

Parfreys Glen — Cambrian conglomerate and conglomeratic sandstone

Location. Off Highway DL (Parfreys Glen Road), 3.4 km east of Highway 113, SE 1/4 NE 1/4, sec. 22, T11N, R7E, Sauk County (Baraboo, Wisconsin, Quadrangle, 7.5-minute series, topographic, U.S. Geological Survey, 1975) (fig. 1). State Natural Area — NO COLLECTING. State Park sticker required. Contact Park Superintendent, Devils Lake State Park, 55975 Park Road, Baraboo, Wisconsin 53913.

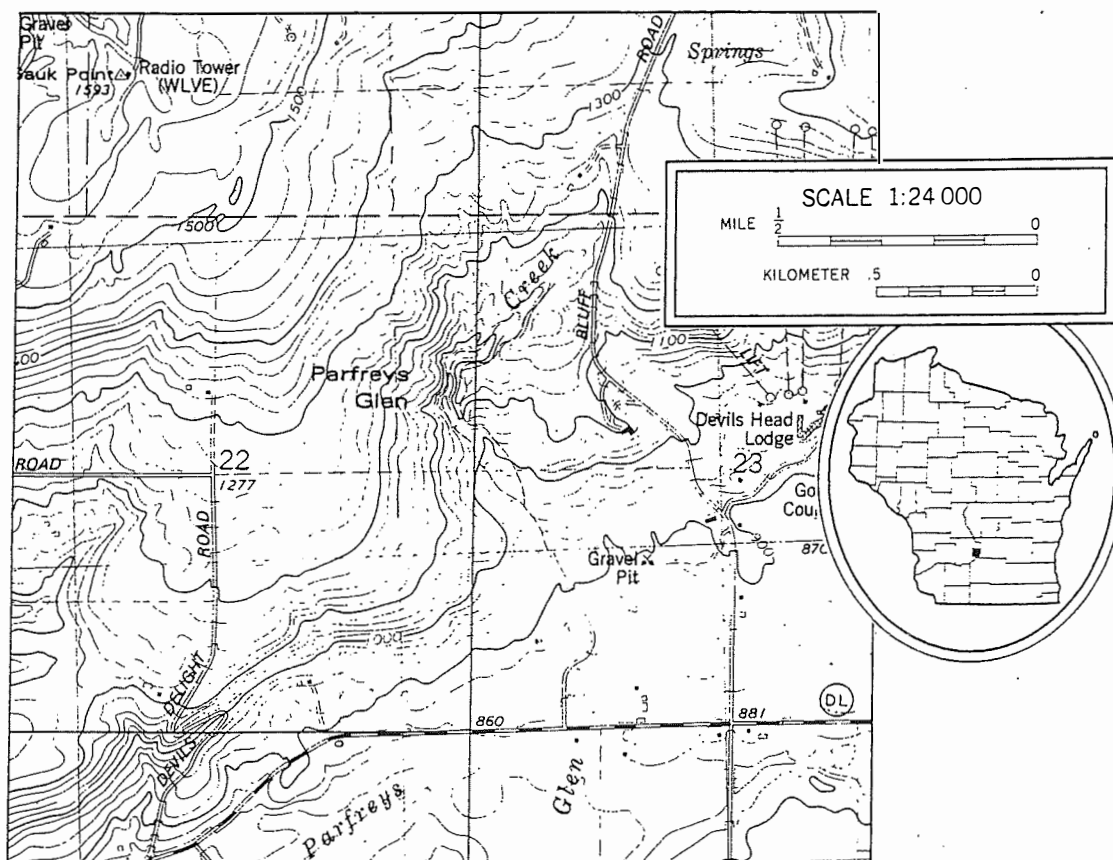


Figure 1. Location of Parfreys Glen.

Authors. M.G. Mudrey, Jr., and S.A. Nichols, 1989 (modified from Dott, 1970)

Description. Parfreys Glen is deeply incised into Cambrian conglomerate on the south flank of the Baraboo Hills. It is dedicated to Norman C. Fassett, a former botany professor of the University of Wisconsin-Madison. While chairman of the Scientific Areas Committee (1945-50), Fassett recommended Parfreys Glen as the first Scientific Area (now called State Natural Areas) in Wisconsin. The wall of the gorge exposes conglomerate and conglomeratic sandstone with clasts up to 1 m in diameter. The gorge is generally sheltered from the summer sun and supports a northern flora of white pine, yellow birch, mountain maple, and rare cliff plants (Zimmerman, 1970). A southern, dry-mesic forest of white and black oak, red maple, basswood, ironwood, and shag bark hickory covers the surrounding uplands.

As indicated by its designation as a State Natural Area, this is a special and fragile place. Over the years vegetation in the glen has been disturbed by human activity; as a result, some areas no longer represent an original northern flora (Wynn and Loucks, 1975). Visitors are required to stay on the trail, which follows the creek to the upper end of the gorge. From here, visitors must retrace their steps and return to the parking lot. *Do not climb the gorge walls or take any other route.*

History. "Glen" is a Scottish word for a narrow, rocky ravine. The glen is named after Robert Parfrey (1816-83), an Englishman who in 1865 inherited one of several mills in the area; the foundation of a mill can still be seen south of the first major stream crossing. The earthen and log dam for the millpond was located at the lower end of the gorge, where the trail ascends along the base of the west wall. Water was carried from impoundment to mill via a flume supported on trestles. Parfrey operated his mill until 1876 (Wynn and Loucks, 1975).

Milling in the glen was replaced by hiking and picnicking in the late 1800s. Enough people were visiting to prompt an 1882 rumor that a large hotel was to be built at the glen. Parfreys Glen thus had a long history of public use before the state began acquiring the glen in 1947. The scientific area was designated in 1952, and since then activities have been restricted to the established trail.

Geologic description. Parfreys Glen provides an excellent opportunity to examine Cambrian strata near the Cambrian-Precambrian unconformity. Extensive work in the glen has been done by R.H. Dott, Jr., whose 1970 report is paraphrased here. In this region at least three settings for conglomeratic material have been recognized. 1) At Pine Hollow, east Devils Lake, and La Rue Quarry, the Cambrian-Precambrian unconformity is exposed; Cambrian conglomerate is in direct contact with Precambrian quartzite as buried sea cliffs and stacks. 2) Parfreys Glen and other localities, which consist of conglomerate that is not in direct contact with Precambrian quartzite, represent sites of deposition slightly more seaward from the cliffs (0.25 to 0.5 km). Seismic work in Parfreys Glen suggests the presence of a quartzite knob east of the trail where Dott (written communication, 1989) recognized a knob or top of a cliff. 3) Other localities have only thin, fine-grained conglomerate, scattered pebbly gravel, or both in a quartz-rich sandstone. These were probably deposited seaward about 1 km from the shoreline.

On the basis of elevation, the strata at Parfreys Glen should be the time-equivalent of the Trempealeau Group, but the southward dip of 6° to 10° makes it probable that time-equivalents of the Tunnel City Group also are present.

Orientation of the prominent cross-bedding shows that Cambrian currents flowed toward the southeast. Movement was nearly parallel to the general shoreline, which lay about 1 km to the north. The distribution of conglomerate in discrete, relatively thin layers separated by sandstone records episodic sedimentation. If we assume that the entire sequence exposed here (a maximum of nearly 30 m) represents 10 million years, then the average apparent rate of accumulation was only about 3 m per million years; even a rate twice as fast for a total interval of 5 million years would be geologically slow. The entire sequence represents net accumulation. The clast-supported conglomerate layers suggest that erosion of Precambrian quartzite was also a major process (fig. 2), and that the depositional rate was higher. Regardless of the total time interval represented, "average" rates are clearly misleading. Parfreys Glen records chiefly the results of *episodic* conditions. Probably the average condition involved minor transport of sand, but was interrupted by violent events, such as storms. The latter produced enough wave and current energy to sweep quartzite boulders up to 1,000 kg from the foot of the nearby sea cliffs offshore for at least 0.5 km. The gravel was spread out as thin layers, winnowed to produce lag gravels, and then buried by migrating submarine sand dunes (or sand waves) now reflected by cross-bedding.

Stratigraphic and refraction seismic analysis by McMillan and others (in press) disclosed that the Cambrian sedimentary rock in Parfreys Glen was deposited in a pre-existing valley, which formed a cove in the Cambrian shoreline. The modern glen is off-center to the west in the ancient valley.

Geologic history. Stratigraphic relationships show that by Late Cambrian time the quartzite in the Baraboo Hills had been eroded to nearly its present form. Sandstone presumed to be of Late Cambrian age occurs near the southwest corner of Devils Lake; this indicates that Devils Lake gorge, which lies 4 to 6 km west of Parfreys Glen, had been cut at least to the level of the modern lake by Late Cambrian time. Geophysical investigations and stratigraphic relationships indicate that by Late Cambrian time a valley had also been cut in the Precambrian rock underlying Parfreys Glen. This valley and the remainder of the flanks of the Baraboo Hills were subsequently buried by nearshore sand, gravelly sand, and gravel during the Late Cambrian marine submergence of the area. Much of this marine sediment was lithified to form sandstone and conglomeratic sandstone. By Ordovician time marine sand and mud had buried the Baraboo Hills and filled Devils Lake gorge.



Figure 2. Typical exposure of Parfreys Glen Formation, showing beds of sandstone interbedded with beds of matrix-supported clasts of Baraboo quartzite. Several individual beds up to 1 m thick can be seen in this 4-m section.

It is not known when Paleozoic and possibly younger sediment was eroded from the Baraboo Hills to again expose the Precambrian rock. Siliceous gravel occurring on the East Bluff southeast of Devils Lake has been interpreted to be Cretaceous stream gravel. If this interpretation is correct, the landscape had been lowered at least to the level of the bluff tops in Cretaceous time. The hilltops surrounding the upper part of Parfreys Glen are underlain by quartzite; as the landscape was being lowered, it would be expected that the valley bottoms would migrate away from the high points in the quartzite surface. This may explain the position of Parfreys Glen with its underlying valley in the surface of the Precambrian rock.

The Parfreys Glen area was covered by ice during the last part of the Wisconsin Glaciation. The western edge of the Green Bay Lobe of the Laurentide Ice Sheet advanced several kilometres west of the glen. On the uplands surrounding the glen several metres of till overlie the Precambrian and Cambrian rock in most places. The glen as we see it today may have at least in part been cut by meltwater flowing along the margin of the glacier as it wasted back across the area. However, similar areas, such as Pine Hollow, occur in the unglaciated area and were formed without the help of meltwater. Parfreys Glen lies within a broader valley that would have funneled meltwater from the ice margin through the glen.

Flora. Parfreys Glen contains about 45 tree and shrub species, more than 100 herbs, 14 vascular cryptogams (10 ferns, 2 horsetails, and 2 clubmosses), and 34 liverworts and mosses. This biotic diversity is due to the abundance of different microhabitats on the site and to the rich floral diversity of the Baraboo Hills in general. The Baraboo Hills have a diverse flora because the topographic irregularity encompasses a wide range of habitats and because they are at a latitude in the state where the ranges of many northern and southern species overlap (Zimmerman, 1970).

Five species in Parfreys Glen are rare in the state. They exist because of the steep cliffs or because of the damp, cool, shaded glen habitat. The cliff and glen habitats also allow some typically more northerly species such as pipsisswea, wintergreen, partridge-berry, bishops-cap, mountain maple, June-berry, yellow birch, mountain ash, and white pine to exist on the site. The glen flora, including the diversity of mosses on the site, is favored by the combination of deep shade, moisture seepage, and the drainage of cool air into the valley bottoms.

Above the gorge, on the bluff tops, a oak-hickory forest more typical of the region prevails. A number of plants are weeds introduced to the site by European settlement of the area.

Significance. The exposures in Parfreys Glen help us interpret the significance of Cambrian conglomerate and conglomeratic sandstone by providing considerable insight into the Cambrian paleogeography and history of sedimentation. The local source of gravel provided by the Baraboo quartzite highlands makes it possible to see clearly the episodic nature of Paleozoic deposition here. Comparison with the modern oceans, especially in areas of violent tropical storms or of large tsunamis, leads one to wonder if most of the stratigraphic record may not record episodic violent events rather than average tranquil conditions.

Parfreys Glen Formation. The rock described has been designated the type section of the Parfreys Glen Formation (Clayton and Attig, 1990). The Parfreys Glen Formation consists of well cemented sandstone, conglomeratic sandstone, and sandy conglomerate on the flanks of the North and South Ranges of the Baraboo Hills. It is the chronologic equivalent of formations ranging from the Mount Simon through the St. Peter, and perhaps younger ones.

References

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