GEOLOGY OF
SHALE HOLLOW PARK

The Huron Member of the Ohio Shale with well-rounded carbonate concretions. Scale segments are 4 and 8 inches (10 and 20 cm).

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PRESERVATION PARKS
DELAWARE COUNTY

Introduction

Shale Hollow Park (managed by the Preservation Parks of Delaware County) is located between the cities of Columbus and Delaware, just west of U.S. Rte. 23 in central Ohio. The hydrocarbon-rich Ohio Shale, underlain by Olentangy Shale and Delaware Limestone, is beautifully exposed in high cliffs, ravines, and creek beds in the park. Bedrock formations exposed in the park provide evidence of Ohio's geologic history and environment 375 million years ago (m.y.a.), when Ohio was an inland sea. Impressive spherical concretions in the Ohio Shale, igneous and metamorphic glacial erratics, and beautifully preserved plant fossils can be seen in the park.

Geologic Formations

The Huron Member of the Ohio Shale is the most prominent bedrock unit exposed in the park. It is dark grayish-brown, hard, brittle, fissile, and jointed. It is exposed in the high cliffs of the park and creek bed (see front cover). Shales are formed by dewatering and compaction of muddy sediments deposited on the sea bottom. Fresh broken pieces of the Ohio Shale give off a sulfurous petroleum odor. Ohio Shale is an organic-rich shale and a good source for oil and gas in the subsurface. Its vertical joints are the pathways for oil and gas migration (fig. 1A). Fossilized plants (fig. 1B) and marine invertebrate burrows are common in the Huron Member. Impressive spherical concretions in the Ohio Shale are the iconic geologic feature in the park (figs. 1C, 1D, 1E, 1F).

Concretions in the park vary from a few inches to more than 8 feet (10 cm–2.5 m) in diameter. These concretions are made of fine-grained dolostone (calcium carbonate and magnesium carbonate) covered by a thin layer of pyrite (fig. 1C). At the centers of the concretions are coarse calcite crystals (fig. 1D) or organic material, such as fish remains or petrified wood. Concretions formed as this organic material would sink to the muddy sea floor and bacteria would begin to decompose the fleshy or woody material. A jelly-like halo would form around the decaying organic material, changing the chemistry and pH of the surrounding water. This change in chemistry would lead to the precipitation of calcium, magnesium, and iron minerals within the halo, resulting in generally spherical concretions.

The concretions formed while the surrounding seafloor sediments were still muddy. As these soft sediments were deposited on the seafloor, they were compacted, dewatered, and hardened into shale. Where concretions were not present, compaction was uniform and resulted in horizontally bedded Ohio Shale. The hard concretions resisted compaction that occurred above, resulting in angular shale layers (fig. 2). The shale layers appear to wrap around the top and bottom of the concretions, like marbles pressed within the pages of a book (figs. 1F, 2B).

Olentangy Shale is a light bluish-gray, soft, clayey shale exposed at the stream bed and lower levels of the cliffs near the waterfall in the "special program access area" downstream along the creek (fig. 3, next page). Its contact with the Ohio Shale is sharp and features small pyrite nodules and phosphate particles. Olentangy Shale historically was used as a source of clay for manufacturing bricks and pipes.

Delaware Limestone is a thin- to medium-bedded gray-brown limestone under the Olentangy Shale, exposed in the creek bed at the far western part of the park (see geologic map on back cover). It is a fossiliferous limestone with brachiopods, fish remains, trilobites, and burrows.

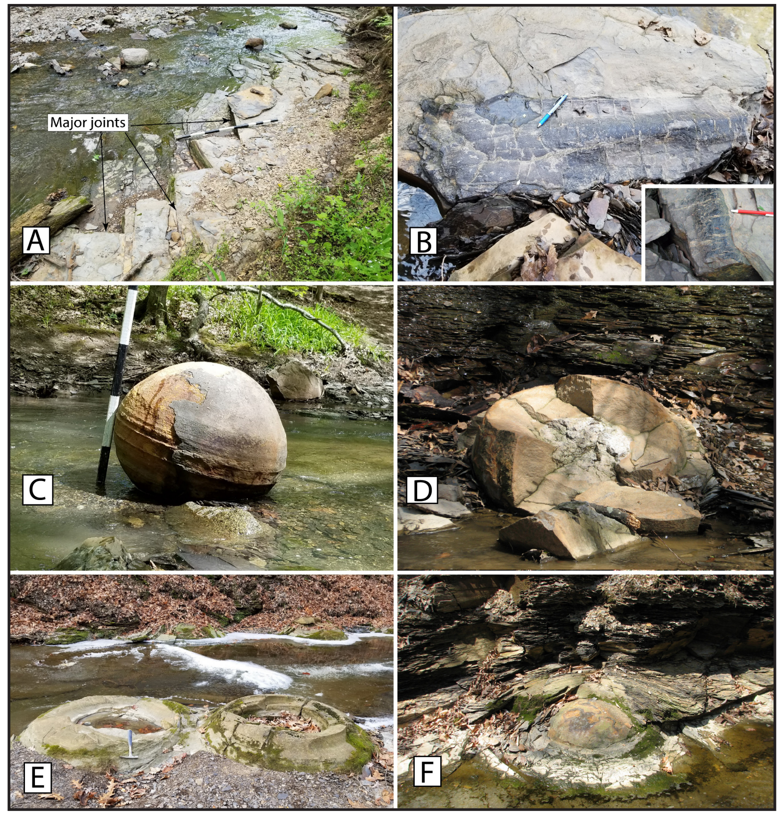

Figure 1. A: Parallel and mainly rectangular vertical joints in the Ohio Shale developed as a result of tectonic activity and are clearly displayed in the creek bed. B: A 370 million-year-old fossilized tree trunk (genus Callixylon Zalessky*) in a limestone block. C: Well-rounded concretion covered by a thin, grayish-brown pyrite layer. D: A large concretion with calcite crystals in the core. E: Two 7-ft (2-m)-diameter concretions with eroded tops and cores. F: Deformed Ohio Shale layers around concretions reveal that these objects were formed prior to the compaction of the surrounding muddy sediments which became the Ohio Shale.*

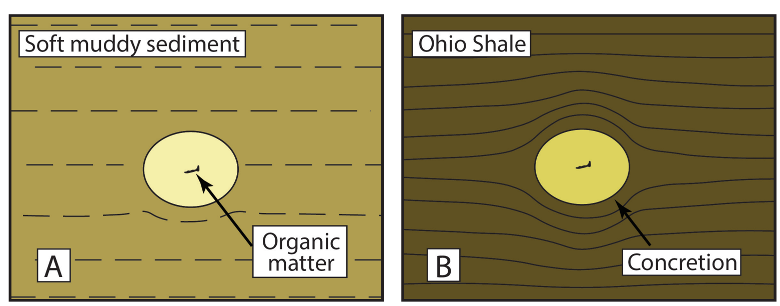

Figure 2. Ohio Shale deformation around concretions. A: Forming carbonate minerals around organic matter in muddy sediment in the sea floor. B: Compacted and dewatered, muddy sediments eventually become Ohio Shale. Deformed layers around the concretion indicate that the concretion was lithified and solid before compaction and dewatering of the shales.

Geologic History

Sediments that formed the solid bedrock formations exposed in Shale Hollow Park were deposited during the Middle and Late Devonian of the Paleozoic Era, about 385 to 370 m.y.a. At that time, Ohio was covered by a shallow, warm, tropical to subtropical inland sea and was in the southern hemisphere between 15 and 30 degrees latitude, about 1,500 mi (2,500 km) south of Earth's equator (fig. 4). Fossiliferous Middle Devonian Delaware Limestone, the oldest rock formation exposed in the park, was formed by the deposition of shells and other carbonate remains of organisms that lived in the warm tropical sea. During that time, a major episode of mountain building began to the east. The weight of the rising Acadian Mountains caused subsidence of the land to the west and deepened the Appalachian Foreland Basin (fig. 4). Erosion of the Acadian Mountains released eroded grains into the basin. Fine grains and clay minerals travelled to the west as far as Ohio and were deposited as the Olentangy Shale on top of the Delaware Limestone.

Further deepening of the Appalachian Basin extended toward Ohio and resulted in deposition of the Ohio Shale in an anoxic environment, like the modern-day Black Sea. The organic-rich Ohio Shale is composed of the remains of plants and marine organisms mixed with clay minerals sourced from the Acadian Mountains.

During the Mississippian and Permian Periods (370–250 m.y.a.), more sediments were deposited in the region. During the last 250 million years, plate tectonic processes repositioned Ohio from 1,500 mi (2,500 km) south of the Equator to its current position, 2,800 mi (4,500 km) north of the Equator. During this time, the region elevated, and the younger rock formations were eroded.

During more recent geologic history, Ice Age glaciers advanced into Ohio for thousands of years, finally retreating during the Late Wisconsinan (18,000–14,000 years ago). These glaciers left behind heterogenous clay, sand, gravel, and boulder deposits (called *till*) eroded from areas to the north. This till is the youngest sediment covering highlands of the park (see geologic map on back cover). Granite and Gowganda erratics (fig. 5A) are the oldest rocks in the park. They were transported by glaciers from Canada.

Figure 3. Erosion of soft blue-gray Olentangy Shale under harder Ohio Shale has formed a small waterfall.

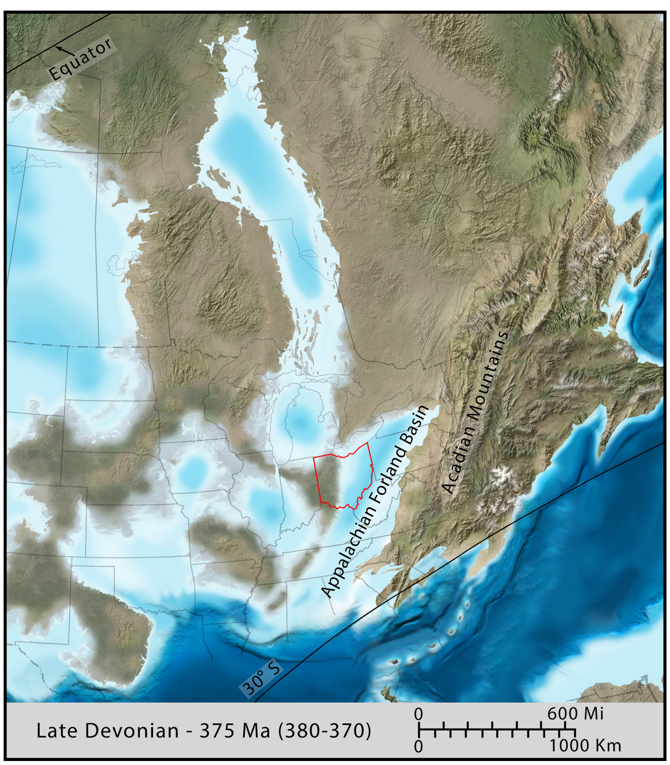

Figure 4. Paleogeographic reconstruction of eastern North America during the Late Devonian, about 375 m.y.a. (Modified from Key Time Slices of North America © 2013 Colorado Plateau Geosystems Inc.) Present-day Ohio is outlined in red.

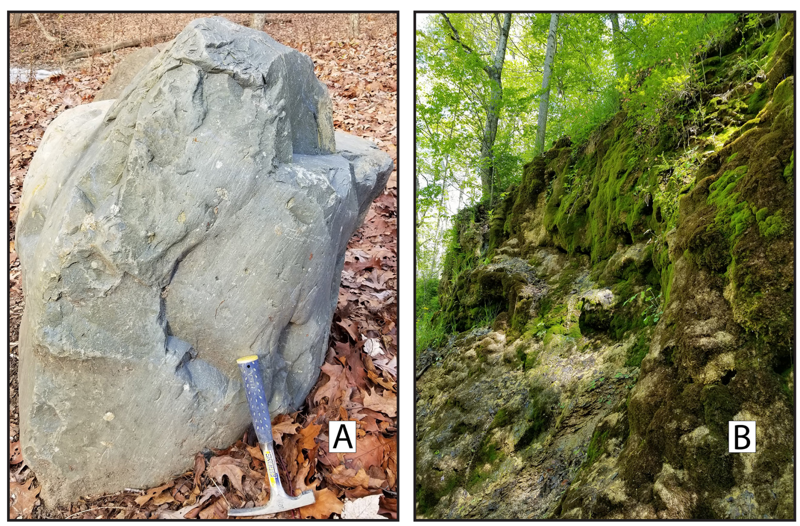

Figure 5. A: A bluish-green Gowganda tillite, about 2.3 billion years old, located near the park facility. The rock was transported to Ohio by glaciers, originating from just north of Lake Huron in Canada. B: Weeping Rock; fresh travertine builds up as carbon dioxide is released from calcium bicarbonate in the spring water (see geologic map on back cover for location).

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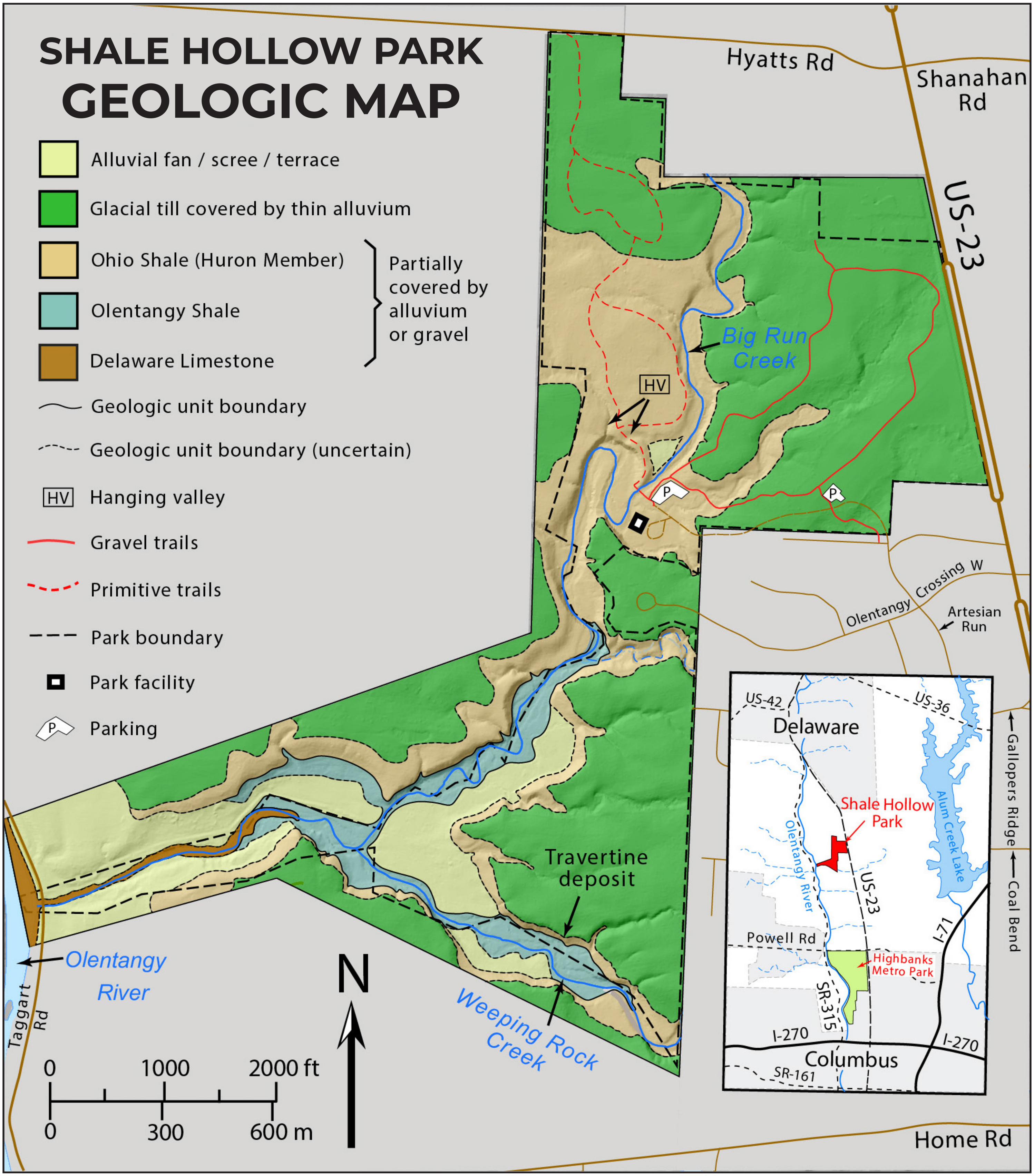

Geologic map of Shale Hollow Park. Note: Not all parts of Shale Hollow Park are open to the public. The southern section is for special program access only; contact Preservation Parks of Delaware County for more information.

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