



THE GEOLOGY OF MILLER SANCTUARY STATE NATURE PRESERVE

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Introduction

Hundreds of millions of years ago, Ohio was covered by a warm, shallow sea. The area that is now Highland County was dominated by quiet lagoons and nearshore reefs, which formed the dolomites and limestones that outcrop at Miller Sanctuary State Nature Preserve (SNP). Far removed from the calm oceans of ages past, Rocky Fork Gorge—the eastern boundary of the preserve—formed thousands of years ago through several stages of glaciation. The confluence of the geologic past and near present at Miller Sanctuary SNP makes for a special geological and ecological landscape.

Bedrock Geology

The bedrock of Miller Sanctuary SNP was deposited during the Silurian Period over 420 million years ago. Warm, shallow seas teeming with marine life stretched across what is now western Ohio. The uppermost unit visible in the preserve is the Peebles Dolomite, a massive, porous dolomite that weathers gray to blue gray. Due to its massive structure, the Peebles is one of the most prolific arch-forming units in Ohio, with 27 arches reported in the southern half of the state, two of which are in the preserve. The Peebles is also highly fossiliferous, containing crinoids, brachiopods, bryozoans, coral, and sea sponges called stromatoporoids (fig. 1). Evidence of these organisms may be seen preserved as casts or molds in outcrop.

Underlying the Peebles is the Lilley Formation, which is comprised of two dolomites of varying grain size and shale content. The Lilley is also fossiliferous, and crinoids and bryozoans are abundant. The middle of the Lilley is marked by a dolomitic shale bed, which is less resistant to weathering compared to the surrounding dolomite. This difference in weathering allows the less resistant shale to be removed and the underlying rock to collapse, leaving behind an overhang of more resistant dolomite. This sloping, tabled appearance is visible on the Arch Trail when looking uphill and also along the Falls Trail near Rocky Fork Gorge.

Underlying the Lilley is the Bisher Formation, which is comprised of silty to shaley dolomites that weather brown-orange. This formation differs from the overlying units



Figure 1. Fossilized stromatoporoid sponge from Highland County, Ohio. After death and burial, water permeated the organism's internal structure, depositing silicate minerals and preserving the internal shape of the sponge.

Cover image: Miller Arch, visible along the Falls Trail within the Peebles Dolomite.

by having abundant sloping and hatched patterns in its layers, also known as *crossbedding*. Crossbeds denote flow direction during deposition and signify tidal action occurring in the shallow sea at the time. Chert nodules are also locally present and can be found along trails, eroded out of the unit. The Bisher is visible at both waterfalls along the Falls Trail.

Glacial Geology

Nestled in a landscape characterized by dissected till, steep-sided valleys, and relief of up to 200 feet, the Miller Sanctuary SNP of today was shaped by ancient seas and the relatively recent movement of glaciers over Ohio during the Pleistocene Epoch (3 million to 11,600 years ago). Evidence of the Illinoian Glaciation (300,000 to 130,000 years ago) can be found over much of Ohio, and all but the southeastern portion of the state contain deposits of sand, gravel, clay, and boulders from this event. Illinoian glaciers covered the preserve at the time, stopping within a mile to the southeast before eventually retreating (fig. 2). As the glacier retreated northward, a proglacial lake formed in the Rocky Fork Valley from the melting ice. Lake levels increased as more meltwater entered the system, but eventually the lake began to drain through a topographic low and carve out a new spillway. The natural outflow would have been to the east, but a ridge of sand and gravel, known as an *esker*, blocked flow in that direction. This esker, deposited from a previous glacial retreat, caused the water to seek a new path. Eventually, the water diverted southeast over the dolomite bedrock and began to carve its way down and through the beginnings of Rocky Fork Gorge. About 24,000 years ago, glaciers from the Wisconsinan Glaciation made their way into Ohio. Glaciers from this event did not advance as far south as previous events, and glaciers did not reach the preserve. However, the meltwater from the subsequent Wisconsinan Glaciation (24,000 to 14,000 years ago) likely helped shape Rocky Fork Gorge into what we see today.

Unique Features

Miller Sanctuary SNP boasts several interesting geological features (see trail map on back). The Miller Natural Bridge ①, formed from the Peebles Dolomite, is visible from the welcome board, but best viewing opportunities are from the loop of the Arch Trail (fig. 3). Also along the Arch Trail, numerous slump blocks dot the edge of the trail and Rocky Fork (fig. 4). These blocks were formed as underlying, less-resistant units of bedrock eroded away, destabilizing the overlying rock until it collapsed along points of weakness and tumbled downhill. Some blocks have made it all the way to Rocky Fork, while others have merely toppled over against one another, creating faux caves and arches of their own.

Beautiful waterfalls can be seen at multiple spots along the namesake Falls Trail. Not far from the trailhead, a small tributary to Rocky Fork can be seen slowly carving its way through the Bisher Formation at the falls ② and further downstream (fig. 5). Also along this trail is the second arch in the preserve, formed again in the Peebles Dolomite ③. Towards the end of the Falls Trail is another spectacular outcrop of all three bedrock formations with a visible waterfall that is present after heavier rains ④. This sharp change in elevation (almost 30 feet) is referred to as a *knickpoint*, where the underlying bedrock erodes more easily than the overlying, creating the bedrock lip at the top. Over time, this knickpoint will propagate upstream so long as there is water to facilitate erosion.

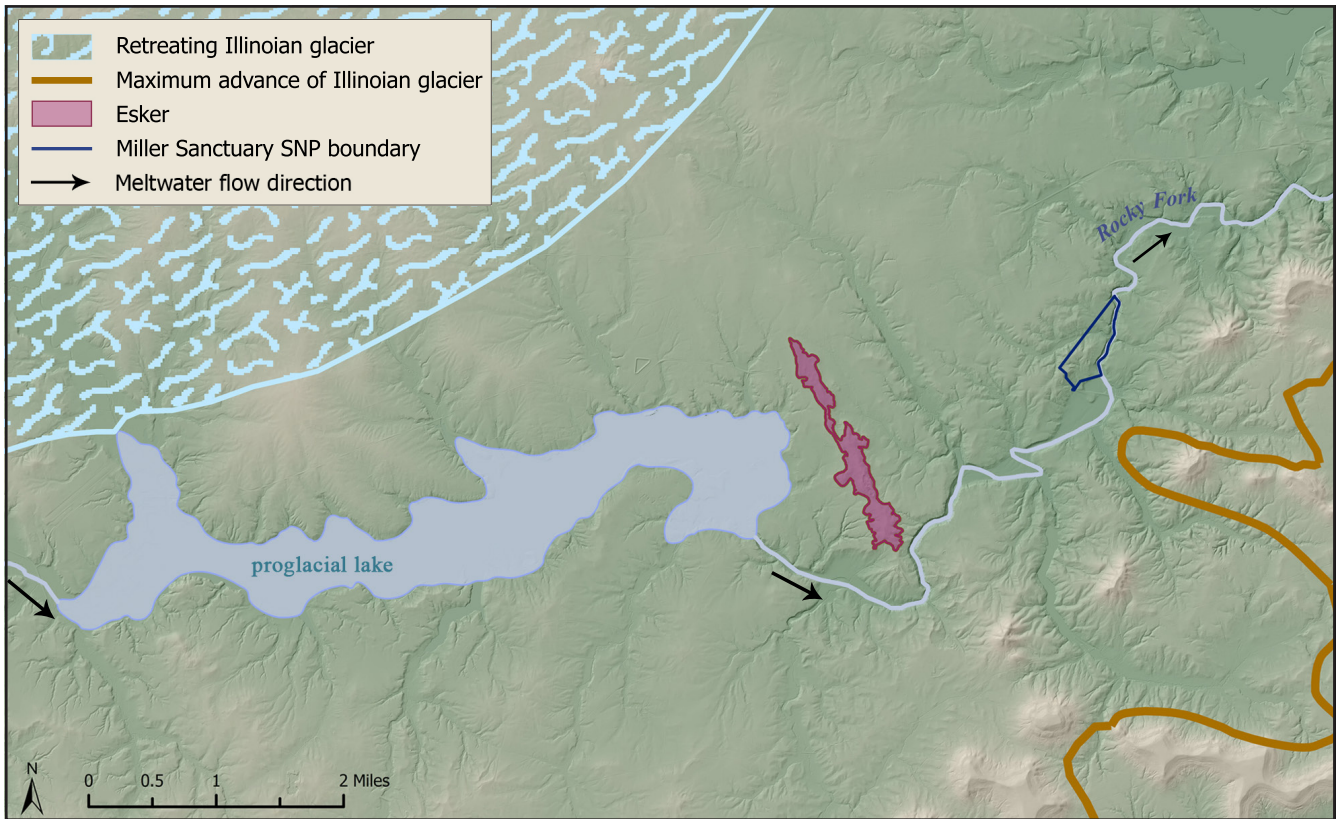


Figure 2. Re-creation of Illinoian Glaciation advance and retreat in Highland County, leading to the formation of Rocky Fork Gorge.



Figure 3. Miller Natural Bridge visible from the Arch Trail within the Peebles Dolomite.



Figure 4. Slump blocks along Rocky Fork Gorge.



Figure 5. Waterfall flowing over the Bisher Formation at the beginning of the Falls Trail.

Further Reading

- Hansen, M.C., 2008 (revised), The Ice Age in Ohio: Ohio Department of Natural Resources, Division of Geological Survey, Educational Leaflet No. 7.
- Rosengreen, Theodore E., 1974, Glacial geology of Highland County, Ohio: Columbus, Ohio Department of Natural Resources, Division of Geological Survey Report of Investigations 92, 36 p., 1 pl.
- 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: Columbus, Ohio Department of Natural Resources, Division of Geological Survey Information Circular 63, 191 p.
- Snyder, Timothy A., 2014 (revised), Ohio's natural arches: Columbus, Ohio Department of Natural Resources, Division of Geological Survey Educational Leaflet No. 18.

Trail Map of Miller Sanctuary State Nature Preserve

