

MORaine AND McCONNELLS MILL STATE PARKS BUTLER AND LAWRENCE COUNTIES GLACIAL LAKES AND DRAINAGE CHANGES

Visitors to Moraine and McConnells Mill State Parks see completely different scenes and attractions. McConnells Mill has a scenic gorge, waterfalls, rugged hiking trails, a whitewater stream, and a historic grist mill. Moraine has a large lake where visitors may go fishing, boating, or swimming, and a gentle bicycle trail. And yet this variety obscures a common geologic foundation and a similar geologic history. How and why two parks that look so different have similar, or related, geologic histories is the story of this park guide, which was originally published as two separate guides (PG 4 and PG 9).

Both parks share the same bedrock formations, and both gained their topography from the same glacial events. The bedrock formed 300 million years ago from layers of sand, mud, and peat. The topography was formed mainly during the Ice Age (approximately 2 million years ago to 23,000 years ago) as rivers diverted by the glaciers cut new channels into the land. Moraine State Park is named for the ground and end moraines deposited by the glaciers. It is somewhat of a misnomer. Little morainal topography exists within Moraine State Park because little of the park was ever covered by glaciers.

How to Use This Guide

The information in this guide is organized in this way:

- * How the bedrock in the parks formed and the mineral resources that impacted the region.

- * Glacial lakes and the formation of Slippery Rock Gorge.
- * Geologic map showing the locations of features and sites of interest described in the text.
- * Descriptions of specific geologic sites of interest.

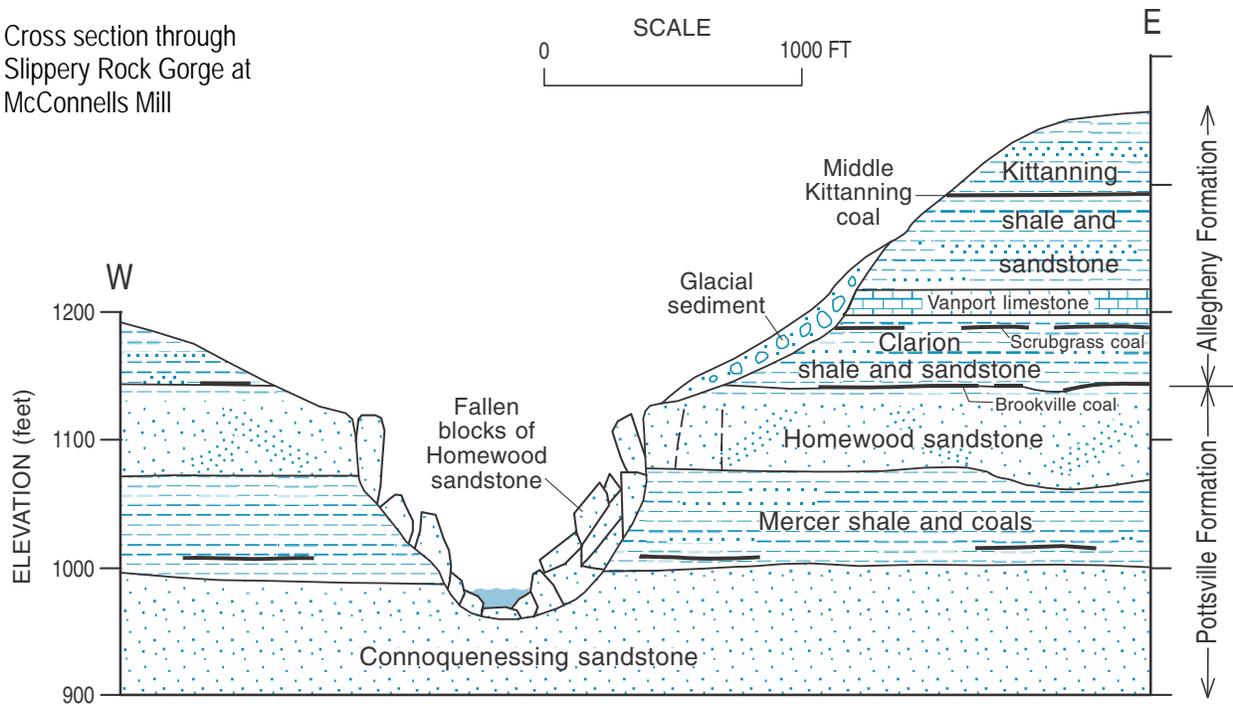


Look for this symbol in the guide and a similar signpost at each site to match descriptions and locations.

Bedrock

The cross section on the next page shows most of the visible bedrock in McConnells Mill and Moraine State Parks. These rocks formed during the Pennsylvanian Period of geologic history (approximately 300 million years ago), when a completely different landscape was present, and when what is now Pennsylvania was south of the equator. Rivers heavily laden with clay, sand, and gravel flowed across Pennsylvania from highlands in eastern Pennsylvania, New Jersey, and Delaware. The sediment was deposited in large deltas along the shoreline of an ancient sea that covered Ohio and western Pennsylvania. Thick layers of sand accumulated in river channels and as beaches and barrier bars along the coast. High-energy waves and currents moved some of the sand into large ripples and dunes. Extensive swamps formed on the river floodplains and behind the beaches. In the quiet water of the swamps, layers of silt and clay and mats of thick vegetation (peat) accumulated. As the rivers changed course or the sea rose to cover the low delta areas,

Cross section through Slippery Rock Gorge at McConnells Mill



the sediments were buried by new sequences of peat, sand, and mud. Several times, the shallow sea rose and deposited marine clays and muds. As each layer was buried, compaction and cementation changed the soft, loose sediment to solid rock. The peat bogs and swamps became coal. The sand became Kittanning, Clarion, Homewood, and Connoquenessing sandstones, and the silts and clays formed Kittanning, Clarion, and Mercer shales. The thickest marine lime mud became Vanport limestone. As the continents moved northward about 250 million years ago, the area was uplifted, and erosion started to create the landscape as we know it today.

Mineral Resources

The early industrial economy of the region was based, in large part, on the iron, lime, oil, and coal contained within the sedimentary layers.

Vanport limestone originally was named “ferriferous limestone” for the large amount of iron mineralization in the upper part of

the member. The iron ore was surface mined in the mid-1800s to feed three furnaces—the Wilroy and Hope Furnaces near Rose Point (upstream from McConnells Mill State Park) and the Lawrence Furnace in Hells Hollow (see the Hells Hollow map). When the vast iron ore resources of the Lake Superior region became available in the 1870s, all of the local ore-mining operations and small furnaces were abandoned. The ruins of the Wilroy Furnace’s stone stack are on private property at **A** on the geologic map, but nothing marks the sites of the other furnaces except for some glassy slag scattered on the surface of the ground. In addition to exploitation of its upper layers for iron ore, Vanport limestone itself was locally quarried and burned to produce agricultural lime.

Approximately 6½ miles south of the old gristmill, an oil seep coated a large rock on the east bank of the stream (**B**). After oil was produced from drilled wells at Titusville in 1859, the “Slippery Rock” and other seeps along the gorge excited local drillers. By 1864, at least 17 wells had been drilled along the creek. They were shallow but

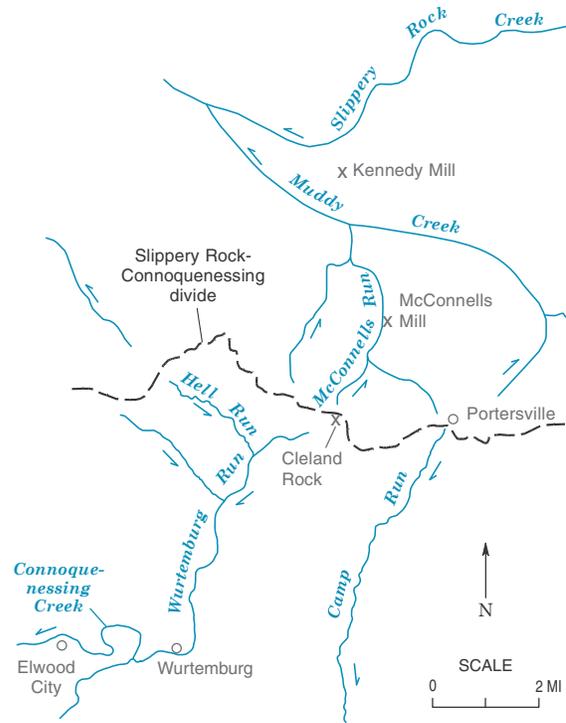
yielded about 45,000 barrels of oil before groundwater invaded the sandstones and prevented further oil production. Drilling activity then shifted eastward into the Muddy Creek valley. By the 1890s, the Muddy Creek field was producing oil from formations deeper than those tapped in the Slippery Rock Gorge. The production continued in decreasing quantity into the 1930s. As production diminished, the wells were abandoned but never properly cemented and plugged. All of these wells had to be located and sealed to prevent oil seeps at the bottom of Lake Arthur, which covers much of the old Muddy Creek oil field.

Most of the minable coal is above Vanport limestone in the Kittanning Member of the Allegheny Formation. The Kittanning crops out away from the rim of the gorge and around the sides of the Muddy Creek valley. Much of this coal was mined, both by underground and strip mining, before the stringent laws regulating mine reclamation were passed in the 1960s and 1970s. Consequently, before Lake Arthur was flooded, extensive reclamation was needed to prevent lake and land pollution from mine drainage.

The Glacial Lakes and Slippery Rock Gorge

Slippery Rock Creek flows in a deep, winding gorge cut into flat-lying layers of bedrock. The gorge cuts through an old drainage divide, the remnants of a ridge that once separated streams flowing to the north from streams flowing to the south. The gorge is deepest and narrowest near Cleland Rock on the divide and becomes progressively shallower and wider both to the north and to the south. This is not a typical pattern because the valleys of streams in areas of flat-lying rocks normally become progressively shallower and wider toward their outlets.

Why does Slippery Rock Gorge have this configuration? The diagrams on this page



Preglacial drainage in the McConnell's Mill area. Present-day locations are shown in gray.

and the next illustrate the geologic history of the gorge.

Preglacial Slippery Rock Creek was joined by Muddy Creek and flowed northwestward from near the present location of Kennedy Mill (C). From the divide at Cleland Rock, McConnell's Run flowed north past McConnell's Mill. Wurtemburg Run flowed south from the divide into Connoque-nessing Creek, 6 miles away.

About 2 million years ago, thick masses of continental ice began to accumulate in central and northeast Canada and periodically spread southward. At least four of these advancing ice sheets, many hundreds or thousands of feet thick, reached northwestern Pennsylvania and modified the landscape and stream patterns. Not much is known about the effects of the first two ice sheets because most of their deposits have been eroded away.

The third known ice sheet to reach the parks moved southeastward into the area

approximately 140,000 years ago and dammed the northwest-flowing Slippery Rock and Muddy Creeks. At the ice-advance maximum, separate lakes formed in the Slippery Rock Creek (Lake Edmund) and Muddy Creek (Lake Watts) lowlands. A third, much smaller lake (Lake Prouty) also formed in the McConnells Run valley, which was dammed south of Muddy Creek.

Lakes Edmund and Watts drained south through outlets at their eastern ends (**D and E**), far from the glacier dam, into Connoquenessing Creek. Lake Prouty spilled over a low point in the old divide near Cleland Rock (see the sketch of Lake Prouty) into Wurtemberg Run. It sufficiently eroded the old divide to form the ancestor of today's south-flowing Slippery Rock Creek.

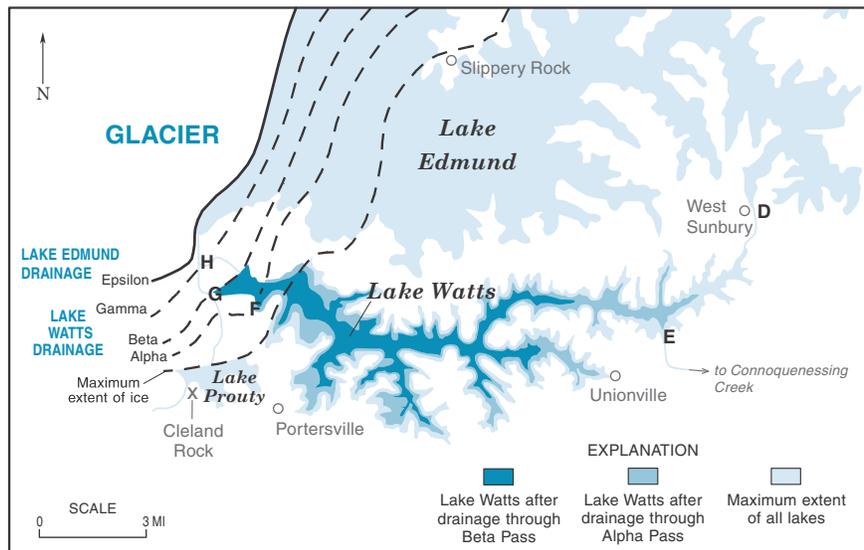
As the glacier melted back to the northwest, Lake Watts began to drain westward through a series of temporary outlets, each lower than the preceding. The first of the outlets was Alpha Pass (**F**). After later drainage through Beta Pass (**G**), the remnant of Lake Watts was still slightly larger than the present-day Lake Arthur. Finally, Lake Watts completely drained through Gamma Pass (**H**) on the present Muddy Creek channel. When the ice receded far enough, Lake Edmund drained through Epsilon Pass, past Kennedy Mill.

As each pass opened, a short-term flood surged into the gorge. These floods deepened the gorge and eroded soft Mercer shale beneath hard Homewood sandstone, leaving the sandstone as an overhanging cliff. Because the sandstone is cut by many intersecting cracks, unsupported large blocks fell from the rim. Some of these large blocks moved only a few feet downslope, but others fell to the bottom of the gorge. This widened the gorge, but left it less deep than originally carved (see the cross section on the second page).

During the last glaciation to reach the area, some 23,000 years ago, ice-dammed lakes again formed in the Slippery Rock Creek and Muddy Creek basins. Drainage from these lakes further deepened and widened the Slippery Rock Gorge.

Today, Slippery Rock Creek still has a steep gradient through the gorge (28 feet per mile compared to 8 feet per mile north of Kennedy Mill). The rushing water has carved potholes in many of the large blocks of sandstone and has scoured out tubes through the remaining debris. The combination of rapids, waterfalls, and eddy currents within the channel makes for a very treacherous stream. These conditions also provided the waterpower to run both McConnells and Kennedy Mills.

Phases of glacial lake drainage during ice retreat. Present-day locations are shown in gray.



GEOLOGIC MAP OF MORaine AND McCONNELLS MILL STATE PARKS

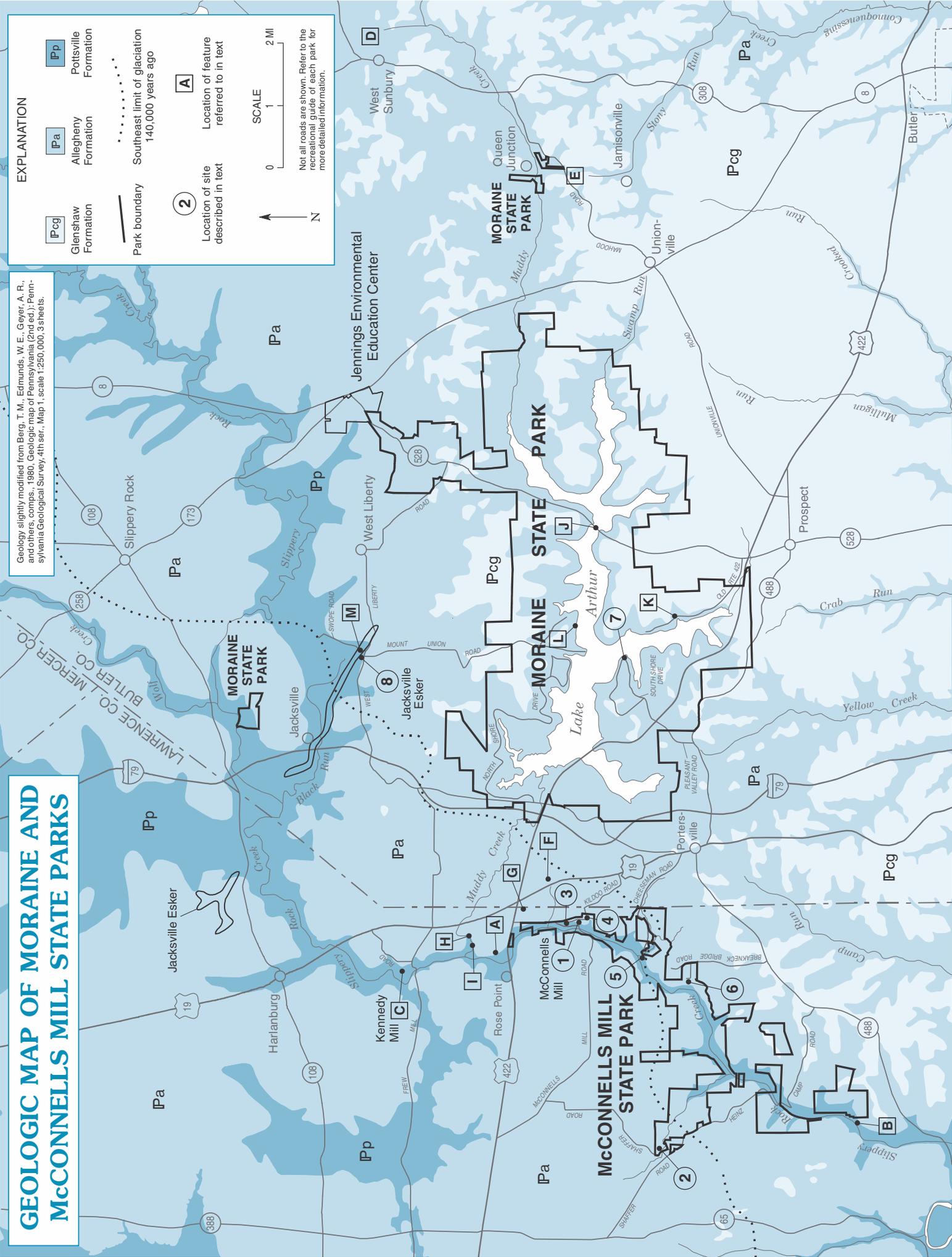
Geology slightly modified from Berg, T. M., Edmunds, W. E., Geyer, A. R., and others, comps., 1980, Geologic map of Pennsylvania (2nd ed.); Pennsylvania Geological Survey, 4th ser., Map 1, scale 1:250,000, 3 sheets.

EXPLANATION

- IPcg** Glenshaw Formation
- IPa** Allegheny Formation
- IPp** Pottsville Formation
- Park boundary
-** Southeast limit of glaciation 140,000 years ago
- ②** Location of site described in text
- A** Location of feature referred to in text



Not all roads are shown. Refer to the recreational guide of each park for more detailed information.



Geologic Features in the Park

Site 1. McConnells Mill Area

The trail from the picnic grounds to the mill, the road past the mill, and the trail to Alpha Falls—all cross outcrops and slump blocks of Homewood sandstone. Separation along vertical cracks (center of the rock city photograph), downslope rotation of some blocks (left side of the rock city photograph), and crossbedding and pebbly composition in some layers are visible features of the sandstone. A honeycomb pattern has also formed on a few weathered surfaces (see the photograph below). This forms because groundwater moving through the rock deposits iron minerals that are more resistant to weathering than the surrounding rock. The iron-rich sandstone layers stand out when the rock is weathered.



Honeycomb weathering

At the Rim Road Climbing Area, large blocks of Homewood sandstone have separated from the outcrop and slumped downslope to create open walkways and a spectacular “rock city.” The north exit road from the mill (McConnells Mill Road) passes through a similar rock city.

The intact ledges at the mill dam are at the top of Connoquenessing sandstone, about 40 feet below Homewood sandstone and directly beneath Mercer shales and coals (see the cross section on the second page).



Rock city along the exit road

Site 2. Hells Hollow

A short hike along Hells Hollow Trail toward Hells Hollow Falls takes you past a number of features related to Vanport limestone and the old iron industry that flourished in the valley of Slippery Rock Creek during the mid-1800s (see the map on the next page).

In the streambed adjacent to the parking lot, sharp, distinct fractures cut through Vanport limestone. During dry periods, no water flows in the stream here, but water does flow in a small cave formed by dissolution of the limestone.



Fractured Vanport limestone

The Lawrence Iron Furnace was a few hundred feet upstream from the third bridge on Hells Hollow Trail.

From the far side of the third bridge, you might see an entrance to a small, long-abandoned (over 100 years) coal mine. The entrance is hidden by foliage high on the hillside across Hell Run.

Further along the trail toward the falls, Hell Run flows in a narrow flume that was originally a limestone cave. With time, the roof of the cave collapsed and exposed the hidden channel. Small depressions beside this section of the trail are sinkholes, also formed by limestone dissolution.

Just upstream from the falls is a small quarry where iron ore and limestone (used for flux) were probably mined for the Lawrence Furnace. Shortly beyond this, the trail ends at Hells Hollow Falls, a picturesque cascade over resistant Clarion



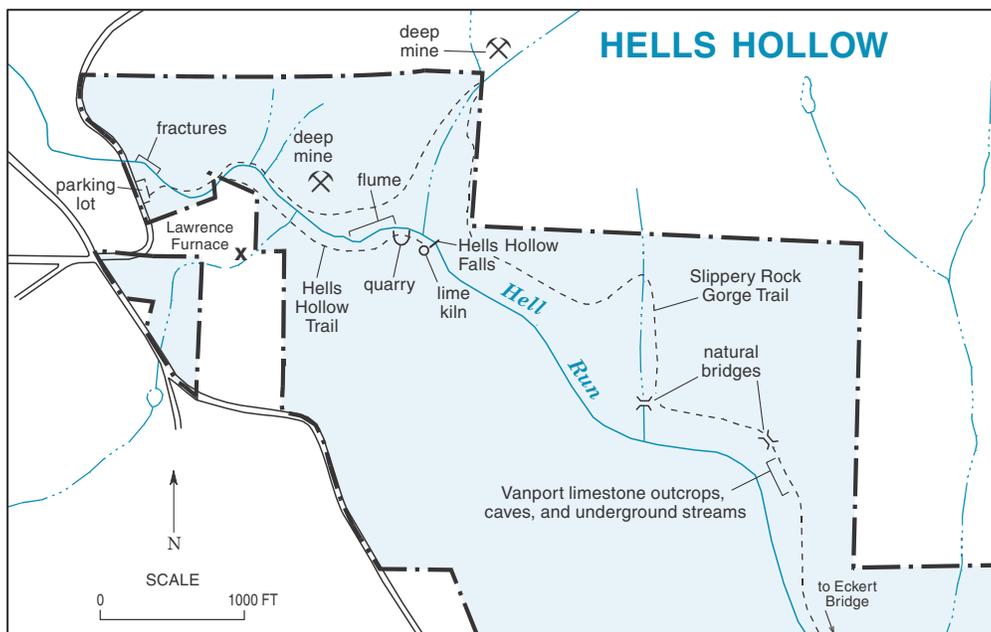
Flume



Hells Hollow Falls

sandstone. Vanport limestone is visible here as ledges along the gorge walls. To the right of the end of the trail is a brick-lined vertical shaft cut into the rock. This is a lime kiln that was used to burn limestone, probably from the quarry, to produce lime.

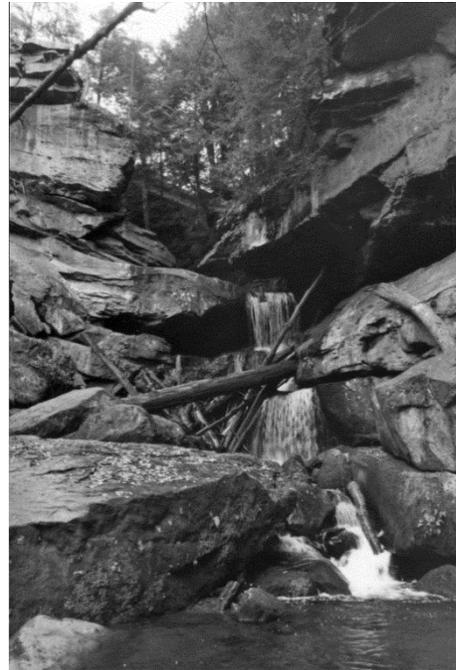
A longer and more rugged trail, Slippery Rock Gorge Trail, follows the north side of Hells Hollow. It also has geologic features, including old coal mine entrances, Vanport limestone outcrops, natural limestone bridges, small caves, and emerging underground streams.



 **Sites 3, 4, and 5. Alpha, Kildoo, and Breakneck Falls**

Waterfalls of two origins are common features along the gorge. Small, low falls, such as Hells Hollow Falls, form where a stream in its normal course flows across hard rock layers (sandstone and limestone) that do not erode as easily as weaker layers (shale and siltstone). This type of falls is the most common and can be found on almost every tributary to Slippery Rock Creek. The rapids in Slippery Rock Creek are situated on reaches of the stream where resistant sandstone blocks are particularly large and numerous in the rubble that fills the gorge.

More spectacular, high falls occur on the east side of the gorge. At Alpha, Kildoo, and Breakneck Falls (Sites 3, 4, and 5, respectively), tributaries to Slippery Rock Creek flow across resistant Homewood sandstone and plunge into the much deeper Slippery Rock Gorge. Because the smaller streams could not erode downward as fast as the main stream, they enter Slippery Rock Creek as “hanging waterfalls.” In the case of Alpha Falls and Muddy Creek Falls (I), the streams that form the cascades were outlets



Break-neck Falls

for Lake Watts as the ice retreated northward and exposed low spots along the western side of the glacial lake. For a short time, water from Lake Watts poured over these lips into the gorge, flushing glacial debris and undercutting the sandstone rim on each occasion.

 **Site 6. Cleland Rock**

Cleland Rock is a ledge of Kittanning sandstone that forms a scenic overlook 400 feet above the deepest part of the 12-mile-long Slippery Rock Gorge. It is also the highest elevation along the rim of the gorge.



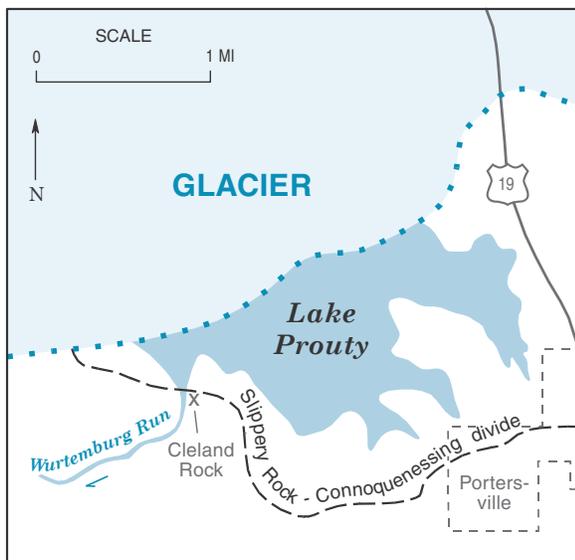
Alpha Falls



Cleland Rock

Approximately 140,000 years ago, a ridge extended across what is now the Slippery Rock Valley. The ridge separated the south-flowing Wurtemberg Run from Lake Prouty, which lay in the McConnells Run valley to the north of this divide (see the sketch of Lake Prouty).

Overflow from Lake Prouty, assisted by meltwater and sediment released from the nearby glacier, spilled over the divide at Cleland Rock into Wurtemberg Run. This overflow eventually eroded a channel through the divide at Cleland Rock deep enough to join McConnells Run and Wurtemberg Run. Together these streams formed the ancestral south-flowing Slippery Rock Creek and drained Lake Prouty.



Lake Prouty overflow

After Lake Prouty drained, the newly created Slippery Rock Gorge was probably no more than half of its present depth. During the last two glaciations (140,000 and 23,000 years ago), catastrophic flooding from the draining of glacial Lake Watts and Lake Edmund caused the gorge to erode to greater than its present depth. Rocks that have fallen into the gorge from the adjacent slopes have reduced the depth of the gorge.

Slippery Rock Creek has continued to erode the gorge since the last glaciation, but compared to the days when water roared through the valley, there has been little change.

Site 7. Lake Arthur

Lake Arthur is a smaller, man-made re-creation of glacial Lake Watts. Its average elevation is only 1,190 feet (70 feet lower than Lake Watts), and it is about 6 miles shorter than the old glacial lake. However, the man-made dam is near where the ice dam blocked Muddy Creek.

Near the middle of glacial Lake Watts, miles from the gravel released from the glacier by melting, only silts and clays settled to the lake bottom. When the Pa. Route 528 bridge (**J**) was being built, initial construction had to be halted because the 90 feet of water-saturated silt and clay was not able to support the bridge, and the bridge had to be redesigned. Although Lake Watts stood higher than Lake Arthur, no high-level, wave-cut notches or beaches are visible, suggesting that Lake Watts was short-lived and had only small wave action.

When Moraine State Park was developed, the old, depleted oil and gas wells were plugged, strip mines were backfilled, and deep mines were sealed. However, a few traces of the drilling and mining can still be seen. Plugged wells, an oil pump-house, and oil-field debris are on the hills near Wyggeston Trail (**K**). Along South Shore Drive, past Pleasant Valley Beach, and at the site marker, a strip-mine highwall shows Kittanning sandstones and shales. This is the same unit that forms the Cleland Rock overlook. Kittanning coals were also strip and deep mined on the north shore of Lake Arthur. Evidence of this mining can be seen along the bike trail between mile 7 and the trail end (**L**). Look for sandstone blocks, rusty seeps from pits, and small waste piles on the north side of the trail.



Lake Arthur, Pleasant Valley Beach, and old strip mine



Strip-mine highwall along South Shore Drive



Site 8. Jacksville Esker Glacial Deposit

Although both parks are the result of glaciation, neither contains easily observable, characteristic glacial deposits. The closest glacial feature of note is the Jacksville Esker, 2½ miles north of Moraine State Park. An esker forms when meltwater drains into a glacier through fractures and then flows through ice tunnels at the base of the glacier. Sand and gravel deposited along the tunnel floor remain as an elongate, commonly sinuous, ridge when the ice melts. Esker

sediment is deposited in a channel confined within the ice, rather than in a channel eroded into the ground. The 6-mile-long Jacksville Esker (known locally as West Liberty Hogback and Miller Esker) formed during the last glaciation, about 23,000 years ago. Although its central portion is eroded, the Jacksville Esker is the best preserved esker in Pennsylvania. The portion of the esker visible from the marker is owned by the Western Pennsylvania Conservancy and is open to the public. Stay near the tree line as you walk to the top of the esker to get a feel for its size.

Swope Road cuts through the esker (M), exposing the sediments. The gravel and cobbles range from local sedimentary bedrock to metamorphic and igneous rocks transported from Canada by the glacier. Because sand and gravel are valuable sources for roadbase, concrete aggregate, and other construction materials, parts of this esker and other glacial deposits are disappearing rapidly through economic exploitation.

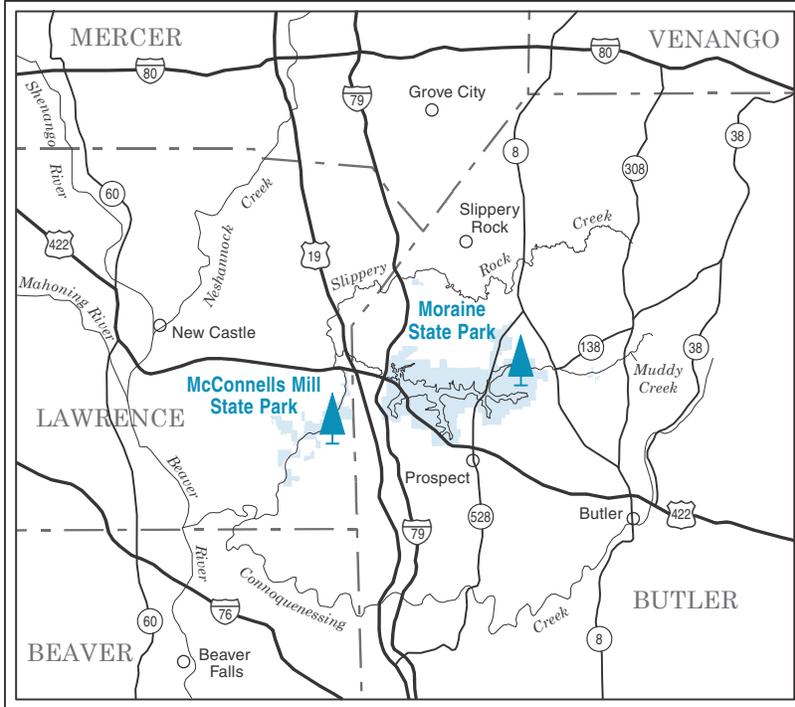
Photograph courtesy of Bradford B. Van Diver from Van Diver, B. B., 1990, *Roadside Geology of Pennsylvania*: Mountain Press Publishing Co., Missoula, Mont., p. 72.



Jacksville Esker

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LOCATION MAP

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