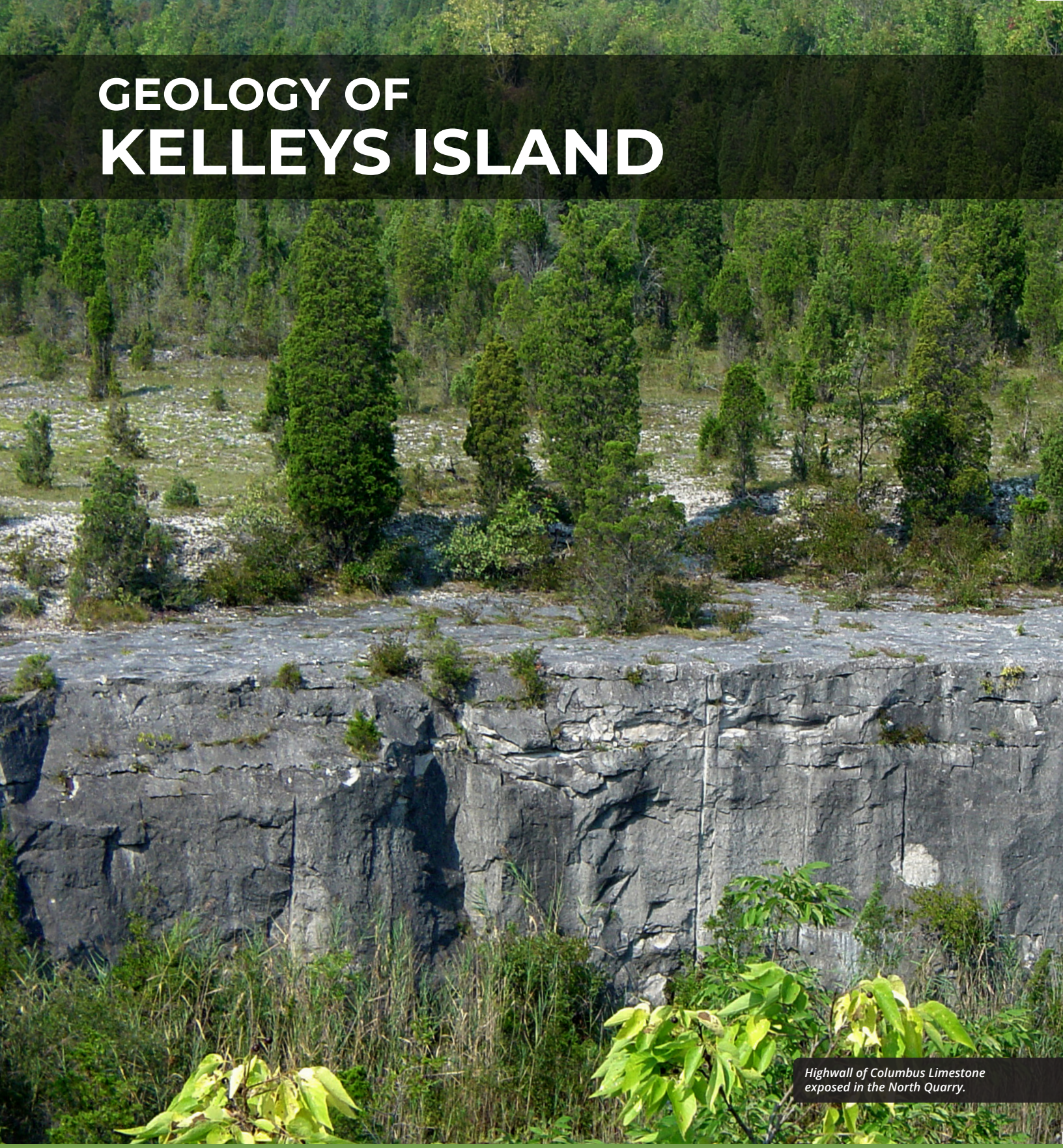
GEOLOGY OF KELLEYS ISLAND



Highwall of Columbus Limestone exposed in the North Quarry.

by Thomas R. Valachovics and D. Mark Jones - 2022

OHIO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

geology.ohiodnr.gov

Introduction

Kelleys Island is the largest Lake Erie island in U.S. waters, with an area of about 11.3 square kilometers (4.3 square miles or 2,800 acres). The bedrock and glacial formations found on the island tell the story of its unique geologic history. The island's bedrock formed over 400 million years ago (m.y.a.), but it wasn't until the glaciations of the past 2.6 million years that the island began to resemble what we see today. For much of its geologic history, the area that is now Kelleys Island was simply a bedrock hill that overlooked the surrounding landscape. This changed when rising waters separated the island from the Ohio mainland.

Visitors can explore the island's fascinating geology at Kelleys Island State Park, the North Shore Alvar and North Pond State Nature Preserves, properties belonging to the Cleveland Museum of Natural History and the Ohio History Connection, and several other sites (see geologic map on back cover).

Bedrock Geology

Kelleys Island is composed mainly of Columbus Limestone with a small exposure of the uppermost Lucas Dolomite occurring near the waterline on the northwestern shore. The island is part of a bedrock ridge that begins at Pelee Island (Canada) on Lake Erie and stretches southward through Marblehead, Johnson Island, and all the way to Ohio's capital, Columbus. Before the glacial period and the formation of Lake Erie, this ridge was eroded by streams into separate bedrock hills, one of which would eventually become Kelleys Island.

During the Devonian Period, about 400 m.y.a., warm seas with abundant life covered much of what would become Ohio. Fossils in the Columbus Limestone, including brachiopods, bivalves, corals, cephalopods, crinoids, gastropods, bony fish remains, stromatoporoids (calcareous sponges), trilobites, and trace fossils, such as the burrows and tracks of sediment-dwelling organisms, are evidence of this ancient environment. The best place to see these fossils is on rocks within the East Quarry.

Ripple marks preserved in the upper portion of the Columbus Limestone are found in various locations, including the south rim of the East Quarry (fig. 1). They are interpreted as oscillation ripples that occurred in shallow water, probably formed by winds blowing across the water surface and setting up standing waves that reworked the bottom sediment. Later, that sediment became cemented into a surface known as hardground, which represents a preserved piece of the seabed.

The Columbus Limestone is softer than many igneous and metamorphic rock types, like granite, that can be found in Canada and elsewhere. Several subdivisions, or members, of the Columbus Limestone are represented on the island, including the Bellepoint, Marblehead, and Venice Members. The Bellepoint is the oldest and lowest member, brownish in color and higher in magnesium than the other members. The Marblehead Member is gray to light brown, finely crystalline, and fossiliferous. The youngest member, the Venice Member, is bluish gray, thin bedded, argillaceous (contains clay), fossiliferous, and locally cherty.

An impressive set of joints can be viewed from the long-term parking lot at the Kelleys Island Airport. Joints are fractures in rock along which no displacement has occurred (a joint where movement has occurred is called a *fault*). Joints are often found in parallel sets that can be traced over a broad area, sometimes for hundreds of kilometers. Such systematic jointing occurs in response to regional tectonic forces. In addition to providing clues about tectonic stresses, joints help determine how rock erodes and they serve as conduits for groundwater, streams, and glacial ice.

The Lucas Dolomite (a member of the Devonian-age Detroit River Group) is exposed on the northwest shore of the island. The Lucas Dolomite underlies the younger Columbus Limestone and was deposited in a shallow-water marine environment. Preserved in the rock are bioherms (mound-like, fossil accumulations of extinct marine invertebrates) composed of stromatoporoids. The bioherms are recognizable as buff-colored, irregularly shaped mounds that stand slightly above the surrounding blue-gray dolomite (fig. 2). Bioherms are easily observable at North Shore Alvar State Nature Preserve.

Glacial Geology

The exposed surface of the ancient Columbus Limestone was eroded further and modified by geologically recent glaciations. During the Quaternary Period (~2.58 m.y.a.–Present), portions

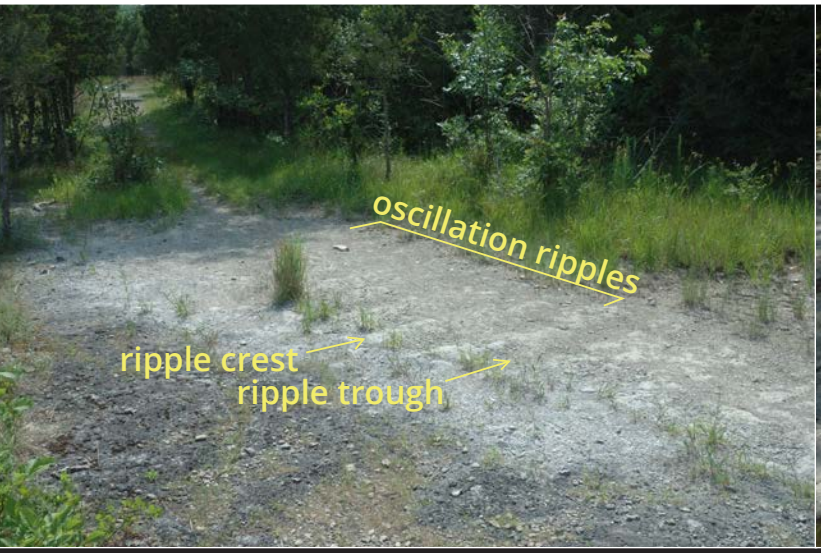


Figure 1. Ripple-marked Columbus Limestone at the former East Quarry in Kelleys Island State Park. The ripples at this site are shallow and broadly spaced, about 0.6 m (2 ft) apart. Having been eroded, they lack sharp crests.

Figure 2. Lucas Dolomite exposed at North Shore Alvar State Nature Preserve. Buff-colored mounds within the rock are bioherms of stromatoporoids.

of Ohio were covered by glaciers at least three times. The most recent of these glaciations, the Wisconsinan, covered Kelleys Island 30,000–14,000 years ago. Ice flowed from northeast to southwest, widening and deepening the preglacial valley that would become the Lake Erie Basin. The Columbus Limestone of the island resisted the glacial erosion better than softer shales to the east but was not left unscathed.

The Glacial Grooves Geological Preserve features the last remnant of some of the largest and most spectacular glacial grooves known in the world. Most of the grooves occur in a single trough, about 120 m (396 ft) long, termed a *megagroove.* The megagroove was once 150 m (500 ft) longer than today and was only one of several deep grooves on the island. Most of the grooves were destroyed by quarrying operations during the nineteenth century. Fortunately, the parcel of land containing the last surviving megagroove was donated to the State of Ohio in 1925.

Like the majority of glacial markings found across the Lake Erie islands, the megagroove is oriented northeast–southwest, indicating the direction of ice travel. But whereas most other markings are mere striations—essentially scratches in the rock—the megagroove is an extremely complex feature. Not actually a single structure, the megagroove is a large furrow which consists of subordinate features, including shallower grooves, striations, and streamlined forms (fig. 3). Historical photographs of grooves that were quarried away show that some of them meandered like streams, a possible clue to their origin.

Geologists who have studied the glacial grooves still debate if ice or meltwater is the primary erosive force behind the formation of the glacial grooves. Advocates for ice propose that the grooves were gouged primarily by slow-moving ice with harder igneous and metamorphic erratics (rocks transported large distances by glacial ice) carving into the "soft" limestone. Others have argued that some features found within the megagroove, such as a pothole and a subgroove with an overhanging lip, are better explained by flowing water than by slow-moving ice. They hypothesized that, confined under a glacier's massive weight, water would be highly pressurized and if also laden with abrasive particles, would be capable of carving streamlined channels and grooves into limestone.

As the glacier retreated northward, the grooves were uncovered from beneath the ice. Water from the melting ice created a large proglacial (in front of a glacier) lake which submerged Kelleys Island under at least 15 m (50 ft) of water. Gradually this water drained, and the emergent surfaces of the island became a temporary shorefront. Traces of some of these lake stages are preserved in the island's topography (fig. 4).

Human Activity and Artifacts

Humans have been using the island's natural resources for thousands of years. Discovered in 1833 along the south shore of the island, Inscription Rock is a boulder of Columbus Limestone bearing numerous Indigenous American petroglyphs that may predate contact with Europeans. Inscription Rock is the most visible sign of prehistoric habitation on Kelleys Island, but it is not the only one; about 60 archaeological sites, some dating as far back as 12,000 years ago, have been discovered on the island.

Beginning in 1830, Kelleys Island was quarried for Columbus Limestone, producing at various times dimension stone, lime, and crushed stone. About 1.3 square kilometers (0.5 square miles, 318 acres) of the island's surface were quarried until the end of quarrying operations in about 2008. The remains of these quarrying operations can be seen throughout the island including the old stone crusher near the North Quarry.

Further Reading

Fisher, Mildred, 1922, The geology of Kelleys Island: Columbus, The Ohio State University, unpublished M.A. thesis, 93 p.

Feldmann, R.M., and Bjerstedt, T.W., 1987, Kelleys Island: Giant glacial grooves and Devonian shelf carbonates in north-central Ohio, *in* Biggs, D.L., ed., Centennial Field Guide, North-Central Section of the Geological Society of America, p. 395–398.

Goldthwait, R.P., 1979, Giant grooves made by concentrated basal ice streams: Journal of Glaciology, v. 23, no. 89, p. 297–307.

Jones, D.M., 2021, Geologic guidebook to Ohio State Parks in the Lake Erie region: Columbus, Ohio Department of Natural Resources, Division of Geological Survey Guidebook 24, 86 p.

Munro-Stasiuk, M.J., Fisher, T.G., and Nitzsche, C.R., 2005, The origin of western Lake Erie grooves, Ohio—Implications for reconstructing the subglacial hydrology of the Great Lakes sector of the Laurentide Ice Sheet: Quaternary Science Reviews, v. 24, p. 2392–2409.

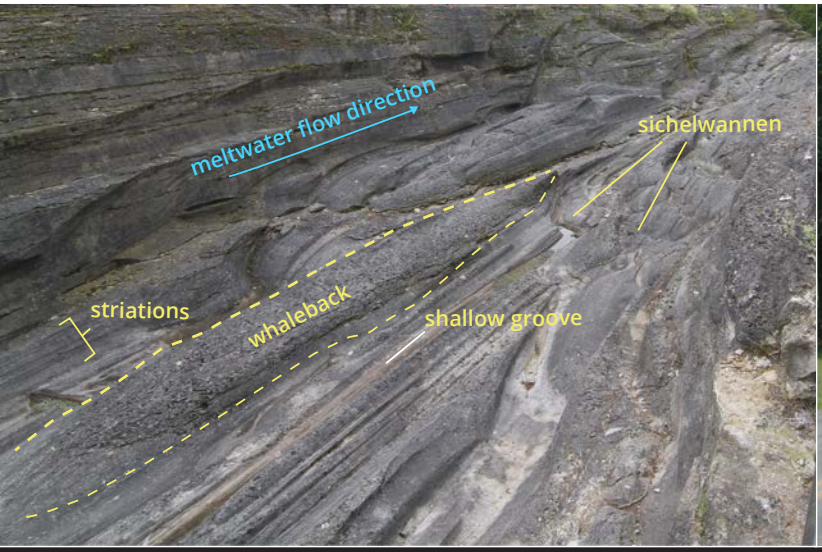
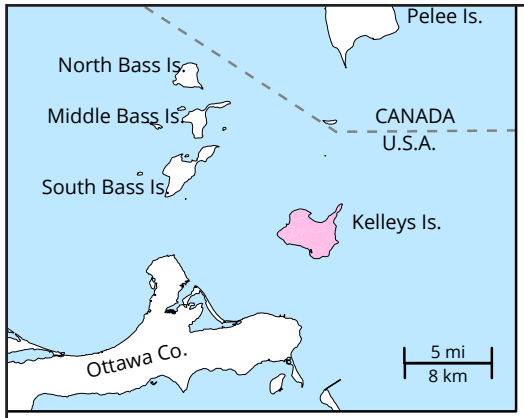


Figure 3. Complex features found inside the megagroove at the Glacial Grooves Geological Preserve. The megagroove contains smaller features, including shallower grooves, sichelwannen *(a German word literally meaning "sickle tubs," crescent-shaped forms gouged into the rock), striations, and streamlined forms sometimes called* whalebacks.

Figure 4. Wave-cut shore on Division Street, possibly a shoreline feature of the proglacial Lake Lundy. The Lundy shoreline records the lake level 12,500 years ago.

GEOLOGIC MAP OF KELLEYS ISLAND



LEARN MORE

LEGEND

- Ferry dock
- ① North Shore Alvar
- ② Old stone crusher
- ③ Glacial Grooves
- ④ Lake Lundy shore
- ⑤ East Quarry entrance
- ⑥ Rippled hardground
- ⑦ Airport joints
- ⑧ Inscription Rock
- Hiking trails
- Roads
- Cleveland Museum of Natural History
- ODNR (Natural Areas and Preserves)
- ODNR (State Park)
- Ohio History Connection
- Quarry
- Made land

0 0.25 0.5 1 mi

0 0.25 0.5 1 km

Quaternary	Qbs	Beach sand
	Qtl	Glacial till
Devonian	Dcl	Columbus Limestone
	Dld	Lucas Dolomite

- Younger striations, direction
- Older striations, direction

N W E S

Please be aware of public land boundaries and do not trespass on private land.

OHIO DEPARTMENT OF NATURAL RESOURCES

OHIO Rocks!

OHIO GEOLOGICAL SURVEY