GEOLOGY OF HIGHBANKS METROPARK

by

Mark E. Peter, Erika Danielsen and Christopher B. T. Waid

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

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Introduction

The high bluffs and deep ravines of Highbanks MetroPark provide a scenic place to explore the geology of central Ohio. The park's rocks, fossils, and concretions tell a fascinating story. This guide is intended to accompany a hike through a major ravine that exposes distinct rock formations. *Please note: collection of natural objects, including rocks, concretions, and fossils, is not permitted within the park*.

Paleogeography

Sediments forming the solid bedrock of Highbanks were deposited during the Middle and Late Devonian Period, approximately 385 to 370 million years ago (m.y.a.). At this time, "Ohio" was covered by an inland sea and located between 15 and 30 degrees south of Earth's equator at a warm, tropical to subtropical latitude (fig. 1).

During the Middle Devonian, a major episode of mountain building began to the east of Ohio. This episode, the Acadian Orogeny, formed a portion of the modern Appalachian Mountains. The weight of the growing Acadian Mountains caused subsidence of the land immediately to the west, adding depth to the Appalachian Foreland Basin (fig. 1). The deepening of this basin into Late Devonian time caused the change in bedrock formations observed in the park.

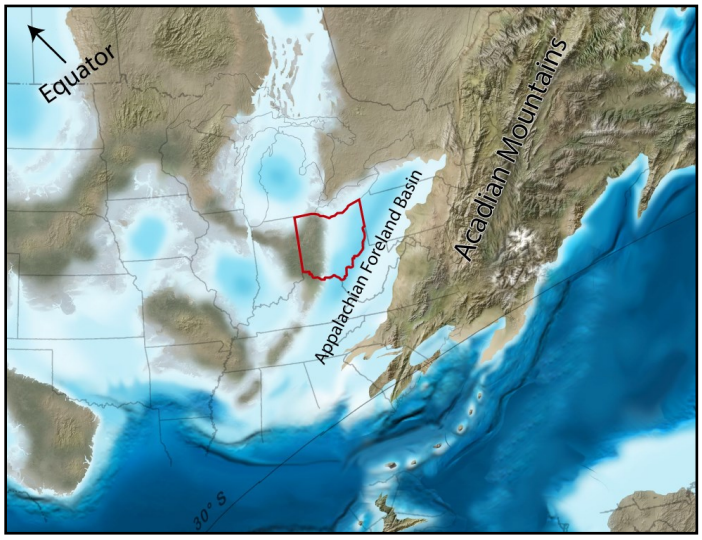


Figure 1. Paleogeographic reconstruction of eastern North America during the Late Devonian Period, about 375 m.y.a. (modified from Blakey: Key Time Slices of North America © 2013 Colorado Plateau Geosystems Inc.). Present-day Ohio is outlined in red.

Bedrock Formations

Visitors to Highbanks can observe three rock formations in the stream beds and banks: the Delaware Limestone, the Olentangy Shale, and the Huron Member of the Ohio Shale (fig. 2). One additional formation, the Columbus Limestone, which lies below the Delaware Limestone, is exposed in the Olentangy River at the extreme southern end of the park in an area that is inaccessible to visitors. Most of the bedrock at Highbanks is Ohio Shale, which is capped by unconsolidated glacial till and soil.

PERIOD	FORMATION	LITHOLOGY
DEVONIAN	Ohio Shale (Huron Member)	Brown to black, laminated to thin-bedded, fissile, organic-rich shale with carbonate and pyrite concretions
	Olentangy Shale	Bluish to green-gray, thin-bedded shale with trace fossils
	Delaware Limestone	Gray to brown, thin- to thick-bedded, argillaceous limestone with shale partings

Figure 2. Generalized stratigraphic column of rock formations exposed in Highbanks MetroPark (modified from Fakhari, 2015).

The oldest accessible formation at Highbanks is the **Delaware Limestone**. Low exposures of these rocks on the west bank of the Olentangy River can be viewed from points along the Scenic River Trail. Limestones are rocks primarily composed of calcium carbonate ($CaCO_3$). They typically form in clear, shallow, warm, marine environments and are the product of living organisms. The Delaware Limestone and portions of the underlying Columbus Limestone contain abundant fossils of marine animals with calcareous shells. As these limestones were forming, the surface of the seafloor was colonized by corals, brachiopods, crinoids, trilobites, and other organisms. For millions of years, accumulation of limestone kept pace with rising sea levels, and a large carbonate platform was established.

Overlying the Delaware Limestone is the **Olentangy Shale**. This light-blue to green shale was deposited as the rising Acadian Mountains caused the Appalachian Foreland Basin to deepen. As the basin deepened, the amount of sunlight reaching the bottom became insufficient for many of the photosynthesizing, carbonate-producing organisms to survive. Clay-sized sediments, shed from the mountains to the east, began to bury the carbonate platform. Shell fossils are

Cover image: *One of many large carbonate concretions eroded from the Ohio Shale at Highbanks MetroPark, Lewis Center, Ohio.*

uncommon in the Olentangy Shale, but trace fossils, such as burrows and feeding traces, are present.

Overlying the blue Olentangy Shale is the black **Huron Member of the Ohio Shale.** This is an abrupt transition, visible in some of the lower park ravines (fig. 3). The sharp contact between the two units was caused by erosion during an ice age.

Figure 3. Contact between the Olentangy Shale and the overlying Ohio Shale. Red and white staff is 1.5 meters (4.9 feet) tall.

After the Olentangy Shale was deposited, advancing glaciers caused sea level to drop, exposing the Olentangy Shale to erosion. Sea level rose again as the glaciers melted, creating a basin for the Huron Member to be deposited. In addition to these climate-induced changes, the Acadian Mountains began to rise faster, causing the basin to deepen again and sedimentation rate to increase (fig. 1). When the basin deepened, the bottom water became depleted in oxygen, or *dysoxic*, which explains the color difference between the shale units. The Huron Member was deposited in a dysoxic environment, so it preserves organic matter, whereas the Olentangy Shale was deposited in an oxygenated environment, so any deposited organic material quickly decayed. The higher organic matter content in the Huron Member contributes to its darker color.

The Huron Member of the Ohio Shale is fissile (prone to splitting in sheets) and contains large concretions. It is relatively resistant to erosion and forms steep exposures and ravines. The black shales contain rare fossils of animals that lived in the water column above and occasional sunken driftwood. Although animals living within the mud left trace fossils (fig. 4), there is no body fossil evidence for organisms having colonized the seafloor.

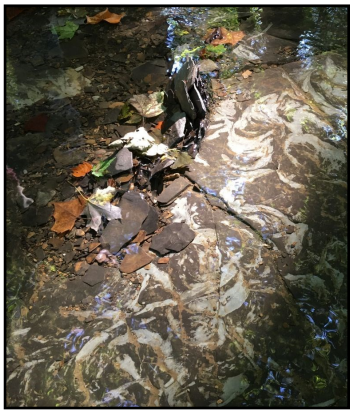


Figure 4. Zoophycos *trace fossils in Ohio Shale; usually interpreted as deposit feeding traces of worms.*

Concretions

Perhaps the most conspicuous and intriguing geologic features of Highbanks Metro Park are the boulder-sized concretions. Carbonate concretions in the Huron Member of the Ohio Shale range from small spheres, measuring only a few centimeters, to large, vertically flattened spheres that reach a meter or more in diameter (cover photo).

Occasionally, parts of arthrodires—extinct, armored fish (fig. 5)—and other fossils have been found at the center of these concretions. When a fish died, its remains eventually sank to the dysoxic muds below. As the organic matter still attached to the skeletal parts decayed, a halo of fungus and bacteria formed around it. Decomposition altered the local chemical environment within the soft sediment, causing precipitation of calcium and magnesium carbonate and in some cases, iron carbonate around the fossil. Geologists have inferred, from the way the Ohio Shale deforms around them, that the concretions formed before the mud sediments were completely compacted and dewatered.

Figure 5. ***Left:*** *Lower jaw of an extinct armored placoderm fish,* Dinichthys herzeri, *preserved in a carbonate concretion; a similar specimen was found at Highbanks MetroPark.* ***Right:*** *Reconstruction of the large arthrodire,* Dunkleosteus terrelli, *which could reach six meters (20 feet) in length. A specimen with a nearly complete skull and thoracic shield (the armored portions of the fish) was collected in the 1960s from the Cleveland Member of the Ohio Shale in Cuyahoga County.*

Glacial Erratics

Not all the rounded rocks at Highbanks are concretions. Some are erratics, which are rocks transported some distance from their source rock. Although erratics can be any size, and any of the three major rock types (igneous, metamorphic, or sedimentary), the large examples of crystalline igneous and metamorphic rocks are the ones that appear most out of place in central Ohio (fig. 6). These "stray" rocks are glacial erratics that were transported hundreds of kilometers by continental ice

Figure 6. Orthogneiss glacial erratic.

sheets from their source in Canada. This occurred between 1 million and 20,000 years ago, during Ohio's Ice Age.

References Cited & Further Reading

Borkow, P.S., and Babcock, L.E., 2003, Turning pyrite concretions outside-in: role of biofilms in pyritization of fossils: The Sedimentary Record, v. 1, no. 3, p. 4–7.

Carlson, E.H., 1991, Minerals of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Bulletin 69, p.23–28.

Clifton, H.E., 1957, The carbonate concretions of the Ohio Shale: Ohio Journal of Science, v. 57, no. 2, p. 114–124.

Fakhari, M.D., 2015, Geological field visit guide to Shale Hollow Preserve, Camp Lazarus and Highbanks MetroPark, *in* American Institute of Professional Geologists 6th Annual Meeting, Columbus, Ohio, April 27–29, 2015: Ohio Department of Natural Resources, Division of Geological Survey, 22 p.

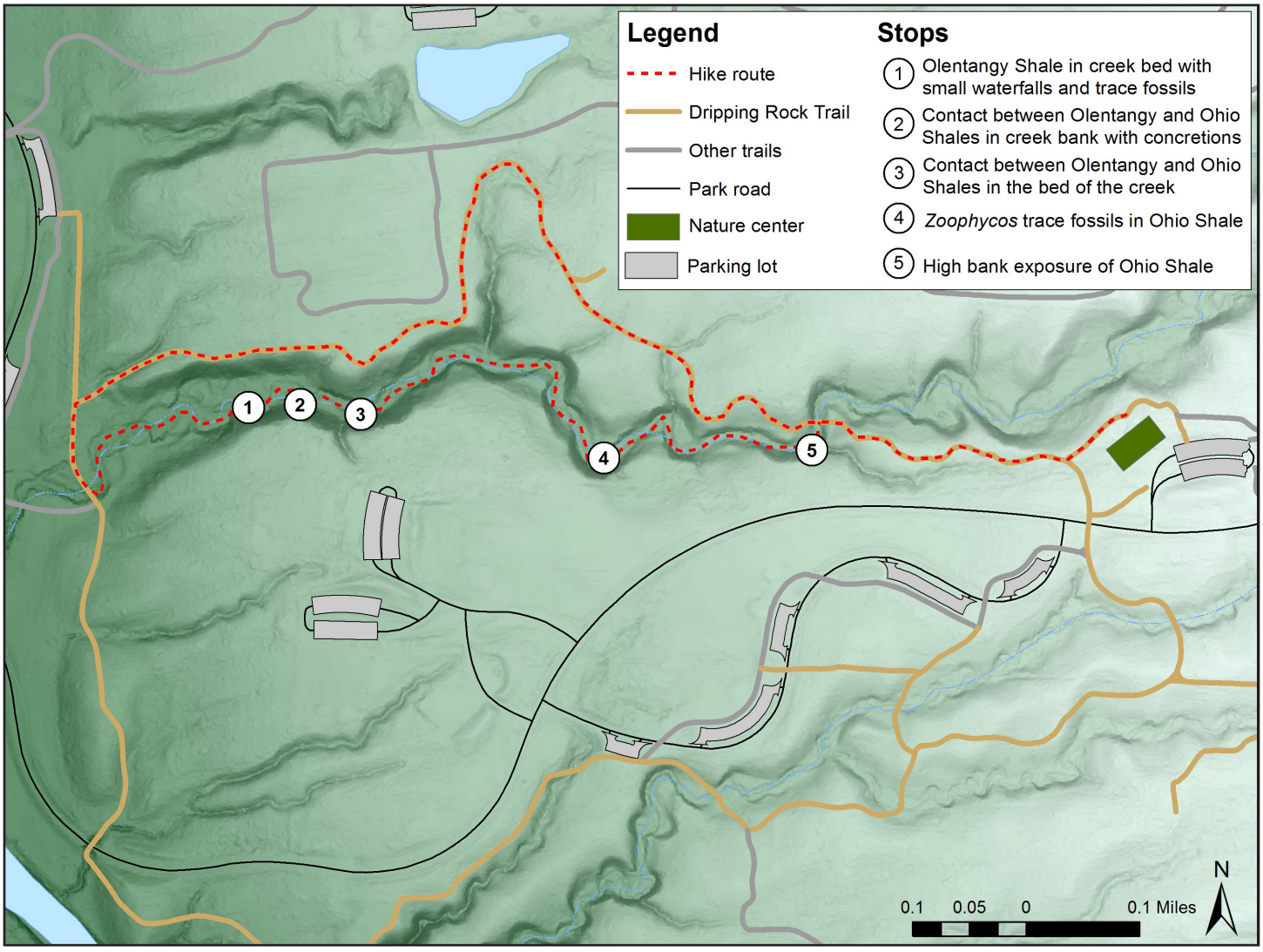
Feldmann, R.M., and Hackathorn, Merrianne, eds., 1996, Fossils of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Bulletin 70, 577 p. [Reprinted with minor revisions 2005.]

Hansen, M.C., 1984, Glacial erratics, or "What's the biggest rock in Ohio?": Ohio Department of Natural Resources, Division of Geological Survey, *Ohio Geology*, winter, p. 1–5.

Hansen, M.C., 1994, Ohio Shale concretions: Ohio Department of Natural Resources, Division of Geological Survey GeoFacts No. 4.

Hansen, M.C., 1994, Concretions: the *Ludus helmontii* of the Ohio Shale: Ohio Department of Natural Resources, Division of Geological Survey, *Ohio Geology*, fall, p. 1–6.

Schumacher, G.A., Mott, B.E., and Angle, M.P., 2013, Ohio's geology in core and outcrop—A field guide for citizens and environmental and geotechnical investigators: Ohio Department of Natural Resources, Division of Geological Survey Information Circular 63, 191 p.



Highbanks MetroPark trail map showing topography, hike routes, and stops of geologic interest. Hike begins and ends at the Nature Center.