GEOLOGY OF NELSON-KENNEDY LEDGES STATE PARK

A passage between slump blocks of the Sharon Conglomerate in the park.

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Introduction

The geology of Nelson-Kennedy Ledges State Park, in Portage County in northeastern Ohio, displays fascinating natural landscape features and interesting sedimentary structures. The rocks that make the massive cliff-forming layers and huge slump blocks of the park were deposited during a time when Ohio was a broad coastal plain with meandering and braided streams flowing from the Alleghenian Orogeny mountain range to the east. Westward-flowing streams from this range carried eroded material to the northeastern plains of Ohio and deposited it as what would become the Sharon Conglomerate. Cliffs and rock blocks are uneroded remnants of sandstones and conglomerates comprised of beautifully sorted, clean white quartzite grains.

Bedrock Deposition and Erosion

Exposed in Nelson-Kennedy Ledges State Park, the Sharon Conglomerate (fig. 1) is the basal member of the Pennsylvanian (318–311 million years ago [m.y.a.]) Pottsville Group. The Sharon Conglomerate is deposited on the erosional surface of the Late Mississippian (330–320 m.y.a.) Meadville Shale Member of the Cuyahoga Formation (fig. 2). During this time, Ohio was about 300 mi (500 km) south of the equator (fig. 3) and the tectonically active Alleghenian Orogeny mountains to the east were releasing eroded material to the western plains, now northeastern Ohio and northwestern Pennsylvania, and depositing the Sharon. The Sharon is composed of milky-white, well-rounded quartzite pebbles and coarse sands (fig. 1). The pebbles' well-rounded shapes are a result of weathering during their long journeys in streams. Microscopic metamorphic clues in the Sharon's pebbles, along with the lack of any igneous-sourced sediments, reveal that the pebbles are sourced from metamorphic rocks. Rare Devonian (416–359 m.y.a.) limestone pebbles in the Sharon indicate that sedimentary rocks were present in some parts of the source area as well. The thickness of the Sharon in the park is about 50 ft (15–20 m), but its thickness increases up to 260 ft (80 m) where older underlaying shale layers were deeply eroded, allowing the Sharon to fill these areas during its deposition.

Figure 3. Paleogeography of Ohio (outlined in red) during the Early Pennsylvanian (318–311 m.y.a.), when deposition of the Sharon Conglomerate took place. The mountains formed during the Alleghenian Orogeny (outlined in yellow) were the source of Sharon Conglomerate sediments. Map is modified from Blakey: Key Time Slices of North America © 2013 Colorado Plateau Geosystems Inc.

Figure 1. Sharon Conglomerate with rounded quartzite pebbles and coarse sand. The smoothness of the pebbles indicates their long journey from the sediment source to deposition.

Figure 2. Bluish-gray Meadville Shale layers under massive Sharon Conglomerate. The Mississippian-Pennsylvanian contact (dashed line) is visible where these two units touch near Gold Hunter's Cave along Cascade Creek. Black-and-white stick is 4.6 ft (140 cm) long.

Classic sedimentary cross-bedding (fig. 4) is displayed on cliffs and slump blocks in the park. The orientation and dip of the cross-bedding and the inclination of the pebbles confirm this eroded material came from the mountains formed during the Alleghenian Orogeny to the present-day northeast.

The sands and pebbles that make up the Sharon Conglomerate were compacted, cemented, and transformed into an erosion-resistant rock by the thick, younger sediments deposited on top of the Sharon during the Pennsylvanian and possibly Permian Periods (299–252 m.y.a.). During the last 250 million years, from the Permian Period to Ohio's Ice Age, plate tectonic processes repositioned Ohio from 300 mi (500 km) south of the equator (fig. 3) to its present position, about 2,700 mi (4,500 km) north of the equator. During this long journey, the region gradually elevated and the younger rock formations were eroded.

The Meadville Shale is the park's oldest exposed rock unit and is exposed under the Sharon along Cascade Creek near Gold Hunter's Cave (see geologic map on back cover). The Meadville is a soft and muddy, thinly bedded, bluish-gray shale with reddish-brown weathering. The irregular erosional surface between the Meadville and the Sharon indicates that the region was exposed for several million years at the end of the Mississippian Period, after the deposition of the Meadville. The Cuyahoga Formation sandstone pieces embedded in the lowermost layers of the Sharon Conglomerate and the well-preserved plant remnants at the base of the Sharon reveal that the region was under active erosion. Flooded streams carved into the nearby Cuyahoga rock unit, depositing their sediments in lowlands.

The Ice Age and a Reshaped Landscape

About 24,000 years ago, during the last Ice Age in Ohio, a thick sheet of ice advanced from the north and covered what is now the modern park. This event, called the Wisconsin Glaciation, was a time when south-moving glaciers eroded soft formations and flattened the region. The area which is now Nelson-Kennedy Ledges State Park was a high-relief region with deep valleys and cliff-forming hills. A valley 350 ft (110 m) deep existed to the east of the park. Devonian Ohio Shale, Bedford Shale, and Berea Sandstone and Mississippian Cuyahoga Formation shales were exposed in the valley (see geologic map and profile on back cover). Heterogenous clay, silt, sand, gravel, and boulders eroded from areas to the north were carried by glaciers and filled these valleys and lowlands when the glaciers melted about 14,000 years ago. Hard-cemented Sharon Conglomerate was more resistant to erosion and formed the remaining highlands and hilltops seen in the park.

The elevated western part of the park is formed by thick-layered Sharon Conglomerate with few vertical joints (fig. 5). The eastern limit of the elevated part of the park contains plentiful joints that are open, and many are large enough to walk through. The huge, tilted slump blocks of the Sharon have separated from the horizontal bedrock along these open joints. The underlying Meadville Shale is impermeable to the precipitation that penetrates through the Sharon's joints, causing water to seep from the Meadville and Sharon contact. When wet, the contact boundary of the Meadville and the Sharon can create conditions where jointed blocks of the overlying Sharon can slide downslope. The slumping of the Sharon is more pronounced along east–west-running Cascade and Sylvan Creeks, where the Cascade and Minnehaha Falls were formed (see geologic map on back cover). The slumping and irregular positioning of Sharon blocks have created interesting passages, open holes, and caves such as Devil's Hole, Devil's Icebox, Dwarf's Pass, Old Maid's Kitchen, and Gold Hunters Cave. Gold Hunter's Cave is formed by erosion caused by the waterfall at Cascade Falls and exposes the most geologically interesting features of the park. The Mississippian and Pennsylvanian Periods contact, paleo-erosional features, and iron-stained seeps are exposed in the cave.

The massive blocks of beautiful, pebble-rich sandstone scattered across the landscape make Nelson-Kennedy Ledges State Park a geologic wonder in Ohio. Visitors can sense the geologic processes at work around them and imagine the immense power of the deposition and erosion that occurred for millions of years to give us what we enjoy today.

Figure 4. Cross-bedding in the Sharon Conglomerate on gigantic rock blocks in the park. Cross-beds indicate that these rocks were deposited in a coastal deltaic plain with meandering streams.

Figure 5. Major open joint on Sharon Conglomerate layer covering the elevated parts of the park. Slump blocks throughout the park are a result of past expansion of similar joints. Park Manager John Trevelline stands next to a bridged part of the joint.

Further Reading

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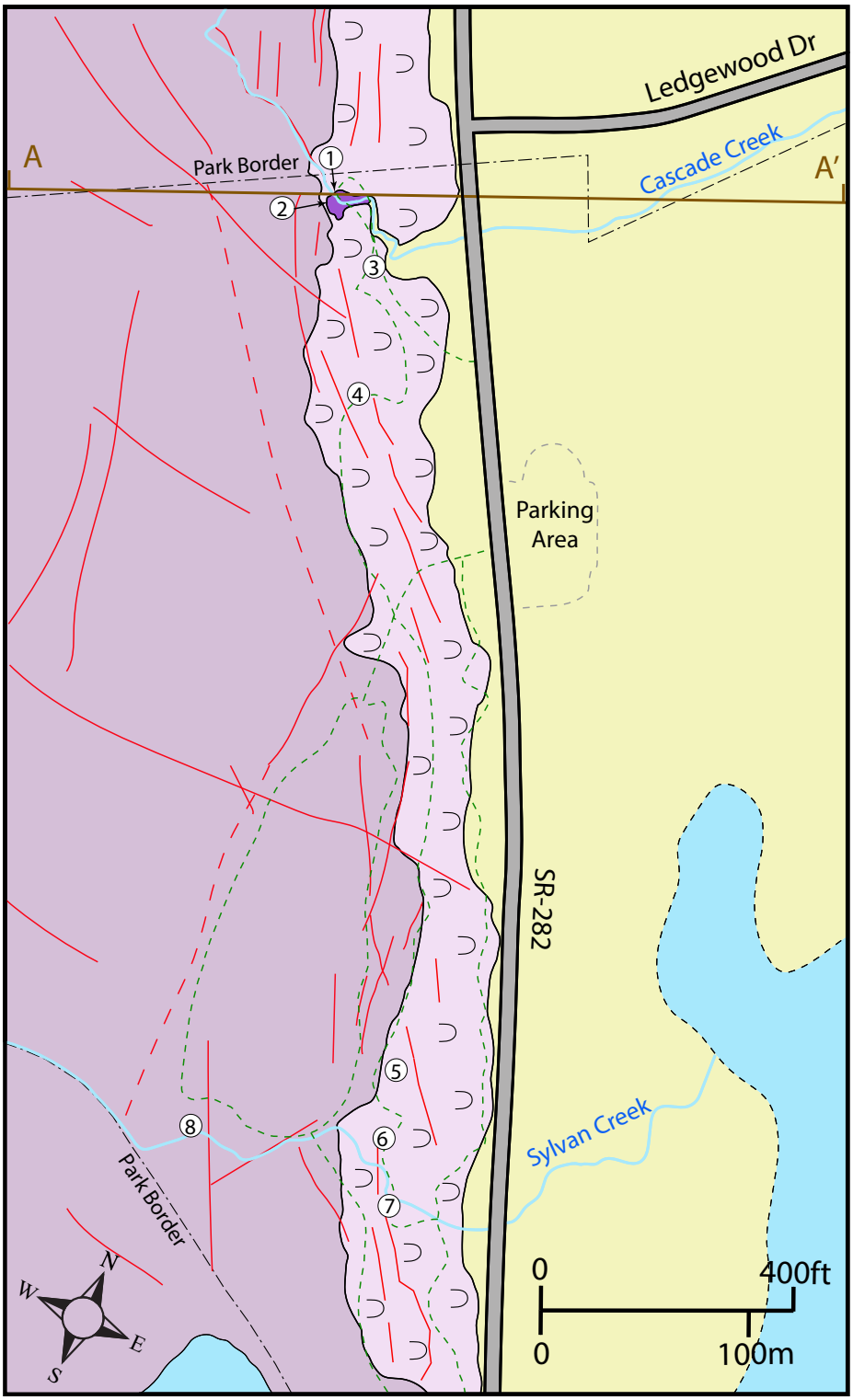
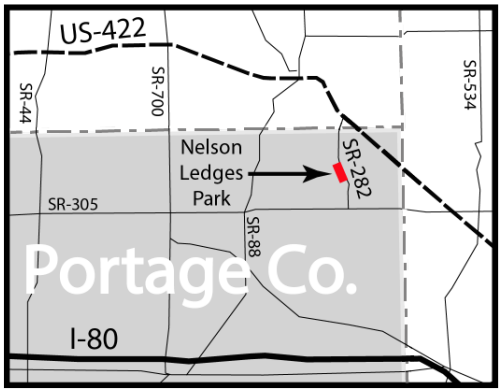
Nelson-Kennedy Ledges State Park

GEOLOGIC MAP & PROFILE



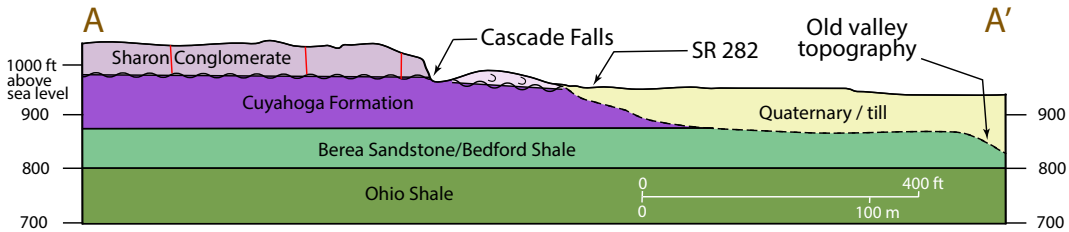


LEGEND

- Quaternary / glacial till
- Sharon Conglomerate
- Cuyahoga Formation
- Berea Sandstone and Bedford Shale
- Ohio Shale
- Slump blocks of Sharon Conglomerate
- Major joint
- Inferred joint
- Pond (permanent/seasonal)
- Trail

POINTS OF INTEREST

1. Cascade Falls
2. Gold Hunter's Cave
3. Old Maid's Kitchen
4. Dwarf's Pass
5. The Squeeze
6. Devil's Hole
7. Devil's Icebox
8. Minnehaha Falls



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