Geologic map of the Dells of the Wisconsin River State Natural Area

Adams, Juneau, Columbia, and Sauk Counties, Wisconsin, USA

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Project Outline

This map is the first in a planned series of geologic maps focused on Wisconsin state parks and other Department of Natural Resources land units. It aims to provide a more detailed look at the geologic formations present around the Dells of the Wisconsin River State Natural Area (SNA) than previous mapping. Significant findings are also presented, along with new scientific questions raised by this work.

The map's unique shape reflects the shape of the SNA, as mapping was restricted to its boundaries. However, the map incorporates findings from the surrounding area in addition to data collected within the SNA. Data used to create the map include field work, geochemical analysis, and previously published descriptions of geology in surrounding counties.

Description of Map Units

This map depicts geologic units at the land surface. Quaternary units are shown where thickness is estimated to exceed one meter.

CENOZOIC

Quaternary

Lake Sediment

Qml — Modern lake sediment. Tan, well sorted, fine- to medium-grained sand.

Alluvium

Qa — Alluvium consists of sand along the Wisconsin River and muddier beds in the tributary valleys. Sand and mud were likely sourced from nearby sandstones based on the textural maturity and compositional purity of the sand, which is comparable to that of the Mount Simon and Wonewoc formations (see below). This interpretation is similar to that of Clayton (1987, 1989). Alluvium was directly observed in a couple of locations and inferred elsewhere.

Loess

Ql — Pleistocene windblown silt and fine sand deposited on flat, upland areas. Mostly inferred, although some loess was directly observed.

PALEOZOIC

Cambrian

Tunnel City Group

Ctc — Fine-grained, well sorted, pale, carbonate-cemented, vuggy sandstone. Light-yellow or orange, uncommonly pink. Burrows and trace fossils are common. The total thickness reaches up to 20 meters in the map area, but once reached as much as 40 meters prior to erosion based on thicknesses reported in nearby portions of Juneau and Sauk counties by Clayton (1989) and Clayton and Attig (1990). The Tunnel City Group conformably overlies the Wonewoc Formation with a gradational contact. The Tunnel City Group was directly observed in the field; the exposed sections are likely the Mazomanie Formation, the Wisconsin Arch-proximal facies of the Tunnel City Group.

Wonewoc Formation

Cw — The Wonewoc Formation (upper formation of the Elk Mound Group) is composed of the upper Ironton Member and lower Galesville Member. The Ironton Member resembles the Mazomanie Formation and is a fine-grained, well sorted, pale, carbonate-cemented sandstone with some trace fossils and bioturbation. It contains some glauconite and frequently forms a topographic bench.

The Ironton Member was directly observed in one location and inferred elsewhere. The total thickness ranges from 2-5 meters.

The Galesville Member is a fine- to medium-grained, well sorted and rounded quartz arenite. Medium to large crossbeds are common, and scoured bedding was observed in some of the outcrops. Trace fossils and bioturbation are absent around the Dells. The Galesville Member has a maximum thickness of 20 meters, but is commonly eroded to as little as one meter thick. It was directly observed in multiple locations.

The lowermost 50–100 centimeters of the Wonewoc Formation around the Dells forms a distinct horizon informally referred to as the delineating layer. Reddish silt occurs in millimeter-thick beds within the sandstone layers. Centimeter-scale, white clayey clasts are embedded in the silty layers. The silty layers contain high levels of aluminum and iron, while the embedded clasts contain high levels of aluminum and potassium. Hematite cement appears in millimeter- to centimeter-thick, wavy, dark brown, continuous to anastomosing bands, which are well-defined and vary in the ratio of cement to sand. The rest of this horizon consists of very fine to very coarse, poorly sorted sandstone, which is otherwise similar to the Galesville Member. No trace fossils or bioturbation are visible in this horizon, which forms a topographic bench. This bench can be traced northwest to sites in Juneau County that have been identified as the Eau Claire Formation (middle formation of the Elk Mound Group) by Clayton (1989). This led Clayton (1989) to consider the Eau Claire Formation in the Wisconsin Dells to be at a similar elevation as the horizon in question. The silty horizon was directly observed at multiple locations inside the SNA.

Mount Simon Formation

Cms — The Mount Simon Formation (lower formation of the Elk Mound Group) resembles the Galesville Member of the Wonewoc Formation. It is a fine- to medium-grained, well sorted, well-rounded quartz arenite. Trace fossils and bioturbation are absent around the Dells (Dott and others, 1986; Clayton, 1989; Clayton and Attig, 1990; this study). Large crossbeds and scoured bedding were observed in this study, and previous workers identified adhesion structures in the Wisconsin Dells area (Dott and others, 1986). The Mount Simon Formation is virtually indistinguishable from the Galesville Member without the use of a marker horizon. We used the distinct horizon at the base of the Wonewoc Formation (described above) as a defining layer. The thickness of the Wonewoc Formation on this map is consistent with thicknesses described in nearby portions of Juneau and Sauk counties (Clayton, 1989; Clayton and Attig, 1990). The Mount Simon Formation is more than 100 meters thick based on well and core data in the area. The Mount Simon Formation was directly observed in numerous locations and comprises most of the cliff faces in the Dells.

Interpretation of a delineating layer at the base of the Wonewoc Formation

The delineating layer at the base of the Wonewoc Formation, observed in this study and described above, matches the stratigraphic location and description of a horizon recognized in Juneau and Sauk counties by Clayton (1989) and Clayton and Attig (1990). While Clayton (1989) and Clayton and Attig (1990) interpreted this distinct horizon as the marine Eau Claire Formation, we interpret this horizon to consist of lacustrine sediments in an interdune and braided river environment.

Clayton (1989) and Clayton and Attig (1990) describe what they identify as the Eau Claire Formation in Juneau and northeastern Sauk counties as a 1- or 2-meter-thick, fine- to coarse-grained, poorly sorted quartz sandstone with mm-thick silt layers, iron layers, thin, flaggy bedding, and bioturbation and some burrows or fossil fragments. In La Crosse, Trempealeau, Eau Claire, and Chippewa counties, Aswasereelert and others (2008) describe the Eau Claire Formation as grading from a thin-bedded siltstone through a thick-bedded, hummocky cross-stratified, fine-grained sandstone with siltstone laminae into a fine-grained, planar or crossbedded sandstone. They interpret these facies as representing a transition from a quiet-water environment below storm wave base through a periodically storm-tossed environment below fair weather wave base into a foreshore environment akin to the Mount Simon and Wonewoc formations as they appear in western Wisconsin. If the Eau Claire Formation is present in the Wisconsin Dells area, this thicker complex of facies presumably pinches out into Clayton and Attig's single facies as one climbs the Wisconsin Arch.

We interpret the silty layers and clayey clasts as interdune deposits, likely formed in ephemeral pools or lakes. These layers thus formed amidst the aeolian dunes and braided rivers preserved in the cliff faces at the Dells of the Wisconsin River (Dott and others, 1986). The coarse and poorly sorted sand grains separating the silty layers, along with the wavy and anastomosing iron bands, suggest these sediments were not deposited below wave base in a calmer, more distal facies of the Eau Claire Formation. Meanwhile, the presence of finely-laminated silt in this horizon suggests these sediments were not deposited in an energetic nearshore or foreshore environment. The lack of any fossils or bioturbation in the silty horizon suggests a wholly nonmarine depositional environment distinct from even the shallowest facies of the Eau Claire Formation (Aswasereelert and others, 2008).

The sandstone surrounding silty beds of the delineating layer contains structures that suggest an interdune or braided river environment, including scour surfaces, slumping, and laminae that alternate between fine and coarse grains. The silt itself is very thin and finely laminated, suggesting an extremely calm environment. Kaolinite found in the silt implies a nonmarine environment, which fits with the common interpretation of the sandstone in the Wisconsin Dells (Dott and others, 1986).

The Eau Claire Formation can therefore be said to be absent at this point on the Wisconsin Arch. However, layer thicknesses and cross sections from further south and west (where the Eau Claire Formation is clearly identified) suggest that it should sit around the elevation of the delineating layer. We therefore use the delineating layer as the contact between the Mount Simon and Wonewoc Formations in this map. We do not include the Eau Claire Formation itself because we find no marine deposits akin to its type sections in western Wisconsin (Aswasereelert and others, 2008) in the Elk Mound Group in the Wisconsin Dells area.

Additional details, a longer discussion on the depositional environment, and possible alternative interpretations are included in the supplemental materials.

References

Allen, B.L., and Fanning, D.S., 1983, Chapter 6: Composition and Soil Genesis, *in* Wilding, L.P., and others, eds., Pedogenesis and Soil Taxonomy: Concepts and Interactions: Amsterdam, Elsevier Science Publishers B.V., p. 141–192, https://doi.org/10.1016/S0166-2481(08)70601-9.

Aswasereelert, W., Simo, J.A., and LePain, D.L., 2008, Deposition of the Cambrian Eau Claire Formation, Wisconsin: Hydrostratigraphic implications of fine-grained cratonic sandstones: Geoscience Wisconsin, v. 19, part 1, 22 p., https://wgnhs.wisc.edu/catalog/publication/000236/resource/gs19a01.

Clayton, Lee , 1987, Pleistocene Geology of Adams County, Wisconsin: Wisconsin Geological and Natural History Survey, Information Circular 59, 14 p., 1 pl., scale 1:100,000, https://wgnhs.wisc.edu/catalog/publication/000309.

Clayton, Lee, 1989, Geology of Juneau County, Wisconsin: Wisconsin Geological and Natural History Survey, Information Circular 66, 16 p., 1 pl., scale 1:100,000, https://wgnhs.wisc.edu/catalog/publication/000316.

Clayton, L., and Attig, J.W., 1990, Geology of Sauk County, Wisconsin: Wisconsin Geological and Natural History Survey, Information Circular 67, 68 p., 1 pl., scale 1:100,000, https://wgnhs.wisc.edu/catalog/publication/000317.

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, v. 33, no. 3, p. 345–367, https://doi.org/10.1111/j.1365-3091.1986.tb00541.x.

Acknowledgments

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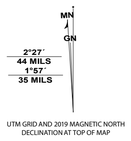


UTM GRID AND 2019 MAGNETIC NORTH DECLINATION AT TOP OF MAP

SCALE 1: 12000

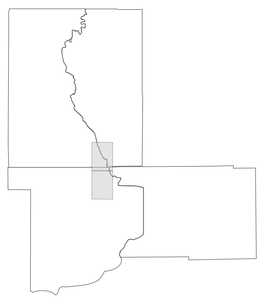
0 0.5 1 MILES

0 0.5 1 KILOMETERS

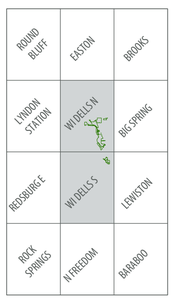
NAD 1983 HARN Wisconsin Transverse Mercator Projection (Meters)
Contour interval is 20 feet. Inset map is 1:48,000 scale.

Shaded-relief image and topographic contours from 5-foot lidar-based digital elevation model, Natural Resources Conservation Service (written commun., 2012). Magnetic north, hydrologic features, and topographic features from The National Map digital data, U.S. Geological Survey, 2018.

Juneau[1], Adams[2], Sauk[3], and Columbia[4] Counties



Location of the Wisconsin Dells 7.5-minute quadrangles in the four counties



Wisconsin Dells North, Wisconsin Dells South, and adjacent quadrangles. The Dells of the Wisconsin River State Natural Area is outlined in green.

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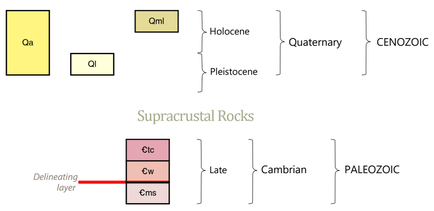
The map and cross sections are interpretations of the data available at the time of preparation. Every reasonable effort has been made to ensure that this interpretation conforms to sound scientific and cartographic principles; however, the map should not be used to guide site-specific decisions without verification. Proper use of the map is the sole responsibility of the user.

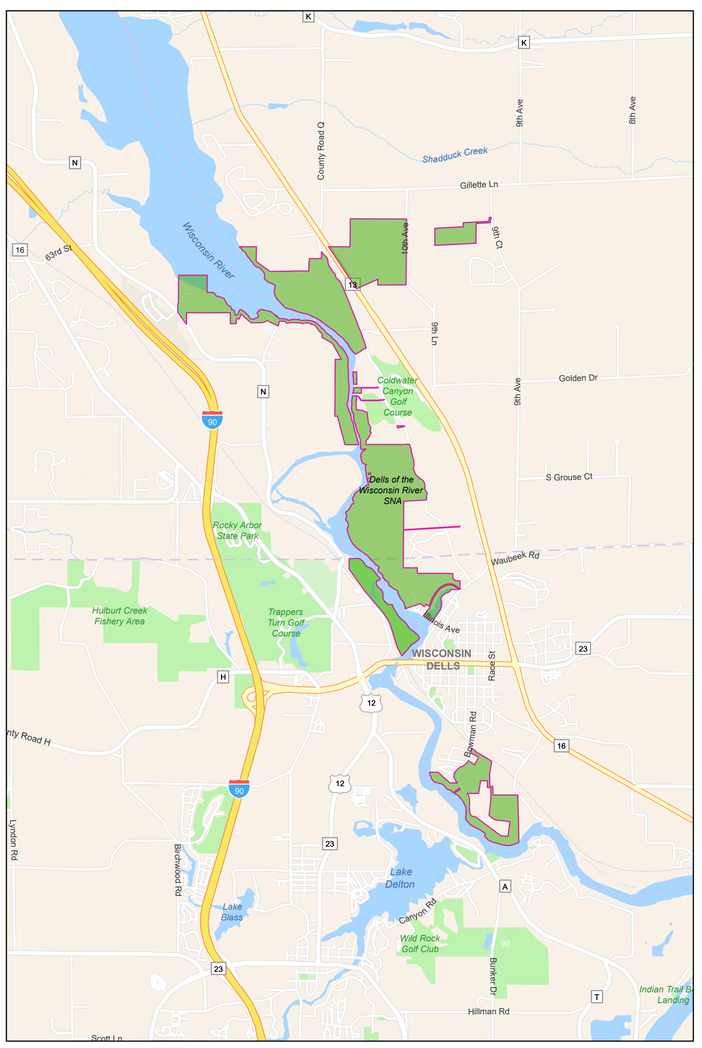
For additional information about the geology presented here, please refer to the report that accompanies this map: https://doi.org/10.54915/bjjd3697.

Symbols

- Inferred contact
- Crossbeds - showing dip azimuth and dip (inferred sediment transport direction)
- Deformation band - showing strike and dip
- Inclined joint - showing strike and dip
- Vertical joint - showing strike
- Delineating layer
- Boundary of State Natural Area
- Kilbourn Dam

Correlation of Map Units





Basemap from World Topographic Map, ESRI, 2022.