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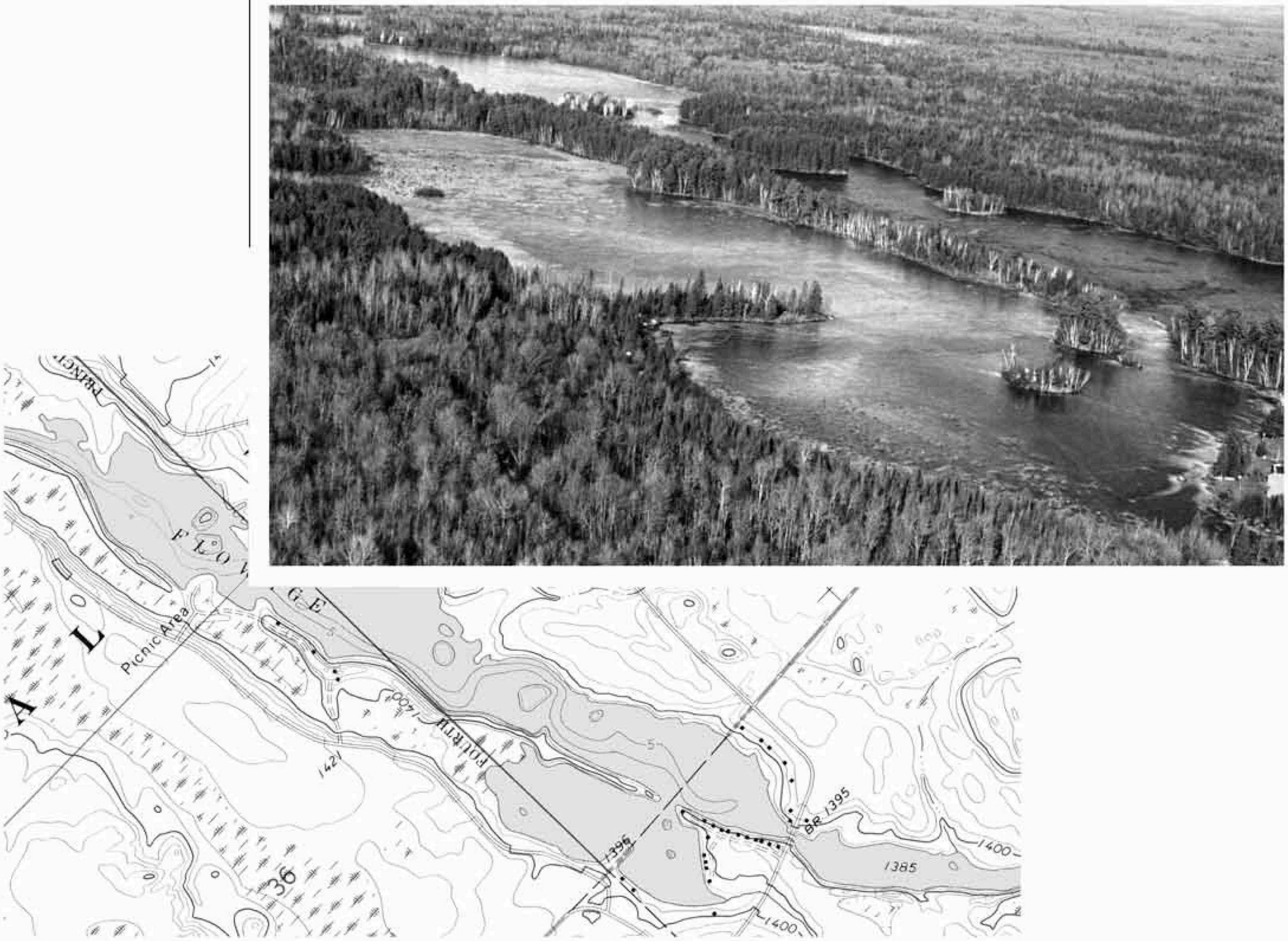
Wisconsin Geological and Natural History Survey

Pleistocene Geology of Taylor County, Wisconsin

John W. Attig



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Pleistocene Geology of Taylor County, Wisconsin

John W. Attig

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PLATE (inside back pocket)

FIGURES

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ABSTRACT

In Taylor County, located in north-central Wisconsin, Precambrian and Cambrian rock is exposed in a few places, but in most areas it is buried by glacial, stream, and lake sediment deposited primarily during Pleistocene glaciations. In a southwest–northeast trending zone across the center of the county, Pleistocene sediment is up to 65 m thick; most of this sediment was deposited during the last part of the Wisconsin Glaciation. In other parts of the county, Pleistocene sediment is typically less than 25 m thick.

During the last part of the Wisconsin Glaciation, the Laurentide Ice Sheet expanded southward and covered the western and northern parts of Taylor County. The south-central and eastern parts of the county were glaciated earlier in the Pleistocene, first from the west or northwest and later from the north.

Permafrost persisted throughout the time of the advance of the Laurentide Ice Sheet to its maximum extent into north-central Wisconsin and its subsequent wastage. Where debris cover prevented melting of buried ice, areas of debris-covered ice became separated from the ice sheet as it wasted back. This ice-cored topography influenced the direction of ice flow during readvances of the ice sheet. While permafrost persisted, ice-walled lakes melted through to the glacier bed. As permafrost ended, buried ice melted and hilly disintegration topography developed between ice-walled-lake plains.

INTRODUCTION

BACKGROUND

The landscape of Taylor County and the distribution and character of the geologic materials that overlie Precambrian and Cambrian rock are a direct result of glaciation. During the last part of the Wisconsin Glaciation, the Laurentide Ice Sheet reached its maximum extent in north-central Wisconsin between about 25,000 and 15,000 years ago (fig. 1); at that time the glacier covered northern and western Taylor County (Attig and others, 1985). The remainder of the county had been glaciated several times earlier in the Pleis-

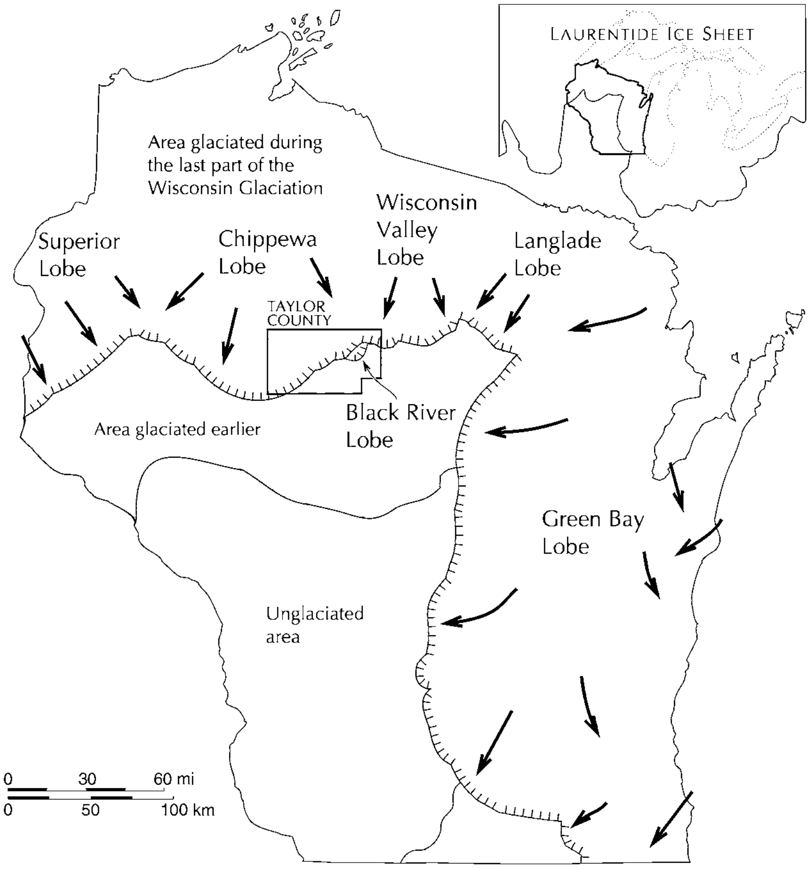


Figure 1. *Location of Taylor County and the maximum extent of the Laurentide Ice Sheet (hachured line) during the last part of the Wisconsin Glaciation. Arrows show the direction of ice flow.*

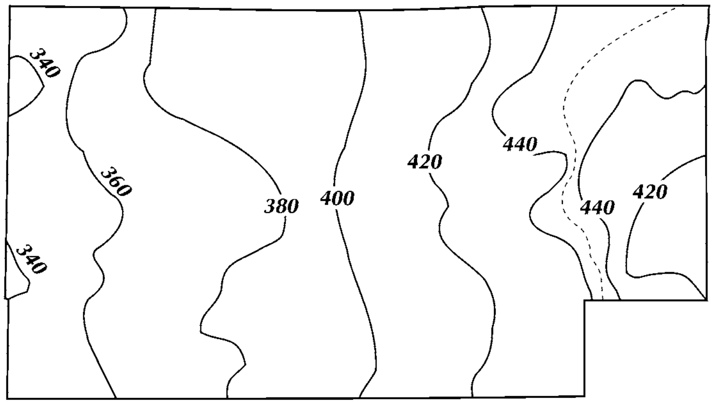


Figure 2. *Elevation of the erosion surface and approximate location of the north–south trending divide (dashed line) on Precambrian and Cambrian rock in Taylor County. Contours are greatly generalized; contour interval is 20 m.*

tocene Epoch. The timing of these earlier glaciations in north-central Wisconsin is poorly known; it is possible that some may have occurred as early as late in the Pliocene Epoch (Attig and Muldoon, 1989).

The landscape in the area covered by the ice sheet during the last part of the Wisconsin Glaciation contains well preserved glacial landforms; landforms resulting from earlier glaciations have been mostly destroyed by erosion. Much of this erosion probably occurred late in the Wisconsin Glaciation when permafrost accelerated erosion beyond the margin of the Laurentide Ice Sheet for 10,000 years or more (Attig and Clayton, 1992).

This report is based on field and laboratory studies completed in 1986 and 1990 through 1992. Field work was conducted using standard field techniques, including the use of a truck-mounted drill. This drill was used to collect sediment samples from either a continuous-flight auger or a split-spoon sampler. Laboratory work included interpretation of stereopairs of black and white (scale 1:20,000) and color-infrared (scale 1:58,000) aerial photographs. Physical properties of selected sediment samples were determined at the Quaternary Laboratory of the Department of Geology and Geophysics, University of Wisconsin–Madison.

MAP RELIABILITY

The reliability of the geologic map (plate 1) varies from area to area as a result of limitations of the information available. Subsurface information derived from the logs of water wells is sparse in many areas, and detailed soil maps exist for only scattered areas. Much of Taylor County is forest covered, which limited the interpretation of aerial photographs; in the northern and eastern parts of the county, the lack of roads restricted access to extensive areas for the field checking of information. The judged reliability of the line showing the contact between units is indicated on the map (plate 1).

ACKNOWLEDGMENTS

I thank the U.S. Forest Service for allowing me to use color-infrared aerial photographs (scale 1:58,000) and the U.S. Soil Conservation Service for making unpublished soil maps available to me. Lee Clayton, Nelson Ham, and William Mode reviewed an early version of the manuscript and map. This project was supported in part by a grant from the U.S. Geological Survey Cooperative Geologic Mapping Program (Grant Number 14-08-0001-A0817).

PRE-PLEISTOCENE GEOLOGY

PRE-PLEISTOCENE ROCK

Taylor County is underlain predominantly by Early Proterozoic metavolcanic rock that is part of the Penokean volcanic belt (Greenberg and Brown, 1983). The metavolcanic rock is intruded by granitic rock in the southeastern, northeastern, and northwestern parts of the county. Outliers of Cambrian sandstone occur in places (Mudrey and others, 1987). Pre-Pleistocene rock occurs at the surface in few places in the county; however, outcrops are common along parts of the Jump and Yellow Rivers. No sedimentary record is known for events between the deposition of Cambrian sandstone and the Pleistocene glaciations in Taylor County.

PRE-PLEISTOCENE EROSION SURFACE

Logs of wells indicate that the erosion surface on Precambrian and Cambrian rock slopes gently westward and eastward from a north–south trending divide in eastern Taylor County (fig. 2).

Although buried by younger sediment, this divide is close to the present divide between the Wisconsin River drainage to the east and the Black River and Chippewa River drainages to the west.

PLEISTOCENE GEOLOGY

THICKNESS OF PLEISTOCENE SEDIMENT

In Taylor County, Precambrian and Cambrian bedrock is buried by a nearly continuous cover of Pleistocene sediment. Most of this sediment is the result of repeated glaciations. Pleistocene sediment is thickest in a southwest–northeast trending zone (fig. 3). In this zone of hills, lakes, and wetlands, sediment deposited along the margin of the Laurentide Ice Sheet is commonly 25 m thick but in some places is up to 65 m thick. In northwestern, south-central, and southeastern parts of Taylor County, Pleistocene sediment is typically less than 25 m thick.

GLACIAL GEOLOGY

The glacial landforms and sediment of Taylor County differ from area to area and can be divided into distinct zones. Each zone contains materials and features that record a geologic history different from that in the other zones. In the following sections, the discussion generally progresses from the area underlain by the oldest glacial sediment in the south-central and southeastern parts of the county to the area underlain by the youngest glacial sediment in the southwest and northern parts of the county. Lithostratigraphic usage follows that developed by Mickelson and others (1984) and Attig and others (1988).

EDGAR TILL PLAIN

The landscape of southeastern Taylor County—the Edgar till plain (area ETP, fig. 4; map unit **ge**, plate 1)—consists of broad, low-relief uplands with broad valleys (fig. 5). Glacial landforms have not been preserved in this area and surface boulders are rare. Till of the Edgar

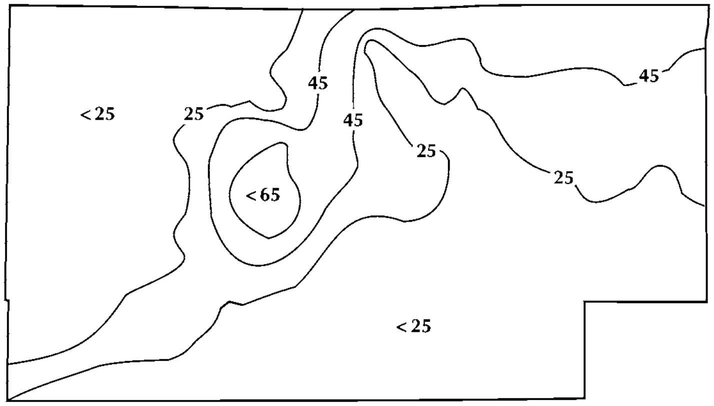


Figure 3. *Map showing the thickness of sediment covering Precambrian or Cambrian rock. Contours are greatly generalized; contour interval is 20 m.*

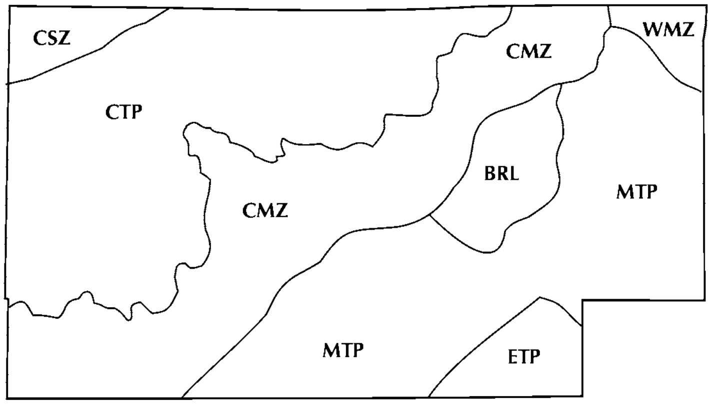


Figure 4. *Landscape areas of Taylor County: ETP—Edgar till plain; MTP—Merrill till plain; BRL—Black River Lobe; CMZ/WMZ—marginal zone of the Chippewa (CMZ) and Wisconsin Valley (WMZ) Lobes; CTP—Chippewa Lobe till plain; CSZ—Chippewa Lobe streamlined zone.*

Member of the Marathon Formation (defined in Mickelson and others, 1984) occurs at or near the surface throughout most of the area. The Medford Member of the Marathon Formation (defined by Attig and Muldoon, 1988) is present in places in the subsurface. Till of both members extends northward beneath till of the Lincoln and Copper Falls Formations (cross-sections A–A' and B–B', plate 1). In southeastern Taylor County, the Marathon Formation is typically less than 15 m thick.

Till of the Medford Member. The till of the Medford Member of the Marathon Formation contains little gravel, is silty (typically 45% to 55% silt in the finer-than-2-mm fraction), gray (moist field color 10YR 3/1 to 2.5Y 5/1 on the Munsell scale), and calcareous (Attig and Muldoon, 1988; Attig and Muldoon, 1989). The

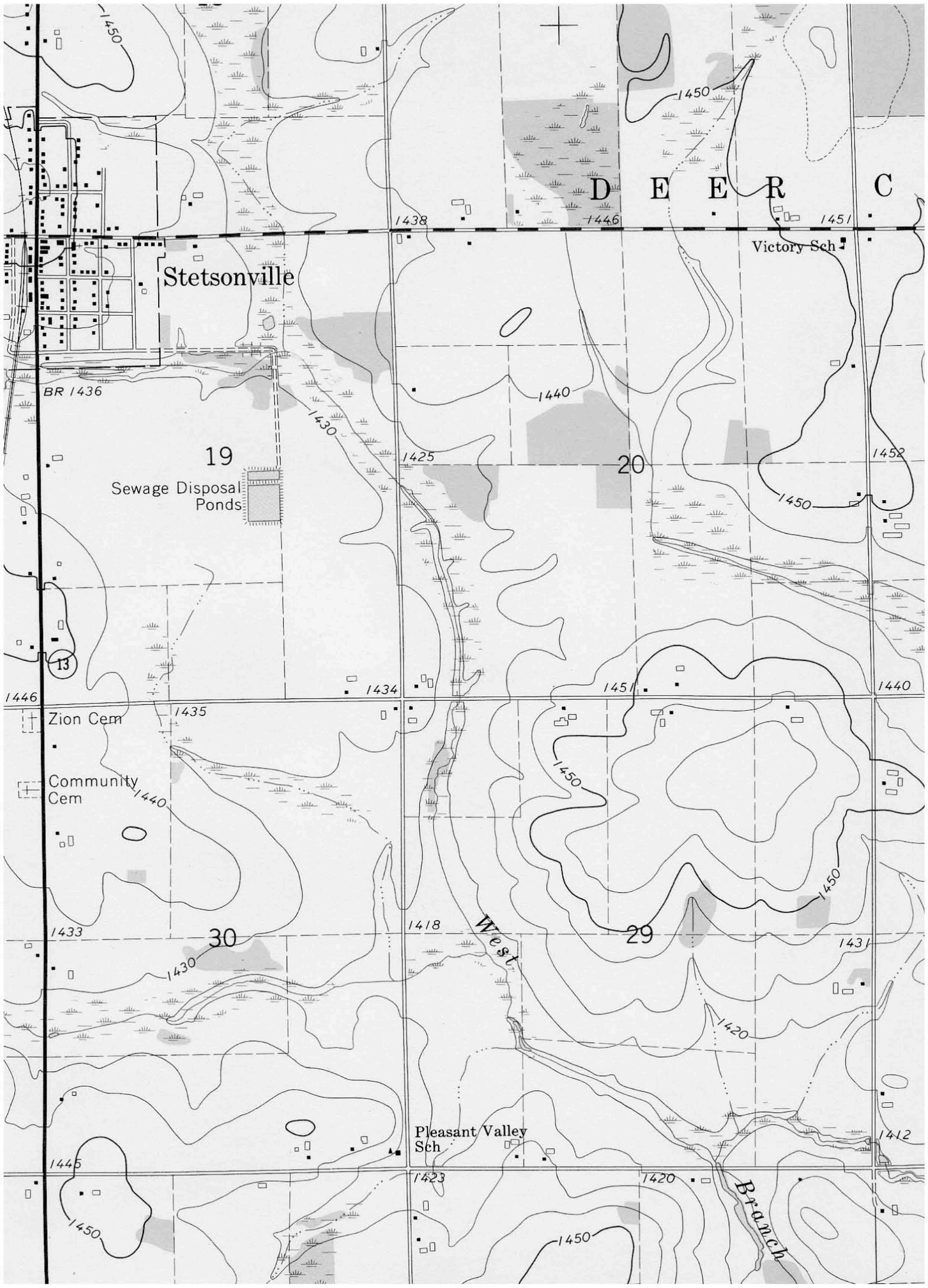
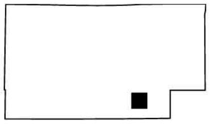


Figure 5. *Part of the Stetsonville Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1969), showing the broad, low-relief uplands in an area where till of the Edgar Member is at the surface.*



areal extent of this till is poorly known. It has been observed in one outcrop along the south bank of the Little Black River in the SE1/4 NE1/4 SE1/4, sec. 3, T30N, R1E (first described by Weidman, 1907) and has been encountered in samples from drillholes in northwestern Marathon County (Attig and Muldoon, 1989). It is probably present in places in the subsurface throughout southern and western Taylor County; however, it cannot be clearly separated from till of the Edgar Member in samples collected from a continuous-flight auger (see cross-section unit **mu**, plate 1) (fig. 6).

Fragments of siliceous limestone are common in till of the Medford Member. These limestone fragments commonly contain fossils that are not well enough preserved to be identified. Samples of Medford till typically effervesce strongly when treated with dilute hydrochloric acid. Small fragments of gray shale are also common; incorporation of shale may account in part for the color and silty nature of Medford till. The orientation of pebbles in Medford till indicates ice flow from the west or west–northwest (Attig and Muldoon, 1989).

Till of the Edgar Member. The till of the Edgar Member contains small amounts of gravel, is silty (typically 40% to 55% silt in the finer-than-2-mm fraction), dark yellowish brown to brown (moist field color 10YR 4/4 to 7.5YR 4/4 on the Munsell scale), and calcareous. Till of the Edgar Member extends eastward into central Marathon County, where it becomes thin and patchy (Attig and Muldoon, 1989) and southward into northwestern Wood County, where it also becomes thin and patchy (Clayton, 1991). Till of the Edgar Member is typically overlain by up to 1 m of silty to sandy windblown and slopewash sediment. The contact with the underlying Medford Member has not been observed in outcrop. Red and orange iron–oxide and black manganese–oxide staining are common on fracture surfaces.

Unleached samples of Edgar till effervesce strongly when treated with dilute hydrochloric acid; carbonate has typically been leached from the upper 2 to 5 m of till. Attig and Muldoon (1989) found that the coarse-silt fraction of Edgar till in adjacent Marathon County contained small amounts of calcite. Similarly, Clayton (1991) reported that Edgar till in Wood County contains considerable calcite in bulk samples, but Chittick analysis of his 30 samples detected small amounts of calcite in the coarse-silt fraction. Mode (1976) found calcite in the coarse-sand fraction of Edgar till in western Marathon County. Hole (1943) reported that the material now included in the Edgar Member in northwestern Wood County is about 20 percent by weight calcite and that about 90 percent of the 2- to 4-mm grains are calcite.

Till and fluvial gravel of the Edgar Member contain fossiliferous pebbles. Hole (1943) reported a segment of a crinoid stem from material now included in the Edgar Member in northwestern Wood County. Mode (1976) reported fragments of Paleozoic crinoids and bryozoans in Edgar till in western Marathon County. Clayton (1991) reported pebbles of silicified limestone containing fossils of a Silurian tabulate coral, *Favosites favosus*, and a rugose coral, *Streptelasma* sp. (Ordovician, Silurian, or Devonian), in meltwater-stream sediment that he included in the Edgar Member.

Depositional history. The till of the Medford Member was deposited during the Stetsonville Phase; till of the Edgar Member, during the Milan Phase (Attig and Muldoon, 1989: Clayton, 1991; Clayton and others, 1992) (fig. 7A).

Till of the Medford and Edgar Members of the Marathon Formation is distinctly different from till derived from the Lake Superior or Lake Michigan basins. In central Wisconsin, till derived from the Lake Superior basin is typically noncalcareous, reddish brown, sandy, and contains clasts of red sandstone and volcanic rock; till derived from the Lake Michigan basin is typically dolomitic, brown, and sandy. In contrast, the Medford and Edgar till units are calcitic, gray to brown, silty, and contain clasts of siliceous limestone, some of which are fossiliferous. Fragments of gray shale are common in till of the Medford Member. This contrast indicates a source other than the Lake Superior or Lake Michigan basins.

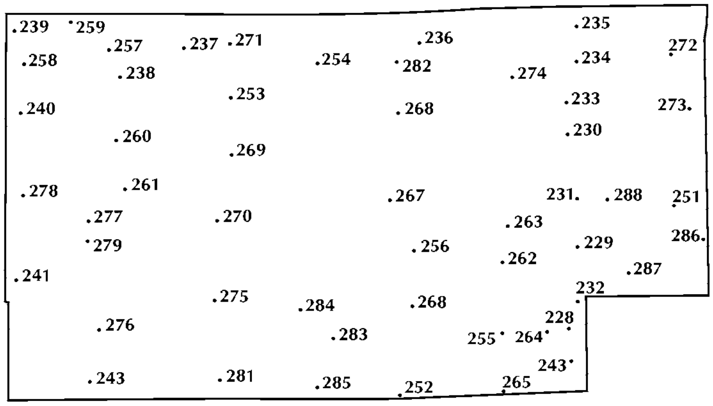


Figure 6. *Location of holes drilled to collect sediment samples. Numbers are Wisconsin Geological and Natural History Survey drillhole identifiers. In text citations of drillholes in this report, "TA-" precedes the identifier.*

The orientation of elongate pebbles indicates that ice advancing into this part of Wisconsin from the west or northwest deposited the Medford (Attig and Muldoon, 1989) and Edgar Members (Mode, 1976) of the Marathon Formation. The eastward to southeastward dispersal fans of clasts from Powers Bluff in Wood County (Weidman, 1907; Clayton, 1991) and Rib Mountain and other sites in central Marathon County (LaBerge and Myers, 1983; Attig and Muldoon, 1989) have also been interpreted to indicate flow from the northwest during deposition of Medford or Edgar till. Till has subsequently been stripped from the area of the dispersal fans (Attig and Muldoon, 1989; Clayton, 1991).

The abundant carbonate rock in the till of the Medford and Edgar Members cannot be accounted for by known local sources. Attig and Muldoon (1989) noted that characteristics of Medford till—the gray color and common shale and limestone fragments—are similar to characteristics of till units in west-central Wisconsin described by Baker and others (1987) and in Minnesota by Goldstein (1987). The fragments of hard gray shale in the Medford

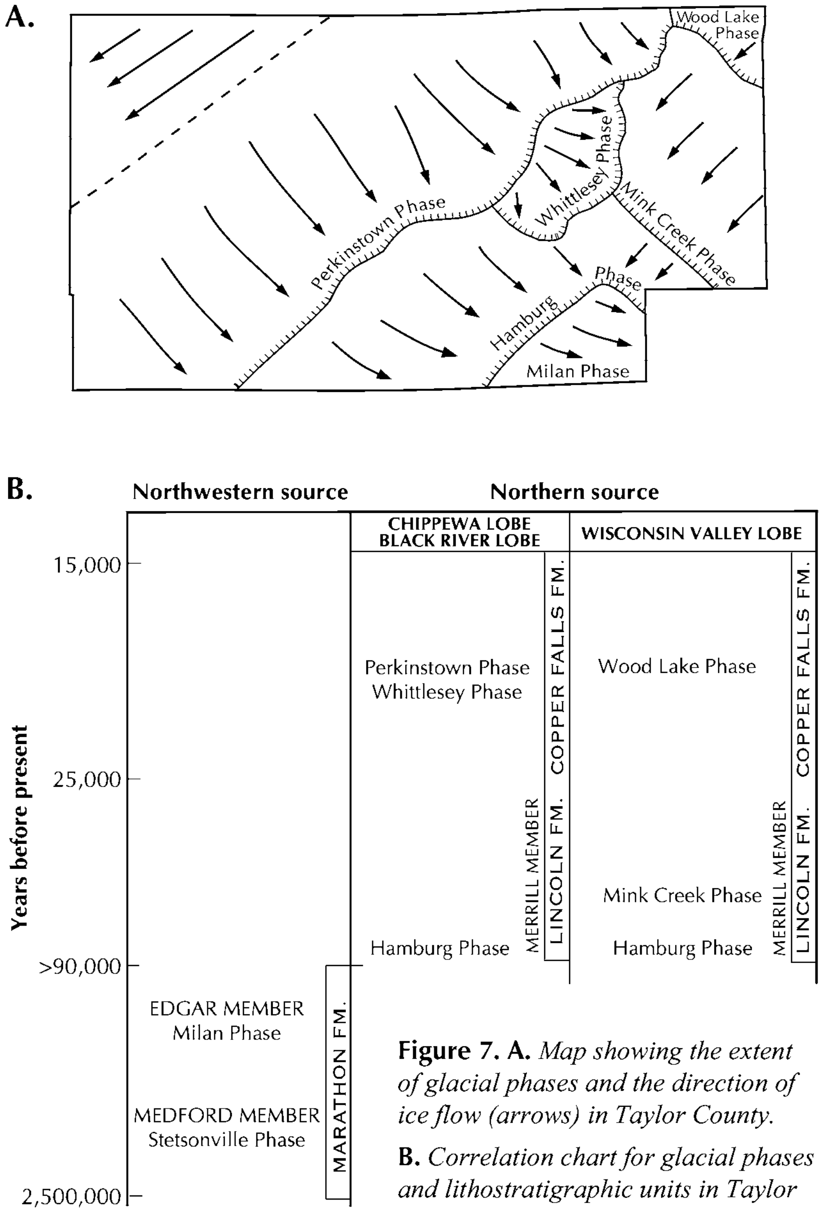


Figure 7. A. *Map showing the extent of glacial phases and the direction of ice flow (arrows) in Taylor County.*

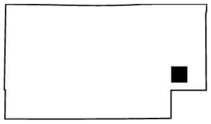
B. *Correlation chart for glacial phases and lithostratigraphic units in Taylor County.*

Member were interpreted by Attig and Muldoon (1989) to indicate flow lines extending from Manitoba across eastern North Dakota and Minnesota to central Wisconsin. These shale fragments are most likely derived from the Cretaceous section in eastern North Dakota, southern Manitoba, and northwestern Minnesota. The fossils in the siliceous limestone fragments in Medford till are not well preserved and are not identifiable, but Clayton (1991) suggested that fossils from similar siliceous limestone pebbles in the overlying Edgar Member may have been derived from carbonate rock units in the Winnipeg lowlands. The incorporation of Cretaceous shale may account for the silty nature of the matrix of Medford and Edgar till. Edgar till contains few hard gray shale fragments. Flow lines of the ice that reached central Wisconsin during deposition of Edgar till may have been east of those that transported material during deposition of the Medford till; there, the glacier would have crossed fewer areas of hard shale.

The time of deposition of till of the Medford and Edgar Members is uncertain. The Merrill Member of the Lincoln Formation overlies Edgar till and is therefore younger. Glacial landforms are subdued but present, and surface boulders are common in areas where Merrill till is at the surface. In contrast, glacial landforms have been destroyed and surface boulders are absent in areas where Edgar till is at the surface. This contrast indicates Edgar till has undergone erosion and weathering considerably longer than Merrill till. The Medford Member is lithologically similar to the Woodville and Hersey Members of the Pierce Formation in west-central Wisconsin (Mickelson and others, 1984; Baker, 1988). On the basis of reversed paleomagnetic remanence, Baker and others (1983), and Baker (1986) suggested that the Hersey Member was deposited before about 730,000 years ago. The Medford Member may have been deposited at approximately that time as well.

MERRILL TILL PLAIN

Till of the Merrill Member (map units **gm** and **gmh**, plate 1; area MTP, fig. 4) is the surface till unit in a broad band across south-central and east-central Taylor County. The area is characterized by a gently rolling landscape with subdued glacial landforms. Surface drainage is less well integrated than in areas where Edgar till is the surface unit; therefore, poorly drained areas are more common. Near its southern limit in Taylor County, Merrill till becomes patchy and the landscape is similar to that underlain by Edgar till (area ETP, fig. 4). A zone of subdued hilly topography (map unit **gmh**, plate 1; fig. 8), which includes segments of subdued ice-marginal ridges visible on black and white aerial



photographs (scale 1:20,000), trends northwest–southeast across the southeastern part of the county. These ice-marginal ridges are referred to as the Mink Creek moraine, named for Mink Creek, which cuts through the moraine in the eastern part of T31N, R2E. Throughout the area shown as map unit **gm** on plate 1, subdued hills occur.

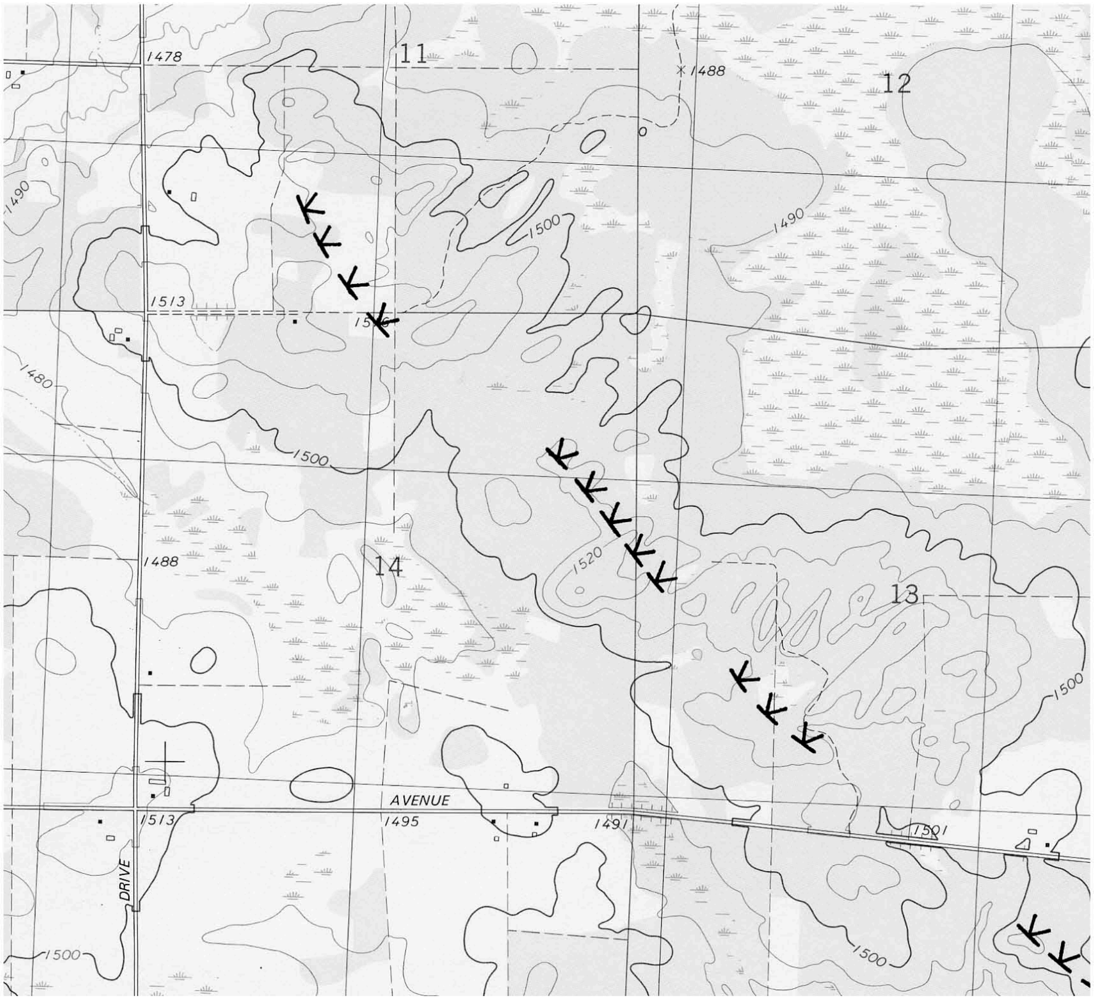


Figure 8. *Part of the Rib River Lookout Tower Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1979), showing the Mink Creek moraine trending northwest–southeast through secs. 11, 14, 13, and 24, T31N, R2E. Moraine is shown with a line symbol.*

Till of the Merrill Member. The till of the Merrill Member of the Lincoln Formation in Taylor County is gravelly, rich in sand (typically about 55% sand, 30% silt, and 15% clay in the less-than-2-mm fraction) (fig. 9), brown to reddish brown (field color 7.5YR 4/6 to 5YR 4/3 on the Munsell scale), and noncalcareous. In adjacent Marathon County, Attig and Muldoon (1989) reported that Merrill till typically contains about 49 percent sand, 38 percent silt, and 13 percent clay. The gravel is rich in rock types derived from the Lake Superior basin. Pebbles and cobbles from Merrill till are typically somewhat rounded. Numerous piles of frost-heaved rocks collected by farmers contain rounded cobbles that are characteristic of areas where Merrill till is at the surface. Such rock piles are not present where Edgar till is at the surface, presumably because surface and near-surface rocks have been destroyed by weathering. Merrill till is typically more silt rich and slightly calcareous near the contact with the underlying Marathon Formation than in other areas.

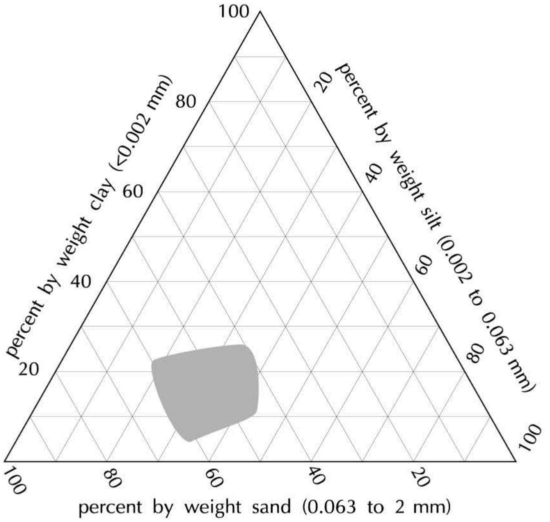


Figure 9. *Grain-size distribution of the finer-than-2-mm fraction of samples of till of the Merrill Member of the Lincoln Formation. The shaded area indicates the range of results from the analysis of 33 samples.*

In the northeastern part of the area shown as till of the Merrill Member on plate 1 (map unit **gm**), very low-relief till surfaces are not clearly separated from flat to low-relief surfaces of meltwater-stream sediment deposited beyond the margins of the late Wisconsin Chippewa and Wisconsin Valley Lobes. In this area, meltwater-stream sediment filled low areas in the low-relief till surface.

Till of the Merrill Member of the Lincoln Formation cannot be clearly separated from till of the younger Copper Falls Formation in Taylor County. Both are noncalcareous, sandy, reddish brown, have similar sand:silt:clay ratios in the less-than-2-mm fraction, and are rich in clasts derived from the Lake Superior basin. They are separated on plate 1 on the basis of surface morphology; glacial landforms in the area of Copper Falls till are better preserved than those in areas of Merrill till. In the subsurface they are separated by layers of sand and gravel in some areas. The distinction between till of the Merrill Member of the Lincoln Formation and that of the Copper Falls Formation on cross-sections A–A' and B–B' on plate 1 is tenuous except where extensive sand and gravel separates the two units, such as in the northern part of section A–A'.

Glacial history. Ice that deposited the Merrill till advanced southward out of the Lake Superior basin. This flow direction is indicated by the abundance of gravel composed of rock types derived from the Superior basin. The southern limit of Merrill till in southeastern Taylor County displays a lobate pattern similar to that of the outermost margin of the Laurentide Ice Sheet during the last part of the Wisconsin Glaciation. The north–south trending divide (fig. 2) that crosses eastern Taylor County influenced ice flow during deposition of the Merrill till and the younger Copper Falls till.

The Merrill Member in Taylor County is the surface material in an area beyond the well preserved glacial landscape deposited by the Wisconsin Valley, Chippewa, and Black River Lobes during the last part of the Wisconsin Glaciation and is therefore older (plate 1). Stewart and Mickelson (1976) reported that the degree of weathering of the clay fraction of Merrill till indicates it underwent a period of subaerial weathering prior to deposition of till during the last part of the Wisconsin Glaciation. Stewart and Mickelson (1976) also reported two radiocarbon dates from organic-rich silt and clay overlying till of the Merrill Member at Schelke Bog in eastern Lincoln County: 40,800 BP ±2,000 (IGS-256) and older than 36,800 BP (IGS-262). If the 40,800 BP date is accurate, it provides a minimum age for till of the Merrill Member.

Merrill till overlies Edgar and Medford till of the Marathon Formation. Mode (1976) reported that clay minerals in Merrill till are less intensely weathered than those in the Edgar Member of the Marathon Formation but more intensely weathered than those in till units deposited during the last part of the Wisconsin Glaciation. Till of the Merrill Member was deposited during the Hamburg (Attig and Muldoon, 1989) and Mink Creek Phases (fig. 7), probably early in the Wisconsin Glaciation.

Map units **gu** and **guh**, shown in the central and northeastern parts of plate 1, include areas of low- to high-relief topography beyond the apparent maximum extent of the Wisconsin Valley and Chippewa Lobes during the last part of the Wisconsin Glaciation. In the northeastern part of Taylor County, unit **guh** includes distinct ice-marginal ridges and moderate to high-relief topography. Low-relief topography beyond the maximum extent of the Chippewa and Black River Lobes is shown on plate 1 as map unit **gu**. The landscape in the area of map units **gu** and **guh** contains better preserved glacial landforms than those typical of surfaces underlain by till of the Merrill Member, but less well preserved than those typical of surfaces underlain by till of the Copper Falls Formation. These areas may have been glaciated just prior to the stabilization of the margin of the Laurentide Ice Sheet during the Wood Lake and Perkinstown Phases (fig. 7A), or earlier during the Wisconsin Glaciation. Glacial landforms are well preserved in the places shown as map unit **guh** in the northeastern part of the county.

Marginal zone of the Chippewa and Wisconsin Valley Lobes

The marginal zone of the Chippewa and Wisconsin Valley Lobes is shown as map units **gch** and **gwh** on plate 1 and as areas CMZ and WMZ on figure 4. These areas include the thickest Pleistocene sediment in Taylor County (fig. 4) and are characterized by a high-relief landscape containing well preserved glacial landforms, lakes, and wetlands. When viewed from the southeastern part of the county, this high-relief landscape forms a conspicuous skyline.

Although material included in the Lincoln and Marathon Formations occurs at depth (cross-sections A–A' and B–B', plate 1), sediment deposited along the margin of the late Wisconsin Laurentide Ice Sheet apparently accounts for Pleistocene sediment being thicker in the marginal zones of the Chippewa and Wisconsin Valley Lobes than in adjacent areas. There is no indication that topography on older Pleistocene sediment or on pre-Pleistocene rock contributes to the high-relief character of these areas.

Ice-marginal ridges. The outermost extent of the Chippewa and Wisconsin Valley Lobes during the last part of the Wisconsin Glaciation is marked in places by a sharply crested, discontinuous ice-marginal ridge (plate 1). These ridges have steep proximal and distal sides, in contrast to the more ramp-shaped ridges typically formed by stacking of basal sediment by active ice (Krüger, 1993). Ridges with steep proximal and distal sides are believed to be typical of ridges formed by the flow of sediment off the ice surface (fig. 10). In some areas, no ice-marginal ridge is present and the maximum extent of late Wisconsin ice cannot be precisely determined.

Several segments of the ice-marginal ridge that formed along the margin of the Chippewa Lobe are shown in figure 11. The glacier was on the north side of these ridge segments; the distal side of these ridges is a steeply sloping outwash plain, where the coarsest part of the bedload of the meltwater streams was deposited. As a result, gravel is abundant, and many sand-and-gravel mining operations are located in this and similar geologic settings. An active gravel pit in the south-central part of sec. 6, T31N, R1E, exposes part of an ice-marginal ridge and its flanking outwash plain. This ridge is composed of crudely stratified sandy gravel and gravelly sand, interpreted to be debris-flow sediment composed of supraglacial debris that moved down the ice surface. The outwash plain is gently sloping and the pit walls expose moderately well sorted, well stratified slightly gravelly fluvial sand 100 m south of the crest of the ridge.

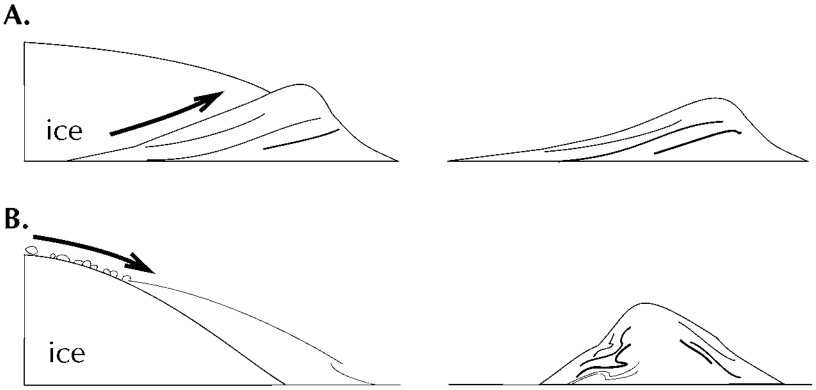


Figure 10. A. *Formation of a ramp-shaped ice-marginal ridge by stacking of basal sediment by active ice.*

B. *Formation of an ice-marginal ridge by flow of sediment from a disintegrating ice mass.*

Ridges similar to those that mark the maximum extent of the Laurentide Ice Sheet occur along the northern limit of map unit **gch** (plate 1) in several areas (fig. 12). No exposures in these ridges are known; their extent was determined primarily from examination of aerial photographs (scale 1:20,000) and topographic maps (scale 1:24,000). These ridges formed along the northern edge of a mass of debris-covered ice that became isolated from the northward-wasting ice sheet (fig. 13). Small sediment fans (many of which are too small to be shown on plate 1) that extended northward from the ridges on the northern margin of map unit **gch** formed when the debris-covered ice wasted back. The thick debris cover and permafrost inhibited the melting of buried ice and probably

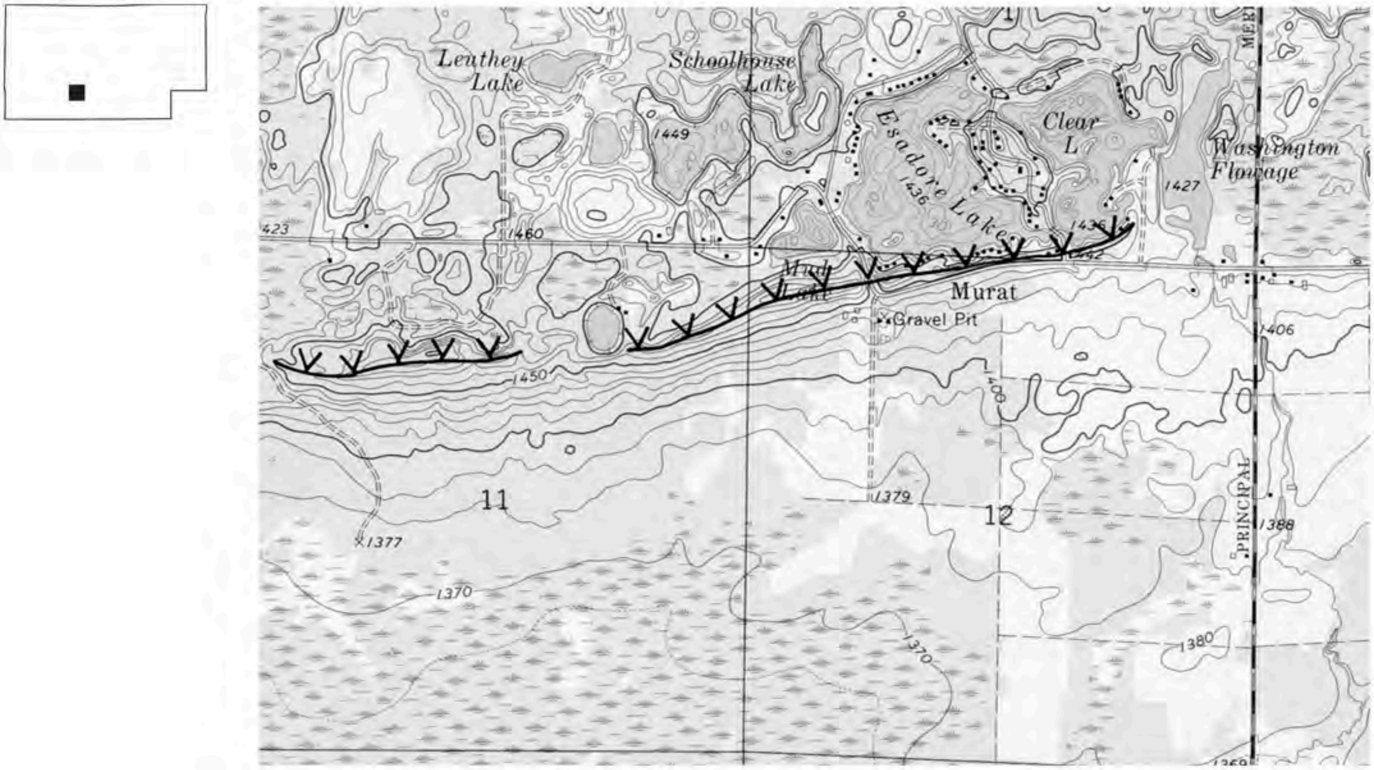


Figure 11. *Part of the Medford NW Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1970), showing segments of the ice-marginal ridge formed along the outermost extent of the Chippewa Lobe during the last part of the Wisconsin Glaciation. Ridge segments are shown with a line symbol.*

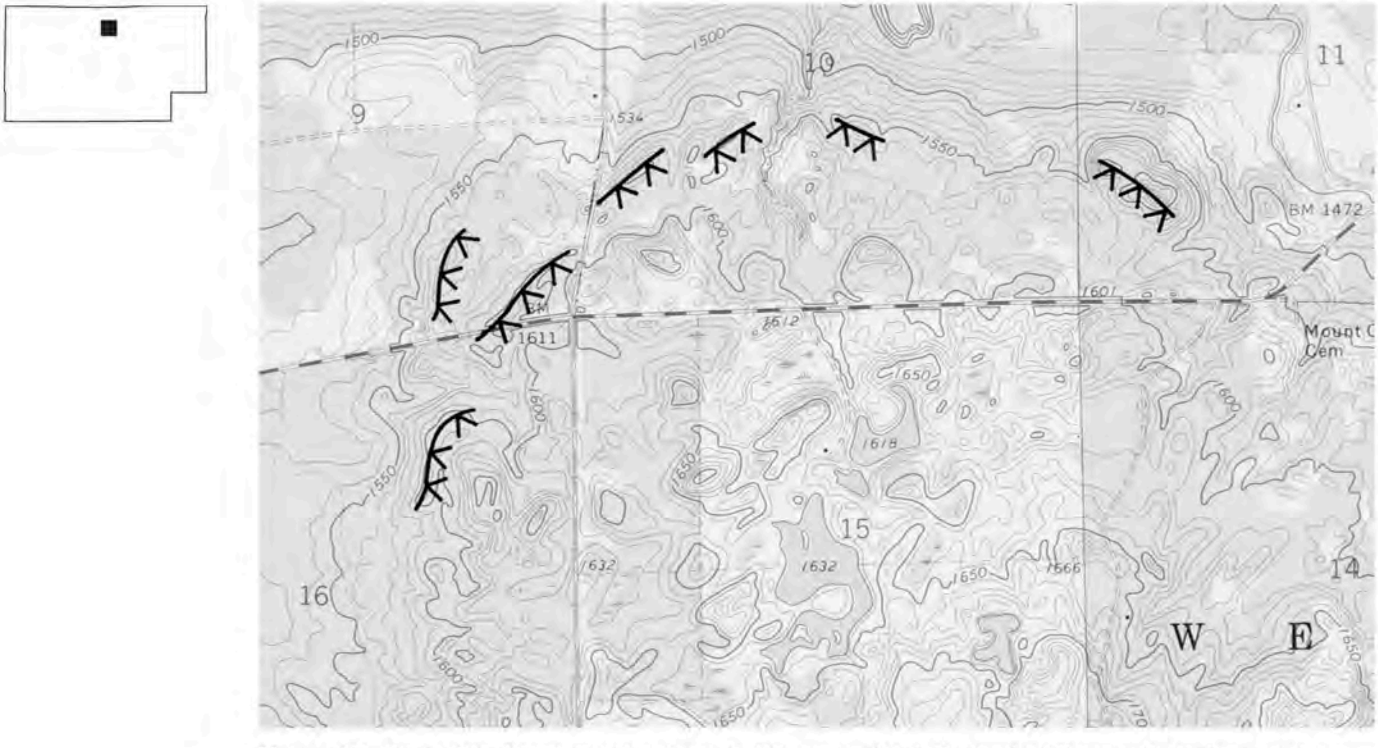


Figure 12. *Part of the Westboro Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1970), showing ridge segments interpreted to have formed as debris flowed northward off a high area of ice with a thick debris cover. Ridge segments are shown with a line symbol.*

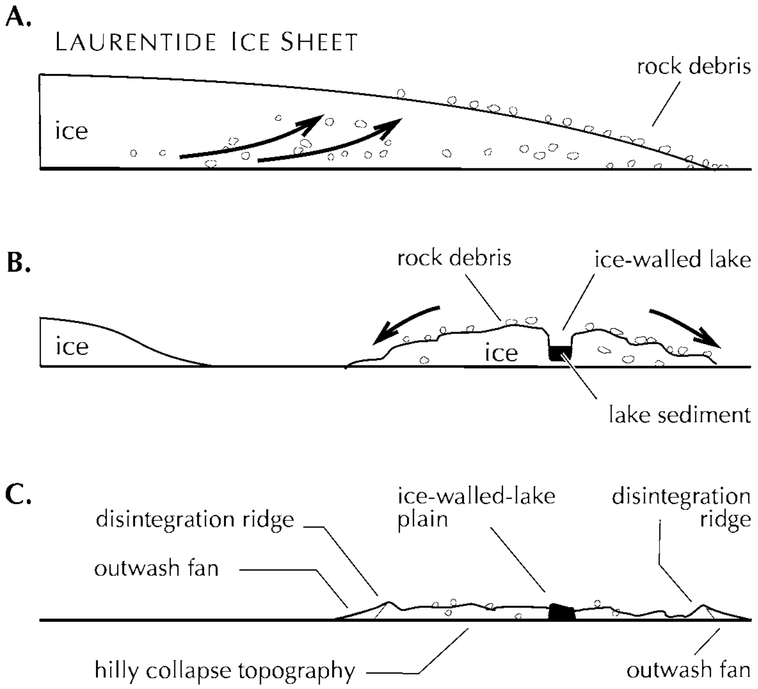


Figure 13. *Diagram showing a sequence of events in the formation of a marginal area of hilly disintegration topography, ice-walled-lake plains, and flanking disintegration ridges along the northern side of map unit* ***gch*** *(plate 1).*

A. *During the maximum extent of the Laurentide Ice Sheet, permafrost penetrates to the glacier bed in a marginal zone. Glacier flow results in the upward shearing of sediment-rich ice and the accumulation of debris on the ice surface.*

B. *As the ice sheet wastes back, the marginal debris-covered ice becomes isolated. The summer thaw layer does not penetrate through the debris cover. Ice-walled lakes melt through to the glacier bed.*

C. *Climate warms and permafrost thaws, allowing buried ice to melt. Ice-walled-lake plains, outwash fans, and other ice-disintegration landforms develop.*

stabilized the debris-covered ice for several thousand years. Sollid and Sørbel (1988) reported a similar sequence of events in the formation of zones of hilly disintegration topography.

Other disintegration ridges and small eskers occur throughout the areas shown as map units **gch, gwh,** and **gbh** (plate 1). Some of these ridges were mapped by Cahow (1976) in parts of western Taylor County and in adjacent parts of Chippewa County.

Hilly topography. Broad areas of hilly collapse topography are also characteristic of marginal zones (map units **gch, gwh,** and **gbh,** plate 1). Typically, the hills are roughly equidimensional in map view and have high centers and steeply sloping sides. Elongate hills show no preferred orientation. Circular disintegration ridges are visible on aerial photographs (scale 1:20,000) of secs. 29 and 30, T30N, R4W.

Few large exposures exist in this landscape. Small (typically less than 1.5 m) exposures throughout this area of hilly topography indicate that the area is composed of a variety of sediment types, including laminated lake sediment, crudely stratified debris-flow sediment, and well sorted and stratified sandy gravel and gravelly sand.

An active gravel pit in the SE1/4 NE1/4 NW1/4 sec. 7, T31N, R2W, exposes a 4-m section through a hill. In this exposure, several tabular bodies of gravelly, crudely stratified sediment are separated by silty sand. Bedding planes clearly dip southeastward toward the high point of the hill. This dip toward the high point of the landscape indicates that the sediment in the hill was derived from the surface of the ice that occupied the area of the wetland northwest of this site. Relief in this area is about 25 m; at least the upper 4 m is material that was derived from the ice surface and flowed to its present position.

Farther east along the margin of the Chippewa Lobe, where topographic relief is about 40 m, material from two drillholes indicates that only the upper 5 to 8 m shows much variability (fig. 14); the cores of some hills are composed of material that has a uniform downhole grain-size distribution in the less-than-2-mm fraction. The ratio of sand:silt:clay in samples from the uniform material of these two holes is typical of that of till deposited behind the marginal zone by the Chippewa Lobe.

The dip of bedding planes toward the high point in the landscape indicates a supraglacial source for the upper several meters of material. The genesis of the uniform material at greater depths is uncertain; it could be supraglacial flow till or melt-out till. Very slow melting of ice beneath a thick debris cover may have resulted in little sorting, stratification, or removal of the finer grain-size fractions. Alternatively, the uniform material could be derived from the bed of

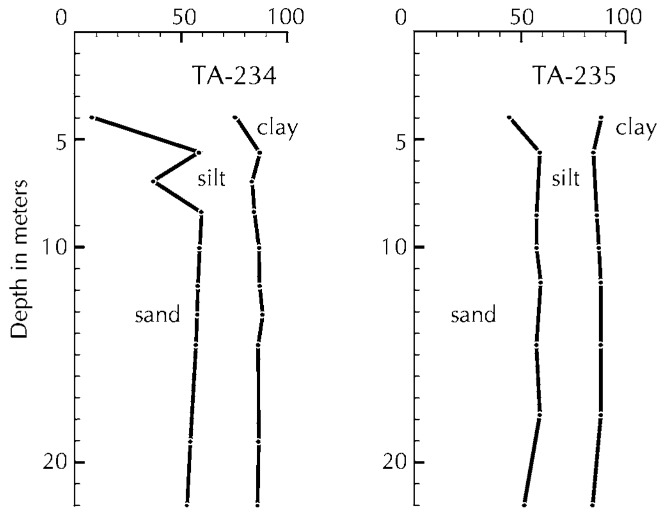


Figure 14. *Down-hole variability in grain-size distribution for the less-than-2-mm fraction of samples from two drillholes in an area of hilly topography.*

the glacier, and the hills may reflect lateral variations in the debris content of ice near the glacier bed, or they may be the result of lodging and stacking of basal debris-rich ice that subsequently melted (Johnson and Mickelson, 1983). Ham and Attig (1993) noted that any sequence of debris and ice thick enough to produce the amount of relief common in areas of hilly collapse topography would result in large amounts of material being released at the ice surface.

Sediment that was deposited in ice-walled lakes now underlies many of the highest points in the landscape and was derived from the surface of the ice. This lake sediment is typically surrounded by hills in areas of collapse topography; these hills are probably also composed of supraglacial sediment even where the sediment is uniform down-section. Nelson Ham (verbal communication, 1993) has observed thick, uniform sediment in hilly areas surrounding ice-walled-lake plains in Lincoln County.

Ice-walled-lake plains. Ice-walled-lake plains (map unit **lc**, plate 1), which consist of a flat to low-relief central offshore lake plain surrounded by a discontinuous rim ridge, are common features in the marginal zone of the Chippewa and Wisconsin Valley Lobes in Taylor County. They are also common in the marginal zone of the Chippewa Lobe farther west, in Chippewa County (Cahow, 1976). To the east of Taylor County, they are common in the marginal zone of the Wisconsin Valley Lobe (Nelson Ham, verbal communication, 1993). Some ice-walled-lake plains occur along the margin of the Langlade Lobe in Langlade County (Mickelson, 1986), and a few occur along the margin of the Green Bay Lobe in eastern Marathon (Attig and Muldoon, 1989) and Portage Counties (Clayton, 1986). They are less common farther south, along the margin of the Green Bay Lobe. Clayton (in press) has identified several ice-walled-lake plains in Waukesha County.

These lake plains formed as sediment was deposited in lakes that were surrounded by ice (fig. 15). Where the bottom of the lake was on solid ground, the bottom and shore topography of the lake is preserved in the modern landscape. Where the bottom of the lake was on ice, subsequent collapse has destroyed the lake bottom and shore morphology. Only well preserved ice-walled-lake plains are shown on the geologic map (map unit **lc**, plate 1). Much of what is shown on plate 1 as units **gch** and **gwh** consists of collapsed lake sediment. This is especially true in the central and western parts of the map area. Collapse topography underlain by sandy and silty lake sediment typically lacks abundant surface boulders and has a smoother aspect than areas underlain by more gravelly debris-flow sediment.

Sediment deposited in ice-walled lakes filled depressions in the ice. Melting of the ice left the lake sediment occupying many of the highest points in the landscape; this indicates a supraglacial source for the sediment deposited in the lakes. Centers of these lake plains are low-relief areas with gently rolling topography. They are underlain by silty and sandy nearshore and offshore sediment that is typically nearly free of cobbles and boulders. Sandy offshore bars are common. Buckley (1901) reported up to about 4 m of clay in a brickyard operated by Otto Fischer about 5.5 km north of Medford, and an area with up to about 8 m of clay at the Langenberg Brick Company at Whittlesey. This clay is most likely offshore sediment that was deposited in ice-walled lakes.

Many of these lake plains are well drained. As a result, in Taylor County ice-walled-lake plains are conspicuous on aerial photographs and topographic maps as islands of agriculture in areas that are generally forested. The typical pattern is agricultural fields on the offshore plain, and farm buildings on the rim ridge.

Rim ridges (dotted lines, plate 1) are present along the margin of most ice-walled-lake plains. In most places the rim ridge does not completely surround the central plain because the ridge may not have been deposited continuously around the plain or because it may have been destroyed by collapse or erosion during draining of the lake. It is common for several rim ridges to occur on one lake plain (fig. 16), indicating that the history of the lake included several phases. The water level in many ice-

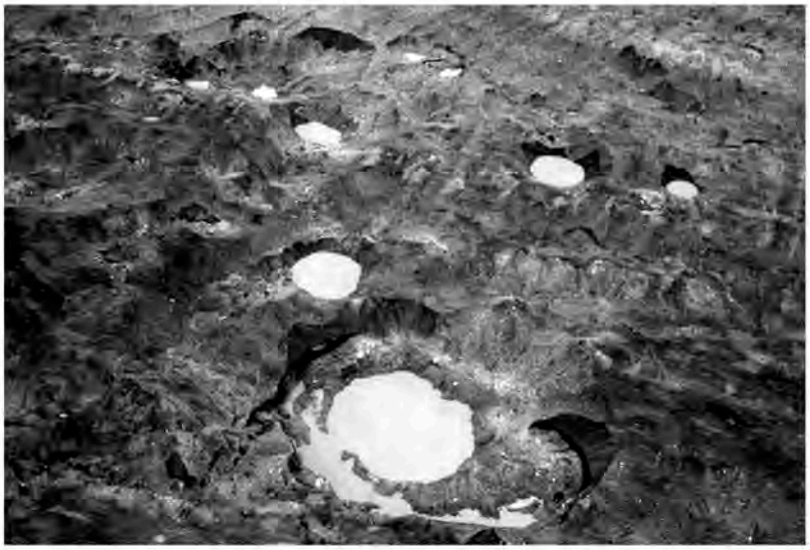


Figure 15. *View of the lower part of the Tokositna Glacier in the Alaska Range, Alaska, showing the debris-covered glacier and a number of ice-walled lakes. The largest of the lakes is estimated to be approximately 100 m wide. The ice wall can be seen at the upper right and lower left of the lake. The lake appears to have been larger recently.*

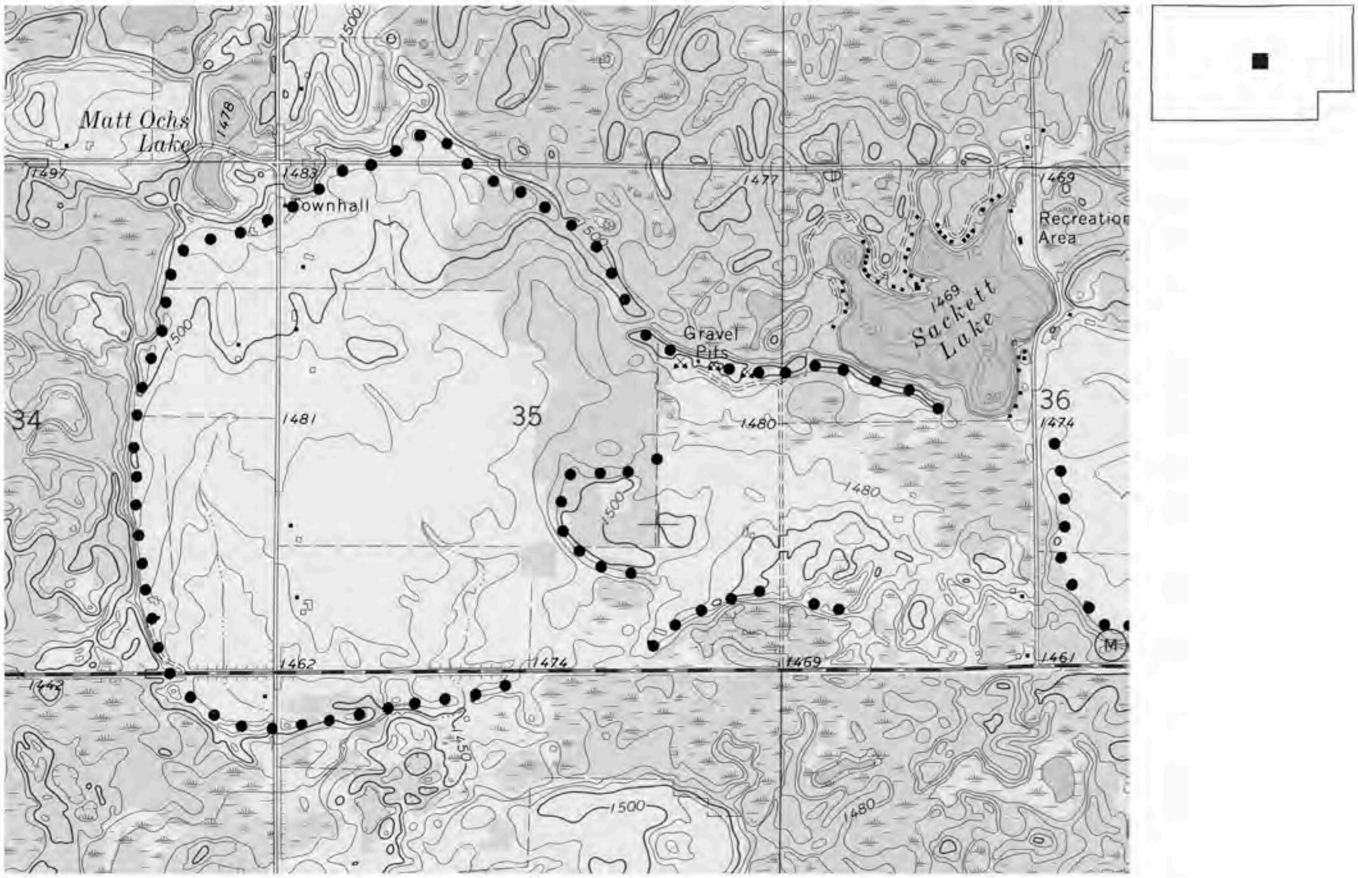


Figure 16. *Part of the Medford NW Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1970), showing an ice-walled-lake plain in sections 34 and 35. Note the well preserved rim ridge (shown by dots) along the western and northern margins of the lake plain. A segment of a smaller rim ridge formed during an early phase of the lake is present in the southeastern part of section 35. Part of a smaller ice-walled-lake plain can be seen just west of Matt Ochs Lake.*

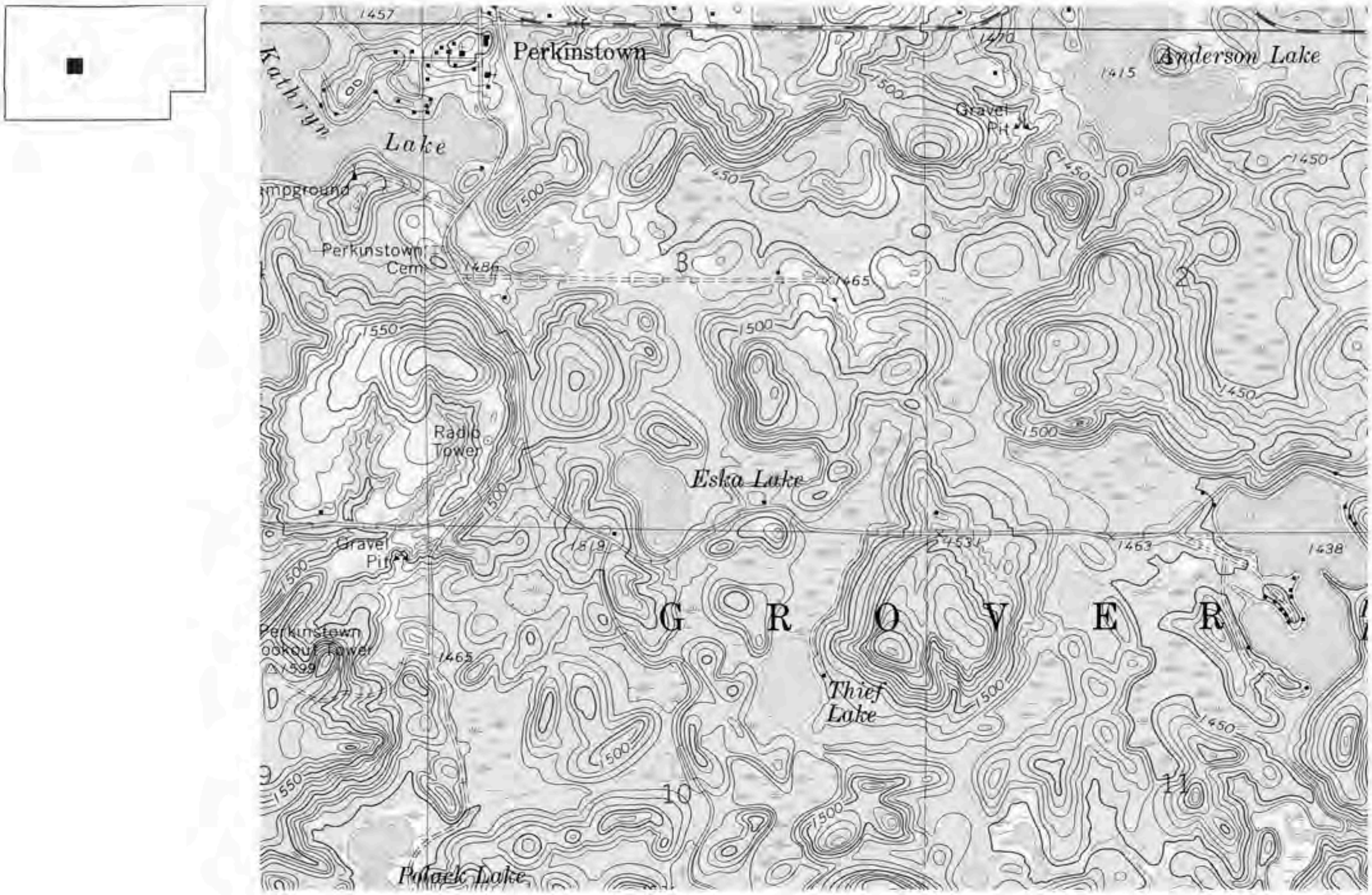


Figure 17. *Part of the Perkinstown Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1969), showing hilly topography composed mostly of collapsed lake sediment. Part of the offshore lake plain and part of its rim ridge is shown in the southwestern part of section 3 and the southeastern part of section 4.*

walled lakes apparently changed as new outlets opened or existing outlets were blocked. Most of the drainage of these lakes was likely subglacial (Clayton, 1964). The side of the rim ridge adjacent to the offshore plain is typically less steep than the ice-contact face. Cobbles and boulders are common on the surface of rim ridges. Gravel is commonly mined from pits in the rim ridges of ice-walled-lake plains.

Many ice-walled lakes apparently expanded and coalesced with other ice-walled lakes. In secs. 29 and 32, T32N, R1W, and sec. 5, T31N, R1W, is an example of an elongate ice-walled-lake plain that appears to have formed as several lakes coalesced. The rim ridges of this lake plain form valley walls that confine part of the modern drainage basin of Paradise Creek. This control of drainage by rim ridges is common. The rim ridges of ice-walled-lake plains confined late glacial drainage and now bound outwash surfaces in many areas, most notably in the Whittlesey area in the central part of the county. These areas are included in map unit **lc** on plate 1. Cahow (1976) described similar features in the marginal zone of the Chippewa Lobe.

A pit in the SW1/4 SW1/4 SW1/4 sec. 3 and SE1/4 SE1/4 SE1/4 sec. 4, T31N, R2W exposes a 5-m section through part of the rim ridge and offshore sediment of an ice-walled-lake plain. Steep-sided hills surround this ice-walled-lake plain. Some ice-walled-lake morphology is identifiable on some of these hills (fig. 17). Offshore sediment exposed in the pit consists of laminated layers of silty fine sand and clayey silt (fig. 18). Small-scale faulting is common in offshore sediment (fig. 18). About 50 m from the crest of the rim ridge (removed by mining), gravel-rich, poorly sorted, matrix-supported, crudely stratified, debris-flow sediment overlies laminated offshore sediment (fig. 19). The contact is sharp and dips away from the rim ridge toward the center of the basin. Many small roadcuts and exposures in pits indicate the rim ridges of ice-walled-lake plains in this area typically contain interbedded, well stratified, slightly gravelly sand, and unstratified to crudely stratified, gravelly, debris-flow sediment. The sediment in these rim ridges is believed to be mostly supraglacial debris-flow sediment, some of which has been reworked by waves or bottom currents. Many small sand and gravel mines are located in the more gravelly parts of these rim ridges.

In Taylor County, ice-walled-lake plains occur in the marginal zones of the Chippewa and Wisconsin Valley Lobes and in the area of the Black River Lobe. They are always associated with hilly collapse topography in areas that became separated from the ice sheet as it wasted back. Figure 13 shows the hypothetical sequence of events in the development of ice-disintegration landforms along the margin of the Chippewa and Wisconsin Valley Lobes in Taylor County.

Permafrost that persisted in the area until about 13,000 years ago (Attig and Clayton, 1992) probably inhibited the melting of ice buried beneath a thick debris cover and created a stable environment in which ice-walled lakes developed. Permafrost would also have restricted drainage of water through the ice. The lakes probably melted through to the glacier bed in a manner similar to that of modern thaw lakes in permafrost (French and Harry, 1983). When climate warmed and permafrost ended, the ice surrounding the ice-walled lakes melted, and hilly collapse features, disintegration ridges, and outwash fans formed.

When the ice surrounding the ice-walled-lake plains melted, the silty offshore plains were left as well drained high points in the landscape. Before vegetation became established, they were local sources of loess. In the southwestern part of the county, up to 1.5 m of this windblown silt is present immediately east of many of the large ice-walled-lake plains, indicating that the prevailing wind was from the west during late glacial time.

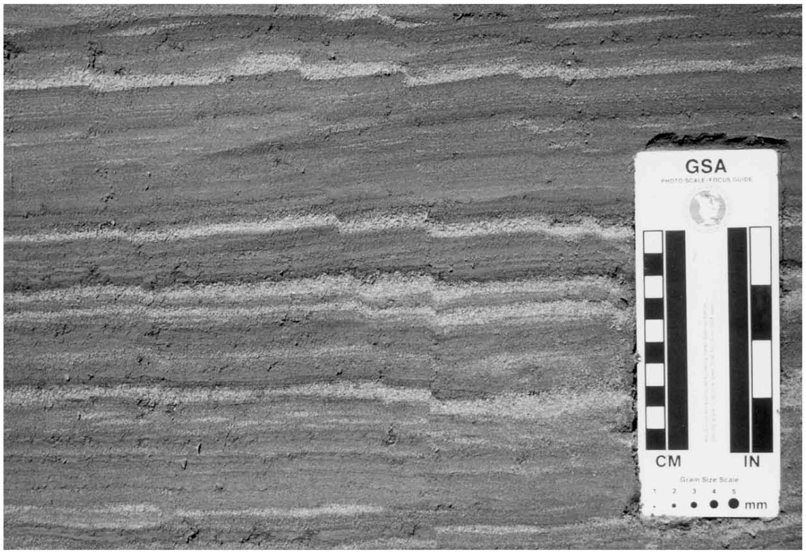


Figure 18. *Laminated offshore sediment deposited in an ice-walled-lake plain. Laminae, which consist of silty fine sand and clayey silt, have been offset by small-scale faulting.*

Figure 19. *Contact between laminated offshore sediment and overlying poorly sorted, crudely stratified debris-flow sediment. Area shown is approximately 50 m from the crest of the rim ridge of the ice-walled-lake plain. Knife for scale.*

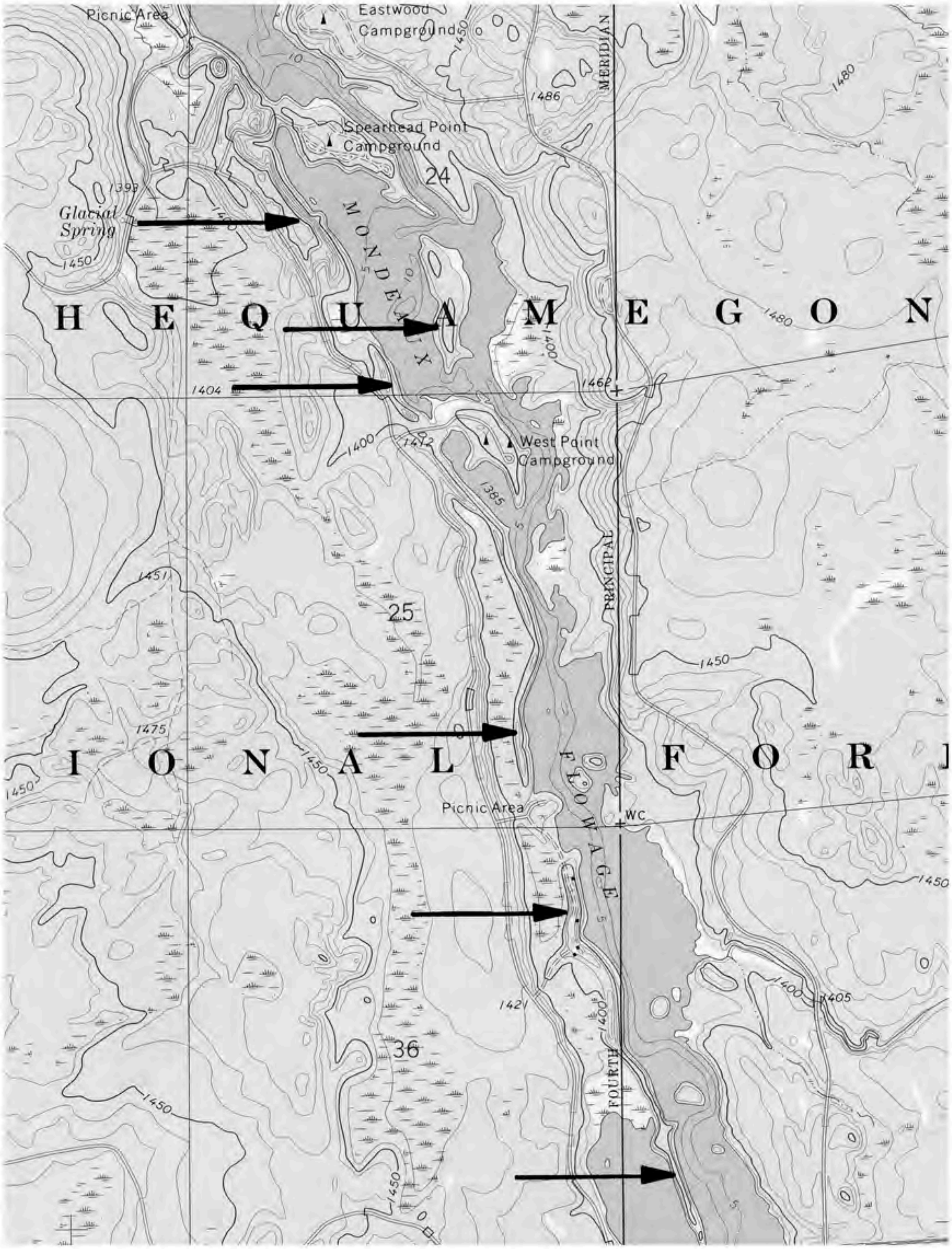


Figure 20. *Part of the Mondeaux Dam Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1970), showing the Mondeaux flowage. Note the esker segments (shown by arrows) and the trough occupied by the flowage.*

Tunnel channels and eskers. The Mondeaux Flowage in north-central Taylor County is a man-made impoundment of part of the Mondeaux River (figs. 20 and 21). It occupies a tunnel channel that is about 12 km long and 1 to 2 km wide. The southern extent of the trough is obscured by thick ice-marginal deposits. Maximum depth of the trough is unknown. The high points of the till upland adjacent to the trough are typically about 30 m above the level of the flowage. A drillhole (TA-268) drilled near the south end of the flowage in the NW1/4 NW1/4 of the west half of sec. 6, T32N, R1E, penetrated 6 m of brown, fine- to medium-grained sand with silt and silty clay lenses, 14 m of gray silt and silty clay with lenses of sand, and 3.5 m of gray silt with lenses of medium- to coarse-grained sand and ended on a large boulder or bedrock. Minimum relief for the trough is about 50 m. A discontinuous esker that splits into two parallel ridges extends through the Mondeaux Flowage area (plate 1; fig. 21).

Figure 21. *Low-angle aerial photograph of a part of the Mondeaux Flowage, looking northeast from the northwestern part of sec. 1, T32N, R1W, showing segments of an esker surrounded by water.*

The trough occupied by the Mondeaux Flowage is believed to have been eroded by meltwater flowing in a tunnel beneath the Chippewa Lobe. If the trend of the trough is projected south–southeastward, it would cross the margin of the late Wisconsin Chippewa Lobe in the area of Anderson Lake in sec. 5, T31N, R1E. Records of several water wells indicate the surface of granitic bedrock is at an elevation of about 425 m in that area. Samples from drillhole TA-268 indicate that the surface of bedrock beneath the southern end of the flowage is below about 410 m. These two points indicate the bedrock floor of the trough probably slopes northward, opposite the flow direction of water that would be expected beneath the Chippewa Lobe.

The trough floor sloped upward to the ice margin; therefore, the tunnel must have been full of water under hydrostatic pressure during the erosion of the trough. Wright (1973) referred to similar features as tunnel channels; according to him, these features probably formed in a similar manner beneath the Superior Lobe in Minnesota. Attig and others (1989) suggested that tunnel channels formed along the margin of the Laurentide Ice Sheet in Wisconsin were eroded by meltwater cutting through a marginal zone where the glacier was frozen to its bed. Following the erosional phase of tunnel-channel formation, discharge through the tunnel decreased and sediment was deposited. The thick, silty sediment penetrated by drillhole TA-268 may be lake sediment, deposited in the northward sloping trough until it filled to a level where drainage was southward to the ice margin. The deposition of the esker in the trough was likely during the last phase of drainage through the tunnel to the ice margin.

The conspicuous esker in the Upper Steve Creek Flowage, about 8 km west of the Mondeaux Flowage, is bordered by broad, linear wetlands (plate 1; fig. 22). These wetlands likely occupy a tunnel channel eroded at the bed of the glacier prior to deposition of the esker. The Chequamegon Waters Flowage in the west-central part of the county may also occupy a tunnel channel.

Black River Lobe. In the central part of the map area, around Whittlesey, an area of well preserved glacial landforms extends beyond the moraine ridge and outwash plain formed along the margin of the late Wisconsin Chippewa Lobe. This area is shown as map unit **gbh** on plate 1, and includes areas of map unit **lc**. The ice that deposited glacial material in this area is

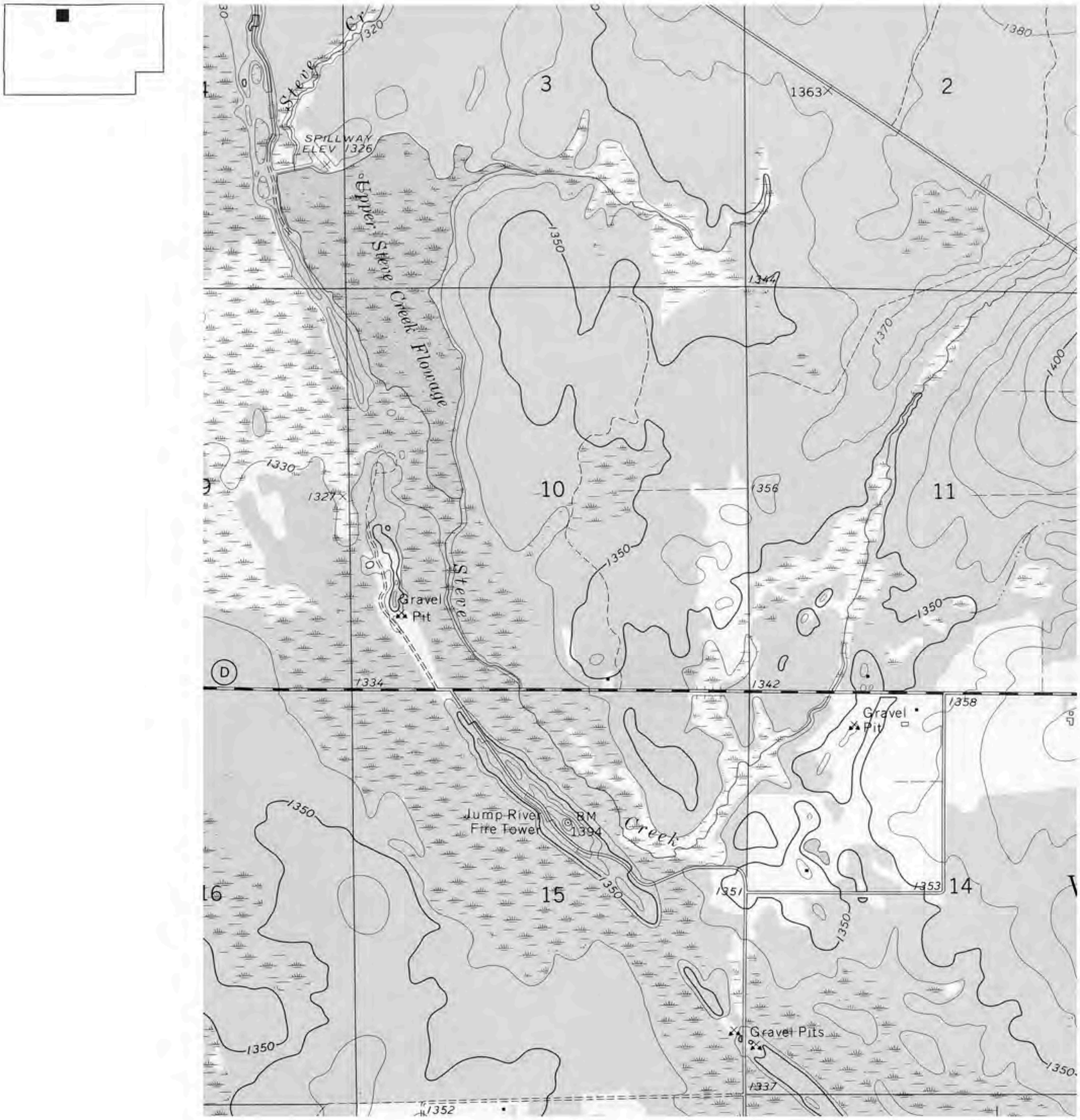


Figure 22. *Part of the Jump River Fire Tower Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1970), showing part of the Steve Creek Flowage. The conspicuous esker and the wetlands flanking it occupy a channel eroded in the bed of the glacier.*

referred to as the Black River Lobe (fig. 1). The margins of the Black River Lobe form part of the drainage divide around the upper part of the Black River.

The glacial sediment in the area that was covered by the Black River Lobe cannot be differentiated with confidence from sediment of the Copper Falls or Lincoln Formations (fig. 23).

The Black River Lobe was likely a small offshoot of the Chippewa Lobe that reached its maximum position slightly before the Chippewa Lobe margin stabilized to the northwest. The most conspicuous glacial landforms preserved in the area are ice-walled-lake plains. In the center of sec. 36, T32N, R1E, is a well preserved ice-walled-lake plain (figs. 24 and 25). The outermost moraine of the Chippewa Lobe can be seen to the northwest from the rim ridge along the northern margin of this lake plain.

The ice-walled-lake plains of the Black River Lobe are as well preserved as those formed while the late Wisconsin Chippewa and Wisconsin Valley Lobes wasted, which indicates that they also formed when permafrost ended in late glacial time. The northwestern margin of an ice-walled-lake plain in the northeastern part of sec. 32, T33N, R2E, is formed by the outermost

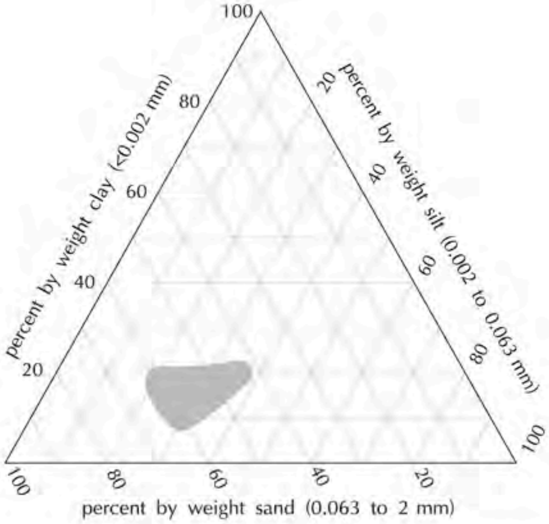


Figure 23. *Grain-size distribution of the finer-than-2-mm fraction of samples from till of the Copper Falls Formation. The distribution of the results from analysis of 56 samples is within the shaded area.*

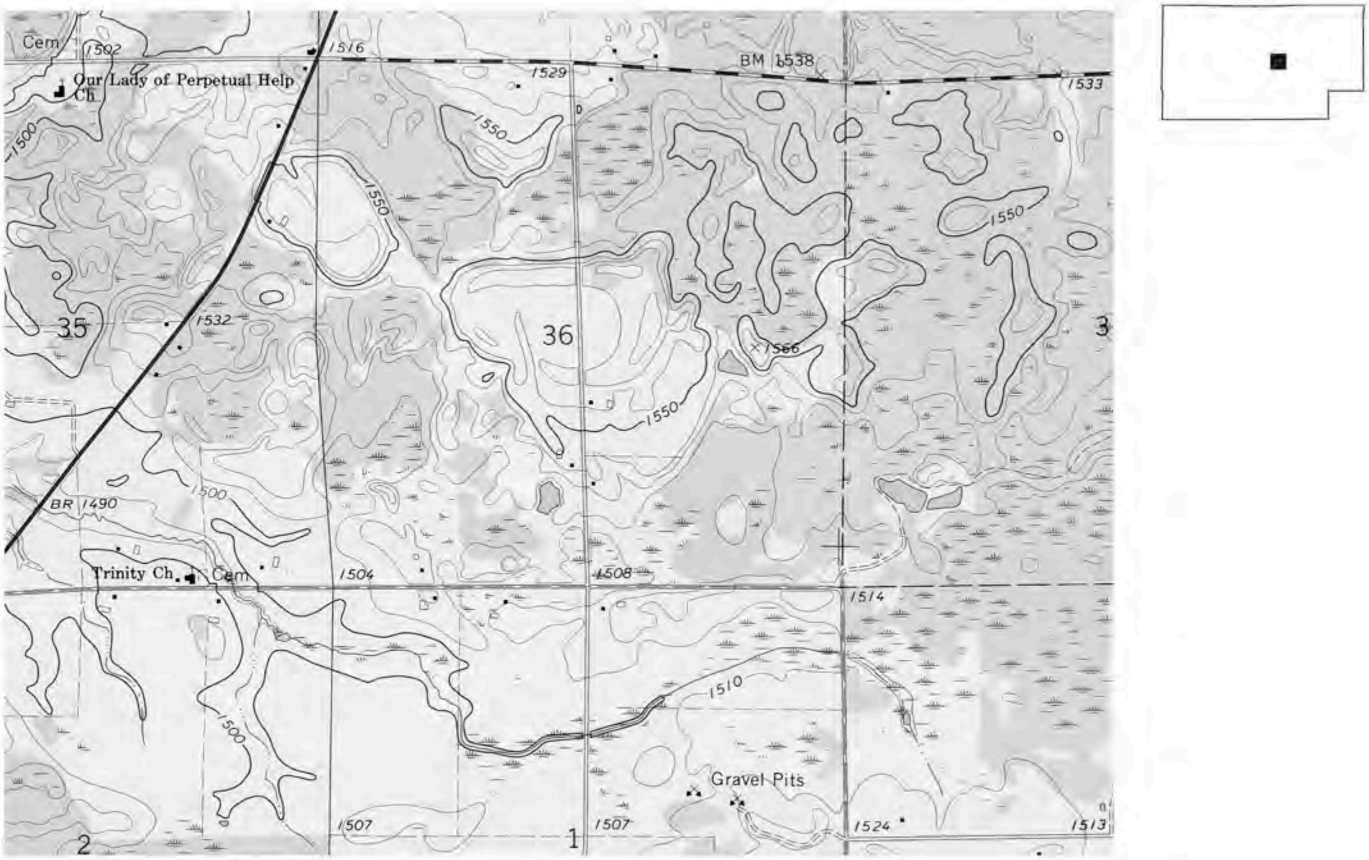


Figure 24. *Part of the Medford Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1969), showing a well preserved ice-walled-lake plain in the center of sec. 36, T32N, R1E. Other ice-walled-lake plains are shown in the northwestern and north-central parts of section 36.*

Figure 25. *Low-angle aerial photograph showing the ice-walled-lake plain in sec. 36, T32N, R1E. View to the west. Note the well preserved rim ridge. The field in the upper right part is another ice-walled-lake plain.*

moraine deposited by the Chippewa Lobe. The outwash surface beyond the moraine grades onto the lake plain but the lake plain was not buried with outwash sand.

Glacial history. By about 25,000 years ago, during the last part of the Wisconsin Glaciation, the margin of the Laurentide Ice Sheet had crossed the drainage divide south of the Superior basin (Clayton and Moran, 1982; Mickelson and others, 1983; Attig and others, 1985). The timing of the maximum extent of the late Wisconsin Chippewa and Wisconsin Valley Lobes in the Taylor County area is poorly known. No closely limiting radiocarbon dates exist. Regional correlation of ice-margin positions by Clayton and Moran (1982), Mickelson and others (1983), and Attig and others (1985) indicates the maximum occurred sometime between about 18,000 and 15,000 years ago, but these correlations are at best tentative.

Expansion of the Black River Lobe to its maximum extent is included in the Whittlesey Phase (fig. 7), named for Whittlesey in east-central Taylor County. Correlation of the outermost late Wisconsin moraine of the Chippewa Lobe in Taylor County westward to the ice-marginal positions identified by Johnson (1986) in Barron County is uncertain.

The ice-marginal ridge marking the maximum extent of the eastern part of the Chippewa Lobe is here named the Perkinstown moraine for Perkinstown in central Taylor County. The maximum extent of the Chippewa Lobe in Taylor County is included in the Perkinstown Phase (fig. 7). The maximum extent of the eastern part of the Chippewa Lobe in Taylor County probably occurred somewhat earlier than the maximum extent of the western part of the lobe. Correlation of the outermost moraine of the Wisconsin Valley Lobe eastward across Lincoln County, through an area where the maximum ice extent is uncertain (Nelson Ham, verbal communication, 1992), is unclear.

The ice-marginal ridge marking the maximum extent of the Wisconsin Valley Lobe during late Wisconsin time is here named the Wood Lake moraine. The name is derived from Wood Lake in northeastern Taylor County. The expansion of the Wisconsin Valley Lobe to its maximum extent is included in the Wood Lake Phase (fig. 7). The Wood Lake phase probably occurred somewhat earlier than the maximum extent of the eastern margin of the Wisconsin Valley Lobe (Nelson Ham, verbal communication, 1993).

TILL PLAIN OF THE CHIPPEWA LOBE

North of the marginal zone of the Chippewa Lobe, the landscape consists of a low-relief, gently rolling, till surface (map unit **gc**, plate 1). Small areas of hilly topography occur in places. Small eskers are also present. Eskers are not systematically separated from disintegration ridges in areas of hilly topography on plate 1. Streamlining is not apparent on topographic maps (scale 1:24,000) or on aerial photographs (scale 1:20,000 or 1:58,000).

The till plain of the Chippewa Lobe is underlain by uniform till of the Copper Falls Formation. Till of the Copper Falls Formation in Taylor County is gravelly, rich in sand, (typically about 57% sand, 28% silt, and 15% clay in the less-than-2-mm fraction) (fig. 23), reddish brown (field color 5YR 4/3 to 5YR 5/4 on the Munsell scale), noncalcareous, and contains gravel that is rich in rock types derived from the Superior basin. Clasts of metavolcanic rock are common. Copper Falls till is typically less than 10 m thick and overlies meltwater-stream sediment or older glacial material in many areas. Loess cover is typically less than 0.5 m thick.

The gently rolling till plain of the Chippewa Lobe in northwestern Taylor County probably closely resembles the shape of the bed of the Chippewa Lobe. Thick supraglacial sediment is present only in some places. Erosion has probably not greatly modified the late glacial landscape except along large, late glacial or postglacial drainageways.

The Chippewa till plain is remarkably similar in appearance to the till plain underlain by till of the Merrill Member of the Lincoln Formation in the central and eastern parts of the county. Hilly areas in the Merrill till plain are somewhat subdued in comparison to those in the Chippewa till plain. Although erosion has subdued the glacial landscape on the Merrill till plain, it may not have greatly altered it in most areas.

It is likely that the area shown by map unit **gc** on plate 1 contains some areas of meltwater-stream sediment. The low-relief landscape, the locally thick forest cover, and the lack of detailed soil maps in many areas may have resulted in some areas of meltwater-stream sediment being included in other map units.

STREAMLINED ZONE OF THE CHIPPEWA LOBE

In northwestern Taylor County the orientation of elongate hills, accentuated by intervening wetlands (map unit **p**, plate 1), characterizes a landscape that has a strong northeast–southwest grain (area CSZ, fig. 4) and that extends northward into Price and Rusk Counties. Its southern limit is indistinct, but seems to end no more than 1 or 2 km south of the Jump River. Topographic relief in the area is typically about 10 m. The few logs of water wells available from this area indicate that Pleistocene sediment is typically less than 25 m thick. Samples from three Wisconsin Geological and Natural History Survey drillholes (TA-239, TA-258, and TA-259) and numerous small surface exposures indicate that the Pleistocene sediment in the area is slightly gravelly, reddish brown, sandy till of the Copper Falls Formation, similar to that found throughout western Taylor County. Till of the Lincoln or Marathon Formation occurs in places beneath till of the Copper Falls Formation.

The origin of the topography in this area is unclear. It may reflect topography on the bedrock surface. The Jump River and the grain of the topography in northwestern Taylor County are approximately parallel to the strike of steeply dipping Precambrian lithologic units in the area described by Cummings (1980). Precambrian rock crops out in many places along the Jump River. It is possible that the elongate hills and wetlands in northwestern Taylor County are a reflection of the structurally controlled topography on the Precambrian rock surface. The modern topography could also be a result of draping of till over an older streamlined glacial landscape. No stratigraphic evidence for this is known.

It is more likely that the low-relief elongate hills in this area are drumlins that formed beneath southwest-flowing ice of the Chippewa Lobe (Attig and Clayton, 1990). This flow event would have occurred later than the advance of the Chippewa Lobe to its maximum position in Taylor County. This flow would have been nearly perpendicular to the earlier flow direction of the eastern part of the Chippewa Lobe in the area. The ice-marginal features that mark the western extent of the Chippewa Lobe west of the Chippewa River and the offseat in the lobe margin at the Chippewa River probably formed during the younger flow event.

How could ice-flow direction in the Chippewa Lobe change so radically during the last part of the Wisconsin Glaciation? I suggest that thick rock debris insulated ice along the outermost extent of the Chippewa Lobe of north-central and northeastern Taylor County and adjacent areas. As a result, buried ice persisted after cleaner ice had wasted northward out of the area. A subsequent readvance may have been deflected westward by the relatively high elevation of the ice-cored landscape. Clark (1992) suggested that the Chippewa Lobe had a low ice profile. The flow direction of a low profile ice mass would have been greatly influenced by ice-cored topographic features with only modest relief. Nelson Ham (verbal communication, 1993) suggested a similar sequence of landform development and change in ice-flow direction for the Wisconsin Valley Lobe.

THE MODERN LANDSCAPE

Permafrost is believed to have persisted in central Wisconsin throughout the time during which the Laurentide Ice Sheet stood at its maximum extent, and during its wastage from the Taylor County area (Attig and Clayton, 1992). Permafrost resulted in accelerated erosion of the landscape beyond the ice sheet.

The degree of soil development on the Edgar, Merrill, and Copper Falls till surfaces is quite similar (Sutherland, 1989), even though the time of deposition of the till units may differ by 100,000 years or more. Clayton (1991) reported that illuvial clay extends to depths of 2 or 3 m in Edgar till in a few localities in Wood County. He interpreted these soils as paleosols that survived erosion in protected places in the landscape. This local evidence for greater soil development, coupled with the general uniformity of soil development over surfaces of quite different ages, indicates that extensive slope erosion probably occurred during the last part of the Wisconsin Glaciation, destroying soils that had developed prior to that time. When permafrost melted, the land surface stabilized and the modern soil began to develop.

Most of the cap of windblown sediment must have accumulated after the landscape beyond the maximum position of the ice sheet had stabilized. Windblown silt that fell on the landscape while permafrost persisted would have been mixed into sediment actively moving downslope. As a result, loess thickness is uniform, typically less than 0.5 m throughout the map area. If not removed or mixed by slope processes, loess should be thicker on the older units, where more loess would have accumulated with each glaciation.

Permafrost also delayed the melting of ice buried by glacial, lake, or stream sediment. When permafrost melted, ice buried along the margin of the ice sheet also melted and sediment in or on the ice collapsed to form the irregular hilly topography that marks the maximum extent of the ice sheet. During this period of collapse, any incipient soil development or accumulation of windblown sediment would be periodically destroyed by mixing as sediment moved down the ice surface.

Since the end of permafrost, the landscape has been relatively stable. Landforms developed at the end of the Wisconsin Glaciation in Taylor County are well preserved. The landscape continues to be modified by the slow, downslope movement of sediment that has been accelerated by land clearing, the accumulation of windblown dust, the development of modern stream features, and other geomorphic processes.

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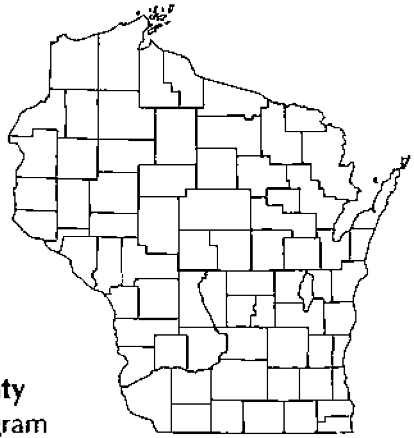
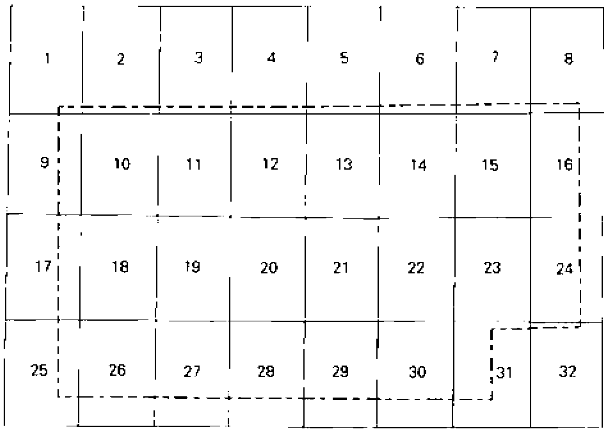


Taylor County
location diagram

Index to U.S. Geological Survey topographic quadrangles
(7.5-minute series; scale 1:24,000)



1 Tony-1971
2 Sheldon NE-1971
3 Jump River Fire Tower NW-1970
4 Jump River Fire Tower NE-1970
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Cover: *Low-angle aerial photograph of part of the Mondeaux Flowage (looking northeast from the northwestern part of sec. 1, T32N, R1W), showing segments of an esker surrounded by water; part of the Mondeaux Dam Quadrangle, Wisconsin (U.S. Geological Survey, 7.5-minute series, topographic, 1970).*