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Pictured Rocks National Lakeshore, northern Michigan

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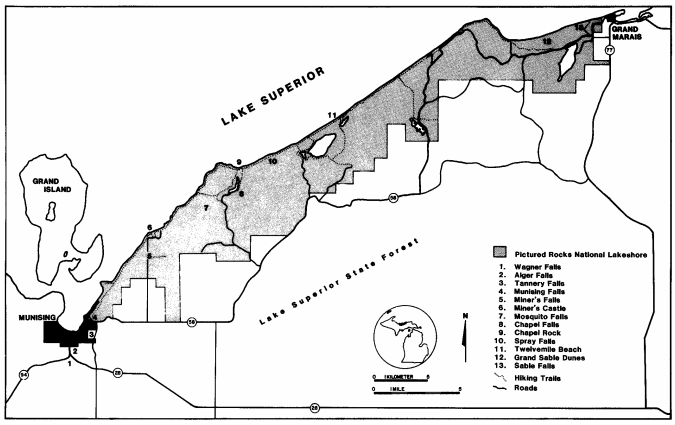

Figure 1. Location of the Pictured Rocks National Lakeshore, Michigan.

LOCATION

Pictured Rocks National Lakeshore, T.48N.,R.19W. and T.49N.,R.13W., Alger County, Michigan; Munising, Wood Island S.E., Grand Portal Point, Trappers Lake, Au Sable Point, Grand Sable Lake, and Grand Marais, Michigan, 7½minute Quadrangles. The Pictured Rocks National Lakeshore extends from the city of Munising, Michigan, along the Lake Superior shoreline 43 mi (69 km) to Grand Marais, Michigan (Fig. 1). Access to Pictured Rocks by automobile is either from Michigan 28 and Michigan 94 at Munising or Michigan 77 at Grand Marais. Access to the lakeshore can also be gained by hiking trails or boat. Commercial boat tours are available between June 1 and mid-October, weather permitting, and leave the harbor at Munising daily.

SIGNIFICANCE

The geological history of Pictured Rocks National Lakeshore observable to visitors encompasses four distinct systems in geologic time. During the late Precambrian, sediments were deposited in a lacustrine environment over the northern Michigan Basin. During the Cambrian and early Ordovician Periods, sediments were deposited in shallow marine environments that covered the same region. These sediments deposited in the basin's northern portion became the sandstone units that are now exposed within the Pictured Rocks National Lakeshore. Except for their exposure adjacent to Lake Superior, these Cambrian and Ordovician bedrock units are almost completely covered throughout the Michigan Basin by younger sedimentary units or glacial drift.

During the Quaternary Period, ice sheets of all four glacial stages advanced, intermittently, through the Pictured Rocks region. Glacial scouring uncovered the Cambrian and Ordovician units near the shoreline of Glacial Lake Nipissing (ancient Lake Superior). The uncovered bedrock was then exposed to changes in ancient lake levels brought about by fluctuation in water volume and isostatic rebound as the glaciers retreated, freeing the land of their great weight. Some of the most striking features of the Pictured Rocks National Lakeshore are the well-developed shoreline structures related to the changes in ancient lake levels. These dramatic shore features include sea caves, stacks, arches, and wave-cut cliffs (Fig. 1). Additional glacial features within the national lakeshore include deep karst fractures filled with glacial debris, the outwash deposits of the Kingston Plains and the Grand Sable Banks, numerous kettle lakes, and the magnificent wind-formed Grand Sable Dunes.

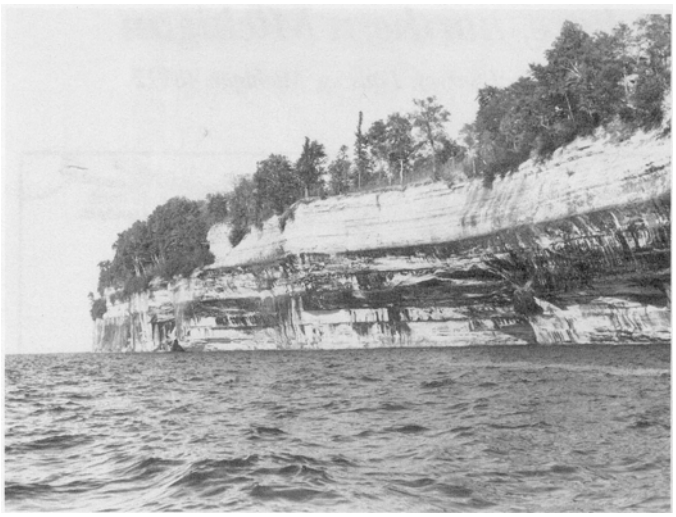

Figure 2. Cliff faces along the Pictured Rocks stained by surface plant growth and mineral leaching (courtesy Michigan Department of Natural Resources).

In 1966, the Eighty-ninth Congress of the United States created the Pictured Rocks National Lakeshore, the nation's first national lakeshore. The national lakeshore includes a 33,550-acre shoreline zone and a 37,850-acre inland buffer zone. Approximately 420,000 people visit Pictured Rocks National Lakeshore each year.

DESCRIPTION

Cambrian and Ordovician bedrock is best exposed in the western one-third of the Pictured Rocks, where dramatic wave-cut cliffs rise more than 200 ft (60 m) above Lake Superior. These picturesque cliffs extend approximately 17 mi (27 km) from Munising to Beaver Basin. The bedrock remains exposed no more than 350 ft (105 m) inland from the escarpments. Surface plant growth and mineral stains impart a dark streaked appearance upon most of the outcrops and cliff faces (Fig. 2). Elsewhere within the national lakeshore, bedrock is found only in the vicinity of the Grand Sable Banks. Here bedrock

forms low bluffs around the north and east sides of Au Sable Point, at the gorge of Sable Creek, and at Sable Falls. These latter outcrops are exposures of the Precambrian Jacobsville Sandstone.

Figure 3. Chapel Rocks, Pictured Rocks National Lakeshore, Michigan. (courtesy Michigan Department of Natural Resources).

The Jacobsville Sandstone is the oldest formation exposed at Pictured Rocks. It is a feldspar-rich, quartz sandstone deep red in color with white mottlings. Throughout the formation, minor amounts of basalt and iron formation can be found (Hamblin, 1958). Although the Jacobsville has a reported thickness of more than 2,000 ft (610 m; Hamblin, 1958), only the top few feet rise above lake level.

The Middle Cambrian Munising Formation, which lies unconformably above the Jacobsville Sandstone, is divided into two members. Both members were deposited in near-shore marine beach environments. The lower member is the Chapel Rock. Along the Pictured Rocks the Chapel Rock is approximately 50 ft (15 m) thick. The member, however, appears to thin eastward from Grand Marais, and little is known as to the member southward. In the central subsurface Michigan Basin, it is equivalent, at least in part, to the Dresbach, Eau Claire, and Mount Simon Sandstones.

The lower 15 ft (4 m) section of the member is a basal conglomerate. Ninety-five percent of the conglomerate is composed of pebbles of vein quartz, quartzite, and chert. The remaining 5 percent is composed of slate, basalt, granite, iron formation, and sandstone. The upper 10 ft (3 m) of the Chapel Rock is a pink or light buff to brown, well-sorted medium-grained, orthoquartzitic sandstone characterized by large-scale cross-bedding. Several blue-shale beds also appear in this section (Hamblin, 1958). Mud cracks, ripple marks, clastic dikes, clay pellets, and sand concretions can be found in the Chapel Rock.

The Miner's Castle Member makes up the upper 140 ft (43 m) of the Munising Formation. The member is a poorly sorted, somewhat friable, light-yellow gray, silty-shaley quartz sandstone, which is characteristically cross-bedded (Ostrom and Slaughter, 1967). The lower-most beds contain thin lenses of blue shale. Mud cracks, ripple marks, large concretions, and signs of bioturbation are noted. A fossil zone containing trilobite *Prosaukia curvicastata* is present roughly 5 ft (1.5 m) below the contact with the overlying Trempealeau. On the basis of the Prosaukia zone, Hamblin (1958) correlates the Miner's Castle with the Franconia in the central basin. The two members of the Munising Formation are best seen at their respective type localities, Chapel Rock (Fig. 3) and Miner's Castle stack.

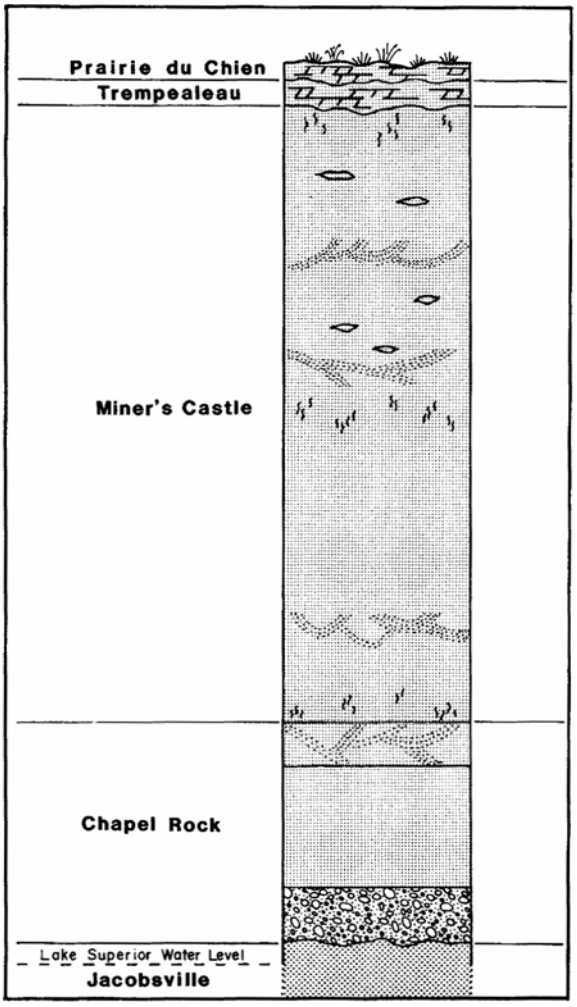

Figure 4. Generalized geologic cross section of lithologies exposed along the Pictured Rocks National Lakeshore.

Above the Miner's Castle Member is the late Cambrian Trempealeau Formation. The Trempealeau is distinctive in that it forms a cap rock on the weaker underlying Miner's Castle. The Trempealeau Formation is evident in the western half of the national lakeshore, cropping out only along the top edge of the cliffs. The Trempealeau is a hard, buff to light brown, mottled, dolomitic sandstone, containing abundant glauconite and minor amounts of chert (Milstein, 1983).

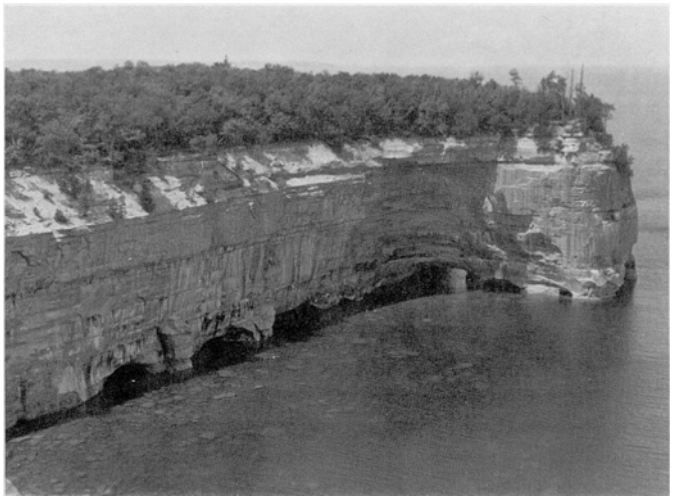

Figure 5. Sea caves beneath Grand Portal Point, Lakeshore Trail, Pictured Rocks National Lakeshore, Michigan (courtesy Michigan Department of Natural Resources).

Figure 6. The Grand Sable Dunes, Pictured Rocks National Lakeshore, Michigan (courtesy Michigan Department of Natural Resources).

Above the Trempealeau, and similar in appearance and lithology, is the early Ordovician Prairie du Chien Group. Within the Pictured Rocks National Lakeshore, the Prairie du Chien outcrops only at Miner's Falls. Figure 4 is a generalized cross section of the lithologic units present along the Pictured Rocks National Lakeshore.

During Lake Nipissing time, the Cambro-Ordovician rocks, which make the magnificent Pictured Rock escarpment, were subjected to intense wave action. As the lake level lowered to form modern Lake Superior, different rock units were assaulted by varying degrees of wave intensity. While some units easily resisted the water, others slowly weakened, crumbled, and gave way. The result of this erosive process is a shoreline spotted with sea caves, stacks, chimney promontories, and arches (Fig. 5). The most spectacular of these shoreline features are the stack and complex sea cave called Chapel Rock (Fig. 3) and the Miner's Castle stack.

In addition to the shoreline features, Pictured Rocks National Lakeshore contains the Grand Sable Dunes (Fig. 6). The dunes encompass 4 mi^2 (10 km^2) and rise 380 ft (116 m) above Lake Superior. The Grand Sable Dunes are perched dunes. These perched dunes resulted from wind-blown sand deposited on the tops of glacial moraines and other high glacial features that lay near the water's edge at a time when Great Lakes levels were higher relative to the land elevation.

The Pictured Rocks Natural Lakeshore offers a variety of single- and multi-day hikes for the visitor. A hearty day hike that exposes the visitor to the true wonders and beauty of the lake-shore begins at the Chapel parking area, proceeds to Chapel Falls, then on to Chapel Rock. By turning westward and taking the Lakeshore Trail to Mosquito Campground, the hiker skirts the wave-battered cliffs and can gaze along the shear walls at wave-carved pillars, arches, and stacks and hear the air thump and feel the ground shake as waves crash into sea caves (thunder caves) below. From Mosquito Campground the trail circles back to the Chapel parking area. The trip covers 9 mi (14 km).

The Pictured Rock region is also noted for its many picturesque waterfalls (Fig. 1). The Pictured Rocks National Lakeshore is home to more than 100 varieties of wildflowers (Kuenzer, 1972) and to a full range of other vegetation and wildlife native to the northern hardwood-conifer forests that dominate the region. The wildlife includes the North American Black Bear, and campers and hikers should take adequate precautions with food stores. It was the Pictured Rocks area that Longfellow wrote about in his immortal poem, “Song of Hiawatha.” The Alger Underwater Preserve extends from Au Train (west of Munising) to Au Sable Point, covering almost the entire length of the national lakeshore. The preserve contains colorful rocks, weedbeds with fish, and more than a dozen shipwrecks. Additional information about Pictured Rocks National Lakeshore can be obtained by writing the U.S. Department of the Interior, National Park Service, Pictured Rocks National Lakeshore, Munising, Michigan 49862.

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