Geology of Juneau County, Wisconsin

Lee Clayton
1989

Information Circular 66
Wisconsin Geological and Natural History Survey

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A description of the geologic materials in Juneau County, which includes the northeast part of the Driftless Area

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ABSTRACT

Juneau County, in south-central Wisconsin, consists of two geologically and topographically different areas: the southwest quarter is a typical part of the Driftless Area, and the rest of the county is part of the central Wisconsin sand plain.

The southwestern part of the county is underlain by Cambrian sandstone and Ordovician dolomite. The Mount Simon Formation occupies the lowest parts of the area and generally has low relief. Above it, the Wonewoc Formation forms a steep escarpment, which is capped by the Tunnel City Group. Above the Tunnel City Group and St. Lawrence Formation, the Jordan Formation forms another escarpment, which is capped by the Oneota Formation.

Northeast of the Wonewoc escarpment is the central Wisconsin sand plain, which was occupied by proglacial Lake Wisconsin during the Wisconsin Glaciation. The plain is underlain by offshore sand, which generally thickens toward the east. The offshore sand is overlain by thin windblown sand in many areas, and a layer of offshore silt often occurs within the offshore sand.

INTRODUCTION

South-central Wisconsin's Juneau County contains two very different geologic areas (fig. 1). The southwestern quarter of the county is a typical part of the Driftless Area, where rock deposited during the Cambrian and Ordovician Periods has formed hills and valleys that have a relief of 150 m. Most of the rest of the county is nearly flat and is underlain by sand deposited in glacial Lake Wisconsin.

This report is based on field work conducted during the summer of 1986. Contacts between map units on plate 1 were drawn using aerial photograph stereopairs (scale 1:20,000) taken in 1957 for the U.S. Department of Agriculture and U.S. Geological Survey topographic maps (scale 1:24,000) that have 20-ft, 10-ft, or 5-ft contour intervals. Additional lithologic information was obtained from the following sources: unpublished preliminary soil maps (scale 1:14,800) of most of the county, supplied by Howard F. Gundlach of the U.S. Department of Agriculture, Soil Conservation Service, in Mauston, Wisconsin; well construction reports and geologic logs of water wells in the files of the Wisconsin Geological and Natural History Survey (WGNHS); various geologic field notes in WGNHS files; logs of wells drilled for the Wisconsin Conservation Department, Emergency Conservation Work, Water Table Survey (Forest Protection Division, Ground Water Survey), summarized by Harloff (1942); test holes augered by Brownell (1986); Wisconsin Department of Transportation bridge borings; and Road Material Investigation Reports and notes in the files of the WGNHS.

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

I acknowledge the helpful suggestions made by Jim Brownell, John Attig, M.E. Ostrom, and M.G. Mudrey, Jr., who reviewed the manuscript of this report.

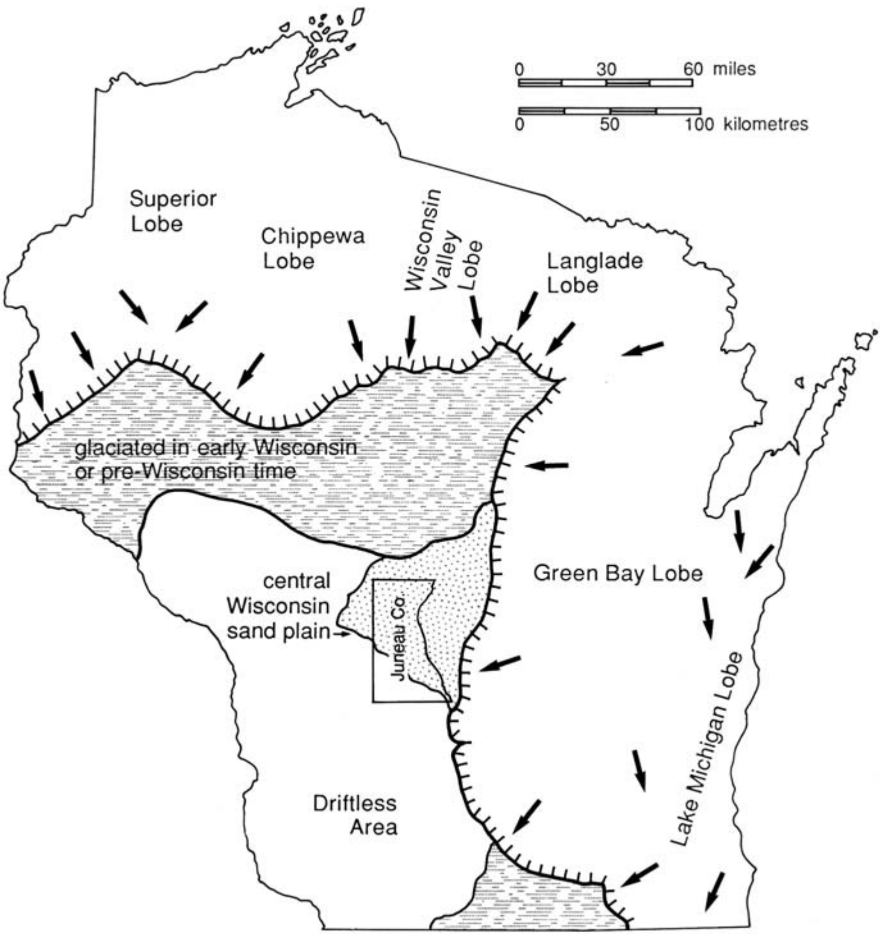


Figure 1*. Location of Juneau County, showing the lobes of the Laurentide Ice Sheet during the Wisconsin Glaciation. Arrows indicate ice-movement direction.*

PRECAMBRIAN ROCK

Precambrian rock crops out at Necedah Bluff in the village of Necedah (NE1/4 sec. 24, T18N, R3E, and NW1/4 sec. 19, T18N, R4W). Precambrian rock is indicated by map unit **hp** on plate 1 and by cross-section unit **P€** on plate 2. It is well exposed in quarries on the southwest side of the bluff. The rock, which has been described by Greenberg and others (1986, p. 37-39), is pink quartzite much like that of the Baraboo Hills, 15 km south of Juneau County.

According to well constructor's reports and geologic logs on file at WGNHS, several wells penetrated Precambrian rock (shown on cross sections on plate 2). The rock, which is described as granite, diorite, or gneiss, occurs at depths of 50 to 200 m in much of the county.

PALEOZOIC ROCK

Rock of Paleozoic age occurs at or near the land surface throughout southwestern and southern Juneau County from an elevation of 254 m at the southeastern corner of the county, to 422 m about 10 km southwest of New Lisbon. In much of the rest of the county Paleozoic rock occurs beneath about 5 to 60 m of Pleistocene sediment. In the cross sections on plate 2, Cambrian and Ordovician rock is indicated by letter symbols that begin with **€** or **O**. On plate 1, Cambrian and Ordovician rock is included in map units that begin with **h**; these units also include hillslope sediment.

The contacts between the Paleozoic units on plate 1 are partly based on field notes in the WGNHS files, including those of W.F.V. Leicht (1924, T15N and 16N, R2E and 3E), Ira Edwards

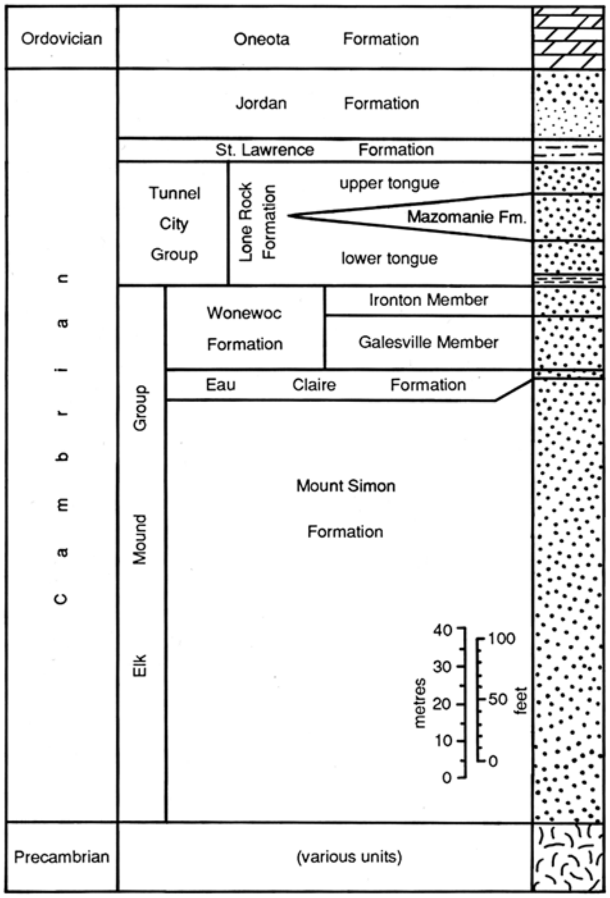


Figure 2. *Paleozoic stratigraphic units in Juneau County.*

(1925 to 1928, T15N, 16N, and 17N, R2E), and G.O. Raasch (1927 and 1928, T15N, 16N, and 17N, R2E, 3E, and 4E). For the Paleozoic outcrop area, stratigraphic identifications also occur in the Road Material Investigation Reports and field notes in the WGNHS files. Detailed tracing of stratigraphic contacts was greatly aided by the recognition of several stratigraphic benches (figs. 2 and 3) on topographic maps and aerial photograph stereo-pairs. Stratigraphic identifications were field checked by M.E. Ostrom in 1986. The Paleozoic rock of parts of the area were described by Johnson (1947) and Salstrom (1962).

The Paleozoic units in Juneau County are nearly horizontal; they have a regional dip of about 1 m/km to the south. A broad, gentle anticline (or anticlines), extending southeast from the Hustler area to the Wisconsin Dells area (cross sections E-E′ and F-F′, plate 2), is associated with a probable southeast-northwest joint or fault zone. This zone is marked by a series of parallel small valleys and ridges (fig. 4). The straight lines in figure 4 represent ridges that are conspicuously straight and parallel, generally formed of sandstone of the Wonewoc Formation; two such ridges are marked by dashed lines in figure 5. Either the ridges represent cemented and therefore less erodible areas along joints or faults, or the adjacent

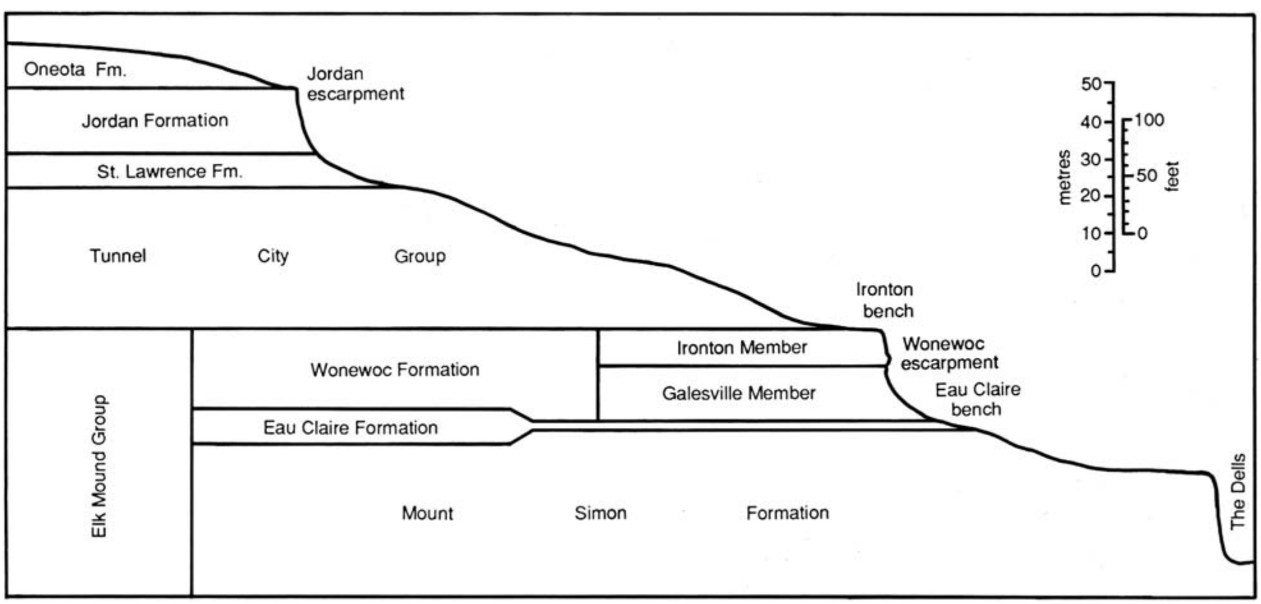


Figure 3. *Topographic expression of Paleozoic stratigraphic units in Juneau County.*

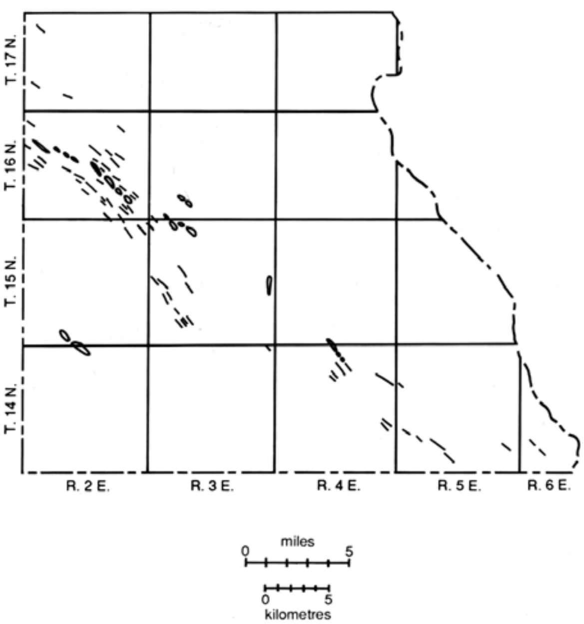


Figure 4. Aligned topographic features in southern Juneau County. Straight lines = straight, parallel ridges; ovals = ridges that are probably the result of local cementation along joints or faults.

valleys represent less coherent and therefore more erodible areas along joints or faults. The ovals in figure 4 show the location of ridges that probably are the result of local cementation along joints or faults, generally formed of sandstone of the Tunnel City Group; four such ridges are marked by **X**s in figure 5. The larger valleys are conspicuously constricted where they cross these cemented areas, such as at the points marked by **Os** in figure 5. A possible fault is indicated on cross section E-E′ (plate 2) where the cross section intersects the cemented area at point **F** in figure 5; the Ironton bench (fig. 3) is about 7 m higher on the southwest side of the cemented zone than it is on the northeast side.

Mount Simon Formation

The Elk Mound Group has been defined by Ostrom (1966, 1967) to include the Mount Simon, Eau Claire, and Wonewoc Formations, which are Late Cambrian. In Juneau County, the Elk Mound Group consists primarily of light-colored quartz sand and sandstone. The sand grains, especially the coarser ones, are generally well rounded.

The Mount Simon Formation overlies either Precambrian rock or weathered Precambrian rock (fig. 2; map unit **hm**, plate 1; cross-section unit **Ꞓm**, plate 2). Its type section is in the city of Eau Claire, 115 km northwest of Juneau County, and it occurs throughout southern Wisconsin and in adjacent states.

In southwestern Juneau County the maximum thickness of the Mount Simon Formation is about 140 m. Its maximum thickness in the Camp Douglas area in west-central Juneau County (cross section D-D′, plate 2) is about 100 m. It consists primarily of poorly cemented fine to very coarse sand, with well rounded quartz grains and considerable feldspar. In outcrop, the unit is generally light colored, commonly nearly white. Large-scale cross-bedding is abundant.

In Juneau County, the Mount Simon Formation is generally soft and easily eroded and forms flat to undulating topography, with slopes less than about 3°. In a few places, vertical cliffs occur in the sandstone, such as in the Wisconsin Dells and in isolated bluffs on the plain of Lake Wisconsin.

In a drillhole at Union Center (cross section F-F′, plate 2; WGNHS Geologic Log JU-24), the lower 23 m of the Mount Simon Formation has been described as red shale, and in a drillhole near Cutler (cross section C-C′, plate 2; WGNHS Geologic Log JU-238), the lower 8 m has been described as red shale with rounded quartz sand grains. At both places this material might be part of a weathering zone on Precambrian rock under the Mount Simon Formation. Elsewhere in central Wisconsin, silt and clay beds occur in the bottom part of the Mount Simon, and a clayey weathering zone occurs on the underlying Precambrian rock in many places. Conglomerate occurs at the base of the Mount Simon at Necedah Bluff and elsewhere in central Wisconsin.

The sand in the Mount Simon Formation has commonly been interpreted to be marine shoreline and nearshore sediment (Ostrom, 1970). However, Dott and others (1986) interpreted the sand in the top of the formation in the Wisconsin Dells at the southeast corner of the county to be windblown, although they assigned it to the Wonewoc Formation (see discussion in the next section, about the Eau Claire Formation).

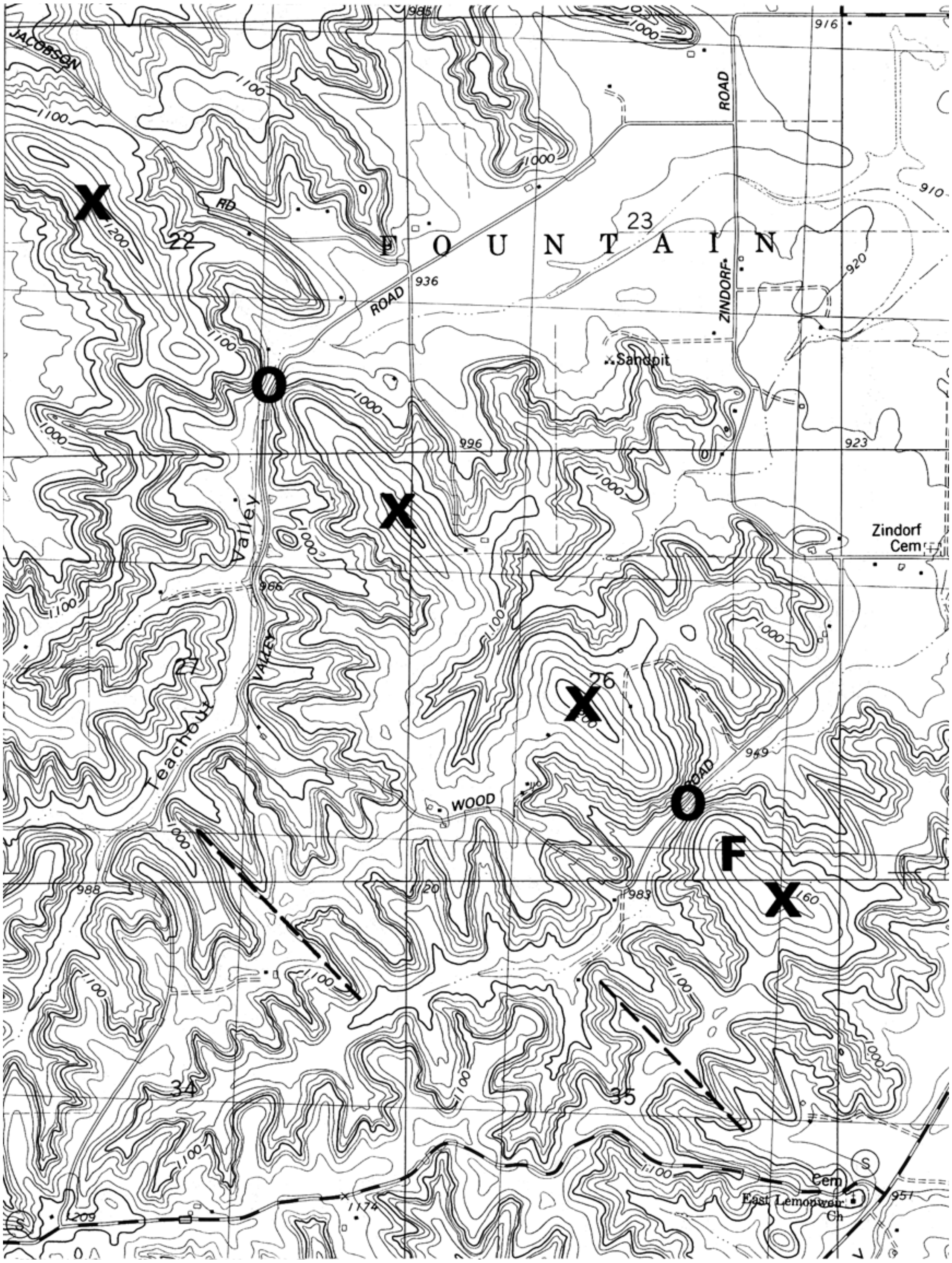


Figure 5. *Aligned topographic features in the southeastern part of T16N, R2E, from U.S. Geological Survey's New Lisbon South Quadrangle (7.5-minute series, topographic, 20-ft contour interval). X = ridges that are probably the result of local cementation along joints or faults; O = constricted valleys; F = possible fault; dashed line = straight ridge. Area shown is 4 km wide.*

Eau Claire Formation

The Eau Claire Formation consists of Cambrian sandstone overlying the Mount Simon Formation in southwestern Wisconsin and adjacent areas. Its type section is in the city of Eau Claire, 115 km northwest of Juneau County. The presence, thickness, and stratigraphic position of the Eau Claire Formation in the Juneau County area has been uncertain for many years, and therefore the positions of the top of the Mount Simon Formation and the bottom of the Wonewoc Formation have also been uncertain. Twenhofel and others (1935, plate 151), for example, assigned the sequence of sandstone exposed in the Wisconsin Dells to the Eau Claire, whereas Dott and others (1986) assigned it to the Wonewoc; in this report the sandstone in the Dells is assigned to the Mount Simon.

This report follows the usage of M.E. Ostrom, who restricts the Eau Claire Formation in the Juneau County area to no more than a few metres at the base of the Galesville Member of Twenhofel and others (1935) and in the upper half of the Galesville Member of Dott and others (1986). At Friendship Mound, 12 km east of Juneau County, Ostrom (1978) identified 0.2 m of the Eau Claire Formation underlying 16 m of Galesville Member and overlying 128 m of Mount Simon Formation (Clayton, 1987). At Sheep Pasture Bluff, 9 km southeast of Mauston (UTM coordinates 259,130mE, 4,847,050mN) Ostrom (1987, p. 185) identified 2 m of Eau Claire Formation, which is overlain by about 20 m of Galesville Member and underlain by roughly 140 m of Mount Simon Formation.

In an area 10 km west of Sheep Pasture Bluff, G.O. Raasch's field notes of 1927 and 1928 (WGNHS files) describe a "lower cliff sandstone," an "upper cliff sandstone," and a "shaley zone" or "shaley laminae zone" at the base of the "upper cliff sandstone." On the basis of 20 sections measured by Raasch in southwestern Juneau County, the "shaley zone" ranges from 1 to 3 m thick. His "upper cliff sandstone" corresponds to the Galesville Member of Twenhofel and others (1935); his "lower cliff sandstone" corresponds to their Eau Claire Member.

The Eau Claire Formation, as identified by Ostrom (1987, p. 185) at Sheep Pasture Bluff, is marked by a topographic bench (fig. 3). This bench can be traced westward to Raasch's "shaley zone," which is here considered to be the Eau Claire Formation (cross-section unit **Ce**, plate 2). The bench can be traced southeastward 10 km from Sheep Pasture Bluff to an area south of Lyndon Station, where Ostrom (field conference, 1986) identified 1 m of the Eau Claire Formation at the edge of the bench in roadcuts of Highway HH, 150 m south of the junction with Highway J (UTM coordinates 264,460mE, 4,840,310mN), and Dees Road, 60 m west of the junction with Lyndon Road (UTM coordinates 267,620mE, 4,839,880mN). From there the bench can be traced to the southeast corner of the county, where it is at an elevation of about 286 or 287 m in the NW1/4 sec. 32, T14N, R6E. All the sandstone exposed in cliffs along the Wisconsin River at the Wisconsin Dells is therefore in the Mount Simon Formation.

The same conclusion is reached if the Eau Claire Formation is traced south from Friendship Mound (12 km east of Juneau County, in central Adams County) by assuming that it is a uniform distance below the top of the Ironton bench (fig. 3): at Friendship Mound the Eau Claire is 22 m below the Ironton bench (Ostrom, 1978). The Ironton bench can be traced southward (Clayton, 1987, plate 2) to the southwest corner of Adams County, where it is at an elevation of 305 m (at UTM coordinates 276,080mE, 4,835,760mN; field conference with M.E. Ostrom, 1986). Subtracting the thickness of 22 m from the elevation of 305 m gives an elevation of 283 m (930 ft) for the approximate position of the Eau Claire, which again indicates that all the sandstone exposed in the Dells is in the Mount Simon Formation.

No Eau Claire Formation was observed at Ragged Rock, northwest of Camp Douglas (NW1/4 sec. 7, T17N, R2E), or at Petenwell Rock, northeast of Necedah (sec. 9, T18N, R4E; cross section C-C′, plate 2). The Eau Claire is either absent here, or the overlying Wonewoc Formation is much thicker than expected and the Eau Claire is below the base of the outcrops.

The Eau Claire Formation, as recognized here, is quartz sandstone, like the overlying and underlying units but is poorly sorted, has abundant silt layers (generally no more than a few millimetres thick), is variable in color, has thin horizontal bedding with flaggy weathering characteristics, commonly has dark reddish-brown ironstone layers, and contains some burrows and rip-up clasts. The Eau Claire Formation is too thin in Juneau County to map separately and has been included with the Wonewoc Formation in map unit **hw** on plate 1; it is cross-section unit **Ꞓe** on plate 2.

Wonewoc Formation

The Wonewoc Formation (map unit **hw**, plate 1) consists of Cambrian sandstone overlying the Eau Claire Formation. It was defined by Ostrom (1966, 1967) to include the Galesville and Ironton Members. The type section is in the village of Wonewoc in southwestern Juneau County (Ostrom, 1966, p. 59-60).

The Galesville Member makes up the lower two-thirds of the Wonewoc Formation in Juneau County (fig. 2; cross-section unit **Ꞓg**, plate 2). The type section is in the city of Galesville, 85 km west of Juneau County.

The Galesville Member in Juneau County is interpreted to be equivalent to the part of Rasch's "upper cliff sandstone" above his "shaley zone." In 16 sections measured by Raasch in southwestern Juneau County, the thick-ness of the Galesville, as defined in this report, ranges from 10 to 20 m. According to Ostrom (1966, p. 60), the Galesville is at least 21 m thick in the village of Wonewoc; according to Ostrom (1978), it is 16 m thick at Friendship Mound.

The Galesville Member is similar to the Mount Simon Formation and is made up of light-colored, well rounded, poorly cemented to moderately well cemented fine to coarse sand. According to Asthana (1969, p. 54-59) and Ostrom (1987, p. 185), the two can be distinguished by the more abundant feldspar in the Mount Simon. The Mount Simon typically is about 20 percent feldspar; the Galesville typically has no more than a few percent feldspar. At Sheep Pasture Bluff, the Mount Simon has 6 to 20 percent feldspar, averaging 11 percent; the Galesville averages 5 percent (Asthana, 1969, p. 54-59). According to Dott and others (1986), the Galesville Member has more planar-bedding and less large-scale cross-bedding than the upper part of the Mount Simon Formation at the Wisconsin Dells; however, they included all the rock exposed at the Dells in the Galesville Member.

The Galesville Member is well exposed in southern Juneau County. It forms vertical cliffs in some areas and tree-covered slopes as steep as 30° in many areas (fig. 3).

The sand in the Galesville has commonly been interpreted to be marine shoreline and nearshore sediment (Ostrom, 1970), but Dott and others (1986, p. 354-355) have tentatively interpreted some of the Galesville sand exposed at Wisconsin Dells (their planar-and-channeled facies) to be stream and windblown sediment.

The Ironton Member overlies the Galesville Member of the Wonewoc Formation (fig. 2; cross-section unit **Ꞓi**, plate 2). The type section is at the north side of the village of Ironton, 10 km south of Juneau County (Ostrom, 1966, p. 61-62); a well known reference section is at Wood Hill, 7 km northeast of the city of Elroy in southwestern Juneau County (UTM coordinates 722,360mE, 4,854,250mN; Ostrom, 1966, p. 57-58).

The contact between the Ironton and Galesville Members is gradational; as a result, geologists have placed the contact at different places, but the Ironton is probably generally between about 5 and 10 m thick in southwestern Juneau County. According to Ostrom (1966, p. 57-62, 1978), it is 9 m thick at Wood Hill, 4 m thick in the village of Wonewoc, 3 m thick in the village of Ironton, and 6 m thick at Friendship Mound.

Like the Galesville Member, the Ironton Member is made up of quartz sandstone (Myers, 1981). Ironton sandstone is generally darker reddish brown, more lithified, more burrowed, more fossiliferous, and appears to be more poorly sorted and to contain more very coarse sand than the Galesville. The Ironton contains some glauconite, which is generally lacking in the Galesville sandstone.

The Ironton Member forms an abrupt topographic bench with a low cliff throughout most of its outcrop area in Juneau County (fig. 3), but it is obscured by trees in many areas. In the areas where the contact between the Wonewoc Formation and the Tunnel City Group is shown dashed on the map of plate 1, the bench is less conspicuous; the Ironton is probably thinner in these areas.

The sand in the Ironton Member is marine sediment, interpreted by Ostrom (1970) to be nearshore sediment deposited in a zone of reworking with slow net deposition.

Tunnel City Group

The Tunnel City Group, which overlies the Elk Mound Group, consists of Late Cambrian sand and sandstone of the Lone Rock and Mazomanie Formations (fig. 2; Ostrom, 1966, 1967). It occurs in southern Wisconsin and adjacent areas; its type section is near Tunnel City, 20 km west of Juneau County.

The Lone Rock and the Mazomanie Formations interfinger laterally with each other. In the area of Juneau County, the Mazomanie Formation is overlain by the upper tongue of the Lone Rock and underlain by the lower tongue of the Lone Rock. West of Juneau County the two tongues merge, and the Tunnel City Group consists entirely of the Lone Rock Formation. Eastward from Juneau County, on the Wisconsin Arch, the group consists primarily of the Mazomanie Formation, and the lower tongue of the Lone Rock pinches out (Ostrom, 1966, fig. 16; Berg, 1954, fig. 7).

The type section of the Lone Rock Formation is south of the village of Lone Rock, 50 km south of Juneau County (Ostrom, 1966, p. 64-69). The type section of the Mazomanie Formation is near the village of Mazomanie, 50 km south of Juneau County (Berg, 1954).

The Tunnel City Group is poorly exposed in Juneau County, and as a result the Lone Rock and Mazomanie Formations could not be mapped separately but are shown together on plates 1 and 2 (map unit **ht** and cross-section unit **Єt**). The thickness of the group, where overlain by the St. Lawrence Formation, is typically 30 to 40 m in Juneau County.

The Tunnel City Group consists of poorly cemented to moderately well cemented, quartzose, fine to medium sand of marine origin. The sand appears less well rounded than that of the Elk Mound Group. The Lone Rock Formation contains considerable glauconite and is commonly highly burrowed; the Mazomanie Formation contains only a slight amount of glauconite. The bottom of the lower tongue of the Lone Rock contains some micaceous shale.

Descriptions of several stratigraphic sections in the Tunnel City Group in Juneau County have been published. The Goodenough Hill section occurs along a now-abandoned road in the middle of the NE1/4 sec. 13, T15N, R2E, 10 km south of the city of New Lisbon. It has been described by Twenhofel and others (1935, p. 1729-1730; the Lone Rock Formation consists of beds 8 to 11, 14, and 19 to 21 and the Mazomanie Formation consists of beds 12, 13, and 15 to 18) and Berg (1954; the Lone Rock Formation consists of beds 5 to 8, 10, and 15 to 18 and the Mazomanie Formation consists of beds 9 and 11 to 14). WGNHS Geologic Logs JU-209, JU-210, JU-241, JU-242, and JU-244 span most of the Tunnel City Group in sec. 13 and 24, T15N, R2E, 1 km south of the Goodenough Hill section.

The Tunnel City Group typically forms undulating to rolling crop land in Juneau County; the flatter benches (fig. 3) have slopes less than about 10° and steeper slopes between about 10° and 15°. In most places the sandstone is too poorly lithified to form natural cliffs, but some Mazomanie sandstone is cemented well enough to stand up as vertical road cuts.

St. Lawrence Formation

The St. Lawrence Formation consists of Cambrian marine sandstone and dolomite overlying the Tunnel City Group (fig. 2). It occurs in southern Wisconsin and adjacent areas; its type section is 270 km west of Juneau County, in Scott County, Minnesota.

In Juneau County, the middle and upper parts of the formation are exposed in several places, but the base of the unit was not seen. The exposed part is typically no more than about 7 m thick. Where exposed it is pale yellow, thin-bedded, horizontally bedded silt and very fine to fine sand that is moderately well cemented. It is commonly burrowed, has rip-up clasts, and is calcareous. According to Twenhofel and others (1935, p. 1729, beds 22 and 23), the bottom of the St. Lawrence Formation contains a 15-cm bed of dolomite in the Goodenough Hill section.

The St. Lawrence Formation occurs at the base of the Jordan escarpment and on the topographic bench at the top of the Tunnel City Group (fig. 3; map unit **hs**, plate 1; cross-section unit **Єs**, plate 2). It is typically exposed in borrow pits on the up-slope side of roads between the tree-covered escarpment and the cultivated bench.

Jordan Formation

The Jordan Formation occurs in southern Wisconsin and adjacent areas; its type section is in Scott County, Minnesota, 270 km west of Juneau County. It consists of Late Cambrian marine sandstone overlying the St. Lawrence Formation.

In Juneau County the thickness of the Jordan Formation, where overlain by the Oneota Formation, is about 20 m. The formation consists of fine to medium sand (the upper part is coarser) that is moderately well to well cemented and ranges from white to reddish brown. Much of it is thin-bedded and flaggy, but large-scale cross-bedding occurs in the upper part. The uppermost part of the formation is commonly cemented with silica and is very hard.

In Juneau County the upper part of the Jordan forms a cliff, and the lower part is covered with trees, with slopes between about 15° and 30° (fig. 3; map unit **hj**, plate 1 and cross-section unit **€j**, plate 2).

Oneota Formation

The Oneota Formation of the Prairie du Chien Group consists of Ordovician marine dolomite overlying the Jordan Formation. The Oneota occurs in southern Wisconsin and adjacent areas, and its type section is in Allamakee County, Iowa, 100 km southwest of Juneau County.

In Juneau County, the Oneota Formation is generally no more than a few metres thick, with a maximum thickness around 15 m. The dolomite, which is well exposed in several crushed-rock quarries, is light brown to gray and commonly has medium to thick bedding. The dolomite contains some nodules and beds of chert, which is commonly light colored and oolitic, and some cavities that have been filled with red clay.

The Oneota occurs on the top of the summit plateaus in southern Juneau County. It is absent in some places behind the brink of the Jordan escarpment (fig. 3; map unit **ho**, plate 1; cross-section unit **Oo**, plate 2). Its topography is generally undulating, with slopes less than about 6°.

St. Peter Formation

The St. Peter Formation consists of Ordovician sand and sandstone in southern Wisconsin and adjacent areas. None was observed in outcrop in Juneau County. However, blocks of St. Peter sandstone have been reported in several places on top of the Oneota uplands (field notes for Road Material Investigation Reports; WGNHS files); Raasch's field note 125 (WGNHS files) describes a probable outcrop of St. Peter in the SW1/4 SE1/4 sec. 11, T15N, R2E.

PLEISTOCENE SEDIMENT

Much of the Paleozoic material in Juneau County is overlain by Pleistocene sediment. Pleistocene sediment is more than 50 m thick in parts of northeastern Juneau County but is less than 1 m thick in much of the southwestern part of the county.

Much of the Pleistocene sediment was deposited during the last part of the Wisconsin Glaciation. At that time, proglacial Lake Wisconsin was created when the Green Bay Lobe of the Laurentide Ice Sheet dammed the Wisconsin River at the east end of the Baraboo Hills, 25 km south of Juneau County (fig. 6). Lake Wisconsin occupied large parts of Juneau and Adams Counties and smaller parts of Wood, Portage, Waushara, Marquette, Columbia, Sauk, Richland, Vernon, Monroe, and Jackson Counties. In Juneau County, glacial Lake Wisconsin rose to the base of the Wonewoc escarpment (fig. 3), to an elevation of about 294 m. Evidence of glacial Lake Wisconsin occurs at slightly higher elevations on the sides of sandstone bluffs on the lake plain to the northeast; this was a result of rebound of the earth's crust when the weight of the glacier was removed. Bays of glacial Lake Wisconsin also extended into southwestern Juneau County, in the upper Baraboo River valley. Additional information on glacial Lake Wisconsin can be found in reports on the geology of Portage, Adams, and Wood Counties (Clayton, 1986, 1987, in press).

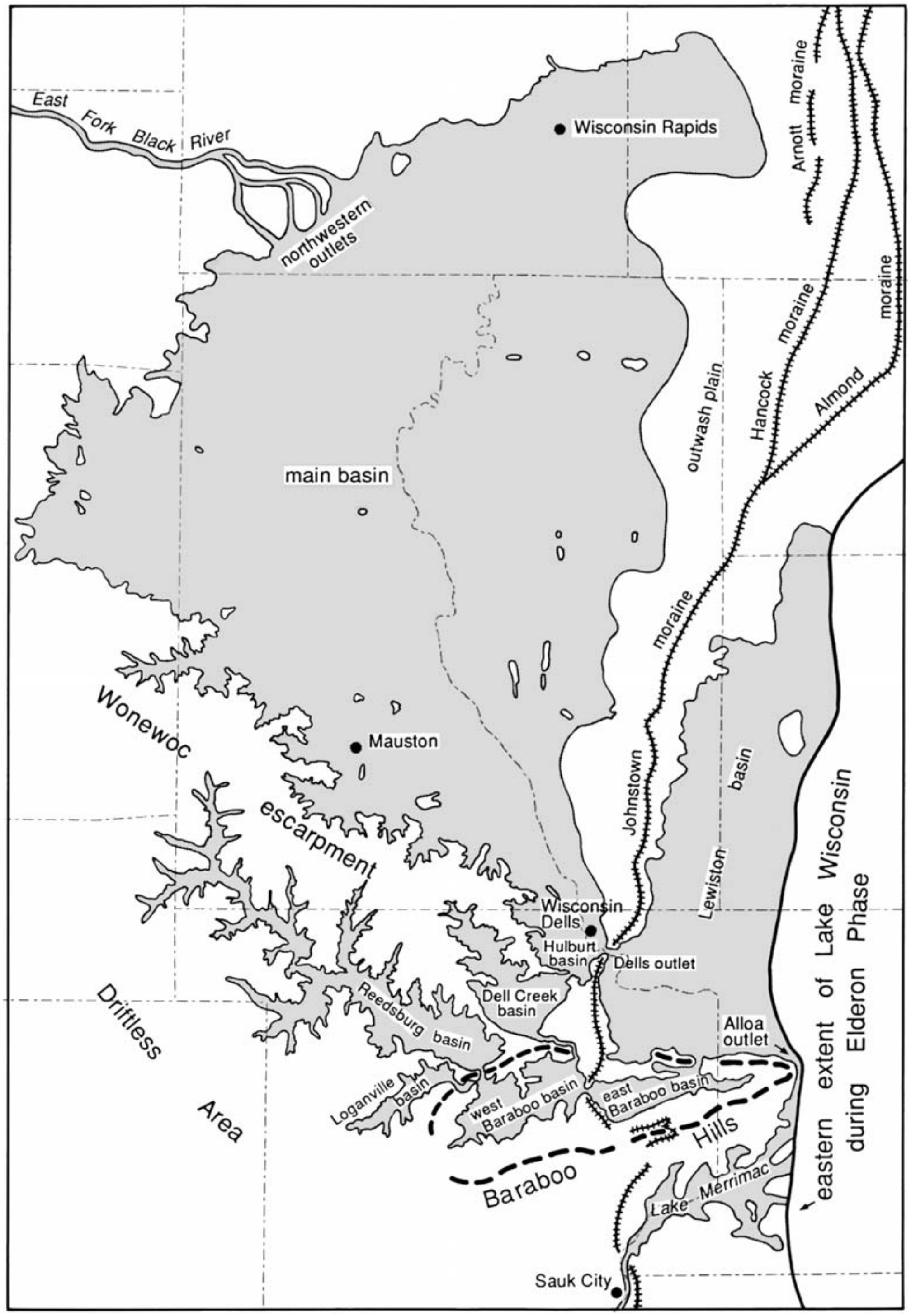


Figure 6*. Map of central Wisconsin showing the main features of glacial Lake Wisconsin. The map shows the approximate maximum extent of the lake during the last part of the Wisconsin Glaciation; it never occupied this entire area at any one time.*

Offshore sediment

Most of central and northern Juneau County and the lower areas of southern Juneau County are underlain by offshore sediment deposited in glacial Lake Wisconsin. Most of the offshore sediment at the surface in Juneau County was deposited during the last part of the Wisconsin Glaciation between about 20,000 and 13,000 years ago, but more deeply buried offshore sediment was probably deposited during earlier phases of glacial Lake Wisconsin (during the early part of the Wisconsin Glaciation or earlier glaciations).

The offshore sediment deposited in glacial Lake Wisconsin consists primarily of quartz sand. On the cross sections, offshore sediment is shown as unit **od** (plate 2); on plate 1, it is shown as map units **ow** and **oy**. Offshore sediment is indicated by shades of blue.

The sand of map unit **ow** was derived from the Wisconsin River, which was fed by glacial meltwater flowing south from the Langlade and Wisconsin Valley Lobes of the Laurentide Ice Sheet (fig. 1) and meltwater flowing west from the part of the Green Bay Lobe in Langlade County. According to Brownell (1986), it is moderately well sorted, moderately well rounded, quartzose, medium to coarse sand, but contains considerable dark-colored minerals and no carbonates. Scattered fine and very fine pebbles are commonly present.

The sand of map unit **oy** was derived from nonmeltwater rivers flowing off the upland to the north, west, and south of glacial Lake Wisconsin, the largest of which was the Yellow River. According to Brownell (1986, 1988), the sand of unit **oy** north of the Lemonweir River is moderately to well sorted, well rounded, fine to medium sand that consists primarily of quartz, with less than about 1 percent of dark-colored minerals and no carbonates or pebbles. Brownell (1988) assigned this sand to the Big Flats Formation, whose type section is 15 km east of Juneau County. The sand was in large part derived from the Mount Simon Formation. The sand of map unit **oy** south of the Lemonweir River was derived from the Mount Simon Formation and higher stratigraphic units through the Jordan Formation.

The sand of map units **ow**, **oy**, and **oc** is commonly underlain by a layer of silt about 0.5 to 4 m thick. According to Brownell (1986, 1988), it correlates with the New Rome Member of the Big Flats Formation in Adams County. It is typically about 50 percent silt-sized grains, 25 percent sand-sized grains, and 25 percent clay-sized grains; it is commonly thinly and rhythmically laminated; it is reddish brown, brown, or gray; and the coarse silt is about 20 percent dolomite (Brownell, 1986, 1988). Analyses of seven samples collected from southern Juneau County as part of an investigation of agricultural-lime resources indicated between 16 and 20 percent calcium-carbonate equivalent (notes in WGNHS files about agricultural lime by E.H. Powell, dated 1934).

In the areas of map units **ow** and **oy** (plate 1), the silt layer is typically at a depth of 3 to 8 m (cross-section unit **ot**, plate 2), but it is shallower in the area of map unit **oc**. Map unit **oc** is a complex area, having a silt layer at the surface in some places and one or more beds of silt buried as deep as several metres in other places. The silt is commonly rhythmically (probably annually) bedded. The topography here, on either side of the Lemonweir River, tends to be more irregular than that of map units **oy** and **ow** (plate 1), a result of irregular erosion of sand off the top of the upper silt bed.

Shore sediment

Beach ridges or shore terraces of glacial Lake Wisconsin have generally not been preserved, probably because of solifluction and wind erosion after glacial Lake Wisconsin drained. Probable shore sediment was noted in several places; however, none occupy a large enough area to be shown on plate 1. A low ridge extending northwest-southeast through the middle of sec. 30, T19N, R2E, in northwestern Juneau County, contains probable beach sand with chert pebbles at an elevation of about 292 m. Probable beach sand with pebbles and cobbles of sandstone and chert occurs at an elevation of about 291 m (955 ft) in the SW1/4 SE1/4 NE1/4 sec. 11, T15N, R4E, 7 km east of Mauston. Rounded sandstone gravel occurs on a bench on the south side of Petenwell Rock at an elevation of 295 m (at UTM coordinates 738,830mE, 4,880,850mN and 738,770mE, 4,880,900mN). Rounded quartzite beach gravel occurs on the west side of Necedah Bluff near an elevation of about 290 m (UTM coordinates 734,000mE, 4,878,130mN). According to Martin (1932, p. 339), shore gravel also occurs on the northern end of Necedah Bluff above an elevation of 293 m (probably near UTM coordinates 734,580mE, 4,878,500mN).

Stream sediment

Stream sediment is shown on plate 1 in shades of red. The oldest is included in map unit **sg**. It consists of sand and chert gravel in dissected terraces about 6 to 12 m above the floodplain of the Baraboo River and its tributaries in southwestern Juneau County. The terrace occurs no farther down-valley than the highest level of glacial Lake Wisconsin during the last part of the Wisconsin Glaciation, suggesting that the terrace formed during that time or earlier. A well developed paleosol occurs on chert gravel below l m of late Wisconsin windblown silt on a small dissected remnant of terrace above the Baraboo River, 3 km northwest of Elroy (UTM coordinates 716,740mE, 4,848,580mN). The intensity of the soil development and dissection suggest that the gravel was deposited before Wisconsin time.

A terrace along the Wisconsin River included in map unit **sl** correlates with the Love terrace in Portage County (Clayton, 1986, p. 13). Near the northeastern corner of Juneau County, the terrace is about 12 m above the modern floodplain; southward it descends to about 2 m above the floodplain near the mouth of the Lemonweir River. Farther south, through the Dells, Love sediment, if present, is probably below the level of the modern floodplain. The sediment of the Love terrace is mostly slightly pebbly sand, with pebbles as large as 1 or 2 cm.

The Love terrace is about 2 m below the level of the lake plain and formed sometime after glacial Lake Wisconsin drained. In contrast to the lake plain, it has little windblown sand on its surface but has channel scars. In contrast to lower terraces and to the modern floodplain, the channel scars are braided rather than meandering, suggesting that Love sand was deposited when sediment-laden glacial meltwater was still coming down the Wisconsin River, perhaps during the time of the Winegar Advance into northern Wisconsin (Clayton, 1987, in press).

Only a few metres above the modern floodplains are terraces composed of stream-deposited sand of map unit **sp** (plate 1). Along the Wisconsin River, channel scars on these terraces are meandering; along the Yellow River, the channel scars include a younger set of meandering scars much like those on the modern floodplains and an older set of braided scars. The sediment of the modern floodplains consists largely of sand; this sediment is included in map unit **sm** (plate 1).

Hillslope sediment

Thin and patchy hillslope sediment occurs at the land surface over much of Juneau County. Several hillslope processes are now active or have been active in the past, including soil creep and slopewash. Little slopewash occurs on sandy soil where most water infiltrates rather than runs off, but more slopewash occurs on less permeable clayey soils and at times when infiltration is prevented by frozen soil. During the last glaciation, with its tundra climate and permafrost, the rate of soil erosion by slopewash was probably much greater than it is now. When the surface of the permafrost thawed during tundra summers, the soil was also much more apt to become waterlogged and to flow downhill than it is at present; such solifluction was a major hillslope process during the last glaciation. The tundra climate also intensified the shattering of rock exposed in cliff faces, with an accompanying increase in rock falls. Landslides were probably also more common at that time.

The hillslope sediment on the Mount Simon and Eau Claire Formations and on the Galesville Member of the Wonewoc Formation consists primarily of sand, with some fragments of sandstone. It is generally less than 1 m thick on the higher parts of the landscape and more than 1 m thick in depressions. In the Dells, around steeper mounds of the Mount Simon in the central part of the county, and around the base of the Wonewoc escarpment (fig. 3), sandstone boulders are common; several metres of hillslope rubble occur at the base of the steepest cliffs. Where the contact between map units **hw** and **ht** is shown as a solid line on plate 1, the Ironton Member forms a cliff that is free of hillslope sediment.

The undulating surface of the Tunnel City Group is typically overlain by no more than about 0.5 m of sandy (generally somewhat glauconitic) hillslope sediment, but it thickens at the base of steeper slopes.

The steep cliff of the Jordan escarpment (fig. 3) is free of hillslope sediment, but the lower parts of the Jordan and the St. Lawrence Formations at the base of the escarpment are commonly overlain by a few metres of sandy debris, blocks of Jordan sandstone, and pebbles and cobbles of chert from near the Jordan-Oneota contact.

The Oneota Formation is overlain in most places in Juneau County by a layer of red to dark red clay a few metres thick. WGNHS Geologic Log JU-202 shows 8 m of red clay near the high point of the Oneota upland in sec. 11, T15N, R2E. It commonly contains abundant pebbles and cobbles of Oneota chert. The clay and chert accumulated in Cenozoic time as a result of the weathering (dissolving) of the Oneota dolomite. The insoluble residue in the dolomite, along with the clay that filled cavities in the dolomite, was concentrated at the land surface. According to Frolking (1978), the scarcity of mica, which is common in the insoluble residue, and the abundance of montmorillonite and kaolinite, which are scarce in the insoluble residue, indicate that the insoluble residue was subsequently greatly modified by soil-forming processes. This material in turn was subsequently acted on by various hillslope processes, including slopewash and solifluction during the last glaciation, when some windblown silt was intermixed with the upper part of the clay.

The red clay occurs only on the Oneota uplands, but the chert, cobbles, and pebbles occur in most hillslope, stream, and shore deposits throughout Juneau County and adjacent areas. The chert is resistant to weathering, and it is commonly the only material coarser than sand found at the surface in the central and northern parts of the county.

Most of the plains of central and northern Juneau County are too flat to be subject to most hillslope processes, but the soil was stirred as the result of the thawing and refreezing of the upper surface of the permafrost. Ice-wedge polygons that are a few tens of metres in diameter can be seen on aerial photographs in several places in Juneau County; they are indicated by star symbols on plate 1. They occur on the lake plain, indicating that permafrost persisted in the area until after glacial Lake Wisconsin drained; evidence elsewhere in Wisconsin indicates that permafrost persisted until about 13,000 years ago (Clayton, 1987; Attig and Clayton, 1986).

Windblown sediment

Windblown sand overlies the offshore sand of map unit **oy** on plate 1. The windblown sand probably averages less than 1 m thick, and the sand dunes are generally no higher than 2 m; however, dunes higher than 6 m are present in a few places, such as near Cutler (T18N, R2E). Windblown sand also occurs on the offshore sand of map units **oc** and **ow**, but it is thinner and patchier.

Windblown silt between about 0.5 and 1.3 m thick occurs on most surfaces above the level of glacial Lake Wisconsin, but it is lacking on steep slopes such as those of the Wonewoc and Jordan escarpments. Windblown silt more than about 1.3 m thick occurs on the upland areas of map unit **wc**. (The distribution of this map unit was derived from unpublished preliminary soil maps [scale 1:15,800] supplied by Howard F. Gundlach of the U.S. Department of Agriculture, Soil Conservation Service, in Mauston, Wisconsin.) Where no thicker than about 1 or 2 m, most of the silt was deposited during the last part of the Wisconsin Glaciation, at the same time as the windblown silt of the Peoria Formation in Illinois (Willman and Frye, 1970). Where the silt is thicker, the lower part is commonly less yellow and more red, is more compact, and shows evidence of transport by hillslope processes. It might be equivalent to the silt of the Roxana Formation of Illinois, deposited during the early part of the Wisconsin Glaciation (Willman and Frye, 1970). For example, 2 m of yellower, less dense silt overlies 1 m of redder, more dense silt in a roadcut at the edge of the Ironton bench in the NE1/4 SE1/4 SW1/4 NE1/4 sec. 32, T16N, R3E (UTM coordinates 728,570mE, 4,856,370mN).

One metre or more of silt also overlies the offshore sand of map units **oy** and **oc** (plate 1) between the Wonewoc escarpment and the Lemonweir River. It may be windblown sediment, or more likely, it is offshore sediment derived from silt washed off the uplands to the south.

Bog iron ore

The term bog iron ore is used for iron oxides precipitated in bogs, swamps, shallow ponds, and slowly moving streams. The bog iron ore of central Wisconsin occurs on the plain of glacial Lake Wisconsin where the water table is at or near the surface. It was deposited in shallow depressions on the plain after the lake drained.

The bog iron ore of central and northern Juneau County was used for surfacing roads in the 1920s and 1930s and was described in Road Material Investigation Reports 134, 461, 828, and 1042 (unpublished reports in WGNHS files). It typically occurs at the land surface or just below the surface soil or below a thin layer of peat, in deposits that are about 0.3 m thick (although some are as thick as 1 m) and tens to hundreds of metres wide. None of these deposits is large enough to show on plate 1. Bog iron ore is commonly porous or thinly bedded and some is hard enough to be referred to as clinker ore in the Road Material Investigations Reports. Some deposits contains more than 70 percent iron oxides, but others have considerable intermixed sand (Irving, 1877, p. 636).

REFERENCES

Asthana, Virendra, 1969, The Mt. Simon Formation (Dresbachian Stage) of Wisconsin: University of Wisconsin, Madison, Ph.D. thesis, 159 p.

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

Berg, R.R., 1954, Franconia formation of Minnesota and Wisconsin: Geological Society of America Bulletin, vol. 65, p. 857-882.

Brownell, J.R., 1988, Big Flats Formation, *in* Attig, J.W., Clayton, Lee, and Mickelson, D.M., eds., 1988, Pleistocene stratigraphic units of Wisconsin: 1984 to 1987: Wisconsin Geological and Natural History Survey Information Circular 62, p. 19-24.

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

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

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

Clayton, Lee, in press, Pleistocene geology of Wood County, Wisconsin: Wisconsin Geological and Natural History Survey Information Circular.

Dott, R.H., Jr., Byers, C.W., Fielder, G.W., Stenzel, S.R., and Winfree, K.E., 1986, Aeolian to marine transition in Cambro-Ordovician cratonic sheet sandstones of the northern Mississippi valley, U.S.A.: Sedimentology, vol. 33, p. 345-367.

Frolking, T.A., 1978, The upland red clays of the Driftless Area of southwestern Wisconsin: their genesis, distribution, and geomorphic significance: University of Wisconsin, Madison, M.S. thesis, 175 p.

Greenberg, J.K., Brown, B.A., Medaris, L.G., and Anderson, J.L., 1986, The Wolf River batholith and Baraboo interval in central Wisconsin: Wisconsin Geological and Natural History Survey Field Trip Guide Book 12, 56 p.

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

Irving, R.D., 1877, Geology of central Wisconsin *in* Geology of Wisconsin, vol. 2: Wisconsin Commissioners of Public Printing, p. 408-636.

Johnson, D.P., 1947, The areal geology and stratigraphy of the Hillsboro quadrangle, Wisconsin: University of Wisconsin, Madison, M.A. thesis, 60 p.

Martin, Lawrence, 1932, The physical geography of Wisconsin: Wisconsin Geological and Natural History Survey Bulletin 36, 608 p.

Myers, M.D., 1981, The stratigraphy and sedimentology of the upper Wonewoc Formation—a critique of the Ironton Member: University of Wisconsin, Madison, Ph.D. dissertation, 130 p.

Ostrom, M.E., 1966, Cambrian stratigraphy of western Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 7, 79 p.

Ostrom, M.E., 1967, Paleozoic stratigraphic nomenclature for Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 8, 4 p.

Ostrom, M.E., 1970, Sedimentation cycles in the lower Paleozoic rocks of western Wisconsin: Wisconsin Geological and Natural History Survey Information Circular 11, p. 10-34.

Ostrom, M.E., [1978], Friendship Mound: [Wisconsin Geological and Natural History Survey Geology of Wisconsin Outcrop Description AD 17/6E/5], 2 p.

Ostrom, M.E., 1987, Cambrian stratigraphy at Whitehall, Wisconsin: Geological Society of America Centennial Field Guide, vol. 3, p. 185-188.

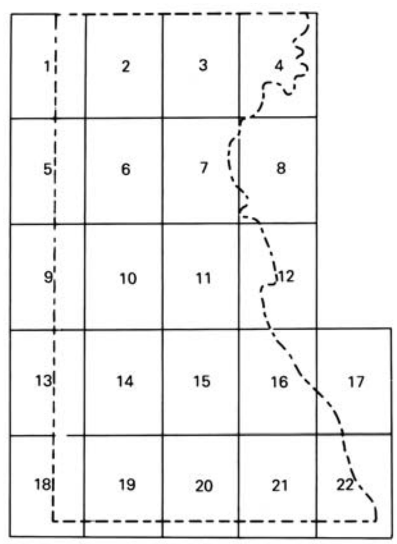
Salstrom, P.L., 1962, The areal geology and stratigraphy of the Reedsburg quadrangle, Wisconsin: University of Wisconsin, Madison, M.S. thesis, 52 p.

Twenhofel, W.H., Raasch, G.O., and Thwaites, F.R., 1935, Cambrian strata in Wisconsin: Geological Society of America Bulletin, vol. 46, p. 1687-1744.

Willman, H.B., and Frye, J.C., 1970, Pleistocene stratigraphy of Illinois: Illinois State Geological Survey Bulletin 94, 204 p.

Juneau County
location diagram

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



1 Mather–1970
2 Finley–1969
3 New Miner–1969
4 Arkdale NW–1969 (85 PR)
5 Shennington–1970
6 Cutler–1969
7 Necedah–1969
8 Arkdale–1967 (85 PR)
9 Camp Douglas–1983
10 New Lisbon North–1983
11 Kelly–1983
12 Dellwood–1983
13 Kendall East–1983
14 New Lisbon South–1983
15 Mauston–1983
16 Round Bluff–1983
17 Easton–1983
18 Hillsboro–1983
19 Wonewoc–1975
20 Potato Hill–1975
21 Lyndon Station–1975
22 Wisconsin Dells North–1975

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