

Qel ***Loam diamicton***—Unsorted sediment; contains pebbles and scattered cobbles suspended in a loam matrix. Ranges from brown (10YR 4/4) to yellow-brown (2.5Y 5/6) where oxidized and gray (5Y 4/1) to dark gray (5Y 3/1, 10YR 3/1) where unoxidized. Depth of carbonate leaching varies depending on how much of the deeply leached weathered horizon has been eroded. This unit is typically encountered beneath the Rose Creek Formation, but is exposed where the land surface is highly dissected, implying erosion of the overlying Rose Creek Formation till. Generally has fewer Paleozoic carbonate clasts than the similar Browerville Formation till (Plate 4, Table 1). *Glacial till.*

ORDOVICIAN

Ou **Bedrock**—Ordovician bedrock covered by less than 3 feet (1 meter) of Quaternary sediment (excluding loess) and soil.

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Numbers in parentheses correspond with those shown on the Mapping Index.

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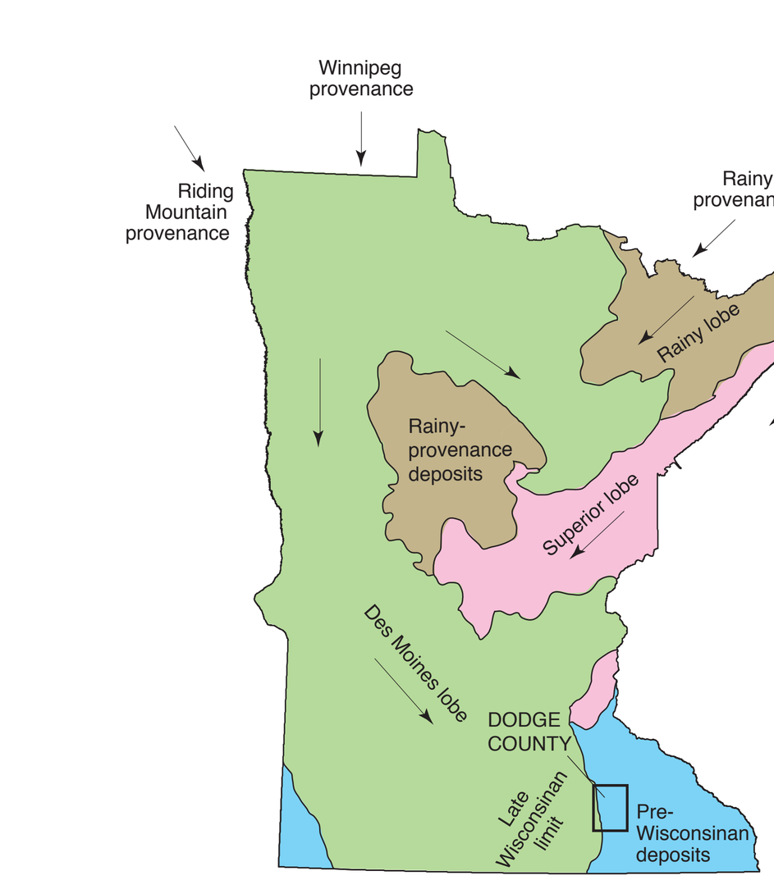


Figure 1. Location of major provenances and a simplified distribution of ice-lobe materials at the land surface across Minnesota. Glacial sediments derive their distinct content from bedrock and sediment incorporated into the ice in these source areas. Glacial sediments deposited during the Wisconsinan glaciation are colored as follows: the Riding Mountain-provenance materials deposited by the Des Moines lobe are green, Rainy-provenance materials deposited by the Rainy lobe are brown, and Superior-provenance materials of the Superior lobe are pink. Ice did not advance into southwestern and southeastern Minnesota during the Wisconsinan glaciation. In these regions, glacial sediments were deposited by pre-Wisconsinan glacial advances and are shown in blue. The provenance of these older sediments are not distinguished in this figure.

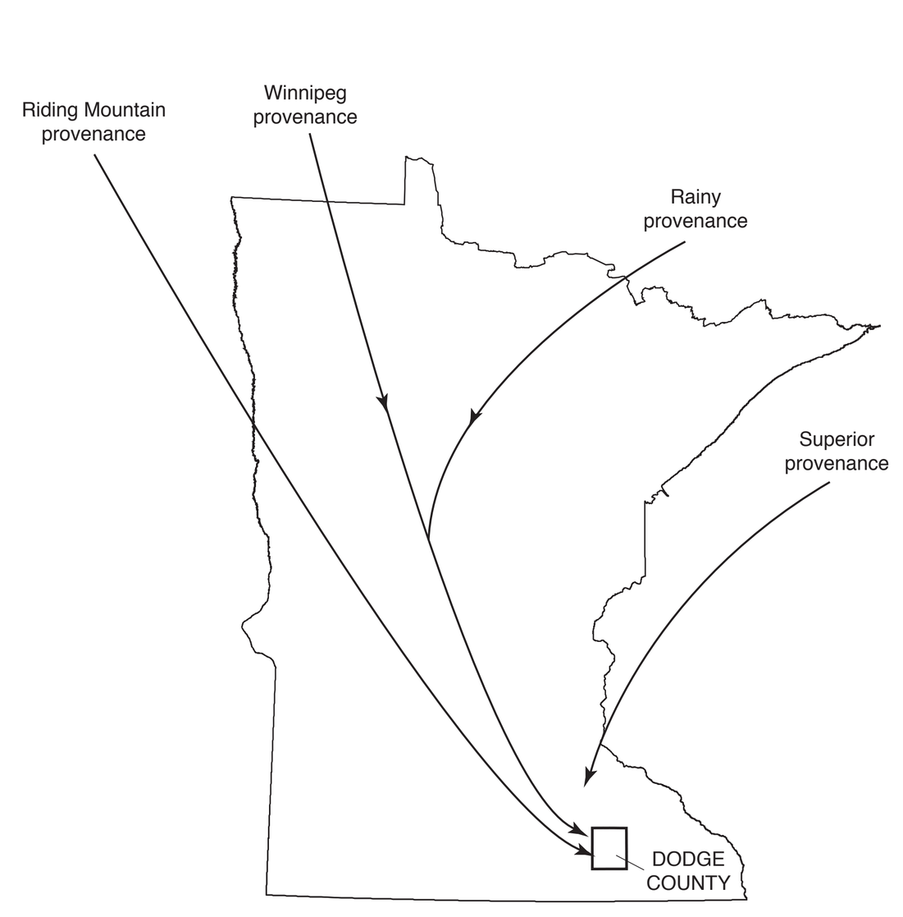


Figure 2. General flow paths of glacial ice from the four provenances towards Dodge County. The flow paths for the Winnipeg and Rainy lobes are nearly identical south of central Minnesota. The flow path for the Des Moines lobe is very similar to the Winnipeg and Rainy lobes. Because the ice incorporated additional rocks while flowing along these similar flow paths, the glacial deposits in southeastern Minnesota tend to have more mixed and therefore less diagnostic lithologic compositions than deposits in central or northern Minnesota. Modified from Meyer (2000).

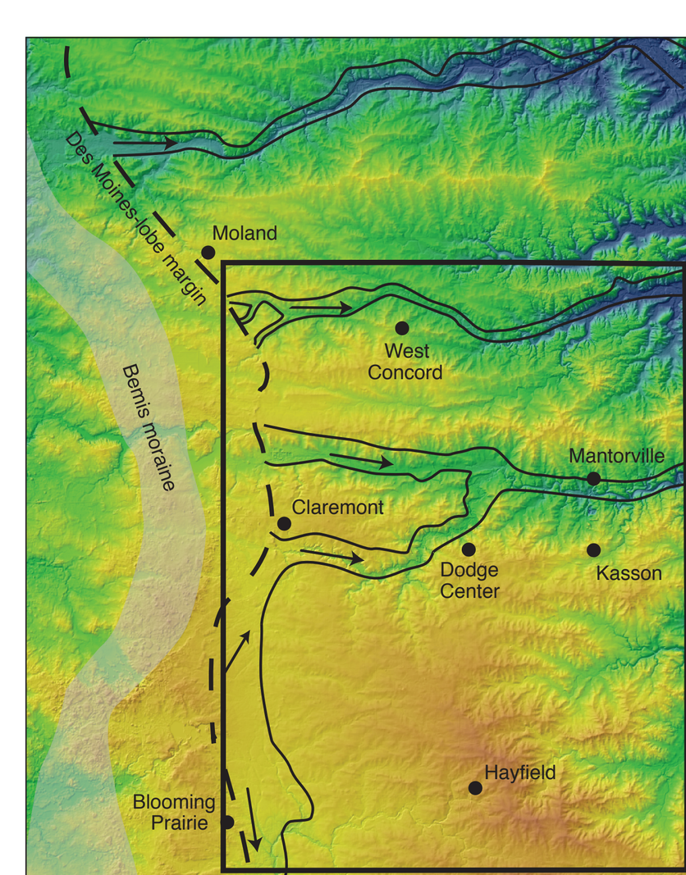
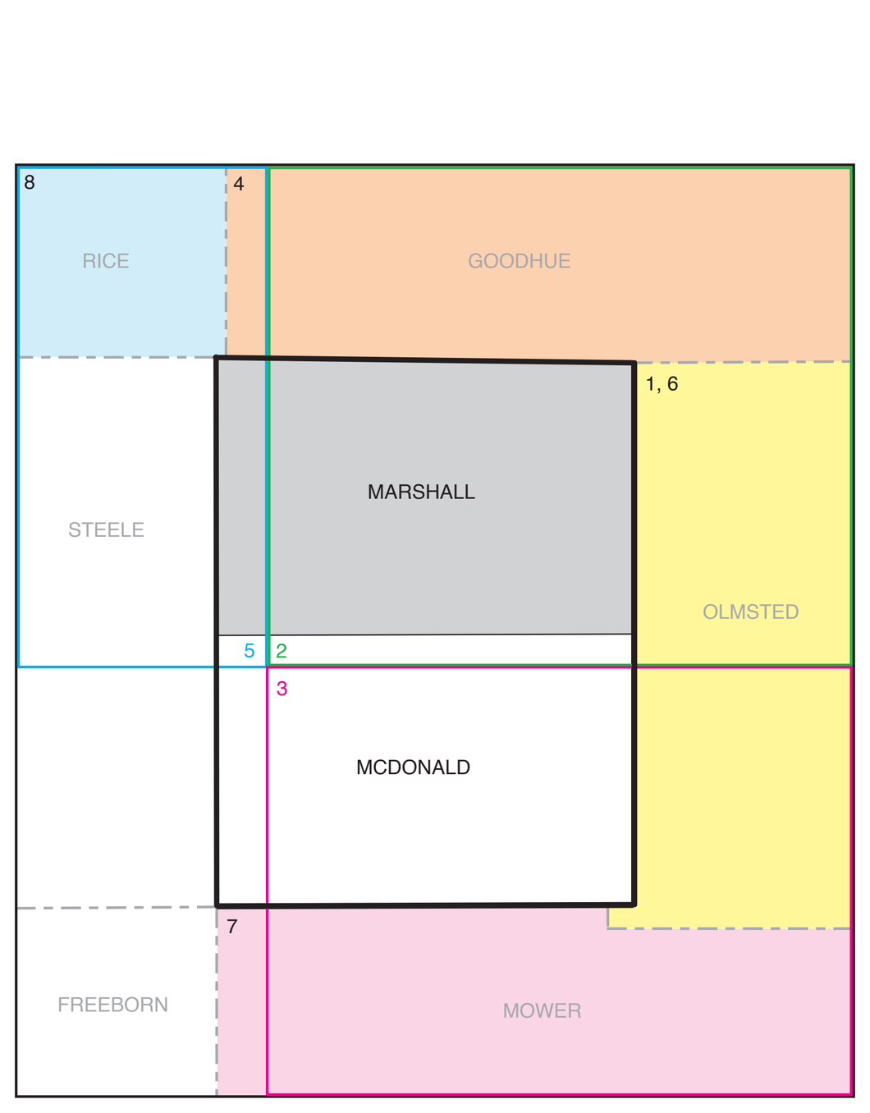


Figure 3. Physical relief of the land surface in southeast Minnesota (vertically exaggerated 2x) showing the extent of the Des Moines-lobe advance during the Moland Phase (dashed line) and the Bemis moraine. Meltwater flow paths are indicated by arrows. Dodge County is outlined. Elevation is shown by color: orange (higher elevation) grading to blue (lower elevation). Elevation in figure ranges from 1,412 to 917 feet (meters) above sea level. A false sun illumination at an elevation of 30° above the horizon and from the northwest (315°) provides contrast to accent landforms. This map was created using the Minnesota Department of Natural Resources' digital elevation model with a 30-meter cell size.



MAPPING INDEX

Marshall mapped the northern part of the county (gray); McDonald mapped the southern part (white). Numbers for previous mapping projects correspond with those listed in the references.

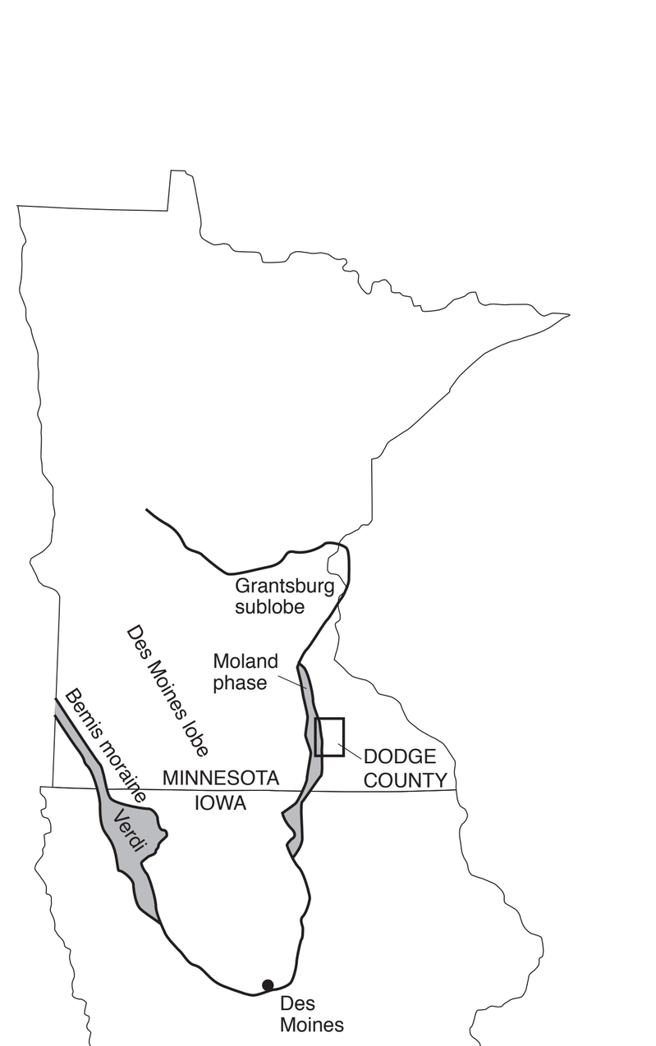


Figure 4. Map showing the location of the Bemis moraine, the extent of the Moland-phase ice margin to the east, and the Verdi-phase ice margin to the west (shown in gray; Patterson, 1995). The Moland and Verdi phases are likely correlative. This position of the Moland- and Verdi-phase ice margins in Iowa was interpreted from Richmond and others (1991). Modified from Meyer and Knaeble (1998).

Table 1. Texture and grain-count averages for tills mapped at the surface in Dodge County. Averages are for samples collected from depths of 10 feet (3 meters) or less (averages for deeper samples are included on Plate 4, *Quaternary Stratigraphy*). Samples with less than two hundred 1-2 millimeter sand grains were not included in the averages.

	MATRIX TEXTURE						CLAST TYPE									
			Percentage of the less than 2 millimeter fraction				Percentage of total grains counted of the 1-2 millimeter fraction			Percentage of Cretaceous grains counted			Percentage of total Precambrian grains counted			
Deposit description	Total number of samples	Gravel (percentage of total sample weight)	Sand	Silt	Clay	USDA texture	Precambrian	Paleozoic	Cretaceous	Limestone	*Inoceramus* shells	Speckled shale	Light	Dark	Red	Clear quartz
New Ulm Formation, Moland Member (unit Qmt)																
Leached	1	2	44	36	21	Loam	93	7	0	—	—	—	63	15	0	22
Unleached	4	4	41	42	17	Loam	71	26	4	28	7	1	63	16	2	19
Browerville Formation (unit Qbv)																
Leached	16	3	41	37	22	Loam	97	2	0	—	—	—	65	10	1	24
Unleached	67	4	43	37	20	Loam	75	22	3	54	36	1	61	13	1	25
Rose Creek Formation (unit Qrc)																
Leached	1	4	60	26	15	Sandy loam	94	6	0	—	—	—	56	9	13	22
Unleached	12	7	47	36	17	Loam	80	20	0	—	—	—	65	12	1	22

Table 2. Texture averages for mapped units in Dodge County that are not presented in Table 1. Averages are for samples collected from depths of 10 feet (3 meters) or less (averages for deeper samples are included on Plate 4).

			Percentage of the less than 2 millimeter sand fraction			
	Total number of samples	Gravel (percentage of total sample weight)	Sand	Silt	Clay	USDA texture
Floodplain alluvium (unit Qal)	8	11	72	20	8	Sandy loam
Colluvium (unit Qco)	6	12	36	53	12	Silt loam
Peoria Formation loess	32	0	20	66	14	Silt loam
Lake and floodplain sediment (unit Qsc)	3	2	6	63	31	Silty clay loam
Terrace alluvium (unit Qte)	8	13	70	22	8	Sandy loam
Deposits associated with the New Ulm Formation						
Glacial ice contact (unit Qmc)	4	16	71	21	8	Sandy loam
Glaciofluvial outwash (unit Qno)	20	12	75	20	6	Sandy loam
Undifferentiated glaciofluvial outwash (unit Quo)	10	0	79	15	6	Loamy sand

Table 3. Radiocarbon ages (^{14}C) were recalibrated using the radiocarbon calibration program Calib 7.1 (Stuiver and others, 2018). The recalibrated ages are the median probability age and are reported in calendar years before present (cal YBP). Recalibrated ages are used within the map text.

Sample name	^{14}C	±	cal YBP	Material dated	Unit	Source
Beta-82571	>45,000		>48,000	Wood	Browerville Till	Meyer and Knaeble (1996)
I-1402	14,200	200	17,300	Spruce wood	Top of Peoria loess	Ruhe and others (1968)
W-512	14,470	400	17,600	Fir, hemlock, larch, spruce wood	Top of Peoria loess	Ruhe and others (1968)
W-153	14,700	400	17,900	Hemlock wood	Top of Peoria loess	Ruhe and others (1968)
W-879	19,050	300	23,000	Spruce wood	Base of Peoria loess	Ruhe and others (1968)
I-1022	20,290	1,000	24,400	Organic carbon from a paleosol	Base of Peoria loess	Ruhe and others (1968)
I-1267	25,000	2,500	29,100	Organic carbon from a paleosol	Base of Peoria loess	Ruhe and others (1968)
I-1269	29,000	3,500	33,200	Organic carbon from a paleosol	Base of Peoria loess	Ruhe and others (1968)
I-1403	23,900	1,100	28,100	Peat, conifer zone	Base of Peoria loess	Ruhe and others (1968)
I-1406	24,600	1,100	29,000	Organic carbon from a paleosol	Base of Peoria loess	Ruhe and others (1968)
Beta-82839	13,580	60	16,400	Wood (AMS)	Colluvium	Mason and Knox (1997)
Beta-82840	14,090	60	17,200	Wood (AMS)	Colluvium	Mason and Knox (1997)
Beta-82841	14,650	210	17,800	Wood	Colluvium	Mason and Knox (1997)
AA-17777	12,053	111	13,900	Shell (AMS)	Colluvium	Mason and Knox (1997)
AA-17779	16,511	125	19,900	Shell (AMS)	Colluvium	Mason and Knox (1997)
AA-17780	13,308	98	16,000	Shell (AMS)	Colluvium	Mason and Knox (1997)
AA-17781	14,388	105	17,500	Shell	Colluvium	Mason and Knox (1997)
AA-17783	12,735	94	15,200	Shell (AMS)	Colluvium	Mason and Knox (1997)
AA-17784	15,737	225	19,100	Shell (AMS)	Colluvium	Mason and Knox (1997)
AA-17787	15,963	136	19,300	Shell (AMS)	Colluvium	Mason and Knox (1997)