

Geology of the Porcupine Mountains

The bedrock of the Porcupine Mountains records part of the evolution of the North American continent during the late Precambrian Era. Rock strata within the mountains belong to the **Keweenaw Supergroup**, a thick sequence of volcanic and sedimentary rocks (exceeding 25 km) deposited about 1.1 billion years ago, during and shortly after an episode of continental rifting. This Midcontinental rift system represents the early stages of continental breakup and is a major geologic feature of the North American Continent.

Outside of the Lake Superior region, most of the Midcontinental rift is concealed by younger rock strata. In the Porcupine Mountains, the rocks that filled the rift and post-rift basin are well exposed along the park's Lake Superior shoreline, rocky river beds, and numerous ridges and escarpments.

The oldest rocks outcropping in the Porcupine Mountains are the massive andesite and rhyolite flows visible throughout much of the park's interior uplands and easily visible at the Summit Peak Scenic Area. These rocks, known as the **Porcupine Volcanics**, lie atop older continental flood basalts of the Portage Lake Lava Series. The Porcupine Volcanics were deposited by a large stratovolcano just south and east of the mountains. This form of volcanism is unique in the rift system, which was dominated by flood basalts issuing from long fissures along the rift axis.

Overlying the Porcupine Volcanics is a sequence of fluvial (river deposited) sedimentary rock known as the **Copper Harbor Conglomerate**. The deposition of these rocks marks the end of rift extension and the beginning of sedimentation in the post-rift basin. Conglomerates of the Copper Harbor formation contain clasts derived primarily from Keweenaw Supergroup volcanic rocks.

A series of thin basalt flows marks a brief return to volcanism during Copper Harbor deposition. These flows, called the **Lakeshore Traps**, form one of the park's most prominent geologic features; the extended basalt-capped escarpment overlooking the Lake of the Clouds.

Lying atop the Copper Harbor sediment is the **Nonesuch Shale**. This body of black to gray shales and siltstones was deposited in a relatively shallow body of water occupying the post-rift basin or valley.

The youngest exposed rock in the mountains are the red sandstones and siltstones of the **Freda Sandstone**. Exceeding 3 km thick beneath Lake Superior, these rocks mark a return to fluvial sedimentation in the post-rift basin. The Presque Isle river flows across the tilted edges of the Nonesuch and Freda formations at the Presque Isle Scenic Area, providing excellent exposures of both rocks.

Following rift extension and post-rift sedimentation, continental compression, attributed to the **Grenville Orogeny**,

produced major thrust faults and folding of Keweenaw strata. As a result of this deformation, the Porcupine Mountains anticline, Presque Isle syncline and Iron River syncline—all features that can be observed in the park—were formed.

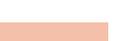
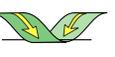
The Keweenaw rocks are notable for significant copper deposits. Secondary mineralization by copper, epidote, quartz, prehnite, and pumpellyite fill voids, fissures and vesicles in basalt flows. Utilization of the region's copper deposits was begun by prehistoric peoples active in the region long before European arrival. Historic extraction of the copper resource began in 1845, when the region witnessed the nation's first mining rush.

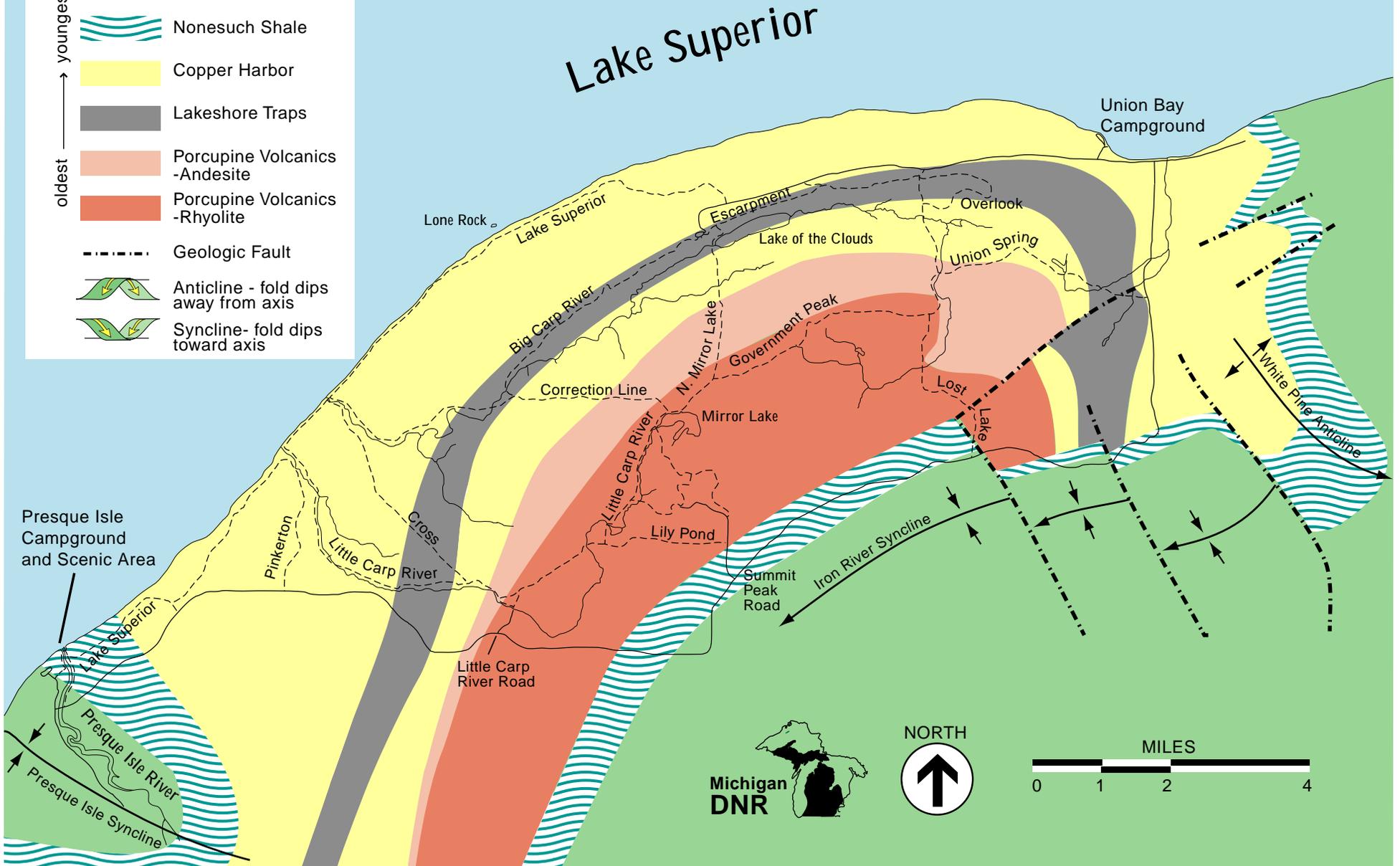
The Pleistocene glaciation has left abundant evidence in the Porcupine Mountains. Lake Superior, relic lake shorelines, erosion of the bedrock comprising the mountains, and extensive ground moraine deposits are reminders of the region's glacial heritage.

The last advance of the Wisconsin Glacial—the Greatlakean—deployed ice in the Porcupine Mountains region about 12,000 years ago, retreating about 9,000 years ago. As the ice sheet melted, water impounded between the ice front and adjacent uplands produced a sequence of proglacial lakes. Although these lakes were relatively short lived, they left signature shorelines along the north flank of the Mountains. Carved step-like into the side of the mountains, these old beaches are among the park's most prominent glacial features.

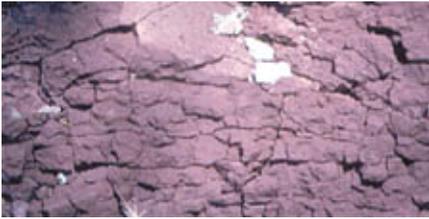
Geologic Map Porcupine Mountains Wilderness State Park

Key to Geologic Strata

- youngest
↑
oldest
-  Freda Sandstone
 -  Nonesuch Shale
 -  Copper Harbor
 -  Lakeshore Traps
 -  Porcupine Volcanics -Andesite
 -  Porcupine Volcanics -Rhyolite
 -  Geologic Fault
 -  Anticline - fold dips away from axis
 -  Syncline- fold dips toward axis



A Field Guide to the Bedrock of Porcupine Mountains Wilderness State Park, Michigan



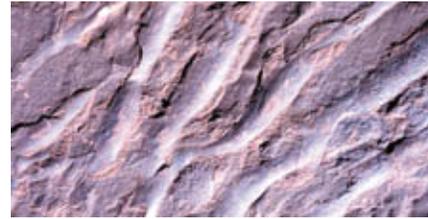
Freda Sandstone-

The youngest of the Keweenawan rocks found in the Porcupine Mountains. This medium to fine-grained sedimentary rock is usually brown, red or tan. You can see Freda Sandstone along the Presque Isle River near Nawadaha Falls at the park's Presque Isle River Scenic Area.



Copper Harbor, Conglomerate-

Conglomerate is a sedimentary rock, like sandstone or shale, that contains many rounded pebbles cemented together by finer materials. The pebbles within the conglomerate are usually durable igneous rocks like rhyolite or granite.



Copper Harbor, Sandstone-

This reddish-brown sedimentary rock often contains wave ripple marks and mud cracks, intriguing evidence of the waters that flowed in the Porcupine Mountains region one billion years ago. This sandstone can be seen along the Lake Superior shore, in the Union Bay campground.



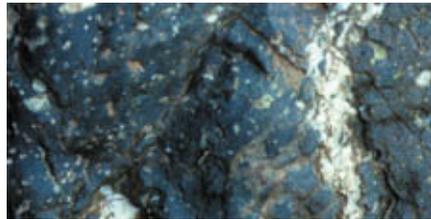
Porcupine Volcanics, Rhyolite-

This pinkish or gray volcanic rock is the oldest rock found within the Porcupine Mountains. Summit Peak and most of the park's interior uplands are composed of rhyolite. Look for this rock along the trail to the Summit Peak Observation Tower.



Nonesuch Shale-

The Nonesuch Shale contains layers of gray to black shale, siltstone and sandstone, all sedimentary rocks. See the Nonesuch formation along the Presque Isle River from Manabezho Falls downstream to Lake Superior. The Nonesuch contains widespread copper deposits.



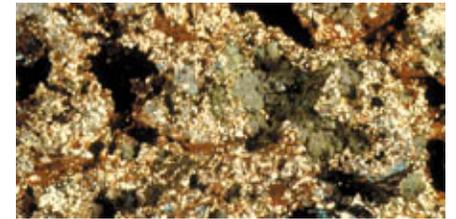
Lake Shore Traps, Basalt-

Basalt is the dark, fine-grained volcanic rock that caps the prominent "escarpment" ridge of the Porcupine Mountains. Basalt often contains numerous small voids created by gas bubbles trapped in the molten rock when it cooled. Can be seen at the Lake of the Clouds Scenic Area.



Porcupine Volcanics, Andesite-

Named for the Andes Mountains in South America, this fine-grained, reddish-brown volcanic rock can be seen in the Porcupine Mountains along the Upper Carp River near Trap Falls. (Andesite and rhyolite are often grouped together and called felsite).



Native Copper-

Keweenawan rocks are known for their deposits of native or metallic copper, which is rare elsewhere in the world. Within the Porcupine Mountains, copper is found in the Copper Harbor Sandstone and Nonesuch Shale.