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PLEISTOCENE GEOLOGY OF THE MARATHON COUNTY AREA OF CENTRAL WISCONSIN

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ABSTRACT

Five geomorphic areas, each with distinctive topography and surficial materials, are present in the Marathon County area. The entire area was glaciated during the Pleistocene, but well-preserved glacial topography occurs only on geomorphic area 5, the area which was glaciated during the late Wisconsin. In the other areas erosion has removed glacial landforms, and the degree of dissection increases with the age of surficial materials. Each geomorphic area represents the surficial exposure of a different glacial sedimentary unit. Glacial sedimentary units have been designated as formations and members ranging in age from pre-Illinoian (Marathon Formation) through late Wisconsin (Mapleview Member).

INTRODUCTION

Marathon and northern Wood Counties are located in central Wisconsin (fig. 1), most of which was glaciated before the last part of the Wisconsin Glaciation (before about 25,000 years ago). Only the easternmost part of Marathon County was glaciated during the last part of the Wisconsin Glaciation about 25,000 to 10,000 years ago in Wisconsin. A number of aspects of earlier Pleistocene history have been studied (see for example Chamberlin, 1882; Leverett, 1899; Weidman, 1907; Hole, 1943b; Thwaites, 1943; Black, 1962; Stewart, 1973; Mode, 1976; LaBerge and Myers, 1983). Although much work has been done, the answers to many questions regarding the Pleistocene history of the area remain incomplete. This summary paper is a revised version of a paper prepared for the 50th Annual Tri-State Field Conference (Mode and Attig, 1986).

For discussion purposes Marathon County and the northern part of adjacent Wood County can be divided into five areas, each of which contains a characteristic landscape and characteristic Pleistocene sediment (fig. 2; table 1; Attig and Muldoon, in preparation; Clayton, in preparation). In this paper we discuss each of the five areas, their landscape, the nature of underlying Pleistocene sediment, and various aspects of Pleistocene stratigraphy and history.

PREVIOUS INVESTIGATIONS

Most workers have interpreted the relative thinness of Pleistocene sediment beyond the outer late Wisconsin moraine to be the result of extensive erosion and therefore treated the thinness as evidence of great age. Some (for example Hole, 1943a, b) have suggested that the sediment was deposited by a thin, debris-poor glacier that was short-lived. One reason for such interpretations is the paucity of exposures in central Wisconsin, especially

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Table 1. Characteristics of geomorphic areas in Marathon County and adjacent Wood County.

AREA	GEOMORPHIC CHARACTER	PLEISTOCENE MATERIALS (Excluding valley-fill deposits)
1.	Low relief, rolling topography; Pleistocene sediment is thin and discontinuous on Precambrian or Cambrian rock	Undifferentiated Marathon Formation including the Wausau Member of the Marathon Formation
2.	Gently rolling topography on uplands; Precambrian or Cambrian rock rarely crops out except where streams have incised through the Pleistocene sediment	Edgar Member of the Marathon Formation
3.	Broad ridge with no small-scale glacial features	Bakerville Member of the Lincoln Formation overlying sand and gravel (calcareous) and the Edgar Member of the Marathon Formation
4.	Gently rolling topography with some subdued glacial topography, including moraine ridges and areas of hummocky topography	Merrill Member of the Lincoln Formation
5.	High-relief hummocky topography in moraines; very fresh glacial landscape with much collapse topography and many undrained depressions	Mapleview Member of the Horicon Formation

those containing more than one stratigraphic unit. Recent studies of the stratigraphy of the area using a power auger have added to our knowledge of the nature and distribution of lithostratigraphic units present (Attig and Muldoon, in preparation).

The earliest geologic map of the area showed Pleistocene material beyond the outer late Wisconsin moraine as an Older Drift of the First Glacial Epoch, bounded on the south by the Driftless Area, and bounded on the north by the prominent moraine of the Younger Drift of the Second Glacial Epoch (fig. 3a; Chamberlin and Salisbury, 1885; Chamberlin, 1882, 1883). The main distinction for these workers between late Wisconsin material and older Pleistocene material was thickness, but they also noted the advanced degree of decay of pebbles in the older material.

Chamberlin (1882) opened the debate about interpretation of the area of older glacial deposits when he stated that the topography was mainly preglacial and had only been slightly modified by deposition of a thin veneer of glacial sediment. He apparently did not feel this was the sole reason for the topography, however, because he was later cited by Weidman (1907; through personal communication) as having noted that the advanced state of erosion of the older deposits was comparable to that of material deposited during the Kansan Glaciation in Iowa.

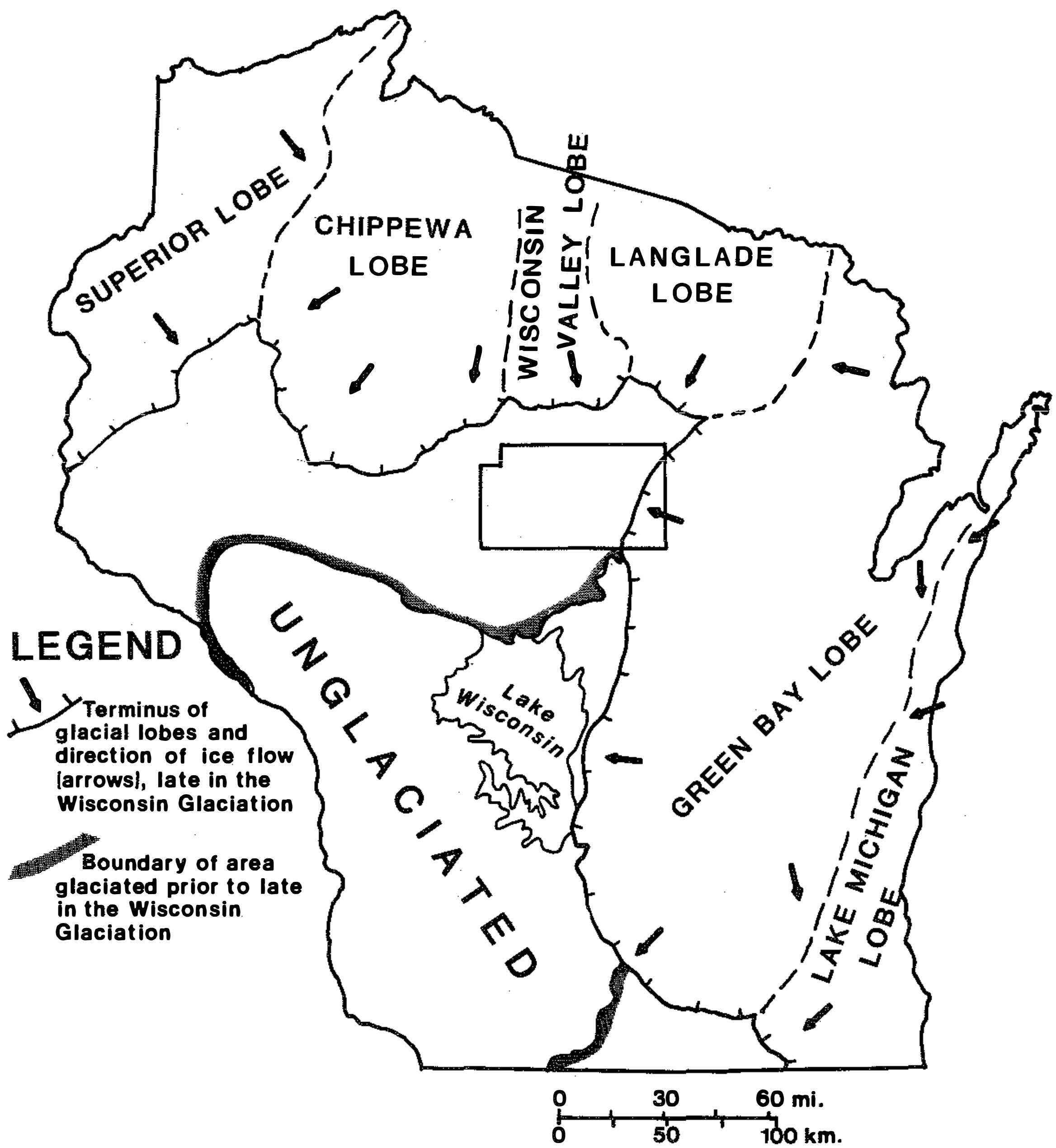

Figure 1. Location of glacial lobes in Wisconsin. Marathon County is outlined and Wood County adjoins its southern boundary.

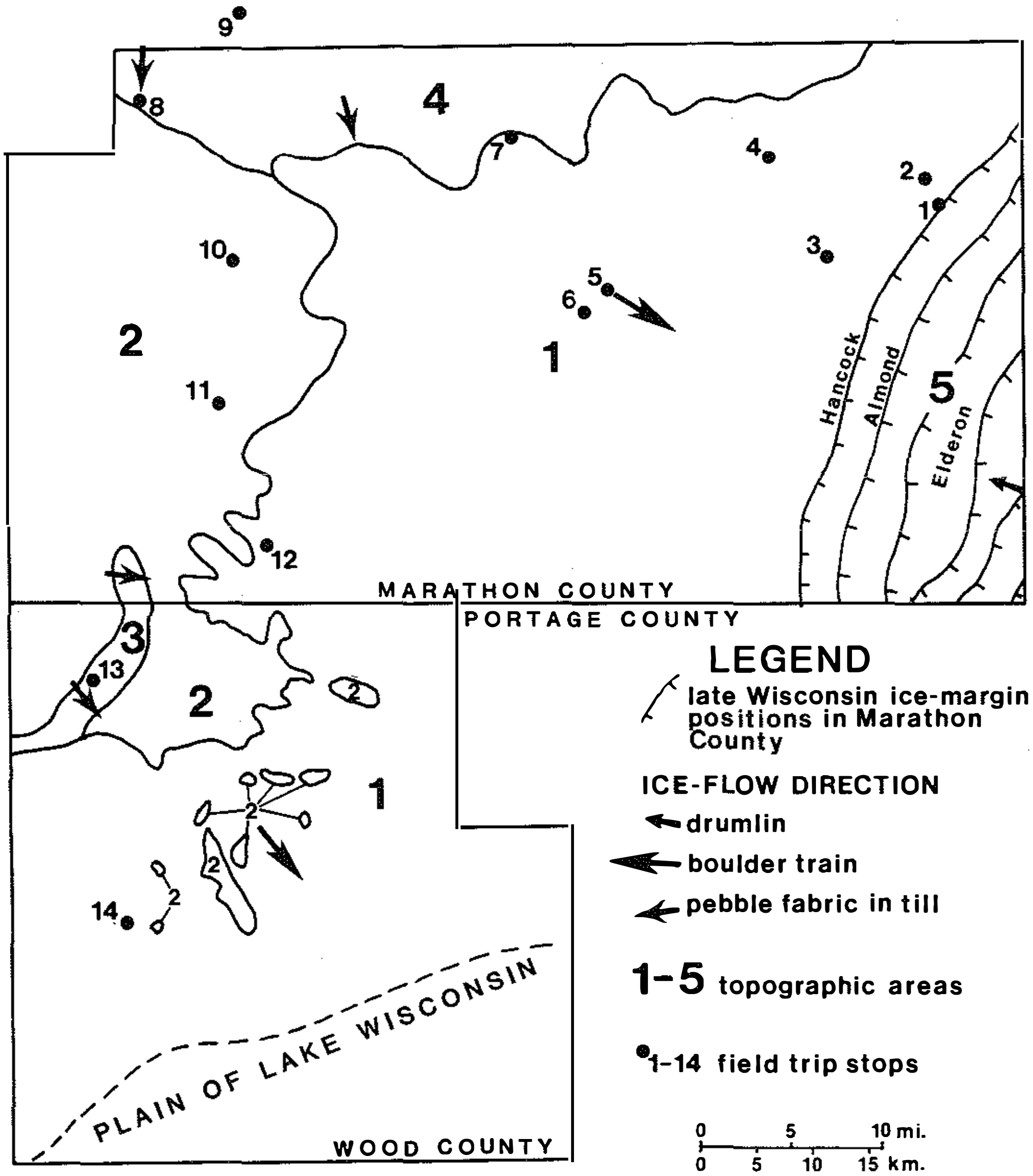

Figure 2. Geomorphic areas in Marathon (Attig and Muldoon, in preparation) and Wood Counties (Clayton, in preparation).

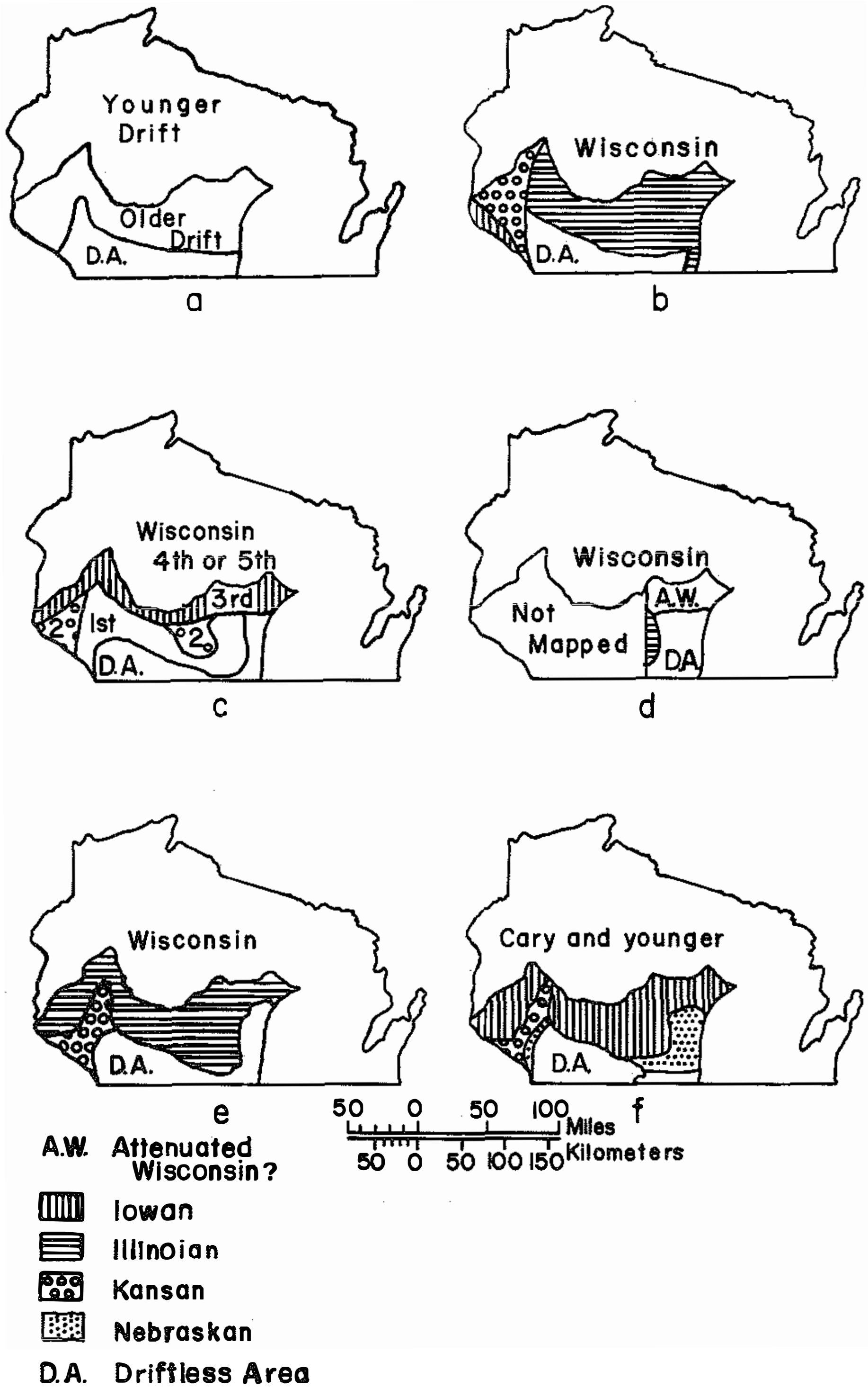

Figure 3. Interpretations of the age of older glacial deposits in central Wisconsin. a) Chamberlin and Salisbury (1885); b) Leverett (1899); c) Weidman (1907, 1913); d) Leverett and Taylor (1915); e) Leverett, in Antevs (1929); and, f) Thwaites (1955).

Leverett (1899) distinguished one pre-Wisconsin unit in central Wisconsin and assigned it an Illinoian age on the basis of color, clay content, pebble lithology, and degree of weathering (fig. 3b).

Weidman (1907) mapped First, Second, and Third Drifts in the area of older materials, with the First Drift being oldest and farthest south (fig. 3c), but he thought that central Marathon County was unglaciated. He used weathering to distinguish units and as an index of relative age. Feldspar grains in igneous clasts are weathered to kaolinite at depths of 10 to 15 feet in the First Drift and 10 to 20 feet in the Second Drift. The yellowish-brown color of oxidized First and Second Drifts results from extensive oxidation and disintegration of iron-bearing minerals to a greater degree than has occurred in the reddish brown Third and Fourth Drifts. Abundant clay and compaction were also thought to reflect the greater age of the First and Second Drifts.

According to Weidman, the Third Drift was intermediate in age between the Fourth (Wisconsin) Drift, and the First and Second Drifts. Though more dissected than the Fourth Drift, it has discontinuous, ice-marginal ridges and hummocky topography, and the degree of weathering is much less than in the First and Second Drifts. Weidman (1913) correlated the Second Drift with the Kansan of Iowa and the Third Drift with the Iowan of northeastern Iowa.

Weidman also discussed the origin of the topography. He believed that the topography in areas of extensive postglacial stream trenching was no longer influenced by the older materials, but in areas where the streams were not deeply entrenched, the older materials did influence topography. This interpretation was based on his observations of overburden thickness. The average thicknesses of till of the First, Second and Third Drifts are 8, 30, and 5 feet, respectively, and Weidman found that each drift thickened at its edge, which he interpreted as remnants of end moraines. However, other workers (Chamberlin and Salisbury, 1885; Hole, 1943a,b) found that the older glacial deposits thin continuously and gradually from north to south.

In a map drafted in 1913 Leverett and Taylor called Weidman's First and Second Drifts both Illinoian, and did not distinguish them from each other. The map also showed Weidman's Third Drift as "Attenuated Drift, Wisconsin?" (fig. 3d). Leverett (in Antevs, 1929) correlated virtually all of the older materials with the Illinoian (fig. 3e).

Hole (1943a, b) concluded that the older materials were only one rock unit and that it was probably Wisconsin (Cary) in age. He saw no strong evidence for more than one glacial event because there were no multiple-till exposures, no till beneath buried soils, and nothing but gradual changes in till lithology, which he thought reflected local differences in bedrock. He found that the older material was not more deeply weathered than late Wisconsin (Cary) deposits, and suggested that Cary ice first advanced to the edge of the Driftless Area and then retreated rapidly before coming to a prolonged halt and depositing prominent end moraines.

Thwaites (1943) found no unglaciated area in Marathon County and stated that moderate erosion and weathering and immature soil profiles in the older materials indicate an Iowan age. His map (1955) showed most of the older sediment as Iowan, but some was mapped as Nebraskan (fig. 3f).

Black (1962) introduced the term Rockian for the period of glaciation in Wisconsin that began around 30,000 B.P. At that time he felt that there were no Pleistocene deposits in Wisconsin that were older than Rockian, that the older materials in central Wisconsin were Rockian, and that it was Rockian ice which glaciated the Driftless Area. He was later to agree with others that there may have been some pre-Rockian glaciation of the state (Frye and others, 1965; Black and others, 1965; Black and Rubin, 1968).

Based on lithologic and weathering studies in northern Marathon County, Olup (1969) supported Hole's (1943a, b) conclusion that the First, Second, and Third Drifts of Weidman (1907) are petrologically the same, and he assigned this single unit a Rockian age.

LaBerge and Myers (1983) defined two old glacial units in eastern Marathon County in the area beyond the outer late Wisconsin moraine and informally named the two till units the Wausau and the Merrill. The Merrill corresponds to Weidman's (1907) Third Drift, and the Wausau is found in Weidman's Driftless Area near the Wisconsin River and in the area of the First Drift. It is extremely thin, and its distribution is patchy. Stewart (1973) differentiated three till units, the Merrill, Wausau, and late Wisconsin using color, grain-size distribution, and clay mineralogy. The Wausau and Merrill units have much higher vermiculite contents than late Wisconsin till. The Wausau unit, which was found beneath the Merrill unit in one locality, has abundant smectite. A radiocarbon date of 40,800 2,000 B.P. (ISGS-256) on organic sediment overlying the Merrill (Stewart and Mickelson, 1976) was the first conclusive evidence that the older materials were deposited before late Wisconsin time.

Mode (1976) informally named two additional old till units, the Bakerville and Edgar (fig. 4). In power auger holes he found the Bakerville overlying the Edgar and the Edgar overlying the Wausau. Dark gray, organic-rich sediment (till?) was also found underlying the Edgar in several drill holes. Drilling logs of Bell and Sherrill (1974) also recorded this dark gray material in the subsurface. The distinctive feature of till of the Edgar unit is that it contains abundant calcite.

Mickelson and others (1984) formalized the Pleistocene rock stratigraphy of Wisconsin. Units that are found in the area described here are shown in figure 5. The Pleistocene geology of Marathon County (Attig and Muldoon, in preparation) and Wood County (Clayton, in preparation) are now being studied by the Wisconsin Geological and Natural History Survey.

The emphasis of this review has been upon the older glacial deposits. Attig and others (1985) reviewed the late Wisconsin glacial history and designated the St. Croix-Hancock Phase as the time when the outer moraine (Hancock moraine of Clayton, in press) of the Green Bay Lobe formed, about 18,000 to 15,000 B.P.

GEOMORPHIC AREAS

The landscape of Marathon County and part of Wood County can be divided into five areas, each of which has distinctive topography and surficial materials (fig. 2; table 1). The topographic character of each area is

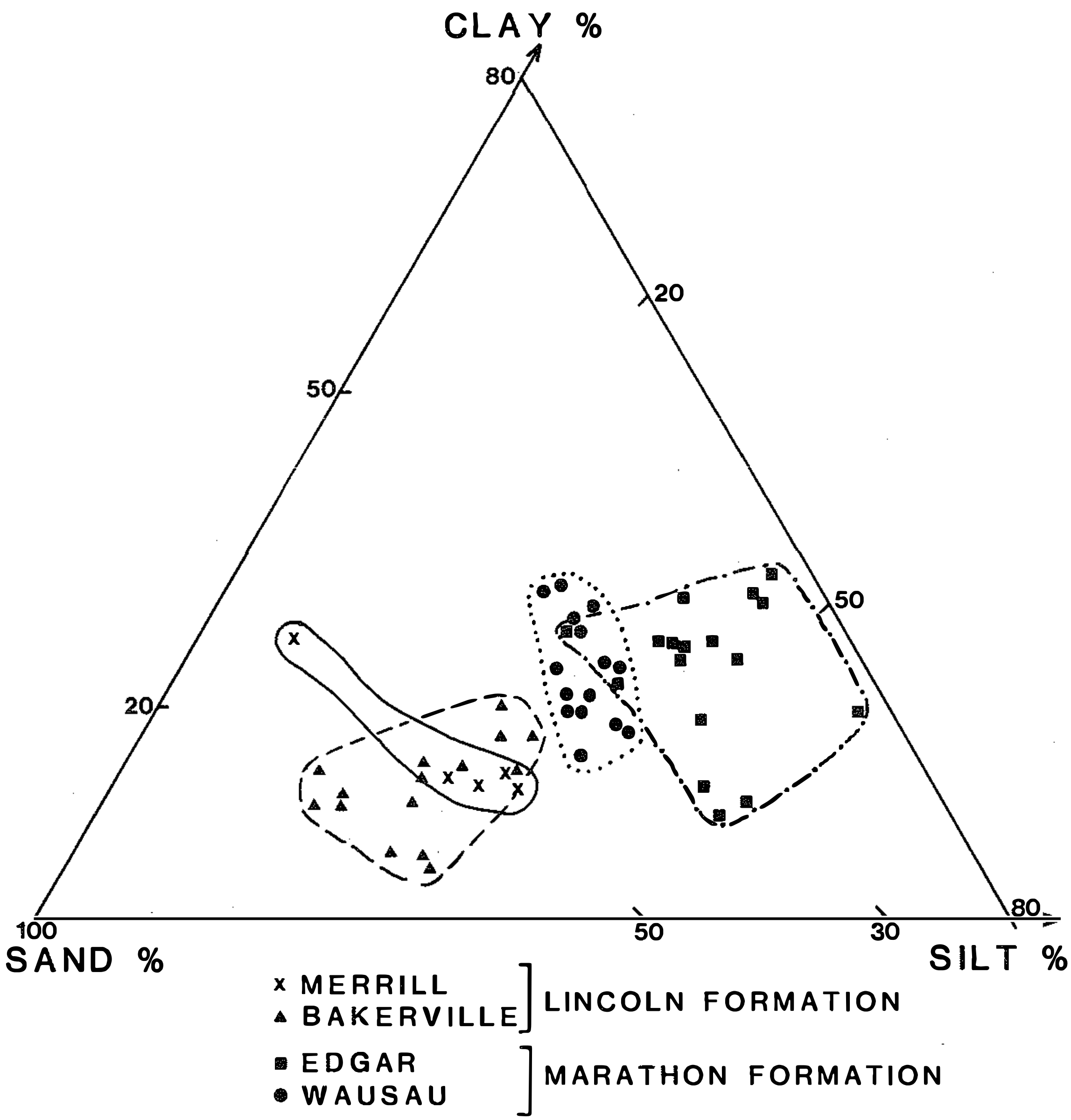

Figure 4. Grain-size distribution of the less-than-2 mm fraction of till samples from Marathon County and adjacent areas (Mode, 1976).

MEMBERS	FORMATIONS
MAPLEVIEW	HORICON
MERRILL	LINCOLN
BAKERVILLE	
EDGAR	MARATHON
— — ?— — — ?— — —	
UNNAMED(?)	
WAUSAU	

Figure 5. Pleistocene stratigraphic units in Marathon County (Mickelson and others, 1984).

primarily related to the time since the area was last glaciated, but it is also related to the proximity of major drainage and the nature, thickness, and distribution of Pleistocene material.

Area 1

Area 1 occupies central Marathon and Wood Counties (fig. 2) and is characterized by rolling topography developed on Precambrian igneous and metamorphic rock and Cambrian sandstone (fig. 6). This is approximately the same area that Weidman (1907) interpreted to be unglaciated, but that was later recognized as being glaciated (Thwaites, 1943; LaBerge and Myers, 1983). Soils are poorly drained because Precambrian rock is near the surface and the overburden has abundant clay. Many rock outcrops occur and the highest points in the landscape are typically underlain by resistant lithologies such as the quartzite underlying Rib Mountain. No glacial topography is preserved except for late Wisconsin outwash surfaces in the valleys of the Wisconsin, Eau Claire, and Rib Rivers.

Attig and Muldoon (in preparation) have mapped the thin surficial materials of this area as undifferentiated Marathon Formation, a map unit which includes till of the Wausau Member, possible other old till units, residuum, and slope deposits. These individual constituents cannot be differentiated because outcrops are few and the materials are not readily distinguishable from

Table 2. Till characteristics, Marathon County. Clay minerals are illite (I), kaolinite-chlorite (K), vermiculite (V), and smectite (S). Calc? indicates whether the till is calcareous. NA means no data are available.

Formation & Member	Color	Sand/silt/ clay (%)	Clay Mins (%) I	K	V	S	Calc?
Horicon							
Mapleview	brown (7.5 YR 4/4) to reddish brown (5 YR 4/4)	83/13/4	69	13	5	14	no
Lincoln							
Merrill	dark reddish brown (5 YR 3/4 to 2.5 YR 3/4)	62/28/10	53	9	22	16	no
Bakerville	reddish brown (5 YR 4/4)	62/25/13	53	8	14	25	no
Marathon							
Edgar	variable; yellowish brown (10 YR 5/6) to reddish brown (5 YR 4/4)	33/43/24	44	6	17	33	yes
unnamed member	brownish black (10 YR 2/2)	NA	NA				yes
Wausau	brown (7.5 YR 4/4)	43/34/23	44	5	18	32	no

one another in the field. Scattered erratics derived from the Lake Superior region, especially clasts of Keweenawan volcanic rock, and loess are widespread at the surface. Wind polished and faceted cobbles are common in this area.

Till of the Wausau Member is found directly overlying Precambrian rock. The Wausau Member of the Marathon Formation is the oldest Pleistocene unit in Marathon County (fig. 5). It contains brown, pebbly loam to clay loam till (fig. 4), which has a clay mineral assemblage dominated by expandable clays, essentially identical to the clay mineral assemblage of till of the Edgar Member (table 2). The reason that till units of the Marathon Formation contain larger amounts of expandable clay than till units of the Lincoln and Horicon Formations is one or more of the following: they were derived from a different source region; they were derived from deeply weathered source materials, which, when removed by glacial erosion, exposed fresh rock to erosion by subsequent advances; or, they have become more deeply weathered since they were deposited. Systematic change in clay mineralogy occurs with increasing depth in Marathon Formation till (Stewart, 1973; Mode, 1976), which demonstrates that weathering has caused at least some of the difference in clay mineralogy

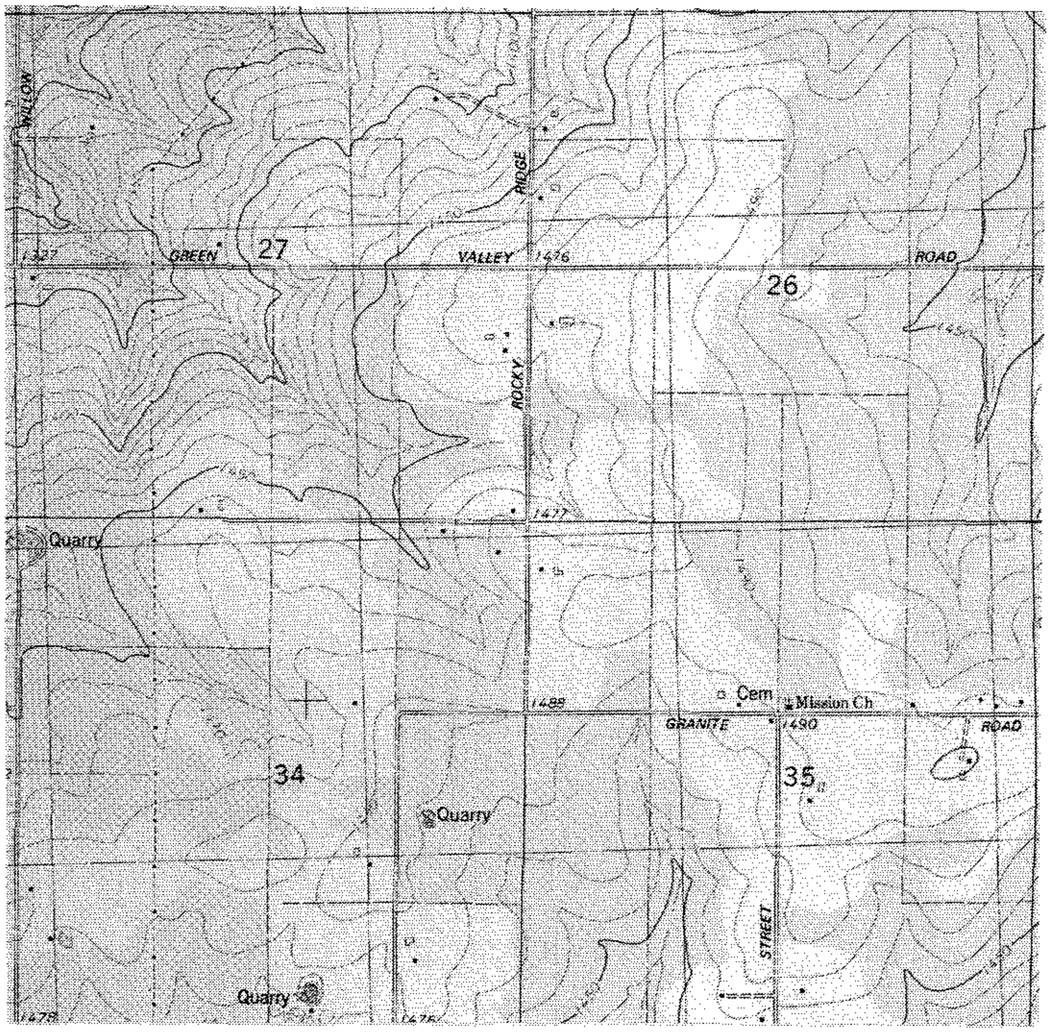

Figure 6. Topography of area 1, undifferentiated Marathon Formation (Attig and Muldoon, in preparation) in north-central Marathon County, Nutterville 7.5-minute quadrangle, T. 30 N., R. 8 E.

between the Marathon Formation and the Lincoln and Horicon Formations. Boulder trains (fig. 2) indicate that ice-flow direction across area 1 was southeast to east-southeast (Weidman, 1907; LaBerge and Myers, 1983; Clayton, in preparation).

Area 2

Western Marathon County and northwestern Wood County are included in area 2 (fig. 2). This area roughly corresponds to the area of Weidman's (1907) Second Drift. Flat to gently rolling uplands with a few deeply incised valleys are the most obvious topographic characteristics. Outcrops of rock in upland areas are uncommon. No glacial topography is preserved (fig. 7). Drainage is well integrated, and no lakes and few bogs occur. Soils are better drained than in area 1, resulting in considerably more cultivation in area 2.

The surficial material in area 2 is the Edgar Member of the Marathon Formation (Attig and Muldoon, in preparation). Its thickness reaches 25 m on uplands and is commonly 15 m. The brown, loam till of the Edgar Member is similar to that of the Wausau Member except that it is calcareous and contains more silt (fig. 4; table 2). It is leached of carbonates to depths of as much

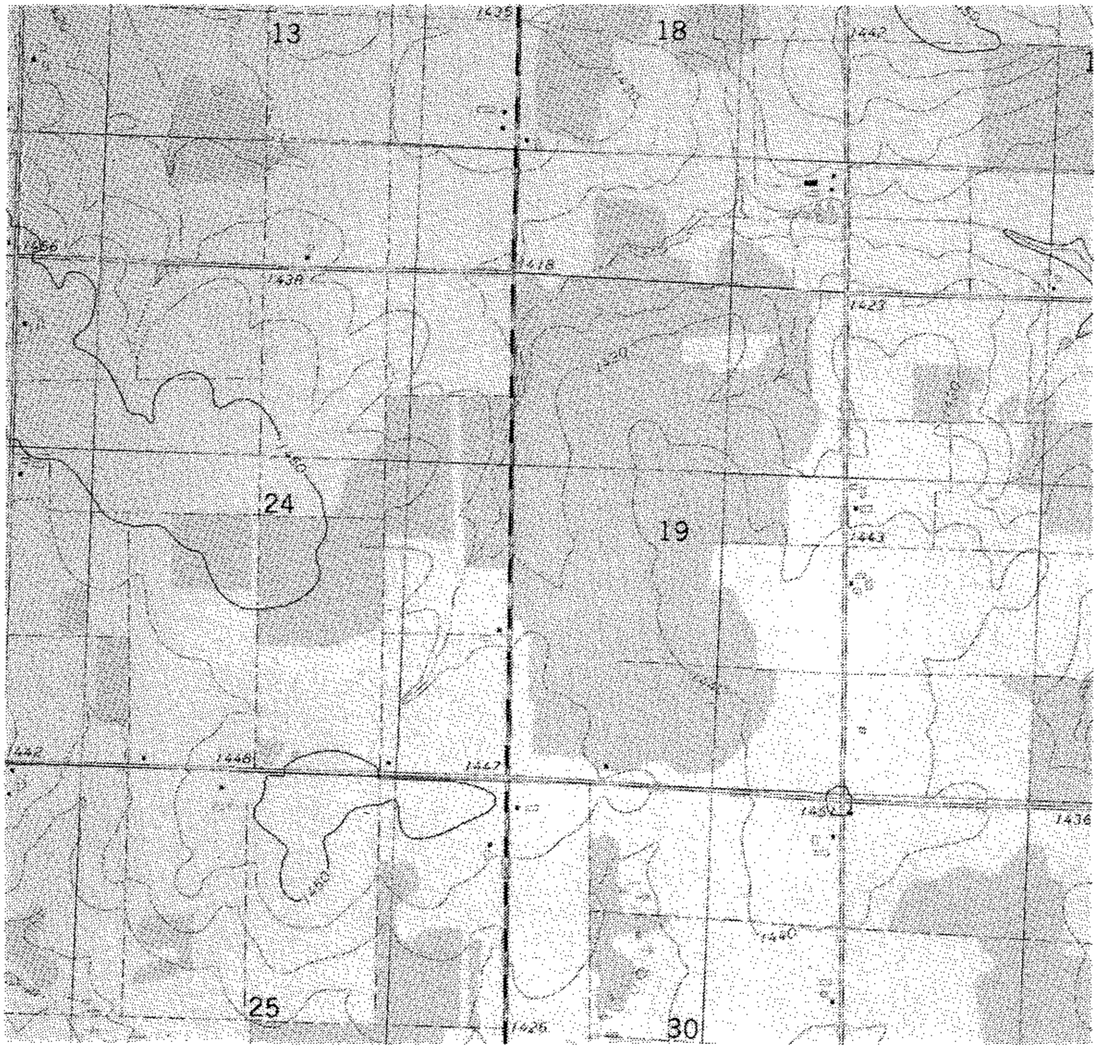

Figure 7. Topography of area 2, the Edgar Member of the Marathon Formation (Attig and Muldoon, in preparation) in northwestern Marathon County, Wein 7.5-minute quadrangle, T. 29 N., R. 3 and 4 E.

as 3 m, but below this level pebbles of fossiliferous limestone are present. In a few areas calcareous material is present within 1 m of the surface. Mode (1976) measured one pebble fabric in till that indicated southward ice flow.

Till of the Edgar Member overlies the Wausau Member, organic sediment, and weathered rock. Organic sediment may also be interstratified with till of the Edgar Member. Though Mickelson and others (1984) distinguished organic sediment as an unnamed member of the Marathon Formation, it may be part of the Edgar Member. Attig and Muldoon (in preparation) report that till of the Edgar Member was deposited by more than one glacial advance. A zone of leached till and organic materials has been encountered within the till section in several power-auger holes.

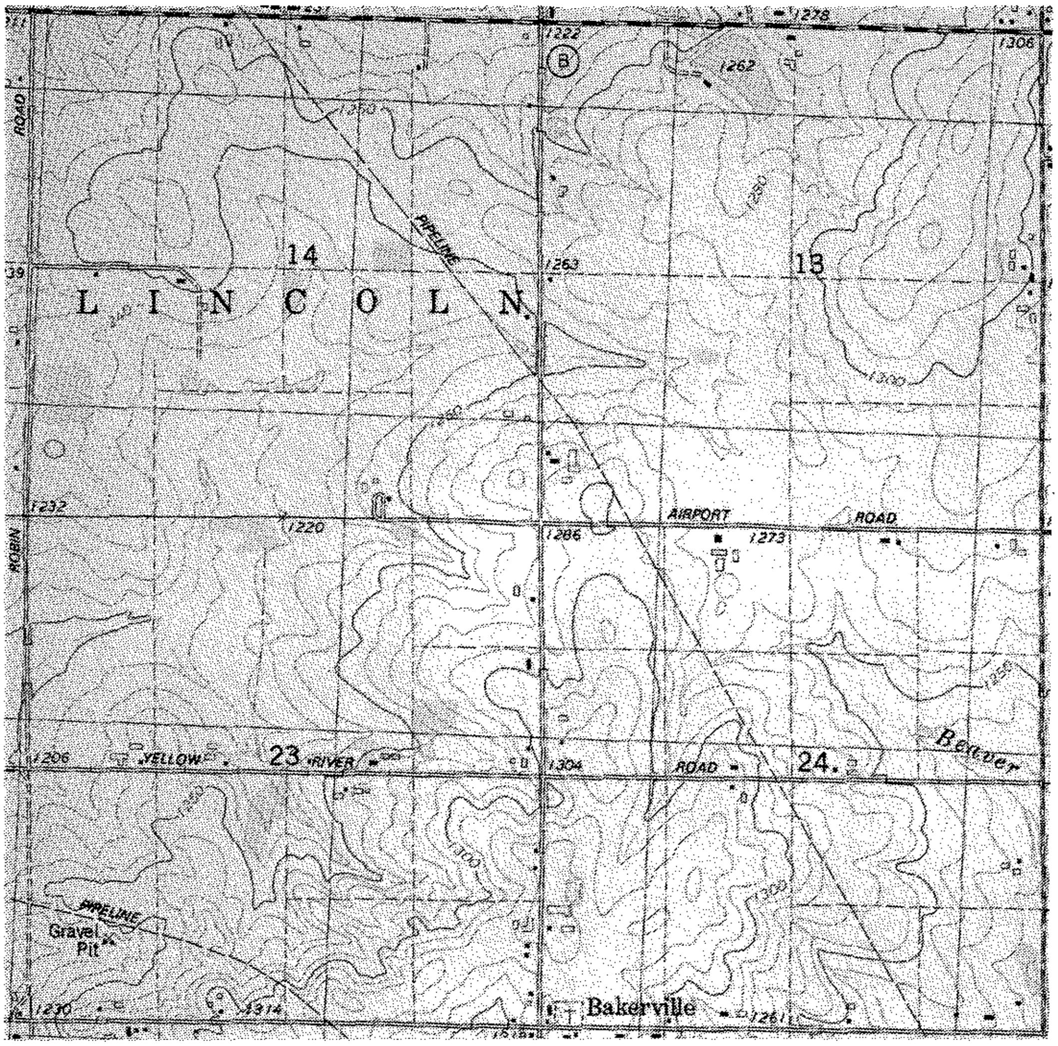

Figure 8. Topography of area 3, the Bakerville Member of the Lincoln Formation (Attig and Muldoon, in preparation) in northwestern Wood County (Clayton, in preparation), Marshfield 7.5-minute quadrangle, T. 25 N., R. 2 E.

Area 3

Area 3 is a broad ridge (fig. 8) in southwestern Marathon and northwestern Wood Counties that has been called the Marshfield moraine (Weidman, 1907), though it has no small-scale glacial topography (fig. 2). Weidman (1907) interpreted this ridge as an end moraine at the southern edge of his Second Drift. The Black and Yellow River valleys are deeply incised where they cut across this ridge. Soils are well drained because of deeply buried rock and permeable surficial material. Surficial material on the crest of the ridge is the Bakerville Member of the Lincoln Formation (Mode, 1976), and it is as much as 30 m thick.

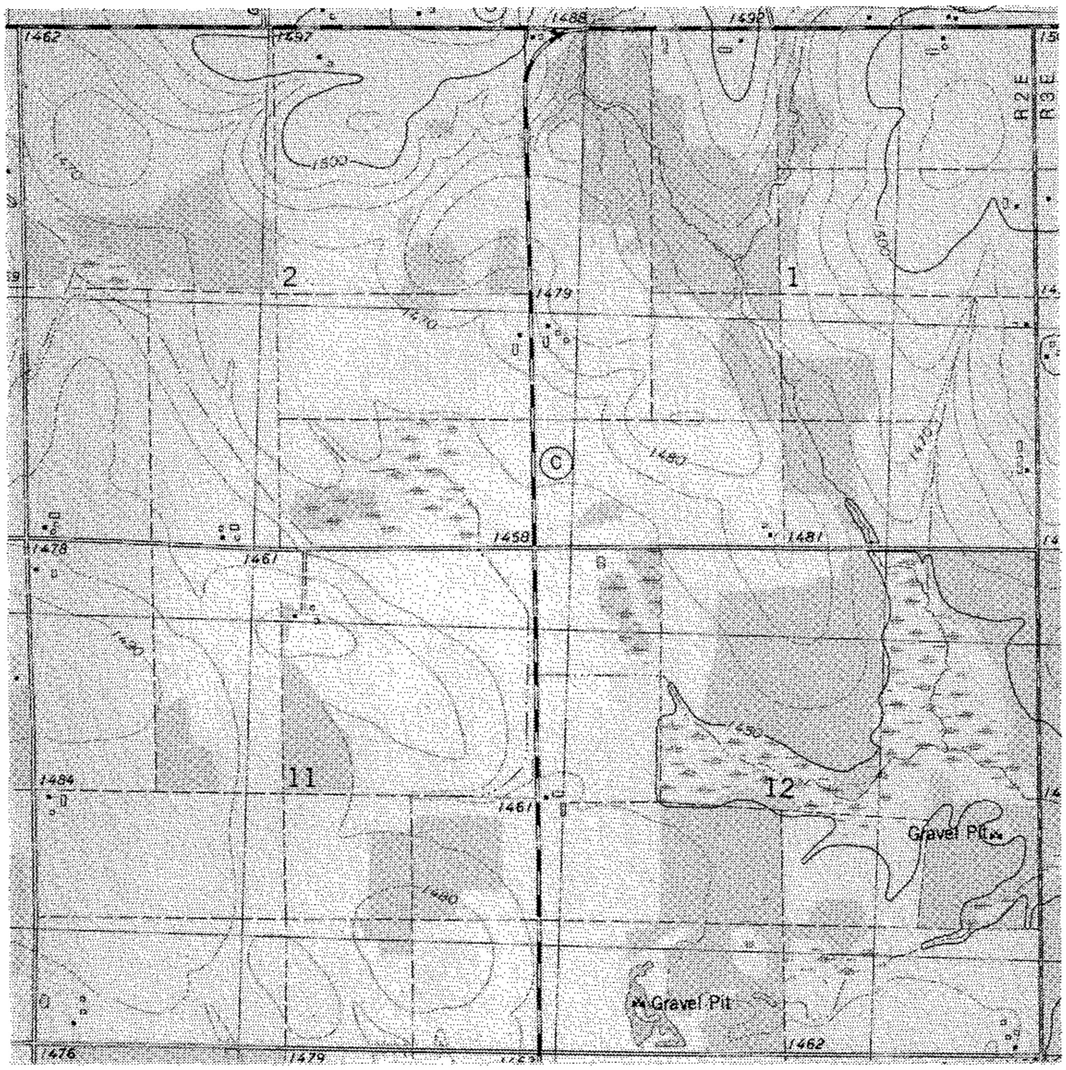

Figure 9. Topography of area 4, the Merrill Member of the Lincoln Formation (Attig and Muldoon, in preparation) in southeastern Taylor County adjacent to northwestern Marathon County, Corinth 7.5-minute quadrangle, T. 30 N., R. 2 E.

Till of the Bakerville Member is reddish brown, sandy loam and consistently redder, sandier (fig. 4), and more illite-rich than till of the Marathon Formation (table 2). It contains erratics from the Lake Superior region. Pebble fabrics in till indicate southeastward and eastward ice-flow directions (fig. 2). This till is lithologically very similar to that of the Merrill Member of the Lincoln Formation (table 2), but the Bakerville Member pinches out 35 km south of the edge of the Merrill Member. Though it has not been found underlying the Merrill Member, it is probably the older of the two because of its position south of the Merrill Member and its greater degree of dissection and lack of glacial constructional topography. The relationship of the Bakerville Member to the Merrill Member will probably not be clear until the area adjacent to Marathon County to the west (Clark County) is studied in detail. Beneath the Bakerville Member, sand and gravel, the Edgar Member, organic sediment, the Wausau Member, and weathered rock may be present. Pleistocene sediment reaches 40 m in thickness in this area.

The deep dissection of area 3 and the absence of hummocky topography, make it difficult to determine whether it originated as an end moraine or is an erosional remnant of a formerly more extensive body of glacial sediment. The ridge is locally underlain by a rock high (Bell and Sherill, 1974), and both the Bakerville and the Edgar Members are thick (Clayton, in preparation; Mode, 1976). The calcareous sand and gravel that separates these two members occurs above the surrounding landscape, and if it represents an outwash surface developed during deposition of till of the Edgar Member, a great deal of that surface and nearly all of the overlying Bakerville Member have been subsequently removed.

Area 4

Area 4 occupies the northern one-fourth of Marathon County (fig. 2), roughly the area of Weidman's (1907) Third Drift, and the Merrill Member of the Lincoln Formation is the surficial material (Attig and Muldoon, in preparation). The landscape is less dissected than area 1, 2, or 3, and constructional glacial landforms, such as ice-marginal ridges, are present in places. Gently rolling topography occurs throughout the area, and undrained depressions are common (fig. 9).

The dark reddish brown, sandy loam till of the Merrill Member is sometimes darker than, but otherwise indistinguishable from, till of the Bakerville Member (fig. 4; table 2). The Merrill Member is much less dissected, and therefore more continuous in its distribution, than any other unit discussed so far. It was this contrast plus the presence of recessional moraines near the northern edge of its area that suggested a late Wisconsin age to many early workers. The Merrill Member reaches a thickness of over 20 m beneath recessional moraines and gradually becomes thinner southward, pinching out 35 km north of the northernmost occurrence of the Bakerville Member in Marathon County. In the absence of a stratigraphic section containing both the Bakerville and Merrill Members, and considering the similarity of the till each contains, it is possible that they are one unit. The Wausau Member or the Edgar Member underlies the Merrill Member in roadcuts near the margin of the latter and in the subsurface.

Two radiocarbon dates on organic sediment overlying till of the Merrill Member suggest it was deposited before late Wisconsin time (earlier than 36,000 B.P. (ISGS-262) and 40,800 2,000 B.P. (ISGS-256); Stewart and Mickelson, 1976).

Area 5

Late Wisconsin end moraines characterize the topography of area 5 (fig. 2 and 10). These ridges are narrow and continuous end moraines. Drainage in area 5 is poorly integrated; many undrained depressions occur, and moraine ridges contain high-relief, hummocky topography. The Eau Claire River valley contains outwash terraces that grade to the outer end moraine. The Plover River, which formed during deglaciation as an ice-marginal stream, drains the proximal side of the outer moraine. Glacial landforms include

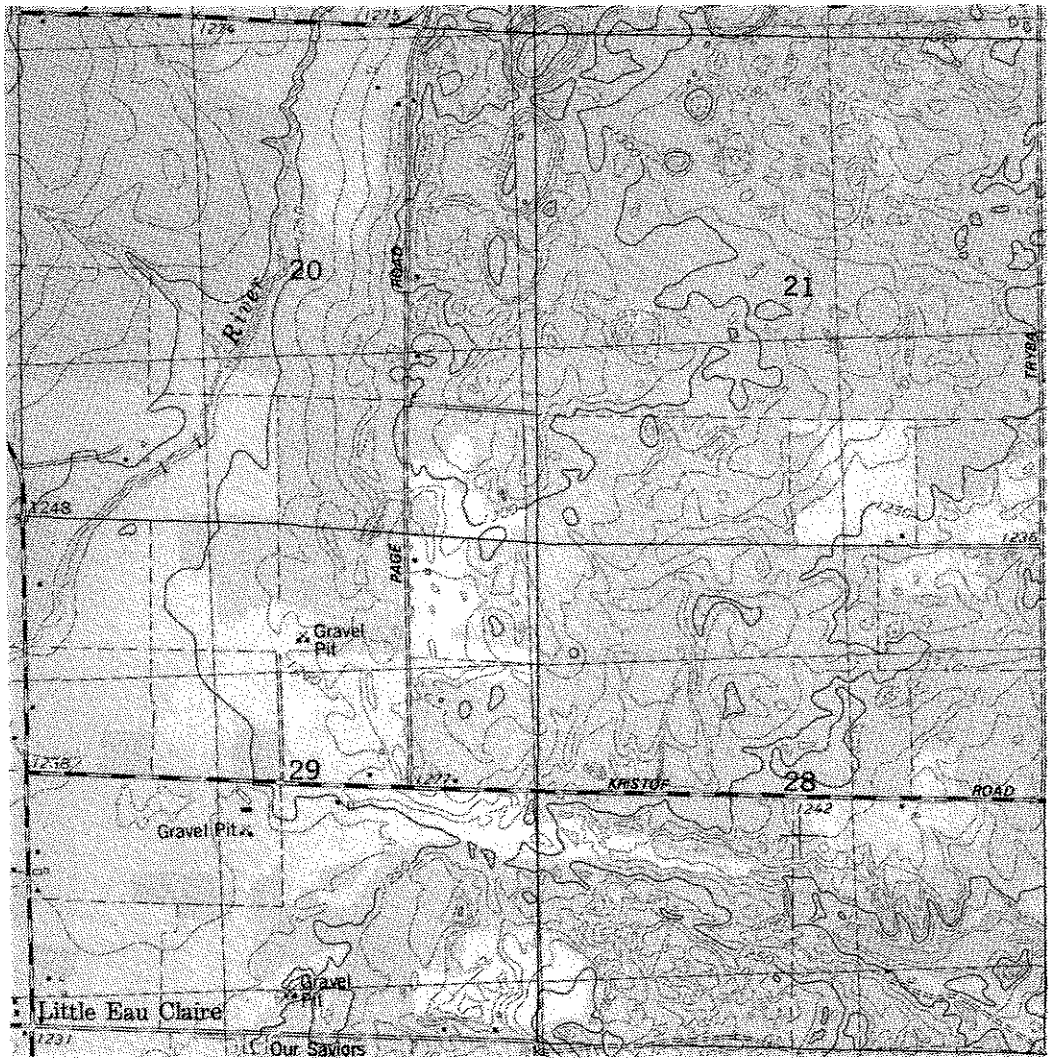

Figure 10. Topography of area 5, the Mapleview Member of the Horicon Formation (Attig and Muldoon, in preparation) in southeastern Marathon County, Bevent 7.5-minute quadrangle, T. 27 N., R. 9 E.

collapsed fluvial deposits, ice-walled-lake plains, and tunnel channels. Surficial materials of area 5 are mapped as the Mapleview Member of the Horicon Formation (Attig and Muldoon, in preparation).

The Mapleview Member includes brown, dolomitic till and associated sediment, which, because of their eastern source, are distinctly different from other Pleistocene deposits in Marathon County. The Mapleview Member is generally thick in Marathon County, and in the few places where its lower contact is exposed, it overlies weathered or fresh Precambrian rock. Till of the Mapleview Member is loamy sand and contains a clay mineral assemblage dominated by illite (table 2). Orientations of moraines and drumlins indicate that ice flow was west-northwestward (fig. 2).

The outer moraine (Hancock moraine; Clayton, in press) and the next moraine to the east (Almond moraine; Clayton, in press) were deposited during the St. Croix-Hancock Phase, between 18,000 and 15,000 yr B.P. (Attig and others, 1985). Ice retreated from Marathon County by 13,000 B.P., and was east of the drainage divide. A a result, meltwater was flowing south along the ice margin and not into Marathon County.

PLEISTOCENE HISTORY AND REGIONAL CORRELATION

The oldest Pleistocene unit in Marathon County is the Wausau Member of the Marathon Formation (fig. 5; Mickelson and others, 1984). The till was derived from the Lake Superior region, and ice-flow indicators reflect southeastward flow. Overlying the Wausau Member are organic sediment and the Edgar Member of the Marathon Formation. Limestone in the Edgar Member indicates a different source from the Wausau Member, and it is probable that an interval of weathering and erosion separated deposition of till of these two members.

The Edgar Member is correlated with the Pierce Formation of western Wisconsin (table 3) (Baker and others, 1983; Baker, 1984) because both members contain limestone. If this correlation is correct, the Edgar Member and the entire Marathon Formation are pre-Illinoian because reversed magnetic polarity indicates that the Pierce Formation is pre-Illinoian (Baker, 1984). The degree of weathering of the Marathon Formation, indicated by magnetite depletion (Johnson, 1984) and the clay mineral assemblage (Mode, 1976), supports this age assignment.

Deposition of till of the Edgar Member was followed by an interval of weathering and erosion; a deep weathering profile occurs in the Edgar Member where it underlies the Lincoln Formation.

The Lincoln Formation was deposited by ice flowing south and southeastward from the Lake Superior basin. This is indicated by derivation of sediment from the Lake Superior region and pebble fabrics in tills. The Lincoln Formation probably is correlative with the River Falls Formation of western Wisconsin (table 3) (Baker and others, 1983; Baker, 1984) because of its similar stratigraphic position and lithology. However, Johnson (1984) found the Merrill Member of the Lincoln Formation to be less weathered than the Prairie Farm and unnamed members of the River Falls Formation. The Lincoln Formation was probably deposited in early Wisconsin time (more than 40,800 + 2,000 B.P.; IGSG-256), but may be partly or wholly Illinoian.

The Mapleview Member of the Horicon Formation was deposited during late Wisconsin following an interval of weathering and erosion. Westward flowing ice of the Green Bay Lobe brought dolomitic sediment into eastern Marathon County between about 18,000 and 13,000 B.P. and constructed a series of end moraines. Ice from the Lake Superior basin did not reach Marathon County during late Wisconsin, but outwash derived from the Lake Superior region was deposited in the valleys of the Rib, Wisconsin, and Eau Claire Rivers.

The Mapleview Member has been correlated with the Mikana and Sylvan Lake Members of the Copper Falls Formation in western Wisconsin (Johnson, 1984; table 3; Attig and others, 1985; fig. 4).

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