Pictured Rocks National Lakeshore

Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory Digital Geologic Data for Pictured Rocks National Lakeshore

piro_geology.pdf

Version: 9/21/2011
Geologic Resources Inventory Map Document for Pictured Rocks National Lakeshore

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Geologic Resources Inventory Map Document

Pictured Rocks National Lakeshore, Michigan

Document to Accompany Digital Geologic-GIS Data

piro_geology.pdf
Version: 9/21/2011

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Pictured Rocks National Lakeshore, Michigan (PIRO).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

National Park Service (NPS) Geologic Resources Inventory (GRI) Program staff have assembled the digital geologic-GIS data that accompanies this document.

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the Earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: http://irma.nps.gov/App/Reference/Search. To find GRI data for a specific park or parks select the appropriate park (s), enter “GRI” as a Search Text term, and then select the Search Button.
For more information about the Geologic Resources Inventory Program visit the GRI webpage: [http://www.nature.nps.gov/geology/inventory](http://www.nature.nps.gov/geology/inventory), or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.
Map Unit List

The geologic units present in the digital geologic-GIS data produced for Pictured Rocks National Lakeshore, Michigan (PIRO) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qal - Alluvium). Units are listed from youngest to oldest. No description for water is provided. Information about each geologic unit is also presented in the Geologic Unit Information (UNIT) table included with the GRI geology-GIS data.

Geologic Map Units

Paleozoic Era

Middle Ordovician

Obr - Black River Limestone (formation)
Oat - Au Train Formation

Late Cambrian

Ct - Trempealeau Formation
Cm - Munising Formation

Proterozoic Era

Mesoproterozoic

Yj - Jacobsville Sandstone
Map Unit Descriptions

Descriptions of the geologic units weren't provided with the source GIS data (MI DNR BG-01). The text provided below was derived from various published and unpublished reports on the Michigan Basin. All of these sources are listed under the GRI Source Map Citations section and are listed with the unit. Descriptions of all geologic map units in the source GIS data, generally listed from youngest to oldest, are presented below.

Obr - Black River Limestone (Middle Ordovician)

The Black River Limestone [formation] in southern Alger County, northern Delta County and vicinity is represented by the Bony Falls member. It consists of hard, buff to gray colored, fine-grained, very argillaceous to relatively pure limestone that may be occasionally dolomitic. A few interbeds of limy shale are present locally. This unit is very fossiliferous. Evidence of subaerial erosion appears at several levels throughout the section, as do disconformities of varying magnitude. The surfaces of these disconformities show numerous borings by unknown organisms. The whole section indicates deposition under shallow water conditions comparatively close to the shore. These sediments along with those from the overlying Trenton Group in the Northern Peninsula of Michigan represent near shore deposits which accumulated under fluctuating conditions in shallow water.

Description summarized from GRI Source Map ID 75573 (MI GSD Publication 46)

Oat - Au Train Formation (Middle Ordovician)

Above the Trempealeau, similar in appearance and lithology and representing the Prairie du Chien Group is a lithologic unit whose physical character is well-known but whose age is apparently in dispute. For clarity and completeness, this unit will be referred to herein as the informal "Au Train formation".

The dominant lithology of the Au Train formation is a medium-to fine-grained dolomitic sandstone. The ratio of sand grains to dolomite throughout the section differs considerably, as some beds are pure dolomite with only an occasional floating sand grain, and other beds are pure sandstone. Lithologic variation in the Au Train makes it convenient to divide the formation into two members. The lower member is approximately 100 feet thick and is characterized by abundant glauconite. The glauconite occurs as disseminated grains in the dolomitic sand, and in thin dark-green beds in which glauconite constitutes over 35 percent of the mineral composition. The thin beds of concentrated glauconite are more abundant near the base of the section at 3 to 12 foot intervals. Higher in the glauconitic member the beds of concentrated glauconite are less numerous. Locally individual glauconite zones may be used as key beds for correlation (fig. 70). The bedding in the glauconite member is thin and undulatory and accentuated by numerous shale lenses and blebs. The color of the glauconitic member is buff to brownish-gray; but where glauconite is extremely abundant a speckled green or solid dark-green color predominates. Some of the more dolomitic beds are characteristically blue to bluish-gray. Much of the weathered surface of the lowermost beds is a definite brown color which stands out in contrast to the white Munising formation along the Pictured Rock cliffs. In the upper member of the Au Train formation glauconite is completely absent and thin sandstone lenses are numerous.

The Au Train formation is a relatively resistant formation that forms the cap rock of the outermost northern cuesta of the Michigan Basin. The escarpment is prominent in Alger County, but is obscured to the south and west by a thick drift cover. Isolated outcrops are at Sault Point, Tahquamenon River about a quarter of a mile above the upper Falls, and in the bluffs approximately 1 mile south of Grand Marais. The Au Train formation is exposed at the top of Chapel Falls and forms the uppermost units of the Pictured Rocks between Miner's Castle and Sand Point. Isolated patches are also at the highest...
elevation on Grand Island. West of Munising the escarpment has receded several miles south of the shore, but it maintains its bold character and provides a drop of approximately 100 feet for many of the water falls of Alger County.

Description summarized from GRI Source Map ID 75574 (MI GSD Publication 51)

**Ct - Trempealeau Formation (Late Cambrian)**

Above the Miner's Castle Member of the Munising Formation 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.

Extracted from GRI Source Map ID 75572 (GSA Centennial Field Guide)

**Cm - Munising Formation (Late Cambrian)**

The Munising formation consists of three distinct lithic units. They are in ascending order: The basal conglomerate, the Chapel Rock member, and the Miner's Castle member. These units persist with only slight lateral changes throughout the entire outcrop belt and can be distinguished on the basis of grain size, sorting, composition, and sedimentary structures.

The following members are listed to provide a lithologic description for the Munising Formation but mapping of the individual units are not provided in the GIS data accompanying this document.

**Basal Conglomerate** - an orthoquartzitic conglomerate which attains a maximum thickness of 15 feet. Vein quartz, quartzites, and chert invariably constitute over 90 percent of the conglomerate. White, red, purple, black, and brown are the predominant colors, but the percentage of each variety is not constant from one locality to the next. The average diameter of the pebbles in the basal conglomerate is from 2 to 3 inches. The most continuous exposures are in the shore cliffs of Grand Island and in several places along the base of the Pictured Rocks.

**Chapel Rock member** - overlies the basal conglomerate and consists of well-sorted medium-grained sandstone characterized by large-scale cross-bedding. The sandstone of the Chapel Rock member is composed almost entirely of quartz, chert and quartzite grains. Calcium carbonate is locally abundant but is restricted to zones near fractures and cannot be considered as the predominant cementing material. Many small angular quartz fragments constitute a matrix for larger grains and thus act as a clastic binder. Silica, however, is in most places the predominant cementing material and occurs as secondary overgrowths in crystallographic continuity with the detrital grains. The degree of secondary quartz overgrowths varies considerably throughout the outcrop belt. Generally the Chapel Rock member is friable but at Tahquamenon Falls the degree of secondary quartz overgrowths is so extreme that an orthoquartzite with very little porosity has been produced. Excepting surficial stains along the Pictured Rocks, the color of the Chapel Rock member is white, buff, or salmon red. The color differs from place to place but changes are not abrupt. Along the Pictured Rocks, the Chapel Rock member is colored in brilliant shades of red, yellow, green, black, brown, and white. The various colors are in vertical bands where mineral and organic matter is deposited from the effluent seepage of ground water down the face of the cliffs. Excellent exposures of the Chapel Rock member are along the entire extent of the Pictured Rocks. East of Mosquito Harbor this member constitutes virtually the entire section exposed in the cliffs, but because of a southwest component of dip only the upper 10 to 15 feet of the Chapel Rock
Miner's Castle member - constitutes the upper 140 feet of the Munising formation and consists of poorly sorted sandstone which is characteristically cross-bedded. Quartz grains constitute over 95 percent of the Miner's Castle member. In most outcrops the color of the fresh sandstone of the Miner's Castle member is primarily light-gray to white and is a weak, non-resistant, slope-forming unit. A striking deviation from the gray to white color is produced by the abundant greenish-blue shale in the lower units. This gives a greenish-blue hue to that part of the section, whereas the upper units, devoid of shale, are characteristically light gray to white. Without much secondary quartz, which is the major cementing agent, the rock remains porous and friable. Like the Chapel Rock member, surficial stains produce various shades of red, brown, yellow, and black in the major outcrops, especially in the Pictured Rocks cliffs. The size of the sets of cross-strata is remarkably small as they average between 4 and 6 inches thick. This small-scale cross-bedding stands out in bold contrast to the large-scale cross-bedding of the Chapel Rock member and in most outcrops it is sufficient to distinguish the two members. Thin lenses of blue shale nearly everywhere separate the sets of cross-strata in the lower part of the section but most of the upper units are pure sandstone and the sorting is much better. The lower Chapel Rock member constitutes most of the section exposed in the Pictured Rocks cliffs and only the lower part of the Miner's Castle member is exposed. Practically all of the Miner's Castle section is exposed at Tahquamenon Falls and in the bluffs behind Grand Marais. Westward, at least the upper part of this member is exposed in all the major falls in Alger County.

Descriptions extracted and summarized from GRI Source Map ID 75574 (MI GSD Publication 51)

Yj - Jacobsville Sandstone (Mesoproterozoic)

The Jacobsville Sandstone is primarily composed of medium- to coarse-grained, rounded to subangular quartz grains that constitute over 75 percent of the detrital constituents in the Jacobsville Formation. The base is generally conglomeratic. Higher in the section, stringers of very coarse sand and conglomerate are concentrated along several horizons or in zones parallel to the cross-bedding. Secondary lithologies within the Jacobsville formation are predominantly red siltstone and shale. After quartz, feldspar is the next most abundant mineral and occurs as fresh or slightly altered angular grains. Pyroxene, amphibole and fragments of basalt and iron formation occur in minor amounts. The matrix consists of fine particles of quartz mixed with clay minerals, that act as a clastic binder. Iron oxide, authigenic quartz and some calcium carbonate are also important cementing materials.

The color of the Jacobsville formation is one of its most striking characteristics. Red and reddish-brown predominate, but in practically every outcrop the basic red color is mottled with white streaks, blotches, and circular spots. This variation in color is thought to be due to changes in permeability within the formation and variable leaching of iron constituents.

Along most of the coast from Munising to Beaver Lake, the Jacobsville is completely below water level and is overlain by the Munising formation, which constitutes the Pictured Rocks in that area. In several places, however, in the Pictured Rocks area, the Jacobsville can be recognized a few feet above the lake level. Farther east, good exposures are found at Au Sable Point and in the bluffs behind Grand Marais.

Description summarized from GRI Source Map ID 75574 (MI GSD Publication 51)
GRI Source Map Citations

The GRI digital geologic-GIS map for Pictured Rocks National Lakeshore, Michigan (PIRO) was compiled from the following sources:

Reed, R.C. and Daniels, J., 1987, Bedrock Geology of Northern Michigan, Michigan Department of Natural Resources, Geological Publication BG-01, 1:500000 scale. (GRI Source Map 72152)

Descriptive text and attribute data for the GRI digital geologic-GIS map for Pictured Rocks National Lakeshore, Michigan (PIRO) was compiled from the following sources:


Additional information pertaining to these reference sources is also presented in the Source Map Information (MAP) table included with the GRI geology-GIS data.

MI DNR BG-01

Reed, R.C. and Daniels, J., 1987, Bedrock Geology of Northern Michigan, Michigan Department of Natural Resources, Geological Publication BG-01, 1:500000 scale. (GRI Source Map 72152)

The source shapfiles can be downloaded from the Michigan Geographic Data Library http://www.mcgi.state.mi.us/mgdl/?rel=thext&action=thmname&cid=2&cat=Bedrock+Geology

MI GSD Publication 51


A PDF version of this publication can be downloaded from the Geology in Michigan Digital Library Catalog http://www.michigan.gov/deg/0,1607,7-135-3307_3331-230209--,00.html
MI GSD Pub 51 Fig. 70

Extracted from: (MI GSD Publication 51)

MI GSD Publication 46


A PDF version of this publication can be downloaded from the Geology in Michigan Digital Library Catalog http://www.michigan.gov/documents/deq/GIMDL-PU46_216253_7.pdf

GSA Centennial Field Guide


A PDF version of this publication can be downloaded from the Geology in Michigan Digital Library Catalog http://michigan.gov/documents/deq/GIMDL-GSA87D_302406_7.pdf
Figure 4. Generalized geologic cross section of lithologies exposed along the Pictured Rocks National Lakeshore.
Extracted from: (GSA Centennial Field Guide)

GSA Field Guide References


Extracted from: (GSA Centennial Field Guide)
GRI Digital Data Credits

This document was developed and completed by Jack Garner (NPS GRD) for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory (GRI) Program. Quality control of this document by Andrea Croskrey (NPS GRD).

The information contained here was compiled to accompany the digital geologic-GIS map and other digital data for Pictured Rocks National Lakeshore, Michigan (PIRO) developed by Jack Garner with assistance from Andrea Croskrey. Quality control of GIS data by Andrea Croskrey.

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