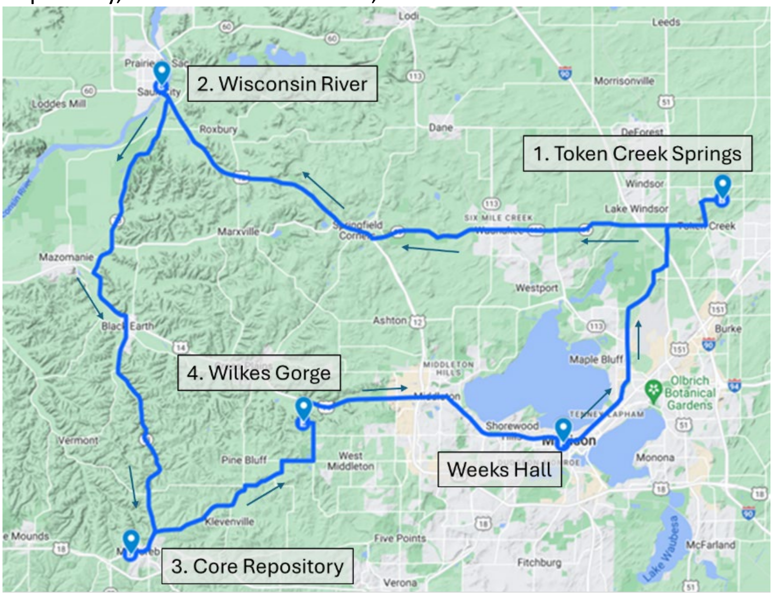
Weeks 50th Anniversary Field Trip Guide
Saturday, 9:00 – 2:30
Motor Coach starts loading at 8:45 on Charter Street,
next to Weeks Hall

This field trip has four stops shown in the map below. We'll meet and start the trip at Weeks Hall. From there we will proceed to Culver Springs, the Wisconsin River, the Wisconsin Geological and Natural History's Core Repository, Cross Plains State Park, and then end back at Weeks Hall.



We'll see examples and applications of hydrogeology, geomorphology, and glacial geology. We'll have lunch and a tour at the Core Repository.

Stop 1 - Token Creek Springs (Mike Cardiff)

Information taken from theses by Laura Parent (2001), Jeremy Patterson (2022), Token Creek Conservancy (https://tokencreek.org), Village of Windsor (https://windsorwi.gov), and the WGNHS Springs Inventory (https://home.wgnhs.wisc.edu/water/springs/) . Summarized by Michael Cardiff, Aug, 2024

On this field stop you will be visiting the Token Creek Conservancy – land overseen by the village of Windsor, Wisconsin and a site that has been part of groundwater and surface water investigations by several UW researchers. After parking at or walking to the end of Mill Road and proceeding directly to the south you will find the headwaters of Token Creek. The Token Creek surface watershed covers approximately 27 square miles and extends north to the border between Dane and Columbia counties. Token Creek is the main contributor of water to the Yahara River, which feeds into Madison's Lake Mendota.

While precipitation and resulting surface water runoff feed Token Creek in wet periods, the water body is sustained primarily by large natural springs, including the Culver Springs complex, which is visible as natural seeps and boils beneath the creek. Based on data from the 2019 inventory of springs by WGNHS, the springs are some of the most productive by volume in Wisconsin, with one individual spring flowing at > 5 cubic feet per second (2,200 gallons per minute). This places this spring among the top 10 of over 400 springs measured by WGNHS. The baseflow generated from these springs, per square mile, is much also greater than flow entering the neighboring Yahara River, suggesting that Token Creek has a much larger "groundwatershed" than surface watershed (Parent, 2001). The speed of groundwater flow within these fractures is exceptional; during drilling of additional wells on-site in 2018, turbid water appeared in the springs 400' away, only 20 minutes after drilling recommenced following a pause.

Geologically, this region is underlain by shallow sandstone bedrock of the Tunnel City and Wonewoc formations (Cambrian age, ~500 Ma). Geophysical and image logging of several nearby wells shows consistent and prominent near-horizontal features within the Tunnel City and Wonewoc sandstones that are suspected to be bedding plane partings. While not "fractures" in the mechanical sense, these features behave hydrologically like fractures in that they provide fast flowpaths for groundwater relative to the surrounding sandstone formation. The Springs at Token Creek are the result of these laterally-extensive near-horizontal fractures intersecting the land surface.

The Token Creek area is the former site of one of the last functioning mills in Dane County, which generated the hydropower for milling via a dam located at Portage Road. In 1994, this dam failed and the pond was drained, revealing portions of the current wetland complex. Over $1 million in funds raised by the Token Creek Conservancy were used to purchase land within the Token Creek watershed and restore the site to natural conditions. This project has been exceptionally effective, restoring the hyporheic system that exchanges flow between groundwater and surface water, and the cold baseflow provided by the springs supports a thriving trout habitat.

Figure 1: Top – Stream netwo watershed boundary for Token showing lake Mendota to SW. Blue site of Elmer & Edna Culver Sprin Bottom – local map showing parl and increase in river width downstream of springs.

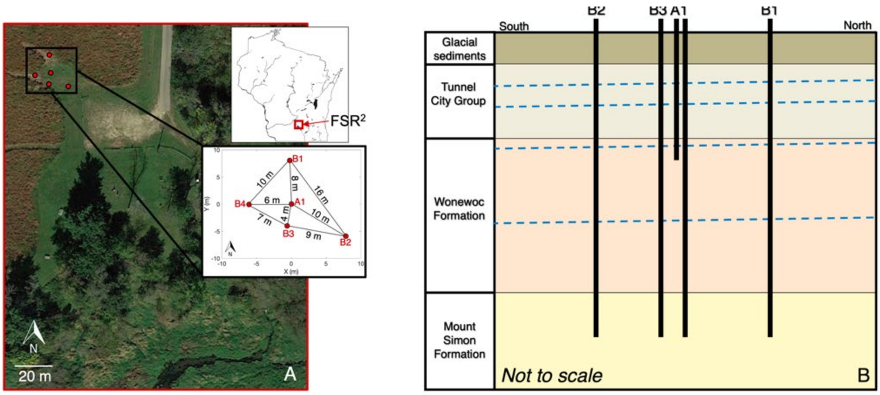


Figure 2: Well network and associated stratigraphic profile used in hydrogeologic investigations. Blue dashed lines represent prominent fractures identified in image logs.

Stop 2 - Wisconsin River/Ferry Bluff State Natural Area (Eric Carson)

Due to lack of accessibility by coach bus to Ferry Bluff, we will stop at Sauk City River Walk instead. *Drawn from Carson, E.C. and Rawling III, J.E., 2015, Late Cenozoic evolution of the lower Wisconsin River valley: Geological Society of America North-Central Section Meeting Field Trip #5 Guidebook. WGNHS Open-File Report 2015-02, 21 pp., and other sources.*

Ferry Bluff State Natural Area provides a dramatic view of the Wisconsin River entering the lower Wisconsin River valley—a deeply incised river valley that cuts roughly east-west across the Driftless Area of southwest Wisconsin to the confluence with the Mississippi River at Prairie du Chien, WI. Visible from this overlook are the Wisconsin River itself; a series of aggradational terraces on the valley floor associated with the last glaciation; the bedrock walls of the valley; and Blue Mounds visible on the horizon to the south.

The broad flat morphology of the ground surface of the valley floor reflects the glacial history of the location. The valley has been carved into bedrock significantly deeper than is visible, and subsequently filled with 150 to 200 feet of sand and gravel. All available evidence indicates this fill was deposited in its entirety during the last glaciation while the Green Bay Lobe of the Laurentide Ice Sheet stood just a few miles to the east of Ferry Bluff. The aggradational terraces and the buried bedrock floor of the valley dip gently to the west, as is required for features deposited and carved by west-flowing water.

However, moving farther down the lower Wisconsin River valley westward, several segments of a remnant strath (bedrock-cored) terrace can be found. This is the highest, and therefore oldest, terrace in the lower Wisconsin River valley, and the bedrock surface on this terrace is as much as 50 to 80 feet higher than the adjacent modern river. The exact nature of this surface is obscured, however, by 5 to 50 feet of aeolian, fluvial, and lacustrine sediment deposited on top of it. This bedrock strath is interpreted to represent remnants of an ancient floor of the valley that predates a more recent episode of regional incision.

A series of geoprobe cores that penetrated to the bedrock surface on the three segments of strath terrace, combined with high-resolution LiDAR topographic data that provided precise ground surface elevation control, demonstrates that the bedrock surface of the Bridgeport strath terrace dips to the east, in opposition of all other surfaces in the valley (Fig. 1). This would indicate that the lower Wisconsin River valley was carved to this level by a stream flowing east, rather than west as does the modern Wisconsin River. There is abundant, independent geomorphic evidence that supports this interpretation including the presence of 'barbed tributaries' and aspects of the morphology of both the lower Wisconsin River valley and the Mississippi River valley downstream of the confluence of the two rivers (Fig. 2).

Additional research (*e.g.*, Carson et al., 2018; Wickert et al., 2019) indicates that the lower Wisconsin River valley is the lone remaining surface expression of a vast pre-Quaternary river system that flowed east across Wisconsin and Minnesota (at a minimum), through what is today the Great Lakes, and drained into the North Atlantic Ocean through the Gulf of St. Lawrence. An early Quaternary glaciation that dammed the valley caused a lake to fill the valley, which eventually spilled over near modern Prairie du Chien, WI. Incision that allowed drainage of the lake to the south initiated formation of a new channel that cut downward rapidly through friable Cambrian sandstones and permanently diverted—or 'pirated'—at least 80,000 square miles from the St. Lawrence drainage to become the modern upper Mississippi River drainage. Subsequent base level adjustment on both the Mississippi and lower Wisconsin River valleys left the few preserved fragments of the Bridgeport terrace stranded far above the modern bedrock valley floor, and exposed only because the Driftless Area has never been glaciated.

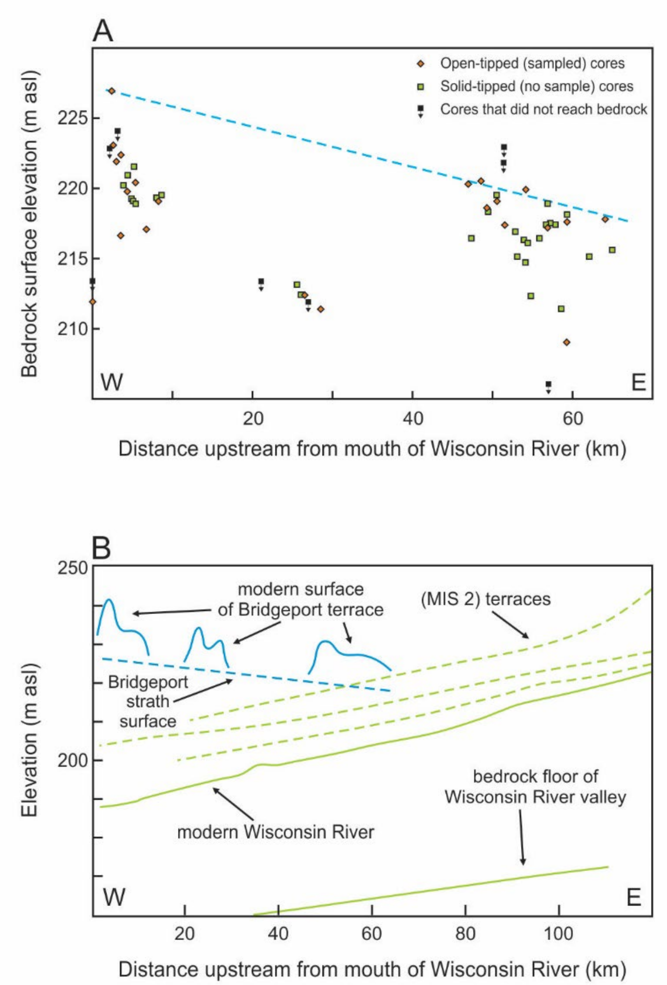


Figure 1. Results of Geoprobe coring to determine orientation of strath surface. (A) Elevation of strath surface at each coring site as a function of distance upstream from the mouth of the Wisconsin River. The black dashed trend line represents the original strath surface, dipping to the east with an estimated slope of 0.38 ft/mi. (B) Bridgeport strath surface (eastward-dipping dashed line) in relation to other major westward-dipping surfaces in the lower Wisconsin River valley. Early to middle Quaternary surfaces shown in blue; late Quaternary surfaces shown in green.

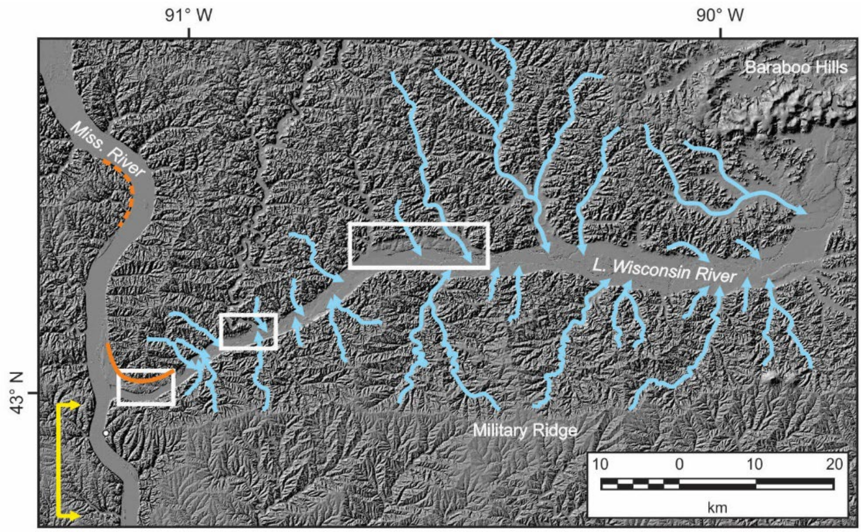


Figure 2. Lower Wisconsin River valley shown in LiDAR-derived hillshade, with general location of segments of Bridgeport strath shown by white boxes. Four geomorphological features of the lower Wisconsin River valley that indicate drainage reorganization has occurred. (1) 'Barbed tributaries' (blue arrows) angle into the Wisconsin River in the opposite direction to which it flows. (2) The valley wall at confluence of the Mississippi and lower Wisconsin Rivers (solid orange line) has a smooth curved radius more similar to the inside of a bend on a single river (dashed orange line) than a feature that evolved by bedrock incision at a confluence of two rivers. (3) Along the length of the lower Wisconsin River, the valley wall-to-valley wall width decreases from ~5 km near Spring Green to little more than 2 km at the confluence with the Mississippi River. This is in opposition to the pattern recognized on most rivers. (4) Immediately downstream from its confluence with the Wisconsin River, the Mississippi River narrows and a series of unusually steep tributaries, locally known as 'coulees', feed in (reach indicated by yellow bracket). This suggests formation of this reach of the river during a period of intense, relatively recent incision.

Stop 3 – Core Repository (Carsyn Ames and Mel Reusche)

Excerpted from the WGNHS website, https://home.wgnhs.wisc.edu/research-data/core-repository/

The Wisconsin Geological and Natural History Survey's geologic repository — the **Research Collections and Education Center** — houses a variety of carefully organized and maintained earth-science materials. These collections are essential to improving our scientific understanding of the geology and natural resources of the state of Wisconsin.

A small portion of the geologic core at MHREC. (Photo by Shazwan Abdul Hamid)

What's in our repository?

To date, the WGNHS core repository holds:

Rock cores

- Cores from more than 2,000 drillholes throughout the state are cataloged and available for study.
- These cores comprise more than 600,000 linear feet of subsurface rock samples from mineral, engineering, and geologic investigations.

Individual rock samples

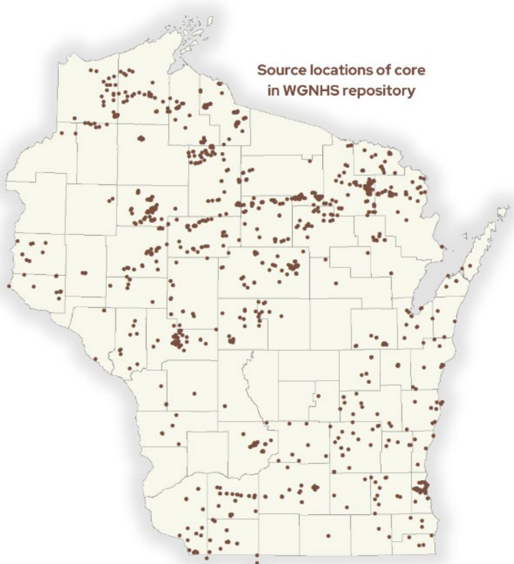
- More than 15,000 hand-size rock samples are labeled and stored.
- These samples represent hundreds of investigations of the geology of Wisconsin.

Water-well cuttings

- Cuttings from more than 11,000 individual water-wells throughout the state are available.
- These cuttings include 570,000 individual samples, each covering a 5-foot interval, collectively representing approximately 2.7 million linear feet of drilling.

Supporting documentation

- Computerized databases provide in-house access to a variety of related information.
- Field notes, geologic logs, geophysical logs and records, thin sections, and assays supplement the cores, cuttings, and samples.
- The inventory of WGNHS publications describe the various studies, mapping projects, and related investigations and build on the information contained in the data collections.



Stop 4 - Wilke Gorge (Luke Zoet)

Excerpted from Mickelson, D.M., Maher, L.J., and Simpson, S.L, 2011, Geology of the Ice Age National Scenic Trail: Madison, WI, University of Wisconsin Press, 395 p. Modified in places by Luke Zoet, Aug, 2024

The Johnstown Moraine borders the site on its eastern side (fig. 1, 2). It is a clearly defined ridge at Mineral Point Rd., but is lower and harder to see from Old Sauk Rd. to where the ice margin crossed Old Sauk Trail. The till is about 50 feet thick above the dolomite bedrock surface.

When the glacier sat at the Johnstown Moraine, the climate was very cold, and permafrost was present in front of and beneath the glacier edge. Meltwater was dammed between the glacier and the Driftless Area landscape to the west. Lake L1 on figure 2 had the highest level. There is still silty lake sediment up to an elevation of at least 1150 feet and likely slightly higher. The lowest outlet for this lake was at an elevation between 1150 and 1160 at its northeastern end. The basin that contained lake L1 was apparently a stream valley that drained toward the east, until the glacier and its deposits blocked its flow. A narrow band of outwash separates the finer silty lake sediment from the till in the Johnstown Moraine.

Lake L2 seems to have been at about the same level as lake L1. It seems likely that these lakes were connected for a period of time when glacier ice advanced against a rock knob and dammed lake L2. This rock knob is just north of the present Old Sauk Road. With a very small retreat of the ice, lake L2 would have drained or at least dropped in level. This water drained through a drainage-way into lake L3. The elevation of the water surface of lake L3 appears to have been about 1100 feet. It seems that this lake drained along the ice margin across the ridge north of Old Sauk Pass Road and into Black Earth Creek valley before Wilkie Gorge was cut. At some point, the lake water from Lake L3 found its way under the ice and down the steep slope to the Black Earth Creek valley, potentially rapidly draining the lake. It was this flow of water that eroded Wilkie Gorge.

As mentioned above, throughout much of the time that the Green Bay Lobe was at its maximum extent, temperatures were very cold and the base of the glacier was frozen to its bed. When the climate began to warm, ice near the edge of the glacier began to melt, releasing water in and beneath the glacier. Generally, water at the base of a glacier flows from areas of thick ice to areas where the ice is thinner, because the pressure is greater under the thicker ice. But there are cases along the edges of modern glaciers where the opposite happens: water flows from the ice margin into or under the ice, and then out again at a lower elevation. The channels that form are called sub-marginal chutes. **Wilkie Gorge is a sub-marginal chute**. The elevation drop from L3 to Black Earth Creek valley would result in a surface slope of the sub glacially draining stream of 0.2 (or 12 degrees). Such a steep adverse slope could easily have overwhelmed the pressure driven water flow typically expected giving rise to the under-ice drainage of the lake. Wilkie Gorge's specific location was probably determined by a preexisting weakness or opening in the ice such as a crevasse where water flowed from the edge to the thicker center of the glacier. The water in lake L3 was about 200 feet higher than the Black Earth Creek valley, and water would naturally take the most direct path to the bottom of the valley. Once water made its way beneath the ice to the level of the bottom of Black Earth Creek valley the lake drained suddenly. Water under high pressure and flowing rapidly would have readily cut the deep gorge that you see today.

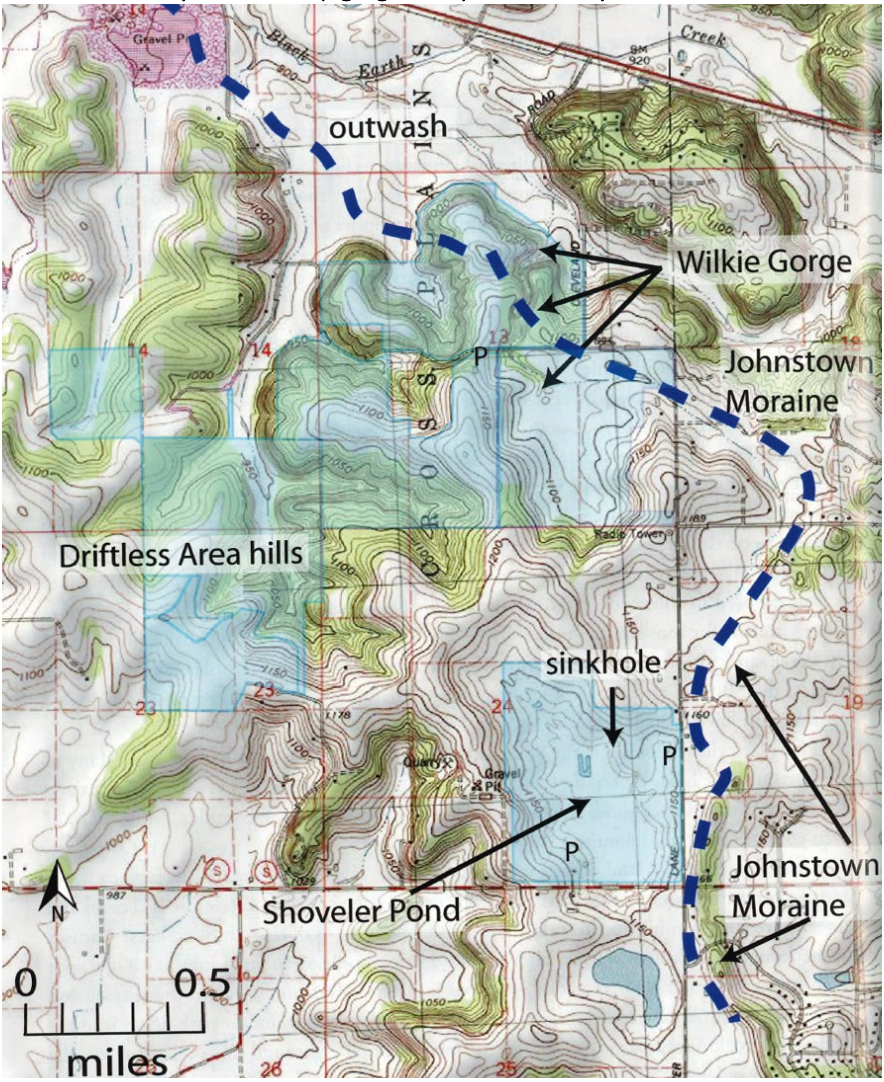


Figure 1. Topographic map of the Cross Plains Ice Age National Scientific Reserve site showing the distribution of public land as of January 1, 2011 (blue shading). Note the sinkhole through which Shoveler Pond drains. P indicates parking areas. (Base map is part of the Middleton USGS Quadrangle and was created with TOPO!©National Geographic Maps.

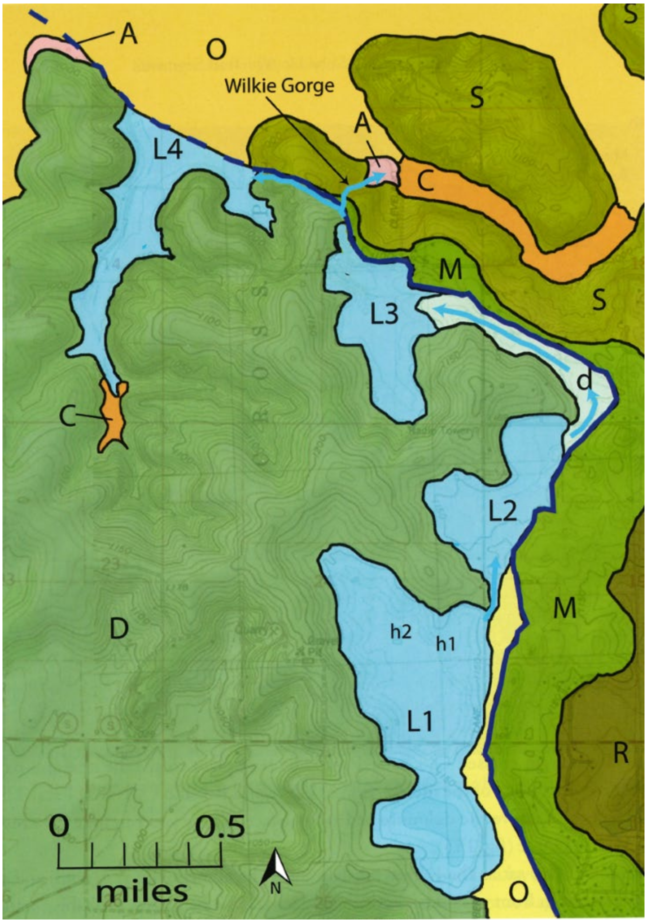


Figure 2. Detailed map of glacial and related deposits in the Cross Plains Ice Age complex. C is colluvium; D is Driftless Area with thin silt over bedrock; M is the Johnstown Moraine; F is alluvial fan; O is outwash; S is steep slope controlled by bedrock with patchy till cover; R is till, but not in the moraine. There is also colluvium at the base of most steep slopes that it is too narrow to map at this scale. Dark blue line is outer edge of Late Wisconsin glacial advance. Blue arrows show direction of meltwater flow. Several shallow lakes were present when the ice was at the Johnstown Moraine. Lake L1 was the highest; L2 was at about the same elevation and was dammed by ice in the present position of Old Sauk Road. Letter d is a drainage way to the next lake, L3, which was substantially lower than both L1 and L2. Label h1 is a sinkhole, and h2 is a possible sinkhole. (GIS Compilation by Midwest Region Geospatial Support Center, National Park Service.)