THE GEOLOGY OF BLACKHAND GORGE STATE NATURE PRESERVE

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OhioGeology.com
2016

Introduction

The geology of the Blackhand Gorge State Nature Preserve bears the imprint of the Mississippian Period (359–318 million years ago [m.y.a.]), the Pleistocene Epoch (or Ice Age, 2.6 m.y.a.–11,700 y.a.), and the Holocene Epoch (11,700 y.a.–Present). The preserve presents great views of the Mississippian-age Black Hand Sandstone and Logan Formation, which were deposited along a tropical coastline during the Mississippian Period. The modern Licking River and Gorge reflect radical changes in stream drainage and flow direction resulting from both glacial ice advance during the Pleistocene and continuing erosion through the Holocene. The preserve also provides tremendous viewing opportunities that demonstrate the interaction between human activity and geology over the years.

The preserve features Blackhand Rock, a massive wall of sandstone that the formation was named after. The name comes from a Native American petroglyph (rock-carving) on a sheer rock face that featured a giant, dark-colored hand. Unfortunately, the rock face was destroyed in 1828 during blasting while building the Ohio & Erie Canal. The top of this rock face provides a scenic overlook that allows visitors a great vantage of the preserve.

Other places within the preserve offer views of the features of the Black Hand Sandstone. It is well exposed along both the Quarry Rim Trail and Blackhand Trail on the south side of the Licking River, particularly where the Blackhand Trail follows the path of the long-abandoned railway. The best exposure is Blackhand Rock on the north side of the river.

Prominent human-made features that augment the scenic geology include (1) a towpath to the canal near the base of Blackhand Rock; (2) locks from the canal period built from locally quarried large blocks of Black Hand Sandstone; (3) the "Deep Cut" which is a large "canyon" cut through a ridge of Black Hand Sandstone during the building of the steam railroad during the 1850s; (4) a unique tunnel cutting through a ridge of Black Hand Sandstone that was associated with the electric interurban railway (streetcar) completed in 1903; and (5) a large quarry on south side of the preserve that was a source of silica for the Newark glass industry from the 1890s to the 1950s. Sites are shown on figure 3.

Bedrock Geology

The preserve provides numerous exposures of the Black Hand Sandstone, which was deposited during the Mississippian Period. At that time, Ohio was in a much different environmental setting roughly ten degrees south of the equator implying a tropical climate. The Acadian Mountains were rising to what is now east of Ohio and sediments washing off these mountains spread to the northwest, entering Ohio. The inland sea that had covered much of Ohio earlier during Devonian and early Mississippian time was becoming infilled with sediment eroding from the Acadian Mountain chain.

Deposition of Mississippian-age rocks began with fine-grained muds and silts that eventually became shale bedrock. This shale rock is associated with the Cuyahoga Formation and referred to as the Raccoon (or Granville) Shale in Licking County; it is exposed west of the preserve in nearby Granville and western Newark. The Raccoon Shale is gray, fine-grained shale interbedded with siltstone and some thin, fine-grained sandstone. It appears crumbly or flaky in outcrop and weathers very readily. The depositional origin of the Raccoon Shale is believed to be at the far (or distal) edge of a major delta and represents fine-grained sediment slowly settling out of the water column some distance from the river mouth. In the vicinity of the preserve, the Raccoon Shale underlies the Black Hand Sandstone and is not visible.

The outcrop (or exposures) of the Black Hand Sandstone extends from south of the Hocking Hills northward to the border of Wayne and Medina Counties north of Wooster. The unit is massive sandstone with thick beds of coarse-grained, quartz-rich sand. The beds may show distinct cross-bedding (beds that are angular or curving; fig. 1), which indicates a higher energy stream that has channels that cross-cut within the stream valley. Such bedding also indicates a large sediment load in addition to the higher-energy environment. The Black Hand Sandstone features many prominent zones or layers of milky white, smooth quartzite pebbles, causing the sandstone to resemble a conglomerate in some zones. The unit shows

Figure 1. Geologist Mark Wolfe points out cross-bedding in the Black Hand Sandstone at Blackhand Gorge SNP. Areas of honeycombing are observed above his head.

Cover image: *View of Black Hand Sandstone from Quarry Rim Trail.*

prominent reddish-orange iron stains and dark-black manganese stains where groundwater seeps out of the rock and becomes oxygenated. A honeycomb weathering pattern is also typical of this unit. Such weathering is caused by capillary action, which draws water to the rock surface; the water then dissolves the cement holding the grains together, resulting in a very irregular, patchy surface resembling a honeycomb.

The depositional environment for the Black Hand Sandstone is subject to debate. Initial thought was that the Black Hand Sandstone had an unusually coarse, heavy load of sand deposited at the mouth of deltaic channels, creating baymouth bars. Shoreline currents and waves then reworked these bar deposits, connecting them and making them coarser yet.

An alternative theory speculates that the deltaic conditions were too idealized for such a widespread deposit. This interpretation suggests that the finer-grained deltaic shale deposits were already in place and then dropping sea level caused for rapid downcutting or incision of large stream channels. Coarse sand and gravel filled the channels, resulting in the deposition and formation of the Black Hand Sandstone.

For either interpretation, the net result is that the Black

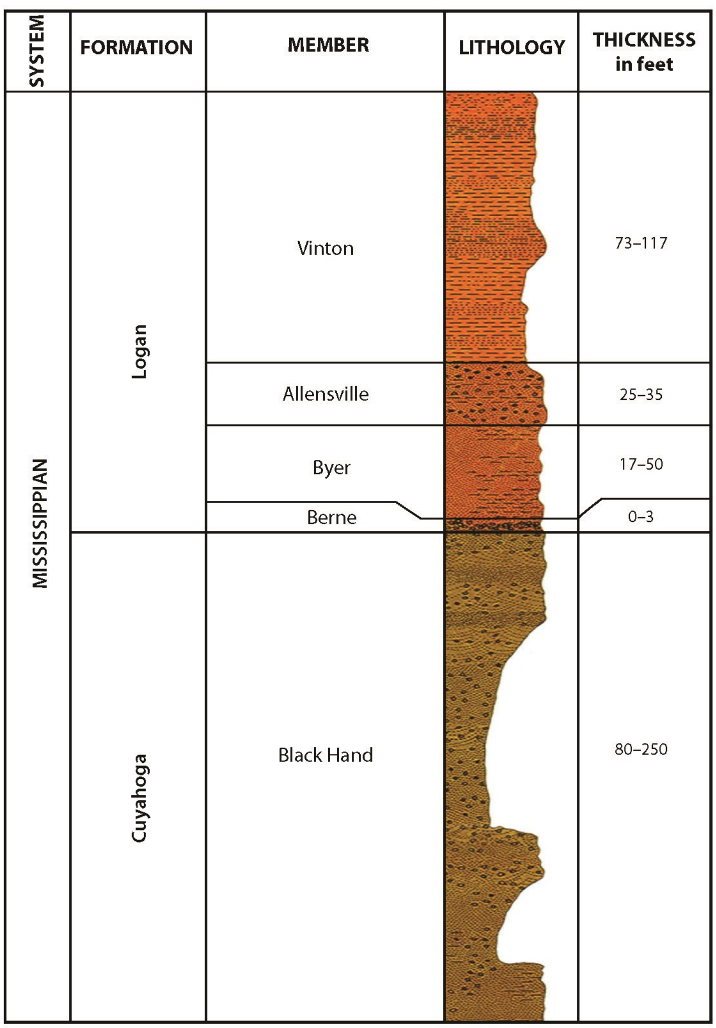

Figure 2. Generalized stratigraphic column of rocks in Blackhand Gorge SNP.

Hand Sandstone shows an inverted topography. The coarse sand and gravel once filled a low area between shale uplands. After millions of years of erosion, the softer shales and siltstones have been eroded away and the remaining more-resistant sandstone now forms impressive ridges and cliffs.

Overlying the Black Hand Sandstone is the Logan Formation, which is composed of four units, from bottom to top: the Berne Conglomerate, the Byer Sandstone, the Allensville Member, and the Vinton Member (fig. 2). The Berne Conglomerate resembles the more conglomeratic zones of the Black Hand Sandstone, but tends to be one thin, very uniform layer. The other units are very thin-bedded, flat-lying, fine-grained sandstones and siltstones that appear markedly different from the Black Hand Sandstone. These units each have a platy to blocky appearance and lack massive beds and cross-bedding. Their depositional environment is believed to mark a return to rising sea level, shallow marine conditions, and represent nearshore deltaic and shoreline deposits.

The Logan Formation caps higher ridges in the preserve and is best seen along the higher elevation portions of the Quarry Rim trail. The contact between the Black Hand Sandstone and the overlying Logan Formation is observed about 2 miles north of the preserve, along a sloping section of Rock Haven Road (Co. Rd. 275) just southwest of the intersection with Seven Hills Road (Co. Rd. 232; see figure 3).

Glacial Geology & Stream Drainage Changes

Prior to the onset of glaciation in central Ohio, the ancestral Cambridge River flowed from Coshocton westward to Frazeysburg and then joined the Groveport River near Newark, which eventually joined with the Teays River south of Columbus. As the ice sheet advanced into this large valley, the streams were dammed and began to pond, ultimately creating a network of large lakes.

Brushy Fork Creek was one of these ponding tributaries that flooded and became a lake. The lake eventually overflowed a low area (or *col*). Then, after breaching the high sandstone ridges, the resulting stream began to rapidly downcut, creating the modern Black Hand Narrows and Black Hand Gorge. The tremendous amount of meltwater and sand produced by the melting ice sheet helped shape this feature. Early interpretations suggested that this reversal and downcutting occurred during Illinoian glaciation (130,000–300,000 y.a). However, recent studies suggest it was during more recent Wisconsinan glaciation (roughly 24,000–18,000 y.a.). The modern Licking River continues this reversed, southeastward flow. Numerous sandy to gravelly point bars are common along the modern stream. Modern flooding has remained an issue, necessitating construction of Dillon Dam in the 1960s.

Further Reading

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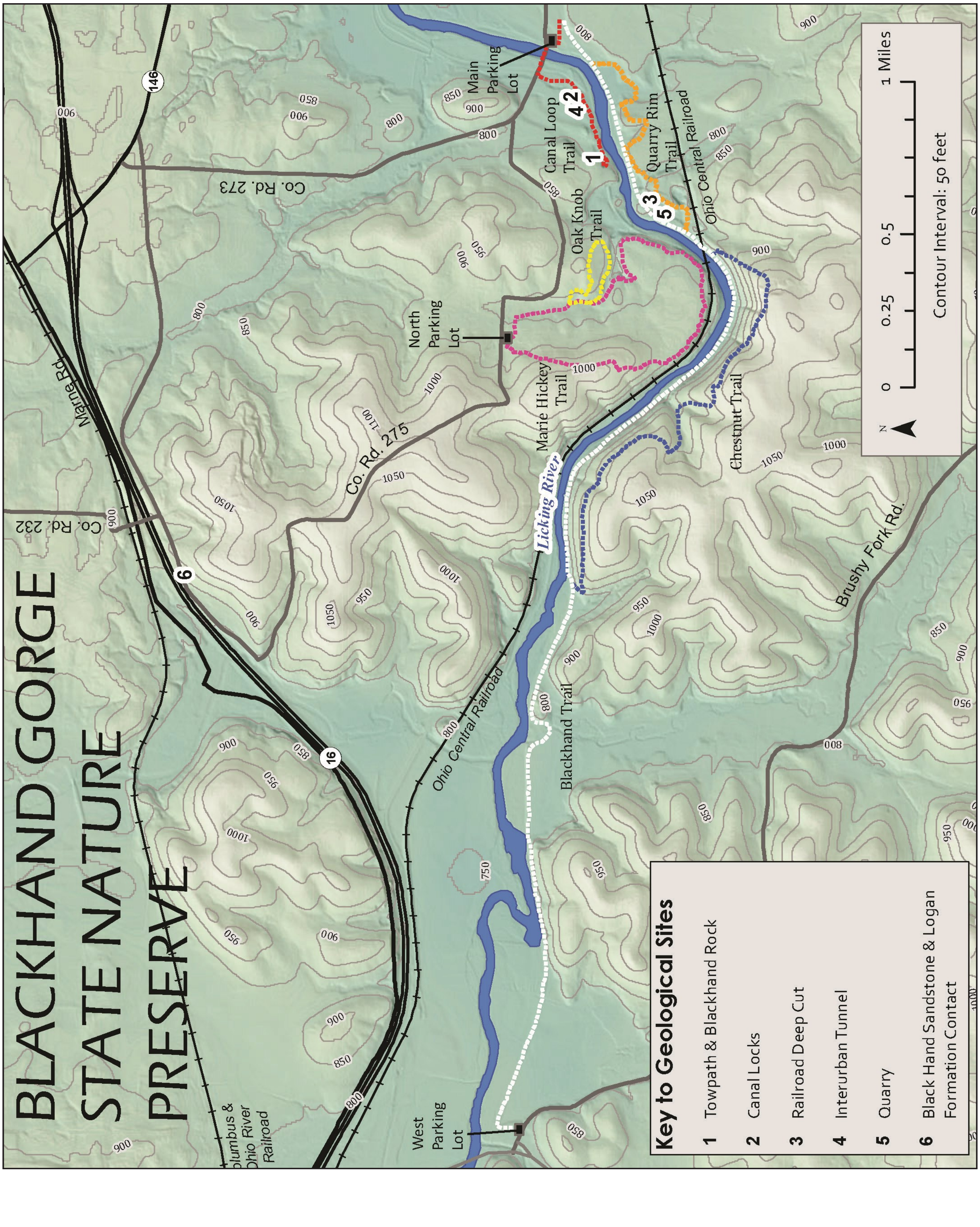

Figure 3. Blackhand Gorge SNP trail map showing geologic sites discussed in the text.