Geological Society of America Centennial Field Guide—
North-Central Section, 1987

The Ledges of the Grand River, Michigan

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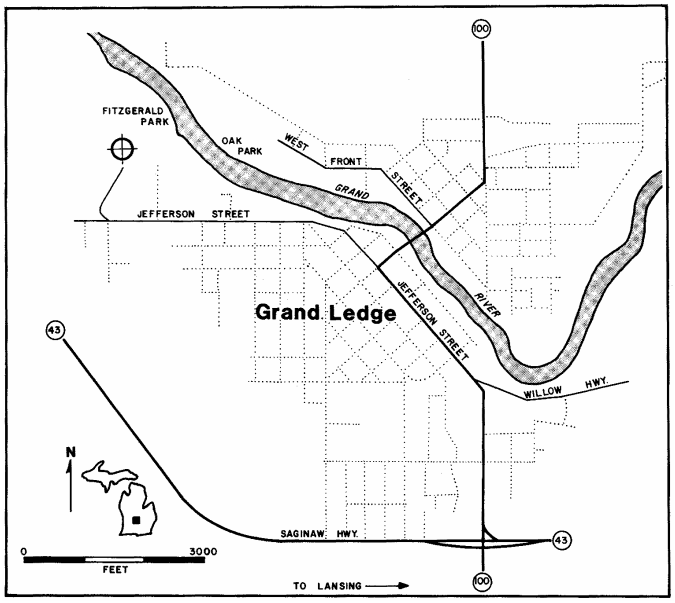

Figure 1. Location of Grand Ledge, Michigan, and Fitzgerald Park.

LOCATION

The Ledges of the Grand River, T.4N.,R.4W., Eaton County, Michigan; Eagle, Michigan, 7½-minute Quadrangle. The Ledges are located in the city of Grand Ledge, Michigan, 11 mi (18 km) west of Lansing, Michigan, on Michigan 43 (Fig. 1). The Ledges occupy both the northeast and southwest banks of the Grand River. Access to the southwest Ledges is by East Jefferson Street to Fitzgerald Park. Access is also possible either by canoe or the River Path Trail that begins at River and Harrison streets in Grand Ledge.

SIGNIFICANCE

The Ledges of the Grand River are the best exposure of Pennsylvanian age rocks in the state of Michigan. Besides their scenic beauty, the Ledges and additional outcrops of the surrounding vicinity provide a unique setting in which to explore and investigate an ancient near-shore marine beach environment. A study of the exposed strata along this portion of the Grand River reveals evidence of cyclic sedimentation (Kelly, 1933). Marine sediments in the section alternate with those deposited under terrestrial conditions.

The sandstone and shale units of the Ledges are fossiliferous and noted for containing numerous varieties of fossilized plants, invertebrates, and trace fossils of ancient vertebrate fish.

DESCRIPTION

The Grand River is one of the most important drainage ways in the southern Peninsula of Michigan. It rises in a series of lakes southwest of Jackson, Michigan, and flows generally north and westward to Grand Haven, Michigan, where it empties into Lake Michigan. The river formed during the final retreat of the last Pleistocene glaciers, developing its course on the newly formed glacially scoured surface and in its initial stage was nourished by water flowing out from the melting ice front. In the relatively short period of its existence, approximately 15,000 years, the Grand River has cut the observed gorge through the Pennsylvania strata in the Grand Ledge area. It is probable that the course of the original glacier river in the area of the Ledges developed on joint structures in the bedrock.

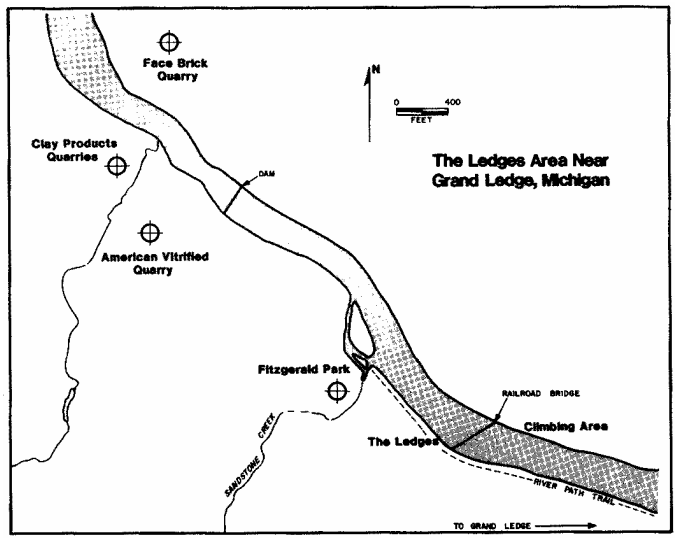

Figure 2. Location of described section, The Ledges area, near Grand Ledge, Michigan.

The early geologic history of the Ledges is essentially that of any marine beach with an open-water lagoon and swamps behind it (Kelly, 1933). These different yet interrelated environments each produced a distinct set of sediment types. The beach environment, dominated by high-energy waves, produced quartz sand with few fossils. The lagoon environment, in which low-energy currents moved, accumulated black muds, and provided a home for various shellfish. The shores of the lagoon were tidal flats where mud and fine sand settled with the rise and fall of the tides.

Ancient storm waves and winds moved beach sand onto the shore of the lagoon and produced fan-shaped deposits called washover fans. On the landward side of the lagoon, sheltered from the ocean, a marsh area existed where plants grew and muddy sediments accumulated.

The thick, flat-lying, multilayered quartz sandstone beds of the Ledges (Fig. 2), including the climbing area (Fig. 3), are interpreted as an ancient beach environment. The thin, dipping beds occurring in the upper portion of the Ledges outcrop are probably ancient windblown dunes (Fig. 4).

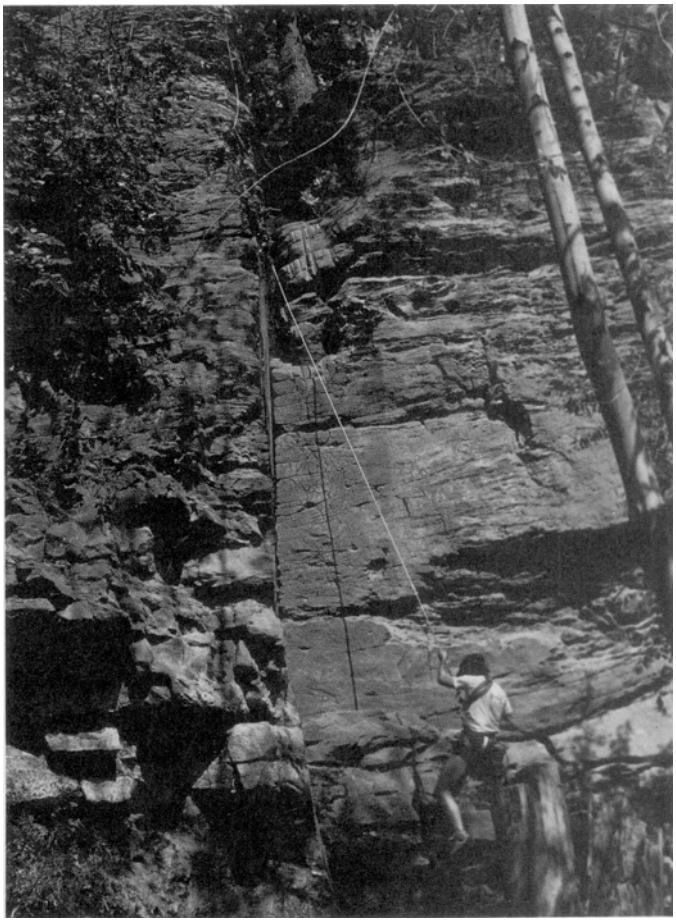

Figure 3. Thick flat-lying multilayered quartz sandstone beds, interpreted as an ancient beach environment, at the climbing area.

Beds of thin quartz sandstone near the abandoned American Vitrified Quarry (Fig. 2) are similar to the Ledges but also contain layers of coal and shale. The shale was probably deposited in a quiet lagoon sheltered from the ocean by a beach. A coal seam evident in the lower portion of outcrops in the quarry formed from plants that grew near the shores of the lagoon. A layer of graywacke sandstone below the coal seam was deposited by small streams flowing into the lagoon. Numerous fossilized plant roots in the graywacke suggest the lagoon eventually filled up with sediment, changing into a marsh where plants could grow. A sandstone layer above the coal is similar to the sandstone seen at the Ledges, although the grains are smaller. This sandstone was deposited in the otherwise sheltered lagoon from the beach environment by hurricane winds and waves. Each sand layer represents another severe storm or hurricane that breeched the beach and dune complex to invade the lagoon. Muddy layers evident in the outcrop were deposited in quiet waters between these prehistoric storms, forming washover fans.

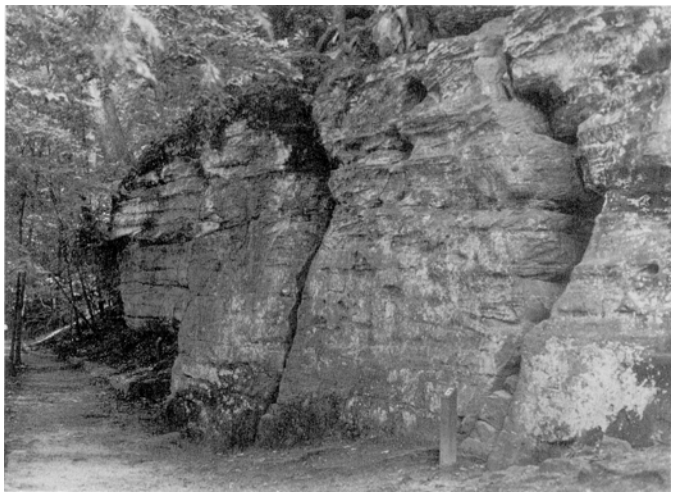

Figure 4. Thin, dipping beds of quartz sandstone interpreted as ancient windblown dunes, along the River Path Trail.

At the Clay Products Quarry (Fig. 2) the rocks are predominantly shale and siltstone. These rocks formed in the quiet waters of the lagoon. Streams flowing into the lagoon from the land brought in some sandy sediments, while swamps on the landward shore of the lagoon produced coal. The sequence of deposition shows how the lagoon gradually filled up with stream-carried sediments. In the lower part of the north quarry, fine black shale, which formed in quiet water in the middle of the lagoon, can be seen. The presence in the shale of the brachiopod *Lingula*, which lived in brackish water, suggests that fresh water from streams and salt water from the ocean mixed together here. The dark color of the shale indicates a large amount of organic decay has taken place. Above the shale is coarse-grained banded-siltstone and sandstone deposited in much the same way as the graywacke at the American Vitrified Quarry, except that the sediment deposition took place farther into the lagoon from the stream mouths. Stream currents would slow as they entered the lagoon, depositing heavier sediments quickly, while still carrying smaller silt-sized sediments farther into the lagoon. Each light-colored siltstone band represents a period of flooding when stream currents moved with greater speed, and could transport sediments farther into the lagoon. Sandstone layers indicate periods of normal deposition. This type of sequential deposition built the lagoon's shoreline outward. After the lagoon was filled in, plants grew in the sediments, and their roots now appear as fossils in the sandstone bands. Above the last sandstone band is a sequence of gray siltstone and coal. The gray siltstone probably formed in marshy areas or large ponds fed by streams. This gray siltstone layer contains a wide variety of well-preserved plant fossils. The excellent state of preservation of these fossils suggests the siltstone was deposited in a quiet water environment; leaves and branches that fell into the water would sink to the bottom without being broken and slowly become covered with sediment. Along the edges

of the marshy areas where there was little water movement, the dead plants and leaves accumulated more quickly than they could decay or wash away. This decaying vegetation became peat, but later was buried by other sediments whose weight compressed it and changed it into coal.

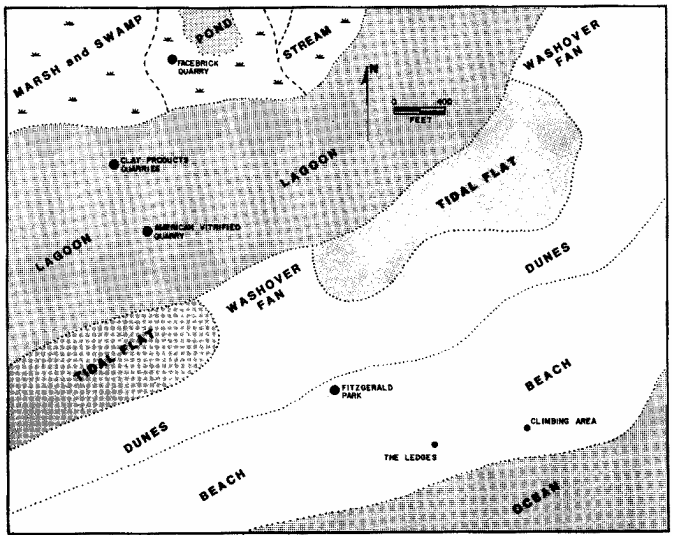

Figure 5. Generalized map showing the approximate location of ancient environments as they may have appeared at one point in geologic time in the area of Grand Ledge, Michigan (after Davis and Bredwell, 1978).

Outcrops at the abandoned Face Brick Quarry (Fig. 2) suggest a stream channel, possibly carved by some ancient hurricane or severe storm, cut through older lagoon and swamp deposits. The older deposits of siltstone, coal, and bedded sandstone were carried away by storm-fed streams and replaced by new deposits of sandstone, which filled the newly cut channel. The sandstone contains many broken pieces of shale, coal, and siltstone appearing as rip-up clasts. The sand is apparently reworked beach sediments. One unusual rock type is also present at the Face Brick Quarry: black limestone. This limestone formed when the area was covered either by a large lake or lagoon, which received very little sand or muddy sediment. The dark color of the limestone indicates that a large amount of decay took place, the water was very calm, and the sediments were undisturbed during deposition. The limestone is peculiar because of its proximity to the layers of sandstone and coal deposited in very different yet related environments.

The above descriptions suggest that a number of depositional environments existed in the vicinity of the Ledges, though not necessarily all at the same time. A single paleographic map would not be sufficient to tell the complete history of such a dynamic and rapidly changing ancient environment. Figure 5 is a generalized map showing the approximate location of these ancient environments as they may have appeared at one point in geologic time. Figure 6 is a generalized cross section of the four described sites.

The fossil record is quite extensive at the Ledges, but is dominated by plant remains. The most common animal fossil found is the brachiopod *Lingula*. Occasionally, remains of the fresh-water shark *Pleuracanthus* and the burrows of ancient lung fish can be found (Davis and Bredwell, 1978). Arnold (1949, 1966) identified more than 90 species of fossil plants around the Ledges area. The most common fossil plants include *Lepidodendron*, *Sigillaria*, *Calamites*, *Neuropteris*, *Sphenophyllum*, and *Cordaites*. It should be noted that collecting of fossils is not encouraged in Fitzgerald Park and that access to the Clay Products Quarry is by permission only.

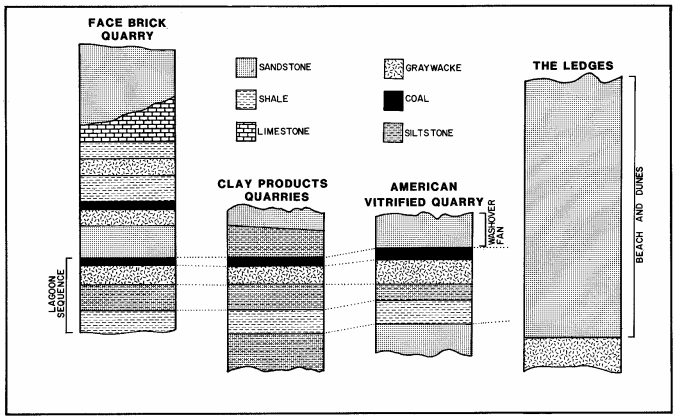

Figure 6. Generalized geologic cross section of the Ledges area, (after Davis and Bredwell, 1978).

In addition to the Ledges, Figzgerald Park offers a full range of nature trails, canoe rental, a fish ladder, and is home to the Ledges Playhouse. There is a $1.00 entry fee to the park. Rock climbing at the Ledges is restricted to the marked climbing area on the northeast bank of the Grand River at Oak Park, and all climbers must be top-roped.

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