PLEISTOCENE GEOLOGY OF WOOD COUNTY, WISCONSIN

Lee Clayton
1991

Information Circular 68
Wisconsin Geological and Natural History Survey

PLEISTOCENE GEOLOGY OF WOOD COUNTY, WISCONSIN

Lee Clayton
1991

A description of the geologic material underlying the surface soil and overlying the Precambrian and Cambrian rock of one of Wisconsin's central counties.

Information Circular 68
Wisconsin Geological and Natural History Survey

Published by and available from

UWEX University of Wisconsin–Extension
Geological and Natural History Survey
Ronald Hennings, Acting Director and State Geologist
3817 Mineral Point Road, Madison, Wisconsin 53705

1991

ISSN: 0512-0640

UW-Extension provides equal opportunities in employment and programming, including Title IX requirements.

PLEISTOCENE GEOLOGY OF WOOD COUNTY, WISCONSIN

Lee Clayton

ABSTRACT

Wood County, in central Wisconsin, contains Precambrian igneous and metamorphic rock, Cambrian sandstone, and a variety of Pleistocene material. The southern part of the county is the flat plain of glacial Lake Wisconsin, which is underlain by offshore sand that thickens to the east; the northwest part of the county is underlain by thick glacial sediment deposited before the Wisconsin Glaciation. Much of the rest of the county is underlain by Cambrian sand and sandstone, but outcrops of the underlying Precambrian rock are abundant; although this area has been glaciated, Pleistocene material generally consists of a surface layer of hillslope deposits containing only scattered fragments of glacially transported material.

Much of the Pleistocene material in the northern and central part of the county is included in the Edgar Member of the Marathon Formation. The Edgar Member contains till deposited during three separate glacial advances. The first two occurred during the Milan Phase of glaciation, and the third occurred during the Marshfield Phase, when the Marshfield moraine was formed in the northwest part of the county. Much of the Edgar till has been removed by erosion.

During the Nasonville Phase of glaciation, the till of the Bakerville Member of the Lincoln Formation was deposited. Bakerville till has been well preserved only on the highest part of the Marshfield moraine.

During the Wisconsin Glaciation, the Green Bay Lobe of the Laurentide Ice Sheet overrode the east end of the Baraboo Hills south of Wood County. The glacier did not reach Wood County, but it dammed proglacial Lake Wisconsin, the northern part of which covered southern Wood County. During that time, the lake discharged northwestward through a series of outlets to the East Fork Black River in the southwest part of Wood County. Permafrost existed in the area during the Wisconsin Glaciation, until after Lake Wisconsin drained. The permafrost intensified hillslope erosion, resulting in the poor preservation of Lake Wisconsin beaches.

INTRODUCTION

This report emphasizes Wood County's Pleistocene sediment (fig. 1), which underlies the surface soil and overlies the Precambrian and Cambrian rock and sediment. The surface soil to a depth of about 1.5 m has been described by Bartelme (1977).

Wood County consists of three geologically different areas (plate 1). The southern third of the county is the flat plain of glacial Lake Wisconsin. Most of the plain is underlain by offshore sand, which is thickest in the east. In many places one or more beds of offshore silt and clay occur in the sand at a depth of several metres or tens of metres. The water table is near the surface in the western half of the lake plain, and peat overlies the sand in many places. The water table is well below the surface in most of the eastern half of the lake plain, which is bisected by the trench of the Wisconsin River. The middle third and northeastern part of the county have undulating topography underlain in many areas by thin Cambrian sand and sandstone; other areas are underlain by Precambrian metamorphic and igneous rock. Although this area has been glaciated, Pleistocene material generally consists of a surface layer of hillslope deposits containing only scattered fragments of glacially transported material. The northwestern part of the county has undulating topography underlain by thick glacial sediment deposited before the Wisconsin Glaciation.

This report is based on several weeks of field work conducted during the summer of 1985. Twenty-five test holes were augered to depths of 3 to 25 m, and samples were analyzed in the Pleistocene laboratory of the Department of Geology and Geophysics of the University of Wisconsin in Madison. Contacts on plate 1 were drawn using aerial photograph stereopairs (scale 1:20,000) that were taken in 1960 for the U.S. Department of Agriculture and U.S. Geological Survey topographic maps (scale 1:24,000). Additional lithologic information was obtained from soil maps (scale 1:20,000) (Bartelme, 1977); from township reports, land-classification reports and notebooks, and well constructor's reports in the files of the Wisconsin Geological and Natural History Survey (WGNHS); from logs of wells drilled for the Wisconsin Conservation Department Emergency Conservation Work Water Table Survey (Forest Protection Division CCC Ground Water Survey) summarized by Harloff (1942); and from logs of test holes augered by Brownell (1986). All ground-penetrating-radar profiles mentioned in this report were run by James A. Doolittle, U.S. Department of Agriculture, Soil Conservation Service, on September 18, 1985.

In this report, general locations are based on the public-land survey (section, township, range), but more precise locations are given using Universal Transverse Mercator (UTM) coordinates. UTM grid lines appear on plate 1 of this report, on all U.S. Geological Survey topographic maps published at a scale of 1:100,000, and on all U.S. Geological Survey topographic maps published at a scale of 1:24,000 after 1974. In addition, UTM grid tick marks occur on all topographic maps published at a scale of 1:24,000 between 1957 and 1974. All UTM coordinates given here are based on North American Datum 1927 (NAD 27).

I acknowledge the helpful suggestions made by Mark Johnson, Jim Brownell, and John Attig, who reviewed the manuscript of this report. I thank the Lewer family for permitting access to their gravel pit east of Marshfield.

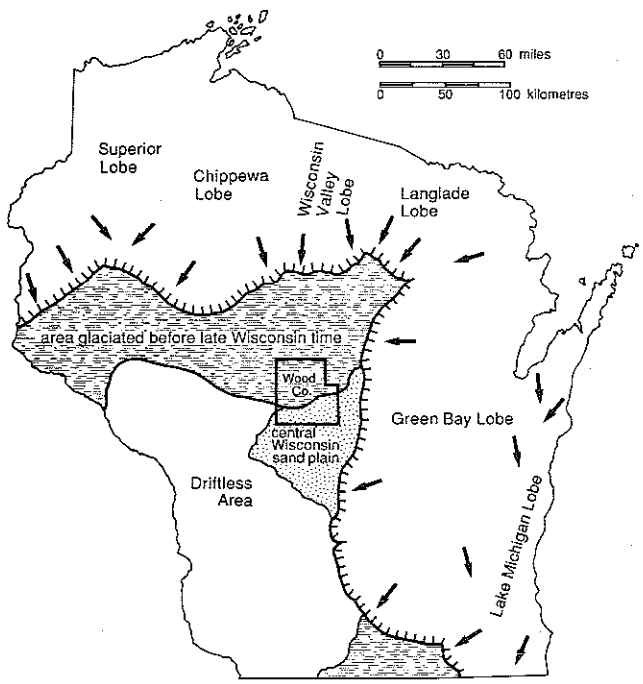


Figure 1 Location of Wood County, showing the lobes of the Laurentide Ice Sheet during the Wisconsin Glaciation. Arrows indicate direction of ice movement.

PREGLACIAL GEOLOGY

The Precambrian and Cambrian geology of Wood County has been mapped by Brown and Greenberg (1986). Precambrian rock crops out in valley bottoms and on some prominent hills like Powers Bluff in the central and west-central part of the county and in much of the northeastern part of the county (map unit **hp**, plate 1). In Wood County, Precambrian rock consists of intrusive igneous rock in many places, extrusive igneous rock in the northeastern part, some gneiss near Pittsville and along the Wisconsin River, and quartzite and associated metasedimentary rock at Powers Bluff and several other places in the county.

Most outcrops of the Cambrian Elk Mound Group are in the central part of the county (map units **hl** and **hu**, plate 1). The Elk Mound is typically several metres thick; maximum thickness in the county is probably about 56 m in Lindsey Bluffs (T24N, R2E). It consists primarily of quartz sand and sandstone, with some pebbly zones and a few clay and silt beds near the base. The lowermost 20 m (map unit hl) is typically poorly lithified and poorly exposed, with undulating to rolling topography. The upper part (map unit **hu**) is better lithified and forms steeper slopes and cliffs, as at Lindsey Bluffs; the unnamed hills in sec. 13, T23N, R6E; Birch Bluff in sec. 18 and 19, T21N, R2E; and South Bluff in sec. 25 and 26, T21N, R2E.

Rock younger than the Elk Mound Group was deposited in the area but has been removed completely by erosion. Pebbles and cobbles of chert from the Ordovician Oneota Formation litter the surface in many parts of the county, but little evidence is available for much of later geologic history. Pebbles and cobbles of quartzose rock similar to that of the Cretaceous or early Cenozoic Windrow Formation are scattered on the surface of much of the county; no outcrops of the Windrow are known, but its type section is 40 km southwest of Wood County (Thwaites and Twenhofel, 1921).

Event	Time	Lithostratigraphic unit		
Wisconsin Glaciation	Late Pleistocene	Big Flats Formation	Mapleview Member	Horicon Formation
			New Rome Member	
Hamburg Phase	?—?—?	Merrill Member		Lincoln Formation
Arnott Phase	Middle Pleistocene	Keene Member		Horicon Formation
—?—?—?—				
Nasonville Phase		Bakerville Member		Lincoln Formation
	?—?—?			
Marshfield Phase	Early Pleistocene	upper	Edgar Member	Marathon Formation
Milan Phase		middle		
		lower		
Stetsonville Phase	?—?—?	Medford Member		
earlier glacial phases	Late Pliocene			

Figure 2 Ice Age events and related lithostratigraphic units in Wood County and adjacent areas.

PRE-MILAN PHASES

During the Stetsonville Phase, which occurred before the Milan Phase, a glacier reached nearby Marathon County and deposited the till of the Medford Member of the Marathon Formation (fig. 2; Attig and Muldoon, 1989). The time of the Stetsonville Phase is unknown but it probably occurred during the Late Pliocene or Early Pleistocene Age (Attig and Muldoon, 1989). Evidence of a possible pre-Stetsonville glaciation exists in Marathon County (Mode, 1976; LaBerge and Myers, 1983; Attig and Muldoon, 1989). It seems likely that pre-Milan glaciers reached Wood County, but no evidence for these Early Pleistocene or Late Pliocene glaciations is known. The Milan Phase was the first Ice Age event to leave considerable evidence in Wood County.

MILAN PHASE

The Milan Phase has been defined in Marathon County by Attig and Muldoon (1989) to include the glacial events responsible for deposition of the till of the two lower subdivisions of the Edgar Member of the Marathon Formation.

Edgar Member

The Edgar Member of the Marathon Formation occurs throughout northwestern Wood County (map unit **ge**, plate 1). It was named for the village of Edgar in Marathon County (Mode, 1976; Mickelson and others, 1984, p. A2-3 to A2-5). The Edgar Member is composed largely of silty calcareous till containing material that was derived from the northwest.

Hole (1943, p. 506-507) found that the till was about 20 percent by weight calcium-carbonate equivalent in 19 sets of samples collected between Blenker, in northeastern Wood County, and the northwestern corner of Wood County. In one sample, he determined that the carbonate was 80 percent calcium carbonate. Using a staining test, Hole determined that 90 percent of the 2-to-4-mm carbonate grains in till in the Marshfield area were calcium carbonate (calcite). Mode (1967) found limestone, but no dolomite, in the coarse-sand fraction of Edgar till. Results of field tests of several dozen bulk samples with dilute hydrochloric acid during the course of this study agreed with Hole's and Mode's observations: my bulk samples of Edgar till contained considerable calcite. Analysis of the coarse-silt fraction of 30 unleached samples by the Pleistocene laboratory of the Department of Geology and Geophysics of the University of Wisconsin in Madison (using the Chittick method) showed that calcite is negligible (typically reported to be around 1 percent, which is near the limit of resolution for the method), and dolomite was typically 5 to 15 percent in this fraction.

Hole (1943, p. 507) and Mode (1976, p. 46) reported limestone fragments containing Paleozoic fossils in Edgar till. In addition, fossiliferous pebbles that look like porous limestone but are composed of siliceous material occur in Edgar till and associated fluvial gravel that have been leached of carbonates.

According to Hole (1943, fig. 2, p. 510), the Edgar till typically has been leached of carbonates to a depth of about 1 m. Information from various sources indicate that maximum leaching depths are more than 5 m, especially where underlying sand or gravel provides a good underdrain.

The pebbles, cobbles, and boulders in the Edgar Member consist of a variety of rock types. In addition to the limestone mentioned above, igneous and metamorphic rock types are especially abundant.

Edgar till in northern Wood County typically has a few percent gravel-sized particles (larger than 2 mm), 20 to 55 percent sand-sized particles (0.063 to 2 mm), 30 to 45 percent silt-sized particles (0.002 to 0.063 mm), and 10 to 35 percent clay-sized particles (smaller than 0.002 mm) (fig. 3).

The till of the Edgar Member in northern Wood County is typically brown or dark brown (7.5YR 4/3 on the Munsell scale, with a range of 10YR to 5YR 3 to 5/2 to 4, on the basis of 50 moist samples). The magnetic susceptibility of the till is typically 0.2 to 5×10^{-3} (SI units) (figs. 4 and 5).

Fluvial sand and gravel occurs between the till of the Edgar Member and the till of the overlying Bakerville Member in the Marshfield moraine (described below). It contains some limestone pebbles and is therefore considered to be part of the Edgar Member (see plate 2). Similarly, the sand and gravel under the Edgar till exposed in gravel pits in the SW1/4 NW1/4 sec. 2, T25N, R3E, 2 km northeast of Marshfield, contains pebbles that were once limestone but have been leached, leaving porous silica; therefore, this sand and gravel is also considered to be part of the Edgar Member. In addition, offshore silt and clay and some organic clay are associated with the Edgar till in some drillholes.

The Edgar Member is at or near the land surface in much of northern Wood County. In these areas it is overlain by no more than a few metres of windblown silt or hillslope deposits. The Edgar Member lies on Cambrian and Precambrian rock in most places, but there may be intervening hillslope sediment and perhaps till in a few places (fig. 4).

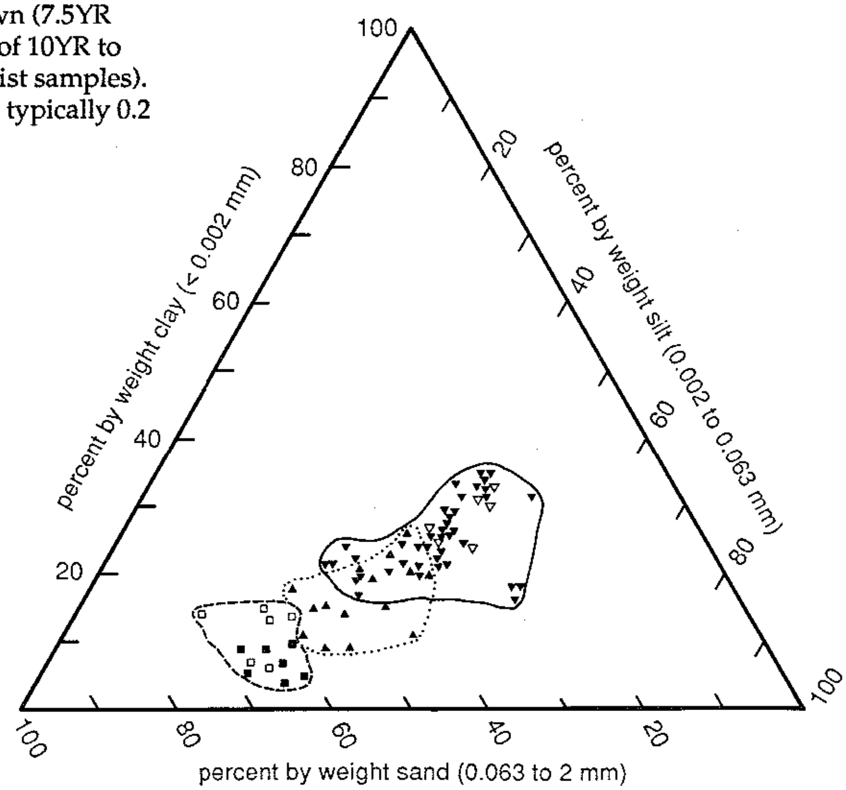


Figure 3 Grain-size analyses of the smaller-than-2-mm fraction of till of the lower and middle Edgar Member (triangles pointing down, surrounded by solid line), upper Edgar Member (triangles pointing up, surrounded by dotted line), and Bakerville Member (squares, surrounded by dashed line). Open symbols indicate analyses of samples from Wood County by Mode (1976); solid symbols, analyses from this study.

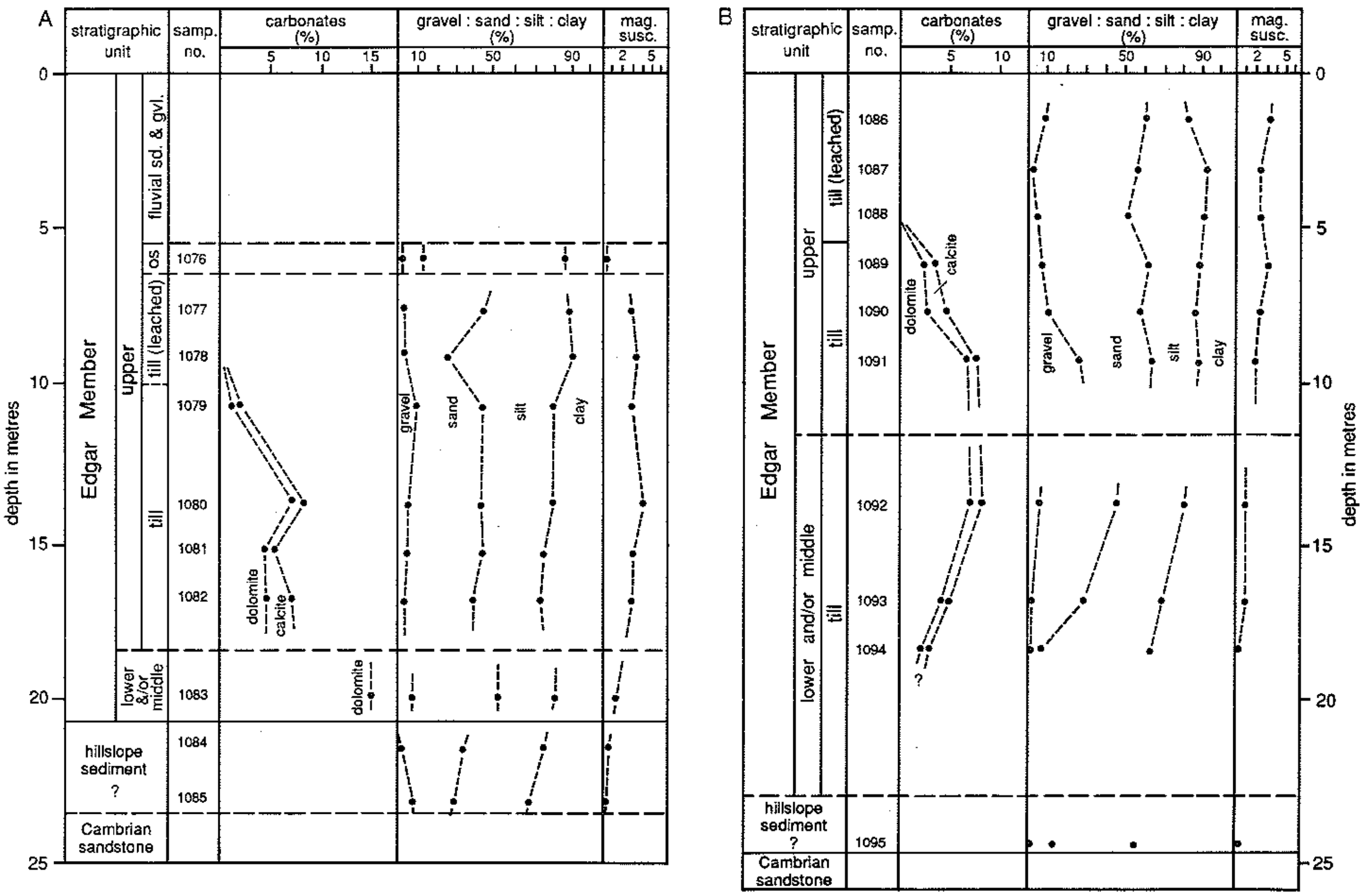


Figure 4 The Edgar Member in the Marshfield moraine. A : at UTM coordinates 718,200mE, 4,943,500mN, 1.8 km north-northeast of Nasonville; os is offshore sediment. B : at UTM coordinates 721,300mE, 4,943,500mN, 1.8 km north-northeast of Bakerville. Magnetic susceptibility times 10^{-3} in SI units.

Edgar till once covered central Wood County, but much has been removed by erosion, leaving only small outliers on stream divides (plate 1). These outliers of till are commonly only a few metres thick. In north-central and northwestern Wood County the large remnants of Edgar till (plate 1) are typically 5 to 10 m thick; in the Marshfield moraine the till is commonly 20 to 30 m thick (cross-section unit ge, plate 2). The southeastern extent of Edgar till in Wood County is suggested by the distribution of map unit ge on plate 1. Edgar till also occurs throughout the western third of Marathon County (Attig and Muldoon, 1989), southeastern Taylor County, and eastern Clark County; its westward extent is unknown.

The Edgar Member is distinguishable from most other stratigraphic units in the region by the abundance of silt and limestone in the till. The till of the Bakerville Member has no limestone, is sandier (fig. 3) and redder, and contains fewer stones of light-colored igneous rock types than Edgar till. The till of the Medford Member in Marathon County is silty and calcareous but is grayer and contains more abundant shale fragments and more smectite (Attig and Muldoon, 1989).

In parts of Marathon County the Edgar Member has two subdivisions (fig. 2); two till units are separated by a layer of offshore silt and clay, stream sand and gravel, or organic sediment (Attig and Muldoon, 1989). Where this layer is absent, these subdivisions are indistinguishable. Two similar subdivisions can also be recognized in a few places in Wood County. In addition, a third subdivision, not recognized in Marathon County, occurs above

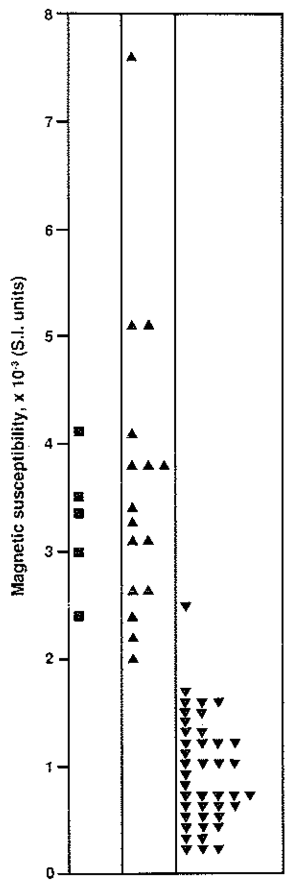


Figure 5 Magnetic susceptibility of the fraction smaller than 2 mm of till of the lower and middle Edgar Member (triangles pointing down), upper Edgar Member (triangles pointing up), and Bakerville Member (squares).

the two just mentioned. The upper subdivision of the Edgar Member in the Marshfield moraine contains till with magnetic susceptibility greater than 2 x 10^{-3}; the lower two subdivisions have till with values less than 2 x 10^{-3} (fig. 5).

Direction of glacial movement

Several lines of evidence indicate that the Milan glacier moved toward the southeast in Wood County. Weidman (1907, p. 444-445) recognized the Powers Bluff chert fan and interpreted it to show that the last glacier (probably the Milan) in central Wood County moved S45°E. Powers Bluff, in S1/2 sec. 30, T24N, R4E, is a prominent hill rising 60 m above the surrounding countryside. It consists of Precambrian (Early Proterozoic) quartzite with a central peak composed of chert (Brown and Greenberg, 1986). The chert fan consists of scattered angular pebbles, cobbles, and boulders of polished, sand-blasted, pinkish-gray chert. The sides of the fan are at an angle of about 35° with each other; the apex is at Powers Bluff. Along the central axis of the fan (plate 1) for 20 km southeast of Powers Bluff, as much as 90 percent of the pebbles, cobbles, and boulders on the land surface are Powers Bluff chert; the chert is less abundant toward the sides of the fan. It seems likely that the Powers Bluff chert fan was formed during the last glaciation in this area and that the last ice moved over central Wood County during the Milan Phase.

Similar boulder fans in Marathon County (LaBerge and Myers, 1983; Attig and Muldoon, 1989), such as the one southeast of Rib Mountain, may also indicate glacial movement to the southeast during the Milan Phase.

Pebble orientation in an exposure of one of the lower two subdivisions of the Edgar till in west-central Marathon County indicates that the ice moved south-southeasterly during the Milan Phase (Mode, 1976, p. 46).

Fragments of limestone in the Edgar till may provide information about the path of the Milan glacier. Hole (1943) reported one small piece of a crinoid stem from Edgar till. Mode (1976, p. 46) reported a pebble with Paleozoic crinoid and bryozoan fragments in Edgar till. M.E. Ostrom (WGNHS, verbal communication, 1987) identified the Silurian tabulate coral *Favosites favosus* and an Ordovician, Silurian, or Devonian rugose coral, *Streptelasma sp.*, in pebbles of silicified limestone from Edgar meltwater-stream sediment under the lower Edgar till in gravel pits in the SW1/4 NW1/4 sec. 2, T25N, R3E. The nearest Silurian carbonates to the northwest are 800 km away, in Manitoba (Goddard and others, 1965). Till with Manitoba rock has been previously identified as far southeast as Dunn County, in west-central Wisconsin (Mickelson and others, 1984, p. A4-3).

Extent of the Milan glacier

The southeastern extent of the glacier during the Milan Phase is assumed to have been beyond the southeastern extent of the Edgar till (map unit ge, plate 1), near the northern limit of the plain of Lake Wisconsin. However, only the large areas of Edgar till in northern Wood County have been identified with much confidence; those shown in the central part of the county on plate 1 could be older. If the

Powers Bluff chert fan was formed during the Milan Phase, the Milan glacier must have advanced at least as far as Wisconsin Rapids.

On the basis of an absence of glacially transported material in those areas, Weidman (1907, plate 2) concluded that the southern tier of townships in Wood County as well as R6E and the east half of R5E had never been glaciated. Clayton (1986, p. 4) noted that there was little evidence for glaciation in northwestern Portage County. In Wood County I noted several places (such as quarries, roadcuts, and fields) that seemed to totally lack glacial material, yet these areas are surrounded by areas with abundant glacial material. The unpublished township reports and land-classification field books in the WGNHS files contain comments on the lack of glacial material on Cary Mounds (northeastern part of T23N, R2E), Powers Bluff (sec. 30, T24N, R4E), and adjacent areas, which were consequently interpreted to have been unglaciated. However, these low hills were certainly glaciated if the ice margin advanced as far as Wisconsin Rapids. It is apparent that postglacial erosion removed evidence of glaciation over large areas, including Cary Mounds and Powers Bluff. It is therefore unlikely that the outer extent of the glacier during the Milan Phase will ever be known with much precision, and the outer extent of earlier glaciers will be even more difficult to locate.

Chronology

The Milan Phase occurred before the Marshfield, Nasonville, and Hamburg Phases and also well before the Wisconsin Glaciation, but probably during the Pleistocene Epoch. The exact time of the glaciation is unknown.

Hole (1943, p. 509-512) argued that the Edgar till was deposited during the Wisconsin Glaciation because the soils developed on the Edgar till are no more highly developed than those on till deposited during the Wisconsin Glaciation. However, it is evident that the Edgar till and the younger Bakerville till have undergone enough erosion to destroy all glacial landforms (with the exception of the gross form of the Marshfield moraine) and to remove much of the glacial material deposited during the Milan Phase. Most of the remaining Edgar till that is now at the land surface has been exposed to soil-forming processes only since the last episode of erosion, probably a period of intense solifluction (soil flowage) during the last glaciation. The presence of a blanket of late Wisconsin windblown silt on most flat areas or gentle slopes indicates that little erosion has occurred since late Wisconsin time. Therefore, much of the till deposited during the Milan Phase and the till deposited during the Wisconsin Glaciation have been exposed to soil-forming processes for about the same length of time.

MARSHFIELD PHASE

The term *Marshfield moraine* was applied by Weidman (1907, p. 452-455, plates 2 and 50) to a ridge extending from a few kilometres north of Marshfield to Marshfield, Bakerville, and Nasonville, and westward to Neillsville. Although not named on plate 1, the Marshfield moraine occupies an area slightly wider than that shown by map unit **gb** (Bakerville Member). The term *Marshfield Phase* (fig. 2) is used here to indicate the glacial event responsible for the deposition of the upper subdivision of the Edgar Member in the Marshfield moraine; Weidman's (1907, p. 465) description of the till of the Marshfield moraine was probably based on an exposure of the upper subdivision in a railroad cut in the northern part of Marshfield.

The Marshfield moraine is typically 15 to 40 m high and 1 to 2 km wide. In Wood County, the Pleistocene material in the ridge is commonly about 30 m thick, with a maximum thickness of about 60 m; Pleistocene material is commonly zero to 10 m thick on either side of the ridge (Weidman, 1907, plate 50; Bell and Sherrill, 1974, plate 3).

The bulk of the moraine probably consists of till of the upper subdivision of the Edgar Member. Total thickness of the Edgar is typically 30 to 50 m (plate 2). This includes several metres of sand and gravel above the upper Edgar till (cross-section unit **se**, plate 2). This sand and gravel is present in most of the moraine in Wood County southwest of Marshfield, where it is exposed in numerous borrow pits. The outcrop area of the sand and gravel is marked by a steepening of the hillslope, which is indicated on plate 1 by a solid-line contact between map units **ge** and **gb**. Over the sand and gravel is several metres of Bakerville till (map unit **gb**), described in the section of this report about the Nasonville Phase. Below the till of the upper subdivision of the Edgar Member, two drillholes (fig. 4) indicated 5 or 10 m of till of the lower or middle subdivision.

Weidman's (1907) interpretation of the Marshfield moraine has been questioned. The ridge might, for example, be a preglacial drainage divide only thinly blanketed with till (Hole, 1943, p. 502). However, abundant water-well logs indicated that in Wood County the ridge is made up largely of till and associated meltwater-stream deposits, not sandstone. The till ridge might also be interpreted to be an erosional remnant of a formerly more extensive layer of thick till. However, this seems unlikely because the Yellow River (south of Marshfield) and the Little Eau Pleine River (north of Marshfield) pass through gaps less than 1 km wide in the ridge; upstream from the gaps are basins several kilometres wide, with elevations well below the crest of the ridge (the basin north of Marshfield is occupied by McMillan Marsh). Any process capable of eroding thick till from these basins would also have removed more of the ridge than just the narrow gaps occupied by the rivers.

It therefore seems most likely that the ridge at Marshfield is a moraine. If so, it may represent the farthest advance of the glacier during the Marshfield Phase because the upper subdivision of the Edgar Member has not been identified southeast of the moraine. Mode (1976, p. 53) thought the moraine at Marshfield was formed by the ice that deposited the Bakerville till during the Nasonville Phase. However, on the basis of the difference in elevation between the sand and gravel at the top of the Edgar Member and the crest of the ridge, the Bakerville till is generally thinner than about 15 m; the upper Edgar till is typically thicker, which makes it seem more likely that this moraine was formed during the Marshfield Phase rather than during the Nasonville Phase. However, the Bakerville till has not been positively identified southeast of the ridge, and the Bakerville till in the ridge is thicker and more continuous than behind the ridge, suggesting that a moraine formed during the Nasonville Phase has been superimposed upon one formed during the Marshfield Phase.

NASONVILLE PHASE

The Nasonville Phase is here named for Nasonville in northwestern Wood County (plate 1) and defined as the event that was responsible for the deposition of the till of the Bakerville Member of the Lincoln Formation (fig. 2). The Bakerville Member will first be described here, and then interpretations of various aspects of the Nasonville Phase will be discussed.

Bakerville Member

The Bakerville Member occurs on the crest of the Marshfield moraine in northwestern Wood County (map unit **gb**, plate 1). It was named for Bakerville, 5 km northeast of Nasonville, in northwestern Wood County (Mickelson and others, 1984, p. A3-1 to A3-3).

The type section is a gravel pit in the SE1/4 NW1/4 NW1/4 sec. 26, T25N, R2E, on the east side of Robin Road, 1.4 km west-southwest of Bakerville. The material being mined is Edgar sand and gravel under the Bakerville till. Several metres of Bakerville till is well exposed all around the sides of the pit.

On the basis of analyses of 13 samples of till from the Marshfield moraine (fig. 3), the till of the Bakerville Member consists of roughly 10 percent gravel-sized particles (larger than 2 mm), 50 to 60 percent sand-sized particles (0.063 to 2 mm), 20 to 30 percent silt-sized particles (0.002 to 0.063 mm), and 5 to 15 percent clay-sized particles (smaller than 0.002 mm).

Bakerville till is typically reddish brown (5YR 4/4 on the Munsell scale). On the basis of analysis of seven samples, the magnetic susceptibility of the till is between 2×10^{-3} and 6×10^{-3} (SI units; fig. 5). No carbonates have been detected in the Bakerville till. Pebbles, cobbles, and boulders in the till consist of a variety of igneous and metamorphic rock types.

At most places where the base of the Bakerville Member was seen on the Marshfield moraine, the contact is sharp and rests on sand and gravel that is considered to be part of the Edgar Member because of the presence of limestone pebbles. The thickness of the Bakerville Member ranges from zero at the contact shown between map units **gb** and **ge** on plate 1 to as much as 15 m under the highest parts of the Marshfield moraine. In most places the Bakerville Member is overlain by no more than a few metres of hillslope sediment and windblown silt.

The type area of the Bakerville Member is the Marshfield moraine (map unit **gb**, plate 1). Bakerville till has been tentatively identified in only a few places behind the moraine, but it is possible that it has been confused with leached upper Edgar till. The Bakerville till is redder and sandier (fig. 3) than the Edgar till, but there may be some overlap. The Bakerville till has greater magnetic susceptibility than the till of the lower two subdivisions of the Edgar, but it is nearly the same as that of the upper subdivision of the Edgar in the Marshfield moraine. The Bakerville is noncalcareous and the Edgar is calcareous, except where leached. The Bakerville till contains less light-colored igneous rock than the Edgar till. Mode (1976, p. 32 and 52) recognized some differences in the composition of the clay and coarse-sand fractions.

Direction of glacial movement

If the ridge at Marshfield represents a Nasonville moraine on a Marshfield moraine, as suggested above, the Nasonville glacier moved into Wood County toward the southeast. This is in agreement with measurements of the orientation of pebbles in Bakerville till (Mode, 1976, p. 53), which indicate east-southeast movement north of Marshfield and southeast movement southwest of Marshfield. This is the same general direction in which the Milan and Marshfield glaciers moved into Wood County. The presence of limestone in Milan and Marshfield till and absence of it in Nasonville till, however, indicate different flow paths northwest of Wood County.

Chronology

The exact time of the Nasonville Phase is unknown, but it probably occurred in the Middle Pleistocene, before the Hamburg Phase, which occurred before or during the early part of the Wisconsin Glaciation. According to Attig and Muldoon (1989), the Hamburg glacier formed a moraine in northern Marathon County that still retains some of its original hummocky glacial topography. In contrast, the original hummocky topography of the Nasonville till has been removed by erosion; the small patches of hummocky topography shown on plate 1 northwest of and southeast of the Marshfield moraine (but not on it) might be glacial topography but are probably the result of wind erosion.

ARNOTT AND HAMBURG PHASES

A moraine was formed in central Portage County during the Arnott Phase, well before the last part of the Wisconsin Glaciation, and probably before the first part of it as well (Clayton, 1986, p. 6). The relationship between the Arnott and the Nasonville Phases is unknown (fig. 2). The Arnott Phase probably occurred before the Hamburg Phase because the Arnott moraine lacks hummocky topography, which is present on the till deposited during the Hamburg Phase, and the Arnott till (of the Keene Member of the Horicon Formation) seems to be weathered much more deeply than the Hamburg till.

The Arnott moraine is parallel to the outer moraine formed during the last part of the Wisconsin Glaciation in Portage County. This suggests the possibility that the Arnott glacier, like the late Wisconsin glacier, reached the Baraboo Hills, damming an early version of Lake Wisconsin in the Wisconsin River valley. Some of the more deeply buried lake sediment in southeastern Wood County may have been deposited at that time.

The Hamburg Phase has been defined by Attig and Muldoon (1989) to include the event responsible for the till of the Merrill Member of the Lincoln Formation in northern Marathon County. The Hamburg Phase probably occurred during the Late Pleistocene Age, but the exact time is unknown. Mode (1976, p. 66) thought that it occurred before the last part of Wisconsin time because the Merrill till is overlain by organic silt and clay radiocarbon dated 40,800 $\pm$ 2000 BP (ISGS-256) and older than 36,800 BP (ISGS-262). Attig and Muldoon (1989) suggested that it may be equivalent to the early part of the Wisconsin Glaciation or that it occurred not long before the Wisconsin Glaciation because hummocky glacial topography has not yet been destroyed in some places. The Hamburg glacier did not extend into Wood County, but solifluction debris may have been deposited at this time, as it was during the Wisconsin Glaciation.

SOIL-FORMING INTERVALS

Although the Edgar till has been leached of carbonates to a depth of only 1 m in many areas, there is some evidence of well developed soils on the younger Bakerville till. It seems likely that there would have been soil-forming intervals between each of the glacial phases mentioned above, but it is also evident that there was extensive soil erosion during each of these phases. It is likely that paleosols would have been preserved in only well protected locations. The paleosols of central Wisconsin are too poorly known to sort out the various soil-forming episodes, and evidence of soil formation generally cannot be confidently assigned to any particular interglacial period. In a few places, illuvial clay was observed to extend to depths of 2 or 3 m, for example, in Edgar till in the gravel pit in the SW1/4 NW1/4 sec. 2, T25N, R3W and in some of the gravel pits on the Marshfield moraine.

Bartelme (1977) has mapped the Withee soil series on the Edgar and the Bakerville till, even where the two members are lithologically very distinct. It seems likely that the Bakerville till that is high on the Marshfield moraine and has an extensive underdrain underwent intense soil formation during interglacial intervals; in contrast, low-lying Edgar till that lacks an underdrain was only slightly leached of carbonates. The same soil series has been mapped on the two different tills, perhaps because the modern soil on the Bakerville till in many places is actually developed in a paleosol with enough pedogenic clay to produce a soil texture similar to that of the Edgar till.

WISCONSIN GLACIATION

No direct evidence for the early part of the Wisconsin Glaciation has been found in this region, but the last part, from about 25,000 to 10,000 BP, is well documented in central Wisconsin, where the Green Bay Lobe of the Laurentide Ice Sheet flowed to within 20 km of the eastern border of Wood County. In Wood County, this interval was marked by the deposition of hillslope, lake, windblown, and stream sediment west of the Green Bay Lobe.

Hillslope sediment

Map units **hp** and **hl** on plate 1 indicate the distribution of hillslope deposits on Precambrian and Cambrian material in Wood County. Hillslope deposits also occur on the till of map units **ge** and **gb**, but they are more poorly known because they are commonly difficult to distinguish from the underlying till and washed supraglacial debris.

Hillslope debris occurs on most Precambrian rock in Wood County (map unit **hp**, plate 1); it is lacking mainly in valley bottoms where it has been eroded away by modern rivers, on steep slopes, and in quarries. This material was first described in detail by Weidman (1907, p. 552-563). Judging from soil descriptions (Bartelme, 1977), several auger holes, a few dozen outcrops, and numerous water-well logs, this material is generally more than 1 m thick, is typically 3 or 4 m thick, and is generally less than 6 m thick, although the maximum may be around 15 m.

On the basis of the analysis of 18 samples, the hillslope deposits on Precambrian rock in Wood County commonly consist of zero to 5 percent gravel-sized particles (coarser than 2 mm), 20 to 35 percent sand-sized particles (0.06 to 2 mm), 30 to 50 percent silt-sized particles (0.002 to 0.06 mm), and 20 to 40 percent clay-sized particles (finer than 0.002 mm). The soil-substratum descriptions of Bartelme (1977) indicate that these deposits may have much more than 5 percent gravel in some places.

The gravel particles consist of several different rock types. Angular pebbles, cobbles, and boulders of the underlying igneous or metamorphic rock are by far the most common. In most areas shown as map unit **hp** on plate 1, farmers' boulder piles consist largely of local rock types. In many areas the hillslope deposits also include angular to rounded pebbles, cobbles, and boulders of various quartzose rock types, which are commonly polished by eolian sand blasting. Many of these were derived from the local Precambrian rock or were glacially transported from more distant Precambrian outcrops. Some of the quartzose rock was locally derived from conglomerate at the base of the Cambrian section or was let down by erosion from former occurrences of younger Paleozoic rock, especially chert nodules and beds in the Oneota Formation. In addition, some rounded quartzose pebbles and cobbles were probably originally derived from the Windrow Formation, although no occurrences of the formation are known to remain in Wood County or adjacent counties. The hillslope deposits in many areas also include pebbles, cobbles, and boulders of a variety of nonquartzose rock types glacially transported from regions to the north.

The colors of the hillslope deposits on Precambrian rock in Wood County vary greatly over short distances. On the Munsell scale, colors commonly range from 5Y to 2.5YR 3 to 6/2 to 5, with various shades of brown, gray, red, yellow, and olive. The magnetic susceptibility of the hillslope sediment is generally less than 0.2×10^{-3} (SI units), but it is as great as 1.3×10^{-3} in some samples.

Hillslope sediment occurs on most Cambrian material in Wood County (map unit **hl**, plate 1); it is generally lacking on steeper slopes (map unit **hu**, plate 1). Judging from soil descriptions (Bartelme, 1977) and a few dozen outcrops, it is typically about 0.5 m thick but may be several metres thick in some places, such as the base of steep slopes. It consists largely of quartz sand derived from the underlying Cambrian sand or sandstone. In addition, it generally has 15 percent or more silt and clay (based on 12 size analyses) derived from Pleistocene windblown sediment, Cambrian silt and clay beds, or the weathering products of feldspar in the Cambrian sand and sandstone. In addition, pebbles, cobbles, and boulders are generally present; they are lithologically similar to those in hillslope sediment on Precambrian rock (described in previous paragraphs), except that locally derived igneous and metamorphic rock is absent, and sandstone pebbles are present in some places. The magnetic susceptibility is generally less than 0.2×10^{-3} (SI units), but is as great as 0.5×10^{-3} in some samples.

The hillslope deposits of map units **hp** and **hl** have been interpreted to be residuum by Bartelme (1977). However, as Clayton (1986, p. 3-4) has pointed out, there is considerable evidence of sorting, transport, and mixing. These materials have moved downslope as a result of a variety of processes, including creep, slopewash, and solifluction during periods of tundra climate. (The ice-wedge polygons shown on plate 1 indicate that this area has been subject to a tundra climate.) The hillslope deposits were derived from a variety of materials, including windblown sediment, stream deposits, till, and Precambrian and Cambrian rock, and from soil and residuum derived from these materials.

The hillslope sediment of map units **hp** and **hl** (plate 1) was primarily deposited before the surface blanket of windblown silt, which was deposited near the end of the Wisconsin Glaciation. The hillslope sediment has probably been remobilized many times, especially during periods of permafrost during the Wisconsin and earlier glaciations. The bulk of the hillslope sediment in Wood County, however, was probably deposited during the Wisconsin Glaciation.

Glacial Lake Wisconsin

Glacial Lake Wisconsin formed whenever the Green Bay Lobe of the Laurentide Ice Sheet overrode the east end of the Baraboo Hills. This probably happened several times, but abundant evidence is available for only the last episode of Lake Wisconsin, during the Wisconsin Glaciation. During that time the lake occupied large parts of Juneau and Adams Counties and smaller parts of Wood, Portage, Waushara, Marquette, Columbia, Sauk, Richland, Vernon, Monroe, and Jackson Counties. Much of the following discussion of the offshore sediment, shorelines, and spillways of Lake Wisconsin is derived from work in adjacent areas (Clayton, 1986; 1987; 1989).

Offshore sediment

The offshore sediment of Lake Wisconsin is indicated by map units **oh**, **ow**, **oy**, and **oe** on plate 1; on plate 2, by units **od**, **on**, and **os**.

Map units **oh** and **oe** show areas where offshore sand is found east of the Wisconsin River and was derived from meltwater rivers flowing west from the Green Bay Lobe in Portage and Marathon Counties. This sand has been included in the Mapleview Member of the Horicon Formation by Brownell (1986), who placed the boundary between it and the Big Flats Formation in Adams County near the border between Adams and Wood Counties; it is here arbitrarily placed exactly at the border. According to Brownell, most of it is moderately well sorted, moderately well rounded, medium to coarse sand consisting mostly of quartz, but with several percent dark-colored minerals. Scattered very fine pebbles are commonly present. The offshore sediment originally had some dolomite grains, but they have been largely or totally leached away.

Map unit **ow** (plate 1) shows areas where offshore sand occurs on either side of the Wisconsin River; this sand was derived from meltwater rivers flowing west from the Green Bay Lobe in Langlade County and south from the Langlade and Wisconsin Valley Lobes and then down the Wisconsin River to the north end of Lake Wisconsin. Accord-

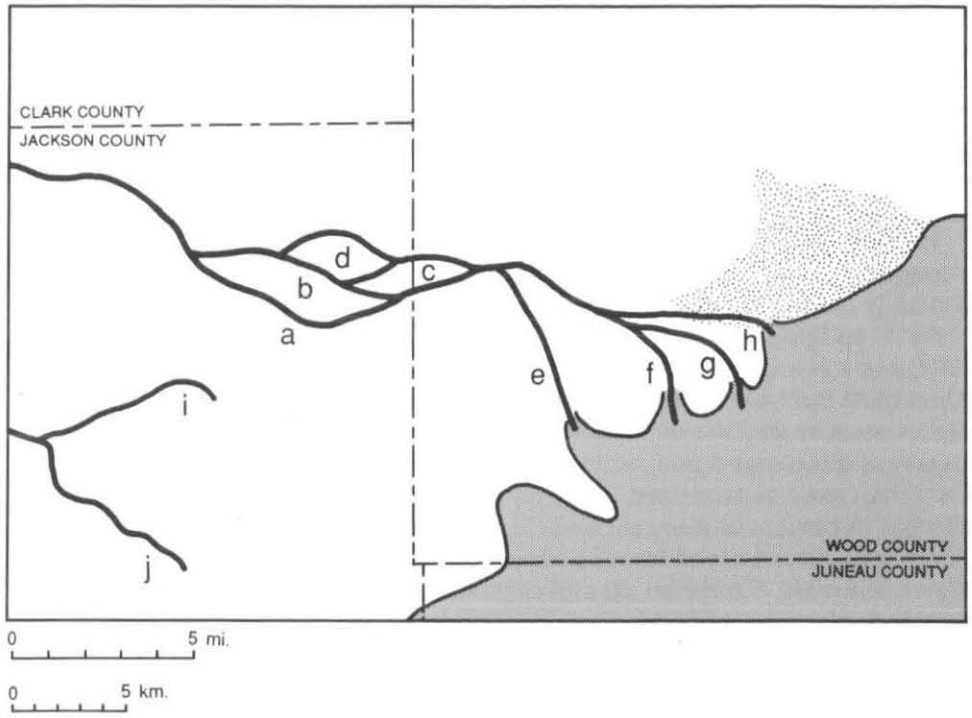


Figure 6 Map of the southwestern quarter of Wood County and adjacent areas, showing outlets of Lake Wisconsin. a: Spaulding outlet. b: East Fork Black River. c: Hay Creek outlet. d: Davidson Creek outlet. e: South Bluff outlet. f: North Bluff outlet. g: West Babcock outlet. h: North Babcock outlet. i: Morrison saddle. j: McKenna saddle. Lake Wisconsin is shown by the screened area; the fan of the Yellow River and Hemlock Creek is shown with dots.

ing to Brownell (1986), most of it is moderately well sorted, moderately well rounded, quartzose, medium to coarse sand, but with considerable dark-colored minerals and no carbonates. Scattered very fine pebbles are commonly present.

Map unit **oy** (plate 1) shows areas where offshore sand occurs in southwestern Wood County, derived from nonmeltwater rivers flowing off the upland to the north. According to Brownell (1986), most of it is moderately to well sorted, well rounded, medium to fine sand consisting largely of quartz, with less than 1 percent dark-colored minerals and no carbonates or pebbles.

Map units **oh**, **ow**, and **oy** (plate 1) show materials that have been differentiated partly by the slight differences in lithology mentioned in the previous paragraphs. They have also been differentiated by their geologic setting, including their topography and position with respect to possible source areas.

Map unit **oh** shows areas where sand occurs at the surface, but in most places the sand is underlain at a depth of 5 to 10 m by silt of the New Rome Member of the Horicon Formation (cross-section unit **od**, plate 2). A silt bed occurring at a similar depth in map units **ow** and **oy** has been correlated with the New Rome Member by Brownell (1986). According to him, the New Rome Member throughout the Lake Wisconsin basin typically consists of about 25 percent sand-sized (0.63 to 2 mm) grains, 50 percent silt-sized (0.002 to 0.063 mm) grains, and 25 percent clay-sized (smaller than 0.002 mm) grains. It is typically thinly laminated, in places rhythmically laminated, and it is reddish brown, brown, or gray. Brownell's (1986) analysis of samples indicated that about 20 percent of the coarse silt is dolomite. In many parts of southern Wood County the New Rome Member is about 1 m thick, but it is absent in some places and is more than 3 m thick in a few places.

In a few places, logs of water wells indicated an additional one or two beds of silt below the New Rome Member. Little is known about these older silt beds; the locations of some are shown on the cross sections (plate 2).

Shore sediment

Beach ridges and shore bluffs of Lake Wisconsin have not been preserved, probably because of the great amount of solifluction and wind erosion that took place after Lake Wisconsin drained. Shore sediment has been noted in a few places, however.

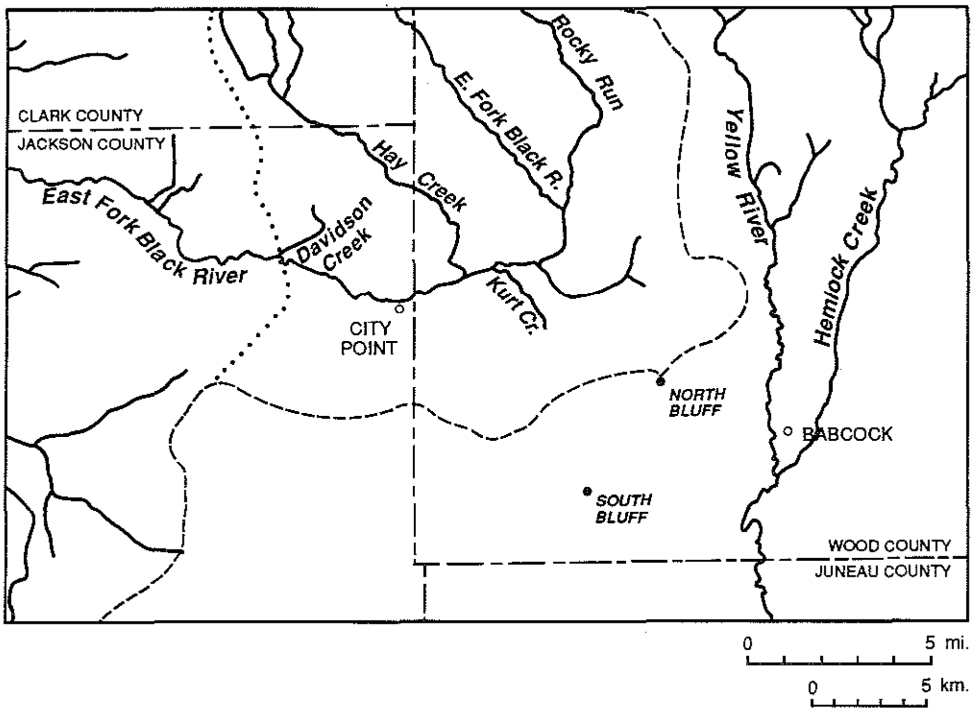


Figure 7 Map of the southwestern quarter of Wood County and adjacent areas, showing the present rivers in the area of the outlets of Lake Wisconsin. Dashed line is the present drainage divide between the Black River and the Yellow River basins. Dotted line is location of the divide before the time of Lake Wisconsin, when Hay Creek, the headwaters of East Fork Black River, and Rocky Run were tributaries to the Yellow River. From U.S. Geological Survey 1:250,000 topographic map.

One large deposit of beach gravel extends 0.5 km north-northwest from North Bluff, in sec. 5 and 6, T21N, R3E (plate 1). It consists of gravel composed largely of metamorphosed rhyolite derived from the bluff. Other deposits of beach gravel, containing cobbles of sandstone, occur at UTM coordinates 716,000mE, 4,912,800mN; 716,500mE, 4,914,500mN; and 737,100mE, 4,915,000mN.

Spillways

Alden (1918, p. 223) thought the outlet of Lake Wisconsin was in east-central Jackson County (**i** or **j** of fig. 6), where low peat-filled saddles occur at the drainage divide east of the headwaters of Morrison and McKenna Creeks. Martin (1916, p. 340) recognized, however, that these saddles are too high to have been outlets. Modern topographic maps show that they are about 10 m higher than the lowest saddles across the divide between the Black River and Yellow River basins in Wood County, and the difference in elevation would have been even greater before crustal tilting occurred after the ice sheet melted. Martin recognized that the East Fork Black River carried the water from Lake Wisconsin (**b** of fig. 6; fig. 7), but he did not locate the position of the outlet across the Black/Yellow River divide. Four outlets are proposed here: the South Bluff, North Bluff, west Babcock, and north Babcock outlets (**e**, **f**, **g**, and **h** of fig. 6).

According to modern topographic maps, the lowest point on the divide is the South Bluff outlet, a broad, flat area of swamp and sand dunes 4 to 6 km wide between South Bluff, North Bluff, and Kurt Creek, around sec. 11, T21N, R2E (**e** of fig. 6). The swamp throughout this area is between the 970-ft and 975-ft (296-m and 297-m) contours. No channel through the area can be seen, however, perhaps because it has been filled in with sediment. Drillholes indicated more than 7 m of Pleistocene sand, peat, and clay in some parts of this area (Harloff, 1942).

The most conspicuous outlet crosses the divide 0.5 km northeast of North Bluff, in sec. 5, T21N, R3E (outlet **f** of fig. 6). The lowest point on the divide here is between the 975-ft and the 980-ft (297-m and 299-m) contours. The area to the west of the divide is marked by channel-like sags through the swamp and sand dunes in sec. 35 and 36, T22N, R2E, and sec. 31, T22N, R3E; and a similar sag occurs south of the divide in sec. 5, 8, and 17, T21N, R3E (visible on the U.S. Geological Survey's Quail Point Flowage, Wisconsin, quadrangle, 7.5-minute series, topographic, 1984). A test hole augered in the middle of the sag at UTM coordinates 725,400mE, 4,911,800mN showed 2 m of peat over 20 m of sand over silt and clay. An east-west ground-penetrating-radar profile through this point showed a buried depression more than 6 m deep filled with cross-bedded sand in the same position as the sag. A test hole near the side of the sag at UTM coordinates 724,600mE, 4,913,000mN showed 2 m of peat over 4 m of sand over 3 m of Cambrian sandstone over Precambrian rock. A north-south radar profile here showed no obvious buried channel form. A test hole near the middle of the sag at UTM coordinates 723,400mE, 4,913,300mN showed 3 m of peat over 10 m of sand over Cambrian sandstone. A north-south radar profile showed no obvious buried channel form. East-west radar profiles through the sags at UTM coordinates 725,300mE, 4,910,600mN and 725,300mE, 4,909,700mN showed no obvious channel forms.

A similar but more obscure sag through the swamp and sand dunes occurs 2 km west of Babcock, 3 km east of the one just discussed (g of fig. 6). An east-west radar profile through UTM coordinates 728,500mE, 4,909,800mN shows a buried scarp at the west edge of the sag, with 2 m of sand on sandstone west of the sag and more than 9 m of Pleistocene fill in the sag. Drillholes here (Harloff, 1942) show that sandstone occurs on the west side of the sag, and 1 m of peat, 4 m of sand, and 2 m of clay occur under the sag. Where this sag crosses the divide between the Black and Yellow Rivers at UTM coordinates 727,000mE, 4,912,500mN, the low point is between the 980-ft and 985-ft (299-m and 300-m) contours; it was probably below the 980-ft contour before the sand dunes were deposited here. A drillhole (Harloff, 1942) indicated the presence of more than 7 m of Pleistocene sand.

Another low point in the divide occurs 5 km north-northwest of Babcock, to the northeast of the sag discussed in the previous paragraph (h of fig. 6) at UTM coordinates 728,800mE, 4,914,200mN. The elevation is between the 980-ft and 985-ft (299-m and 300-m) contours. Drillholes (Harloff, 1942) indicated more than 7 m of Pleistocene sand.

Each of the four proposed outlets — the South Bluff, North Bluff, west Babcock, and north Babcock outlets (**e**, **f**, **g**, and **h** of fig. 6) — may have been an outlet of Lake Wisconsin at one time. Theoretically, at the beginning or end of a proglacial lake episode, the earth's crust was tilted least steeply and the lake would probably have used the outlets farthest from the glacier. During the height of a proglacial lake episode, the earth's crust was tilted most steeply and the lake would probably have used the outlets nearest the glacier.

Therefore, during the early part of the late Wisconsin glacial episode, the South Bluff or North Bluff outlets were most likely used. During the height of the glaciation, the north Babcock outlet, or perhaps one farther to the northeast, now entirely covered by the fan of Yellow River and Hemlock Creek (figs. 6 and 7; map unit **sp**, plate 1), was used. During the last part of the glaciation, the North Bluff outlet, the only proposed outlet that still retains a channel-like form, was probably used.

Water from these outlets flowed westward to the East Fork Black River (**b** of fig. 6). Downstream from City Point, and especially downstream from the mouth of Davidson Creek (figs. 6 and 7), the spillway has a distinct channel form. There, the channel is about 0.5 km wide and has fresh cutbanks that are several metres high. Upstream from City Point, the channel has been filled in with sediment that was deposited after Lake Wisconsin drained.

The South Bluff, North Bluff, west Babcock, and north Babcock outlets joined the East Fork Black River channel (**b** in fig. 6). One of the probable predecessors of the East Fork Black River and these associated outlets is the Hay Creek outlet (**c** of fig. 6); the saddle across the local drainage divide there is between the 965-ft and 970-ft (294-m and 296-m) contours, a few metres above the East Fork Black River channel. The earlier Davidson Creek outlet (**d** of fig. 6) passes through a saddle between the 970-ft and 980-ft (296-m and 299-m) contours. A possible earlier outlet occurs east of Spaulding (**a** of fig. 6) where the saddle is between the 980-ft and 985-ft (299-m and 300-m) contours.

Windblown silt

Windblown silt occurs at the surface over much of Wood County, primarily on till (map units **gb** and **ge**, plate 1) and hillslope sediment (map units **hp** and **hl**). The silt is typically about 0.5 m thick, and it contains some windblown clay and sand and some pedogenic clay. Some sand and pebbles from the underlying material have also been intermixed with the silt by burrowing animals; in addition, some mixing may have occurred when trees were uprooted during wind storms. The base of the silt sheet is generally sharp, indicating that it was deposited after the hillslope sediment was deposited — that is, most of the silt was probably deposited after permafrost melted during the last part of the Wisconsin Glaciation, or after about 13,000 BP (Attig and Clayton, 1986). The silt is not present on sand dunes, indicating that it was deposited before the dunes were active.

Love terraces

After Lake Wisconsin drained, the Wisconsin River cut several metres into the lake plain and then aggraded to or stabilized at levels referred to as the Love terraces in Portage County (Clayton, 1986, p. 13). The Love terraces (map units **su**, **sl**, and **st**, plate 1) are 1 to 4 m below the lake plain and 5 to 13 m above the present river. They differ from the lake plain (map units **oh** and **ow**) in being marked by stream channels and having little windblown sand on the surface. They differ from later river terraces (map unit **sw**) in that the channels of the Love terraces are less fresh-looking and are braided rather than meandering. On plate 1, two Love terraces are shown. The upper one is about 2 m above the lower, but they merge near the south boundary of Wood County.

Love sediment consists of pebbly sand or slightly pebbly sand. It is coarser than adjacent offshore sand; it contains pebbles as large as 2 or 3 cm. The thickness of the Love sand is unknown in most places, but it is probably thin. Near Biron, Precambrian rock occurs only a few metres beneath the terrace surface. In most places it probably overlies offshore sand. In a modern cutbank south of Nekoosa, at UTM coordinates 267,520mE, 4,905,830mN, 4 m of pebbley sand interpreted to be Love sediment overlies several metres of sand interpreted to be offshore sediment.

Love sediment was deposited after Lake Wisconsin drained — that is, after the Green Bay Lobe stood at one of the Elderon ice margins, roughly 14,000 years ago (Clayton, 1986, p. 13; 1989). Because no ice-wedge polygons have been seen on the Love terraces and because channels on the Love terraces are well preserved, Love sediment was probably deposited after permafrost melted about 13,000 years ago (Attig and Clayton, 1986). The braided channel pattern indicates significantly different sedimentation conditions than on later terraces, which have meandering channel patterns; this suggests that Love sediment was deposited by meltwater when the Ontonagon Lobe stood at the Winegar margin roughly 12,500 years ago (Attig and others, 1985).

POSTGLACIAL EPISODE

Wisconsin River terraces

Following the deposition of Love sediment, the Wisconsin River entrenched and then aggraded or stabilized at the levels of the terraces indicated by map unit **sw** on plate 1. These terraces, which are several metres above the modern river level, are conspicuously marked by meandering channel scars and in most places are underlain by sandy gravel with a few tens of percent of pebbles as large as 5 cm. Northeast of Port Edwards the terraces are narrow and are only 1 or 2 m below the Love terraces; the river here cut down to Precambrian rock. South of Port Edwards, the river was unrestrained by rock. The terraces are 2 km wide and as much as 11 m below the Love terrace.

Windblown sand

Windblown sand is widespread in southern Wood County, primarily on offshore sand (map units **oh**, **ow**, and **oy**, plate 1), and to a lesser extent on stream sediment (map unit **sp**) and other materials. In some places the sand is in the form of oval or parabolic dunes that are about 0.1 km across and 1 to 2 m high, although in many areas the dunes are irregular, with no specific form; in a few areas they are as high as 8 m (W1/2 sec. 34, T21N, R6E, for example). Dune orientation indicates wind direction from west-northwest or east-southeast. The windblown sand is highly irregular in thickness but is most commonly about 0.5 m thick, ranging from zero in blowouts to 8 m in the highest dunes. The windblown sand is less common where the underlying sand is coarse — for example, near the apex of the fan formed by underflow currents at the mouth of the Wisconsin River. The windblown sand is generally medium to fine sand consisting of well rounded quartz grains ultimately derived from Cambrian sandstone.

The exact age of the dune sand is unknown, but it was deposited after Lake Wisconsin drained. Some dunes are well preserved, indicating that they formed after a period of intense erosion that resulted from permafrost, which ended about 13,000 BP. The middles of the oval dunes in the southwestern part of the county are now active peat bogs, indicating that the dunes formed before the peat was deposited — probably when the water table was considerably lower, during the middle Holocene dry period, which occurred about 6,000 or 7,000 years ago.

Peat

Peat is indicated on plate 1 by map unit **p**. It is widespread between the sand dunes in the southwestern part of county, where it is generally about 1 m thick, but is as thick as 3 m in some places (Harloff, 1942).

In the area of cranberry farms near Cranmoor, in the north half of T21N, R4E, and the south half of T22N, R4E, the peat occurs between the fans of offshore sediment deposited at the mouths of the Wisconsin River to the east and the Yellow River and Hemlock Creek to the west. The thickness of the peat here is unknown, but in much of the area it is known to be afloat. Figure 8 shows an area of floating peat, where the larger mats (as large as 0.3 km across) still retain their original shape. The straight and angular edges were initiated by ditches; like a jigsaw puzzle, these mats could be fitted back into their original position. Smaller peat mats are round because they have floated around enough to abraid their corners. The islands of map unit **oy** and **ow** (plate 1) in the bog are sand dunes.

REFERENCES

Alden, W.C., 1918, Quaternary geology of southeastern Wisconsin: U.S. Geological Survey Professional Paper 106, 356 p.

Attig, J.W., and Muldoon, M.A., 1989, Pleistocene geology of Marathon County: Wisconsin Geological and Natural History Survey Information Circular 65, 27 p.

Attig, J.W., and Clayton, Lee, 1986, Late Wisconsin continuous permafrost in northern Wisconsin ended about 13,000 years ago: Geological Society of America Abstracts with Programs, vol. 18, p. 278.

Attig, J.W., Clayton, Lee, and Mickelson, D.M., 1985, Correlation of late Wisconsin glacial phases

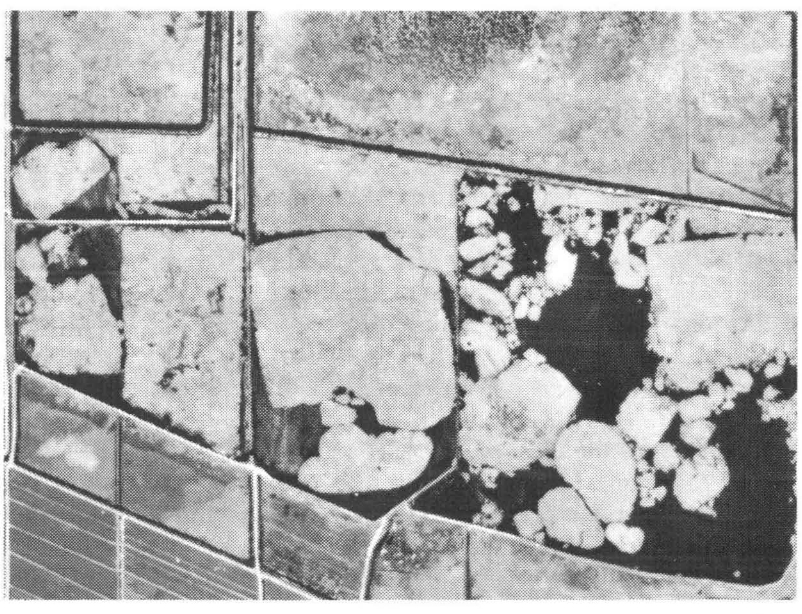


Figure 8 Aerial photograph of floating bogs in sec. 26 and 27, T22N, R4E. Area shown is 1.4 km wide. Dark areas are open water; light areas are floating bogs. U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service aerial photograph BIL-6AA-27.

in the western Great Lakes area: Geological Society of America Bulletin, vol. 96, p. 1585-1593.

Bartelme, R.J., 1977, Soil survey of Wood County, Wisconsin: U.S. Soil Conservation Service, 104 p.

Bell, E.A., and Sherrill, M.G., 1974, Water availability in central Wisconsin — an area of near-surface crystalline rock: U.S. Geological Survey Water-Supply Paper 2022, 32 p.

Brown, B.A., and Greenberg, J.K., 1986, Bedrock geology of Wood County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 54, plate 1 (scale 1:100,000).

Brownell, J.R., 1986, Stratigraphy of unlithified deposits in the central sand plain of Wisconsin: University of Wisconsin, Madison, Master's thesis, 140 p.

Clayton, Lee, 1986, Pleistocene geology of Portage County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 56, 19 p.

Clayton, Lee, 1987, Pleistocene geology of Adams County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 59, 14 p.

Clayton, Lee, 1989, Pleistocene geology of Juneau County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 66, 15 p.

Goddard, E.N., and others, 1965, Geologic map of North America: U.S. Geological Survey.

Harloff, N.C., 1942, Lacustrine clays of Glacial Lake Wisconsin as determined by fire protection well records: University of Wisconsin, Madison, Ph.B. thesis, 116 p.

Hole, F.D., 1943, Correlation of the glacial Border Drift of north central Wisconsin: American Journal of Science, vol. 241, p. 498-516.

LaBerge, G.L., and Myers, P.E., 1983, Precambrian geology of Marathon County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 45, 88 p.

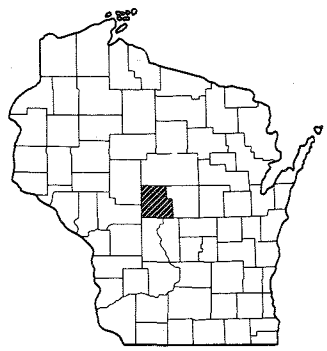
Martin, Lawrence, 1916, The physical geography of Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 36, 549 p.

Mickelson, D.M., Clayton, Lee, Baker, R.W., Mode, W.N., and Schneider, A.F., 1984, Pleistocene stratigraphic units of Wisconsin: Wisconsin Geological and Natural History Survey Miscellaneous Paper 84-1, 15 p.

Mode, W.N., 1976, The glacial geology of a portion of north-central Wisconsin: University of Wisconsin, Madison, Master's thesis, 85 p.

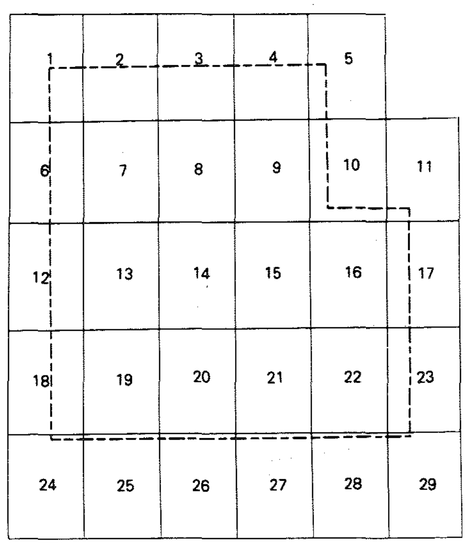
Thwaites, F.T., and Twenhofel, W.H., 1921, Windrow Formation; an upland gravel formation of the Driftless and adjacent areas of the upper Mississippi valley: Geological Society of America Bulletin, vol. 32, p. 293-314.

Weidman, Samuel, 1907, The geology of north central Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 16, 697 p.



Wood County
location diagram

Index to U.S. Geological Survey topographic quadrangles
(scale 1:24 000)



1 Spencer South–1979
2 Marshfield–1979
3 Hewitt–1979
4 Honey Island–1970
5 Big Eau Pleine Reservoir–1970
6 Lindsey–1979
7 Lake Manakiki–1979
8 Arpin–1979
9 Sherry–1970
10 Junction City–1970
11 Rocky Run–1970
12 City Point NE–1970 (85 PR)
13 Pittsville–1984
14 Lake Dexter–1984
15 Vesper–1984
16 Wisconsin Rapids North–1984
17 Meehan–1970
18 City Point–1970
19 Quail Point Flowage–1984
20 Babcock–1984
21 Nekoosa–1984
22 Wisconsin Rapids South–1984
23 Kellner–1970
24 Mather–1970
25 Finley–1969
26 New Miner–1969
27 Arkdale NW–1969
28 Arkdale NE–1969
29 Coloma NW–1968

PR Photorevised