Geology and Habitats of the Cuyahoga Valley National Recreation Area, Ohio[1]

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ABSTRACT. This field trip to the Cuyahoga Valley National Recreation Area in northeast Ohio has been prepared in association with the National Association of Geology Teachers' (NAGT) symposium entitled "Public Lands and the Teaching of Geology." Stops are in a logical sequence to examine the geologic section, glacial deposits, and the following habitats: slump, hemlock ravine, upland dry woods, floodplain, slope, old field and wetland. Activity by man is minimal; sites are accessible and protected from future development; and the sequence of stops follows ages of bedrock, oldest to youngest. In order to protect the sites, national park policy prohibits collection of samples.

Shallow marine black shales of Devonian age, offshore marine, coastal, fluvial, and marine sedimentary rocks of Mississippian age, and braided stream sandstones of Pennsylvanian age are exposed in stream valleys. Stratified and unstratified deposits of Wisconsinan age cap the area.

Three contradictory hypotheses (i.e., continental lower, marine upper; eolian; and fluvial and tidal channel) on the origin of Berea Sandstone are considered at field sites. Geologic terrain and geomorphic history have influenced development of the seven habitats.

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INTRODUCTION

The Cuyahoga Valley National Recreation Area (CVNRA) is in the glaciated part of the Allegheny Plateau in northeast Ohio. The Allegheny Plateau is characterized by relatively undeformed sedimentary rocks and is bound on all sides by a steep topographic descent to adjacent geomorphic regions characterized by older sedimentary rocks (Thornbury 1965).

Igneous and metamorphic rocks underlie sedimentary rock at a depth of about 1,676 m in the CVNRA. Basement rock in Ohio, recognized from well borings, is composed of granite, gneiss, schist, and marble (Owens 1967). None is exposed in the CVNRA. Older Paleozoic rocks of Cambrian, Ordovician, Silurian, and Devonian age are at depth in the area of the CVNRA.

Rock units of Devonian, Mississippian, and Pennsylvanian age and glacial deposits of late Wisconsinan glaciation are exposed in the CVNRA (Fig. 1) The Devonian system is represented by black shales which accumulated in shallow seas. The Mississippian system is represented by a basal shale interbedded with siltstone, overlain in sequence by sandstone, black shale, and silty, clayey, or sandy shale. The Mississippian sequence was deposited in environments changing from offshore marine, to coastal, to fluvial, and back to marine. The Pennsylvanian system is represented by a sandstone and conglomerate that were deposited by low-discharge braided streams.

No younger sedimentary rocks occur within the CVNRA. Bedrock dips 3.8 m per km to the east and south-southeast (Manner 1987). Stream erosion incised a steep-sided river valley which in Pleistocene time was filled by glacial deposits. Evidence of early glacial activity is obscured, but events are known from deposits elsewhere in northeast Ohio. Landforms of late Wisconsinan glaciation occur as ground moraine, end moraine, kames, kame terraces, and kame deltas (Fig. 2). Outwash and lake plain deposits formed as the level of Lake Erie dropped. The present Cuyahoga River basin was formed after final retreat of the glaciers 14,000 years ago (Szabo 1987).

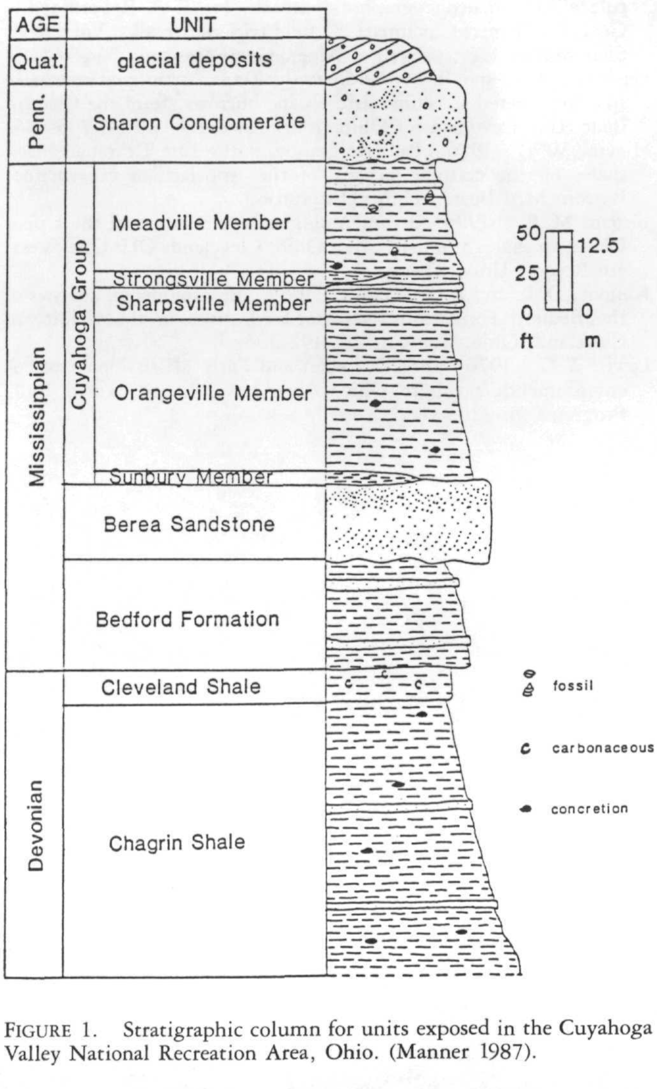

FIGURE 1. Stratigraphic column for units exposed in the Cuyahoga Valley National Recreation Area, Ohio. (Manner 1987).

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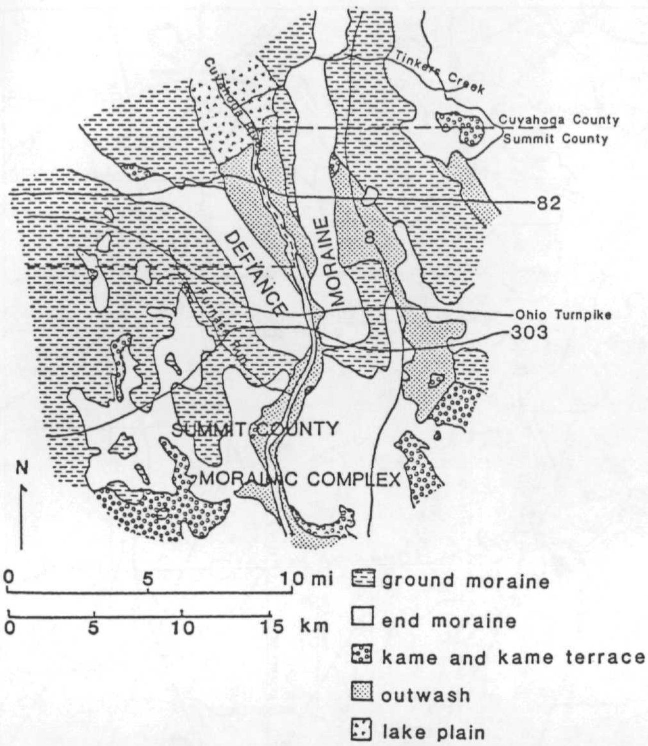

FIGURE 2. Glacial landforms in area of the Cuyahoga Valley National Recreation Area, Ohio (after White 1982).

FIELD TRIP ROAD LOG

Distance: km (mi) cum.		inc.		
0.0	(0.0)	0.0	(0.0)	Start from visitors parking lot behind Bierce Library at The University of Akron. Turn right (north) onto College Street. Turn right (east) onto James Street. Continue to bridge over Ohio 8.
0.6	(0.4)	0.6	(0.4)	Turn left (north) at east end of bridge onto Ohio 8 north.
1.8	(1.1)	1.1	(0.7)	Bridge over Little Cuyahoga River.
5.6	(3.5)	3.9	(2.4)	Cuyahoga River is to the left (west) of the road.
8.2	(5.1)	2.3	(1.6)	Bridge over Cuyahoga River. River here is flowing southwest; downstream it is flowing north. Sharon Conglomerate is exposed in road cut.
11.6	(7.2)	3.4	(2.1)	Turn right (north) onto Hudson Drive. Terrain is poorly drained end moraine. Oil and gas production is from the Newburgh and "Clinton" Formations.
18.0	(11.2)	6.4	(4.0)	Turn left (west) onto Terex Road.
22.4	(13.9)	4.4	(2.7)	Turn left (west) onto Ohio 303.
22.9	(14.2)	0.5	(0.3)	Turn right (north) onto Ohio 8. Drainage here is poorly developed; tributaries on this side of the Cuyahoga River do not reach this far east. We are travelling parallel to the Cuyahoga River, which is 4 km (2.5 mi.) to the west.
32.4	(20.1)	9.5	(5.9)	Turn left (west) onto Ohio 82. From here we descend into the valley and cross the Cuyahoga River to reach STOP 1.
37.7	(23.4)	5.3	(3.3)	Bridge over Ohio Canal and Cuyahoga River. River valley here is narrow, confined by bedrock rather than more readily eroded glacial deposits.
38.5	(23.9)	0.8	(0.5)	Turn left (south) onto Riverview Road. Note grindstone on display in private yard on left (east).
38.6	(24.0)	0.2	(0.1)	Turn left (east) onto Station Road. Be careful as this is a narrow road. We are descending toward river level.
39.0	(24.2)	0.3	(0.2)	Park within sight of Station Road Bridge, a registered historical structure.

STOP 1. Pinery Narrows

Walk north about 0.2 km (700 ft) along a railroad right-of-way to vicinity of Ohio 82 bridge overhead.

CHAGRIN SHALE. Chagrin shale is composed of soft, blue-gray, sparsely fossiliferous shale with a few, thin, siltstone layers and some concretions. Notice the good exposures along drainages. Unlike other shale units, jointing is not prominent. Concretions (flattened spheroids) weather to limonite. As the shale weathers, it changes to a soft, sticky clay. According to Szmuc (1970a), clay-sized particles are composed of quartz, illite, chlorite, and kaolinite, and do not shrink and swell. Mass movement of weathered Chagrin Shale is obvious. Note encroachment of shale on railroad tracks, last used in 1985. Trace fossils are the only fossils readily seen at this exposure. Elsewhere Chagrin Shale has flaggy, fossiliferous sequences containing brachiopods and mollusks as well as trace fossils (Szmuc 1970a). It also contains pyrite as a thin, discontinuous layer. Carbonized plant fragments, fish bones, and other fossils have been reported at locations outside of the CVNRA (Hannibal and Feldmann no date). Chagrin Shale is 365 m thick in eastern Ohio and 152 m thick in western Ohio (Hoover 1960). The Chagrin accumulated as black muds in shallow seas from material transported from the east (Szmuc 1970a).

SLUMP HABITAT. Slump habitat has developed at this site. Typical conditions exist: dryer at the top and wetter below, minimal soil development and characteristic vegetation such as Coltsfoot.

39.3	(24.4)	0.3	(0.2)	Return to Riverview Road and turn right (north).
39.6	(24.6)	0.3	(0.2)	Turn right (east) onto Chippewa Road (Ohio 82).
40.9	(25.4)	1.3	(0.8)	Turn left (north) onto Chaffee Road.
43.5	(27.0)	2.6	(1.6)	Turn left (west) onto Valley View Road.
45.2	(28.1)	1.8	(1.1)	Turn right (east) onto Sagamore Road.
48.0	(29.8)	2.7	(1.7)	Turn left (north) onto Dunham Road. We are now travelling on ground moraine.
48.5	(30.1)	0.5	(0.3)	Bridge over Sagamore Creek. Bedford Formation exposed in creek.
49.4	(30.7)	1.0	(0.6)	Turn right (north) onto Egbert Road.
53.8	(33.4)	4.3	(2.7)	Turn left (north) onto Union.
54.3	(33.7)	0.5	(0.3)	Turn left (north) onto Broadway (Ohio 14).
54.4	(33.8)	1.8	(1.1)	Turn left (west) onto West Munroe (just past railroad tracks).
54.7	(34.0)	0.3	(0.2)	Turn left (south) at dead end onto Willis Street.
54.9	(34.1)	0.2	(0.1)	Turn right (west) into Bedford Glens Park. Park on left near baseball field.

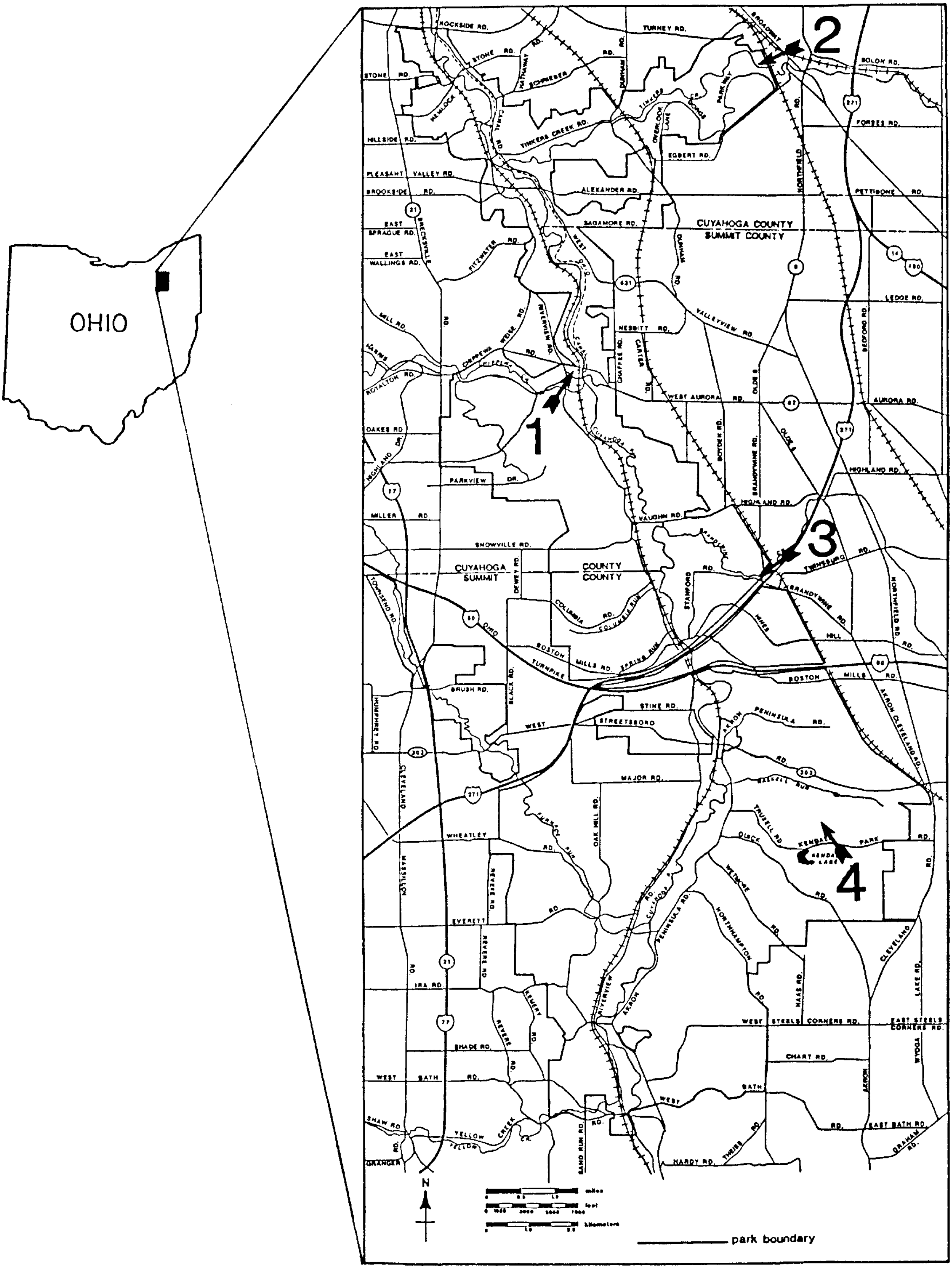

FIGURE 3. Field trip stops within the Cuyahoga Valley National Recreation Area, Cuyahoga and Summit Counties, Ohio.

STOP 2. Tinkers Creek

Walk outside of fence south of baseball field. Walk past restrooms to path into woods. At 'T' in trail, veer right. Stay on high ground for 46 m. We are walking on Berea Sandstone in an upland dry woods habitat, described later. Trail begins to descend. Stay on trail for another 80 m and continue on the trail, turning 180° to the left. Trail has numerous rocks and roots, so be careful. Proceed to first exposure of Berea Sandstone. The Cleveland Shale is at water level on south bank of Tinkers Creek directly across from this point.

CLEVELAND SHALE. Cleveland Shale is a bluish-black to brownish-black shale which weathers light brown. High carbon content in the petroliferous shale masks the high silt content. It is composed of quartz, illite, and chlorite, similar to the Chagrin, but with little or no kaolinite (Lewis and Schwietering 1971). Cleveland Shale is thickest in Cuyahoga County and thins both to the east and west in northern Ohio. At outcrop it is compact and massive, commonly with a blocky appearance as a result of joints (Hoover 1960).

TRANSITION FROM DEVONIAN TO MISSISSIPPIAN. The transition from Devonian to Mississippian is marked by a change from offshore marine to shallow coastal environments. Several species of marine brachiopods occur at the contact between the Cleveland Shale and Bedford Formation. Higher in the Bedford section, fossil species decrease in number, reflecting a lower salinity as younger deposits accumulated (Coogan 1986). A newly uplifted drainage basin to the north in the Canadian Shield brought fresh water into the shallow remnant of the Devonian sea (Hoover 1960, Pepper et al. 1954). During Bedford deposition, mild climate, abundant vegetation, and considerable precipitation in the upper reaches of the stream courses resulted in sediment being transported into central Ohio and eastern Pennsylvania (Coogan 1986). Deposition of mud and silt at the mouth of the Ontario River created a large delta, the Red Bedford delta (Fig. 4). The 338km (210 mile)-long delta was wider at the north than at the south. Prongs that were 8-10 km long extended southward into the sea.

Continue on trail to the point where the Bedford Formation is exposed and an unstable slope has developed.

BEDFORD FORMATION. In the CVNRA, the Bedford Formation is a generally gray to bluish-gray shale containing 50-200 mm lenses of either nodular, light gray mudstone or brownish-gray, irregularly bedded siltstone. Sand in some siltstones imparts an appearance of fine-grained sandstone. Clay-sized particles of the Bedford Formation consist of quartz, illite, chlorite, and kaolinite (Hoover 1960, Szmuc 1970b). Trace fossils and *Lingula sp.* also occur. The Bedford Formation characteristically thickens from east to west and is 26 m thick at the type section directly across Tinkers Creek. Oscillation ripples, trending N 60° W with crests 76-127 mm apart, are quite common. Sole markings, which are narrow, linear furrows made by current-impelled objects that gouge marine muds, trend N 40° E (Szmuc 1970b).

The contact between the Bedford Formation and the Berea Sandstone is an undulating erosional surface, showing a relief of 2.4 m along the 30-m exposure. Return along the trail to examine the Berea Sandstone.

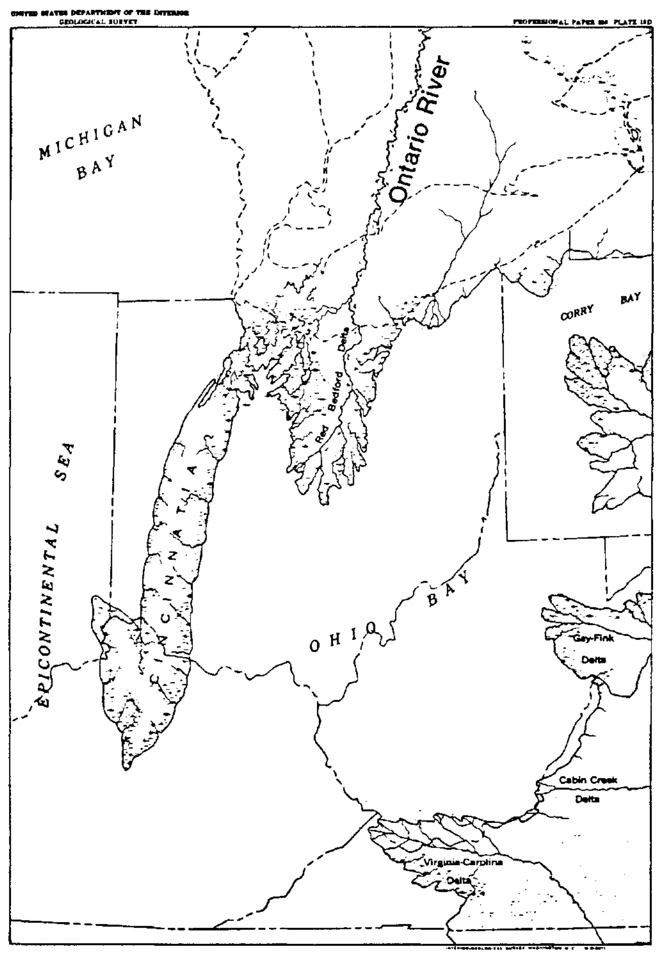

FIGURE 4. Paleogeographic map of Red Bedford delta (Pepper et al. 1954).

BEREA SANDSTONE. From the base to top of outcrop, two zones of cross-bedding alternate with horizontal bedding in the sandstone. Minor repeated displacement in the lowest unit is traceable along fault planes. Several blocks to the south (toward the creek) have dropped down distances of centimeter order. The unit above shows a different kind of response, resembling slump. The minor displacement can be described as a draping, downside to the south. Most of these features are continuous through several thin beds, but no distinct break is observable. This suggests that deformation involved brittle behavior in the oldest unit, and possibly soft-sediment deformation in the younger unit. Asymmetrical ripple marks are exposed in at least three zones in the upper half of the outcrop. Orientation of long direction within each zone is relatively constant, but ranges at least 102° among the exposed zones, testifying to the changing direction of water flow.

The lower sandstone is coarse-grained, massive, cross-bedded, and clay-bonded, with some quartz or shale pebbles (Fig. 5). The upper sandstone is light-brown, loosely cemented, and medium-grained. Its wide distribution indicates a blanket sandstone. Petrographic studies of the Berea report predominant quartz grains with some chert, feldspar, rock fragments, and sparse heavy minerals such as tourmaline and zircon (Pepper et al. 1954).

Depositional environment of the Berea Sandstone is uncertain. Three hypotheses and their supportive evi-

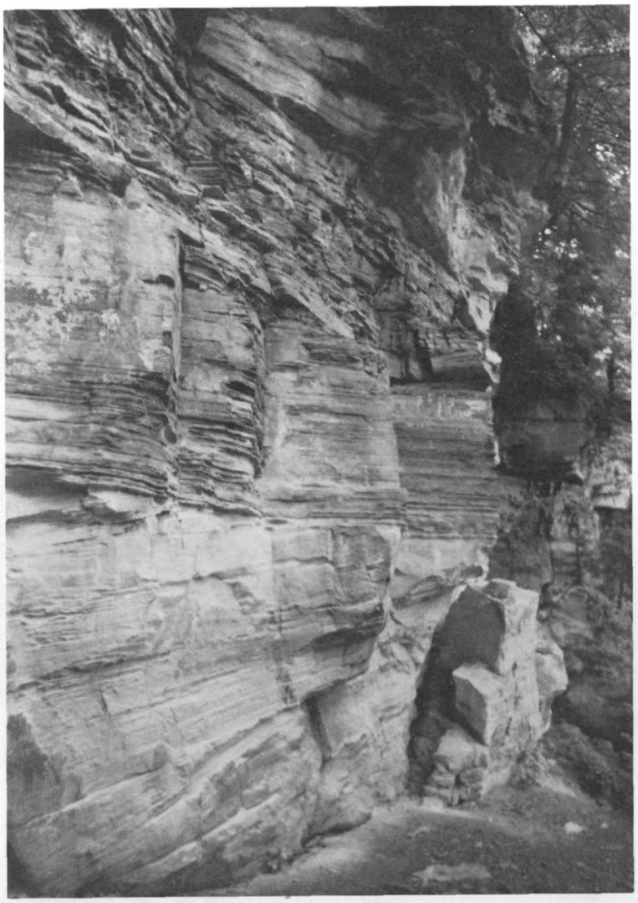

FIGURE 5. Lower part of Berea Sandstone exposed in Bedford Reservation.

dence are presented. Any of the three may be valid for some areas, and the actual origin of the Berea may involve a complex of environments. One hypothesis (Pepper et al. 1954, Banks 1970, Szmuc 1970b) involves introduction of large amounts of sand and silt into streams. Deposition of the Berea began with drainage changes in a river system in Ontario. Cessation of tilting along the northern edge of the Appalachian Basin and continued subsidence of the Ohio Basin resulted in a change from an erosional to a depositional environment. Early deposits formed in a main distributary channel which fanned out across northeastern Ohio. Shallow seas then inundated the area. Thus, the Berea may be both continental (lower) and marine (upper). Pepper et al. (1954) Banks (1970) and Szmuc (1970b) cited supportive field evidence:

1) decrease in grain size to the east, south and west consistent with a source to the north;
2) sinuous alignment of sand bodies; therefore, a distributary channel;
3) shape of the Berea in the Buckeye quarry (Fig. 6) is a meander of a large river;
4) carbonaceous material, worn and rounded parts of stems and branches, consistent with channel sand;
5) brachiopods in upper sandstone, consistent with a marine origin;
6) asymmetrical current ripple marks indicating southward movement of water;
7) mud cracks, coaly lenses, plant fossils at the non-gradational and non-deformational contact with the Bedford Formation;

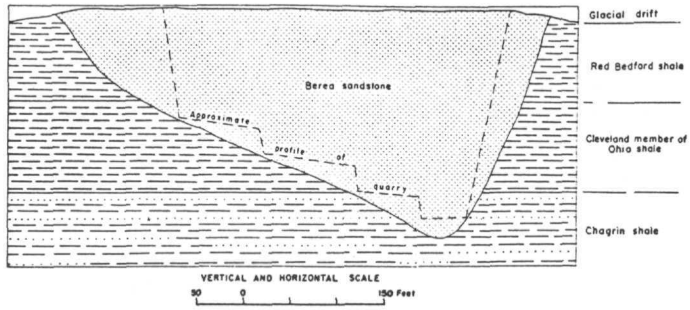

FIGURE 6. Cross section of Buckeye Quarry, South Amherst, Ohio. Berea Sandstone occurs in channels eroded into Bedford Formation and Cleveland and Chagrin Shales (Pepper et al. 1954).

8) presence of pebbles of Cleveland Shale and Bedford Shale indicating lithified state at time of deposition;
9) great changes in thickness in short distance;
10) relatively uniform horizontal bedding indicative of slow moving water in a scour channel; and
11) linear trend of north-to-south offshore bars.

Another hypothesis proposes an eolian coastal origin of the Berea. Large-scale crossbeds oriented to northeast alternate with interference ripples, or wave ripple sets that trend more northerly indicate a shore with dunes perpendicular to or tangential to the shoreline. Forms of wave sets indicate prograding offshore sets with alternating erosion and deposition. These features could result from dunes built out over the water. Trace fossils, mainly burrows, are probably the result of marine organisms. Paleocurrent directions in the Berea Sandstone are different than in clastic wedges found in stream environments. These characteristics argue against a northern source of the sediment and suggest eolian sands along a shoreline as the environment of deposition of the Berea Sandstone (Lewis 1968).

A final hypothesis involves a fluvial or tidal channel deposit. Potter et al. (1983) used gamma ray logs, modal grain size, and paleoccurrents to support the hypothesis. In northern Ohio, specifically Stebbins Gulch and Chagrin Falls, they interpreted the Berea to be a fluvial or tidal channel deposit.

Hemlock and Upland Dry Woods Habitats. Hemlock ravine across Tinkers Creek is characterized by cool, moist, and rich soils on north- and east-facing slopes. In the valley, this habitat occurs on valley fill in ravines or in the shadow of bedrock ledges, as seen across the creek. The north-facing slope is cooler. Here ravines are found in association with bedrock ledges, and springs and seeps commonly keep the otherwise droughty soils moist throughout most of the year.

As seen between the ballfield and the descent into the valley, upland dry woods are characterized by plants tolerant of dry conditions or an almost total lack of soil. At STOP 2, the upland dry woods environment is composed of droughty soils derived from Berea Sandstone. Elsewhere it develops on glacially derived sands and gravels (Manner 1987).

55.2	(34.3)	0.3	(0.2)	Return to Willis Street. Turn left (north) onto Willis Street.
55.4	(34.4)	0.2	(0.1)	Turn right (east) onto West Monroe.
55.5	(34.5)	0.2	(0.1)	Turn right (south) onto Broadway (Ohio 14).

55.7	(34.6)	0.2	(0.1)	Turn right (west) onto Union Street.
55.9	(34.7)	0.2	(0.1)	Bridge over Tinkers Creek.
56.2	(34.9)	0.3	(0.2)	Turn right (south) onto Egbert Road.
56.7	(35.2)	0.5	(0.3)	Turn right (north) onto Gorge Parkway.
61.2	(38.0)	4.5	(2.8)	We are now passing Tinkers Creek National Natural Landmark. This is another example of hemlock ravine habitat, a north-facing slope on bedrock, Bedford Formation. It is cooler and wetter here than on the south-facing slope. Berea Sandstone is exposed immediately below viewing platform. Bedford Formation is to the northeast in clearing by Tinker Creek.
61.5	(38.2)	0.3	(0.2)	Turn left (south) onto Overlook Lane. We are driving on Defiance End Moraine.
62.9	(39.1)	1.5	(0.9)	Turn right (west) onto Egbert Road.
63.4	(39.4)	0.5	(0.3)	Turn left (south) onto Dunham Road.
66.5	(41.3)	3.1	(1.9)	Turn left (east) onto Valley View Road.
67.3	(41.8)	0.8	(0.5)	Turn right (south) onto Boyden Road.
69.2	(43.0)	1.9	(1.2)	Turn left (east) onto Ohio 82.
70.0	(43.5)	0.8	(0.5)	Turn right (south) onto Brandywine Road.
74.1	(46.0)	4.0	(2.5)	Turn right onto Brandywine Falls area. Park beyond concrete bridge.

STOP 3. Brandywine Falls

The Brandywine Falls site shows the relationship between geology and early industry. A grist mill at Brandywine Creek Falls was one of the earliest industries in the valley. In 1810, G. Wallace Sr. built his mill where Brandywine Creek drops 19.8 m over the Berea Sandstone and Bedford Formation. Endeavors at Brandywine expanded to a sawmill and a distillery in 1816, and a woolen factory in 1821. Still evident are carved mortises which supported the mill wheel, and grooves which diverted water to the grist mill nearest the falls and to the two-story saw mill nearest the present bridge. The undulating contact between the Bedford Formation and the overlying Berea Sandstone is well exposed in the cliff face on the south side of Brandywine Creek. Characteristic iron staining at this contact appears on the cliff face and also immediately to the north of the falls area.

74.5	(46.3)	0.5	(0.3)	Return to entrance. Turn right (south) onto Brandywine Road.
77.1	(47.9)	2.6	(1.6)	Turn right (south) onto Olde Eight Road; we are now travelling on ground moraine.
77.8	(48.3)	0.6	(0.4)	Bridge over the Ohio turnpike. An overview of the Cuyahoga River valley is on the right (west).
78.2	(48.6)	0.5	(0.3)	Turn left (east) onto Boston Mills Road.
78.9	(49.0)	0.6	(0.4)	Turn left (north) onto Ohio 8 and immediately turn right onto entrance ramp to Ohio Turnpike. Take "Toledo and West".
80.2	(49.8)	1.3	(0.8)	Merge onto turnpike west. Second bridge is Olde Eight where we crossed at kilometer 77.8 (mile 48.3).
81.1	(50.4)	1.0	(0.6)	Sharon Conglomerate is exposed.
83.9	(52.1)	1.0	(0.6)	Borrow pit for highway construction is on left (south).
84.5	(52.5)	0.6	(0.4)	East end of bridge over Cuyahoga River. Good perspective of the river valley both north and south. Notice how much wider it is at this point than at kilometer 37.7 (mile 23.4). To the right (NW) you can see Boston Mills Ski Area, built in glacial till.
85.5	(53.1)	1.0	(0.6)	West end of bridge.
87.9	(54.6)	2.4	(1.5)	Shale exposure. Shale is fissile to flaggy. It is part of the Cuyahoga Group, probably the Meadville Shale. The Cuyahoga Group is not exposed at any convenient site in the CVNRA. It occurs in valleys of western tributaries to Furnace Run and in some parts of Salt Run.

CUYAHOGA GROUP. The lowest member of the Cuyahoga Group is the Orangeville Shale. Dark gray mudstone and a dark blue-gray flaky, fissile, silty shale comprise most of this unit. Nodular limonite concretions with concentric weathering bands are also present (Pepper et al. 1954, Szmuc 1970b). The Orangeville Shale thickens westward. It is 38-41 m thick near Cleveland and in Summit County, and 23 m thick at the Ohio-Pennsylvania line.

During Cuyahoga time, northern Ohio was inclined toward the west, and marine currents carried materials from the east, northeast, and southeast. Deoxygenated shallow seas of oldest Cuyahoga time disappeared and sediment accumulated at a faster rate in an environment with more diverse animal life.

Turbid, sediment-charged currents carved grooves and reworked material as sediment moved down basinal slopes. Sporadic coarse silt and sand alternating with fine silt and clay comprise the younger units of the Cuyahoga Group; Sharpsville, Strongsville and Meadville members.

The Sharpsville is cross-laminated sandy siltstone with some silty shale. Low angle, cross laminations resulted from turbidity currents. The unit contains brachiopods, groove casts, pyrite, and marcasite (Szmuc 1970b). The Sharpsville grades laterally into Strongsville toward the west outside of the CVNRA.

The Meadville is primarily fissile with some blocky shales that are blue-gray, soft, and clayey to very sandy. Some thick flagstone sequences of micaceous sandy limestone or calcareous sandstone occur. Sphalerite, galena, and probably calcite and siderite are also present. The Meadville Shale was deposited during a time of abundant oxygen and nutrients. It is the most fossiliferous unit in northeastern Ohio and contains 125 species of sponges, snails, brachiopods, trilobites, corals, cephalopods, bryozoa, and other fossils. Low-angle cross-laminations indicate deposition by turbid, sediment-charged currents similar to those forming the Strongsville and Sharpsville members (Hoover 1960). The area was emergent and subject to erosion for the remainder of the Mississippian.

90.6	(56.3)	2.7	(1.7)	Take Exit 11 ramp.
91.8	(57.0)	1.1	(0.7)	Pay toll and take Akron South exit.
92.4	(57.4)	0.6	(0.4)	Ohio 21 South.
93.9	(58.3)	1.4	(0.9)	Continue straight on Brecksville Road.
94.2	(58.5)	0.3	(0.2)	Turn right (west) onto Townsend Road to Furnace Run Metropolitan Park. Lunch stop.
97.7	(60.7)	3.5	(2.2)	Return to Brecksville Road and turn right (south).

101.8	(63.2)	4.0	(2.5)	Turn left onto Wheatley Road (Ohio 176).
103.8	(64.5)	2.1	(1.3)	Turn right (south) onto Revere Road.
105.8	(65.7)	1.9	(1.2)	Turn left (east) onto Everett Road. We are now travelling on ground moraine.
107.7	(66.9)	1.9	(1.2)	Glacial lake clays on right (south). These are most likely from glacial Lake Independence. The clays were used by early settlers for making bricks. This is also a slump habitat.

SLUMP HABITAT. Slump has developed on areas of glacial lake sediments which are now eroding away. This environment is unique because the slow but constant movement prevents succession. The slipping creates interesting and isolated habitats that are quite small and support species found no where else in the Park. Upper parts of the slump are dry; lower slopes are sites of seeps and quite moist. Soil development is minimal because soil moves downslope and has little time to develop much deeper than a few inches.

108.5	(67.4)	0.8	(0.5)	Reconstructed covered bridge affords a view of cobbles and boulders in Furnace Run, which floods annually. Turn right (south); we are now on Oak Hill Road.
110.1	(68.4)	1.6	(1.0)	Hale Farm and Village.

Jonathan Hale arrived in the Connecticut Reserve in 1810 to claim 202 hectares of land in what is now Bath Township. For 16 years, he and his family lived in a small cabin. In 1826, he built a large house of timber and clay bricks made from material found on his land (Jackson and Jackson 1985). Although renovated, some of the original bricks remain in place and visible on the north side of the house. Hale Village is a seasonal attraction, for which an entrance fee is charged.The hill to the east of Riverview Road is a kame delta.

110.6	(68.7)	0.5	(0.3)	Continue straight. Road is now Ira Road.
111.9	(69.5)	1.3	(0.8)	Intersection with Riverview Road. Continue straight. Cross the Cuyahoga River. This is an example of a floodplain habitat.

FLOODPLAIN HABITAT. The floodplain is the relatively flat area bordering a stream. This area is occasionally flooded and plants, although not always in the water, are affected by very moist conditions which may last for several days. Plants that can withstand flowing waters of floods will survive. Floods also bring in and deposit sediments which replenish soils. Meadow areas may form adjacent to rivers on terraces (formerly active floodplains).

112.2	(69.7)	0.3	(0.2)	Turn left (north) onto Akron-Peninsula Road.
117.5	(73.0)	0.5	(0.3)	Intersection with Quick Road. Kame terrace deposits located in this area and to the east.
118.2	(73.4)	0.6	(0.4)	Turn right onto Truxell Road.
121.7	(75.6)	3.5	(2.2)	Turn left (north) onto Ledges area of Virginia Kendall Park.
122.2	(75.9)	0.5	(0.3)	Park in northernmost parking lot.

STOP 4. Ledges Area

Hike the trail to Ice Box Cave, along the base of the ledges, and then to Happy Days Visitors Center. This is about a 1.1-km (0.7-mi) trail. The trail to the ledges is on upland dry wood habitat and at the base of the ledges is on a hemlock ravine habitat. Walk north from the parking lot. Turn right (east) when you get to a cross trail. This will take you along the top of the ledges which are Sharon Conglomerate.

SHARON CONGLOMERATE. Sharon Conglomerate is the youngest rock unit exposed in the CVNRA and caps some of the highest hills, at elevations exceeding 335 m above sea level (Manner 1987). Sharon Conglomerate is clean, white, friable, medium-grained, quartz arenite. The name is misleading because the sandstone fraction exceeds >2 mm pebble fraction at most exposures. Cement is generally silica, but limonite or pyrite exceeds silica in the basal unit. The basal unit may contain pebbles other than quartz or quartzite. Crossbedding is in two forms. Planar, or omicron crossbedding is most abundant and dominates the sandstone. Trough, or pi crossbedding is more common in the conglomerate.

Proceed to Ice Box Cave. The floor of the cave is the erosional surface upon the Meadville Shale. Rivers had entrenched and widened, forming as much as 76 m relief. Pennsylvanian-age sands and gravels were laid down on this erosional surface by low-discharge, braided streams. Cut-and-fill features are common. Sharon Conglomerate rests disconformably on the Cuyahoga Group; the contact is commonly a line of springs. Initial deposits filled channels that trended south and southwest (Heimlich et al. 1970). Sides of the cave correspond to two prominent joint sets, N 80° W and N 20° E (Coogan et al. 1974).

Other features farther along the trail include honeycomb weathering (from differential erosion resulting from differences in cementation), a glacial groove, and horizontal chevron-shaped beds, possibly from soft sediment deformation.

Continue on trail until you come to steps (constructed of Berea Sandstone). Drivers may choose to hike back to the parking lot at the Ledges and use the following log to drive to Happy Days Visitors Center.

122.8	(76.3)	0.6	(0.4)	Return to entrance and turn right (west) onto Truxell Road.
126.4	(78.5)	3.5	(2.2)	Turn right (north) onto Akron-Peninsula Road.
126.9	(78.8)	0.5	(0.3)	Meander in Cuyahoga River to left (west).
128.0	(79.5)	1.1	(0.7)	Turn right (east) on Ohio 303.
131.4	(81.6)	3.4	(2.1)	Turn right (south) into Happy Days Center.

The rest of the group takes the right branch of the trail and follows it to Happy Days Center. At the next junction, take trail to the left. A small exposure of the Meadville Shale appears in Haskell Run just upstream of the small bridge. The trail beyond here is in a slope habitat.

SLOPE HABITAT. This is one of the most common habitats in the park. It is characterized as having fertile, moist, well-drained, and loamy soils. At this location glacial till is relatively thick and has sufficient clay content to prevent soil from becoming droughty. The till also has sufficient sand content to prevent the soil from becoming water-logged. The direction that the slope faces has a profound effect. The warmer south- and west-facing slopes tend to form slope habitats, whereas cooler, north- and east-facing slopes develop hemlock ravine habitats. Continue to the visitor center, which provides displays, publications, and restrooms.

131.7	(81.8)	0.3	(0.2)	From Happy Days Visitor Center return to Ohio 303. Turn left (west).
135.4	(84.1)	3.7	(2.3)	Bridge over Cuyahoga River in Village of Peninsula. We are now travelling on outwash.
135.7	(84.3)	0.3	(0.2)	Turn left (south) onto Riverview Road.
136.5	(84.8)	0.8	(0.5)	View of Deep Lock Quarry to left (east), beyond the guard rail and downhill. It was a source for Berea Sandstone used in constructing locks in the Ohio Canal, buildings, and grinding stones for the Quaker Oats grist mill.
140.2	(87.1)	0.7	(2.3)	Town of Everett, a canal town, was the place for care, feeding, and exchange of horses and mules.
141.4	(87.8)	1.1	(0.7)	Old field habitat to the right (west).

OLD FIELD HABITAT. The old field habitat forms on an abandoned field or a disturbed area. In each case, disturbed soil allows establishment of pioneer species of plants. A large variety of species is possible.

141.8	(88.1)	0.5	(0.3)	View of Indigo Pond to the right (west). Indigo Pond occupies Gray Quarry, a former sand and gravel operation in a kame delta (Manner 1987). Kame deltas are built outward from glacial ice. As the ice calves and melts, residual masses of sediment form in an irregular mound. Kame deltas may also form in a temporary lake into which ice-derived sediments are deposited by streams. Kame deltas are composed of sequences of silty clay, fine sand and silt, medium to coarse sand, and gravels (Bain 1975).
142.2	(88.3)	0.3	(0.2)	Wetland habitat can be seen on the left (east).

WETLAND HABITAT. At this site a beaver dam created an oxbow lake from the Cuyahoga River, forming a wetland habitat. Wetlands are low areas, along banks of streams and river margins, and on newly formed sandbars, swamps, swales, sloughs, and drainage ditches. The soil is generally fertile because of abundance of organic materials; is moist because of proximity to the water table; and has a pH of 5.5 to 7.5. The area is frequently inundated by water for long periods of time; therefore, roots are shallow. The largest trees in the canopy layer have a short lifespan because the root systems cannot support size beyond a limited age (Thompson 1984).

149.4	(92.8)	7.2	(4.5)	Intersection with Portage Path. Proceed straight; now on Merriman Road.
154.4	(95.9)	5.0	(3.1)	Turn (east) onto West Market Street.
156.8	(97.4)	2.4	(1.5)	Turn right (south) onto South College Street.
157.5	(97.8)	0.6	(0.4)	Trip ends in campus parking lot.

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