Introduction

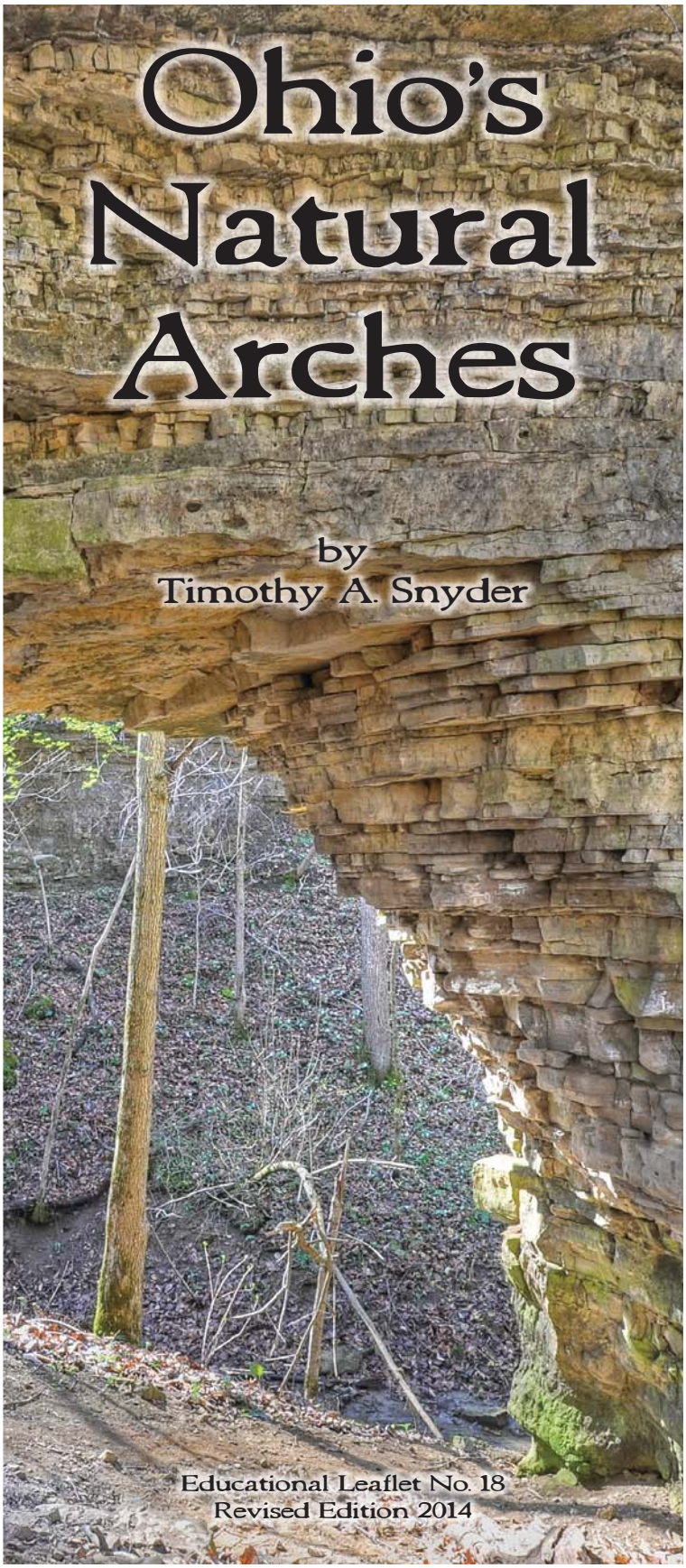
There is something magically impossible about a natural arch. The sight of a sliver of rock against the sky seems to violate our understanding of both gravity and the ponderously earthbound nature of stone. Their existence naturally raises questions about how they formed and how many might exist.

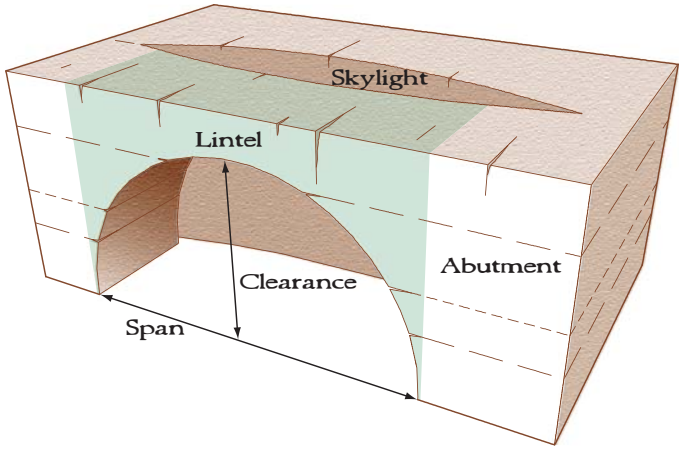
Natural arches are, in fact, more numerous than one might suppose, and they can be found throughout the country. One of the largest concentrations of these interesting geologic features is found in the Colorado Plateau of the American West, where three national parks—Arches National Park, Rainbow Bridge National Monument, and Natural Bridges National Monument—were set aside specifically to protect impressive examples. Many other regions of the country boast natural arches. In the eastern United States, the Red River Gorge in Kentucky contains a large collection of arches. The Natural Bridge of Virginia, one of the most famous natural arches in the country, was once owned by Thomas Jefferson. And Ohio, with more than eighty recorded arches, has its share of these fascinating geologic features. Even though natural arches may not be as rare as most people think, they still have the power to inspire in us a sense of wonder.

What is an arch?

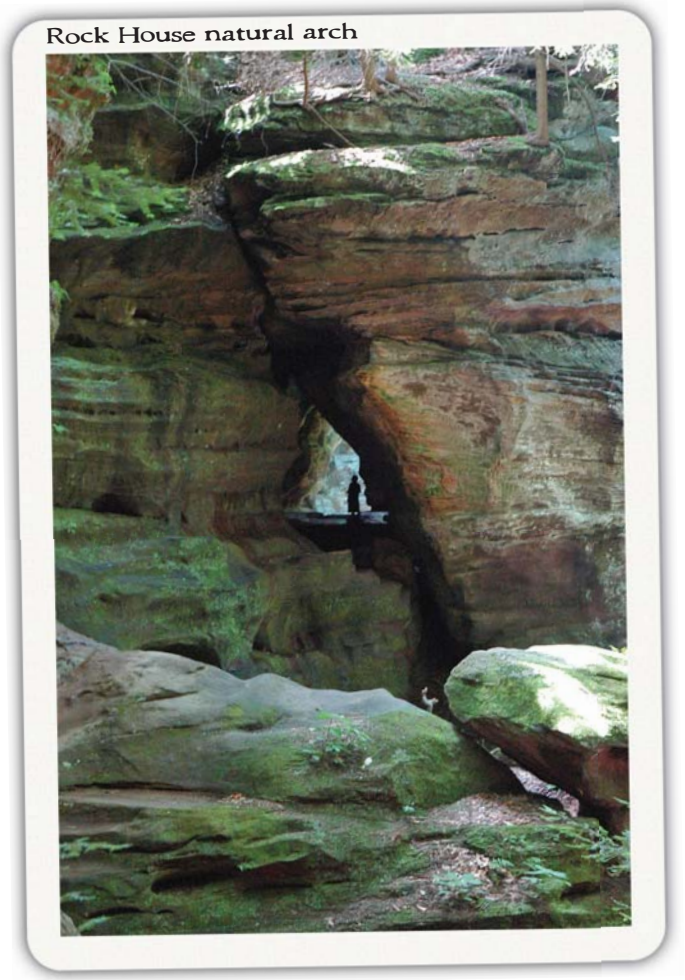
According to the Natural Arch and Bridge Society, a *natural arch* is defined as "a rock exposure with a hole completely through it, created by the natural removal of some of the rock to leave an intact rock frame around the hole"—a definition that eliminates openings formed solely by rock movement, such as when two slump blocks lean against each other. If the resulting arch crosses a valley of erosion (that is, a stream channel), the arch also is considered to be a *natural bridge*. If the width of the arch is greater than three times its span, it is classified as a *natural tunnel*. Natural bridges and natural tunnels are types of natural arches.

The opening of an arch—the hole through the rock—creates the arch and determines its significance. The size of the opening is the most important factor. In order to compare arches, two measurements are required: the longest horizontal dimension of the opening (the *span*) and the longest vertical dimension (the *clearance*). The remnant of bedrock defining the top of the opening is called the *lintel* and is what most people picture when they





Elements of a natural arch.



think of a natural arch. The lintel's length is determined by the span of the opening, which creates the most striking feature of a natural arch—its defiance of gravity. The bedrock remnants on either side of the opening, holding up the lintel, are called *abutments*. All natural arches have at least two of them, although arches with multiple openings, such as Rock House in Hocking County, will have more.

Of course, a multitude of holes—ranging in size from the barely visible to the impressive—have formed in the bedrock of Ohio, all of them meeting the definition of a natural arch. Whether or not an opening will be considered significant enough to warrant listing as an arch is determined by its size, as defined by its span and clearance. For a natural arch to be considered significant in Ohio, its opening must have a span or clearance that extends at least three feet with the other dimension extending at least one foot. While this might seem an especially generous interpretation of significance, it is, in fact, stricter than that used in Arches National Park in Utah, where any opening large enough to allow a three-feet long bar to pass through is considered significant.

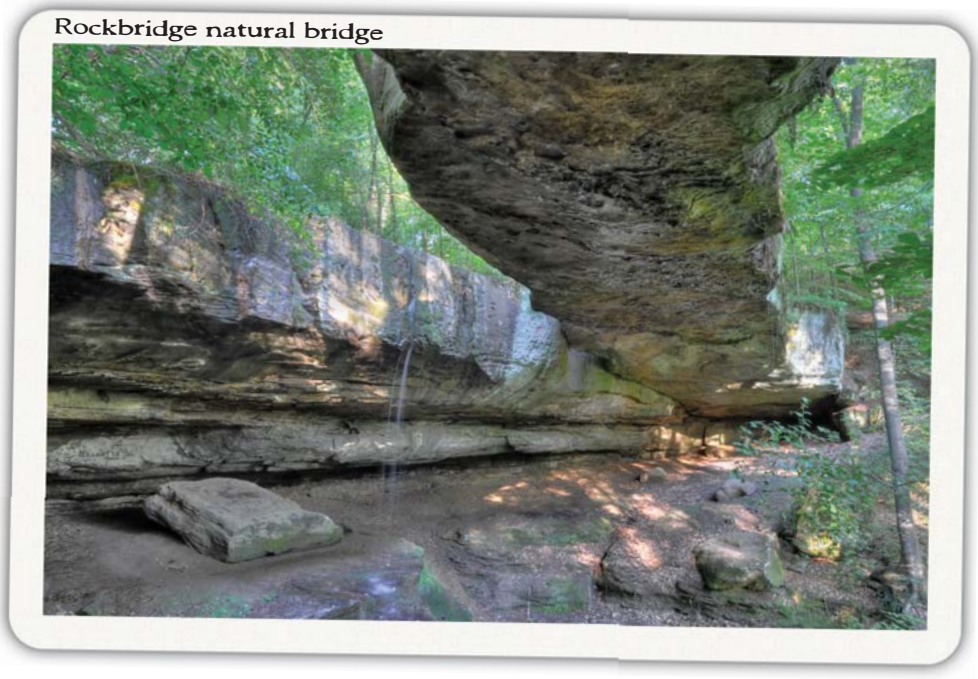
Geology of an Arch

Once the initial surprise at seeing a natural arch passes, the question of how it might have formed asserts itself. Ohio's known arches have formed in six different ways, which also serve to categorize them. *Breeched alcove arches* result when the roof of an alcove partially collapses, leaving the front edge of the alcove intact as a lintel. Rockbridge, in Hocking County, is Ohio's finest example. A vertical crevice through a wall of rock can be enlarged through weathering to create a *vertical crevice arch* that is usually tall and narrow, such as that of The Keyhole in Highland County. The union of a vertical crevice paralleling a cliff and a horizontal bedding plane can be enlarged into an L-shaped opening to form a *joint and bedding plane arch*, such as Ladd Natural Bridge in Washington County; these are usually found at the face of a waterfall. Where weakly-cemented parts of a bedrock layer are removed by erosion from around more strongly cemented portions, a *bedrock texture remnant arch*, such as Spring Creek Arch in Highland County, may result. Trimmer Arch, in Ross County, is a fine example of an *opened bedding plane arch* in which multiple horizontal bedding planes allow the removal of rock. A cavern with multiple openings forms a *collapsed cave arch*, especially if the openings occur close together. Although very common in other parts of the country, this type of natural arch is rare in Ohio.

Natural arches are not found everywhere in the United States, and the same holds true in Ohio. For a natural arch

to form, some specific conditions must first be met. Among the most important are (1) the presence of consolidated bedrock strong enough to span an opening and (2) enough topographic relief to contain it. These two conditions are often interdependent, since strong bedrock resists erosion to form cliffs and hills, which provide the necessary topographic relief. The bedrock also must be permeable, providing a path for water movement through it. These paths may take the form of vertical joints, horizontal bedding planes, interconnected pores, or areas subject to chemical dissolution by water as either liquid or vapor. The slow enlargement of these pathways by the erosive action of water creates the openings that form an arch.

Many bedrock layers in Ohio are capable of forming natural arches, but because of their characteristic texture and exposure, some strata are more productive than others. In southwestern Ohio the Silurian-age Peebles Dolomite is especially notable in this regard, containing twenty-seven reported arches. In eastern Ohio the Mississippian-age Black Hand Sandstone holds nineteen reported arches, many of them in the Hocking Hills region. The Pennsylvanian-age Sharon Formation contains seven reported arches. The remaining known arches are found in various rock units ranging from Silurian to Permian in age. None have yet been reported from Ohio's Ordovician strata, which consists mainly of thin layers of shale and limestone that are apparently too weak to form sizeable arches.


Rockbridge natural bridge

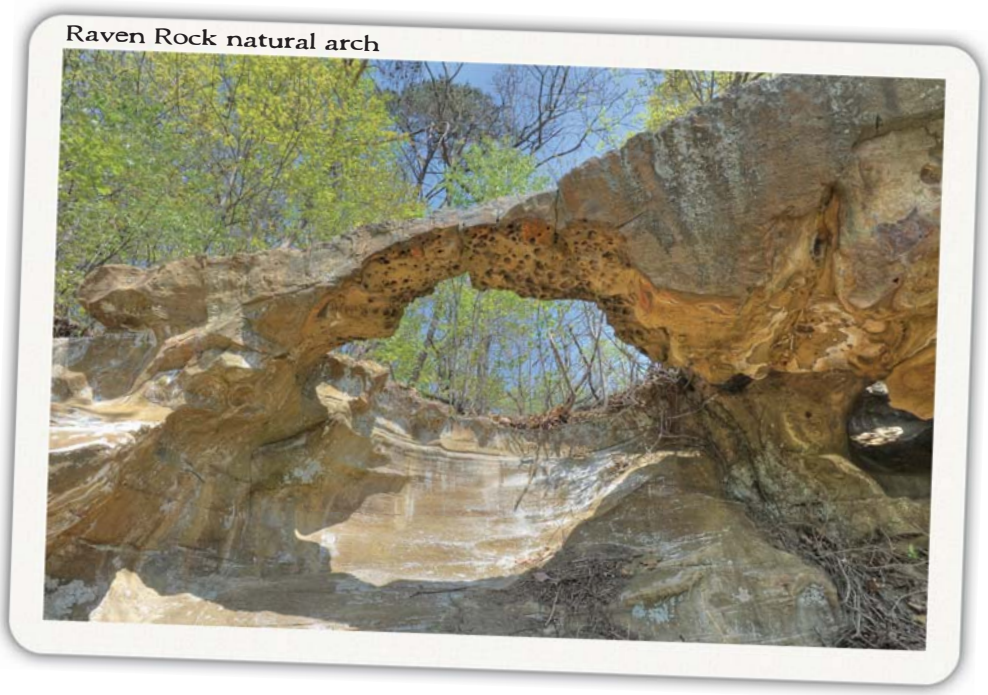
All of Ohio's known natural arches are found in the southern and eastern parts of the state, where bedrock hills provide the required conditions. None are located in flat, northwestern Ohio, where the level bedrock is covered by glacial drift. The only exceptions are found along the Lake Erie shore, where parts of the Marblehead Peninsula and the islands have been cut into low cliffs by wave action.

How old are Ohio's natural arches?

The process of eroding an opening through bedrock to form a natural arch takes an incredible amount of time, proceeding grain-by-grain and even molecule-by-molecule. From our human perspective, these features are unchanging and extremely old. However, in geo-logic terms most, if not all, of Ohio's natural arches are actually quite young. Two thirds of the state was covered by continental glaciers during the Quaternary Period—not once, but several times. During each advance, the ice destroyed or covered with glacial debris any arches that may then have existed. Arches now found in formerly glaciated areas could only have begun forming after the retreat of the last glacier that affected the areas in which they are located. For most of the state, that would have been the Wisconsinan glaciation, which began its retreat approximately 14,000 years ago.

Natural arches found in the unglaciated part of the state may be older, but even here many of them are found in gorges cut by drainage systems diverted by the advancing ice or by glacial meltwater streams. Even those arches appearing to be some distance from meltwater drainage or diverted streams are often found to be dependent on topographic relief created by headwater streams incising their courses into the underlying bedrock in response to the lowered base level created by glacially-influenced master streams, most notably the Ohio River. Because of this, it is doubtful that any natural arch in Ohio was formed earlier than the beginning of the Quaternary period, 1.6 million years ago. Most are considerably younger.

A Sampling of Ohio's Natural Arches


Raven Rock natural arch

Most of Ohio's natural arches are privately owned, but some of the largest and most interesting fortunately have been made accessible to the public. Rock House, part of Hocking Hills State Park, is Ohio's most unusual arch. With a span of 20 feet, a clearance of 40 feet and a length of 185 feet, it is not only our largest natural arch but also our longest natural tunnel. At 92 feet, our longest natural bridge is Rockbridge, protected in Rockbridge State Nature Preserve. Both Rock House and Rockbridge have formed in the Mississippian-age Black Hand Sandstone of eastern Ohio, but the calcareous bedrock of western Ohio also has its share of these features. In fact, the largest concentration of natural arches at one site in the state is found in the gorge of Baker Fork, much of which is protected within Fort Hill State Memorial. Cut into Silurian-age Peebles Dolomite, this gorge contains seven arches, including The Keyhole, a natural tunnel 77 feet long and easily seen from the trail. Natural Y Arch, with its multiple openings, and Spring Creek Arch are also readily visible.

Ladd Natural Bridge, one of Ohio's more spectacular arches, was formed on the edge of a cliff in Permian-age sandstone by water from an ephemeral waterfall seeping into a vertical joint behind the falls and then out the face of the cliff through a horizontal bedding plane. Flowing water eventually eroded the crevices enough to capture the entire flow of the tiny stream, leaving the brink of the cliff suspended as a natural bridge. Irish Run Natural Bridge, a more massive example located in Wayne National Forest (Washington County), was formed in much the same way.

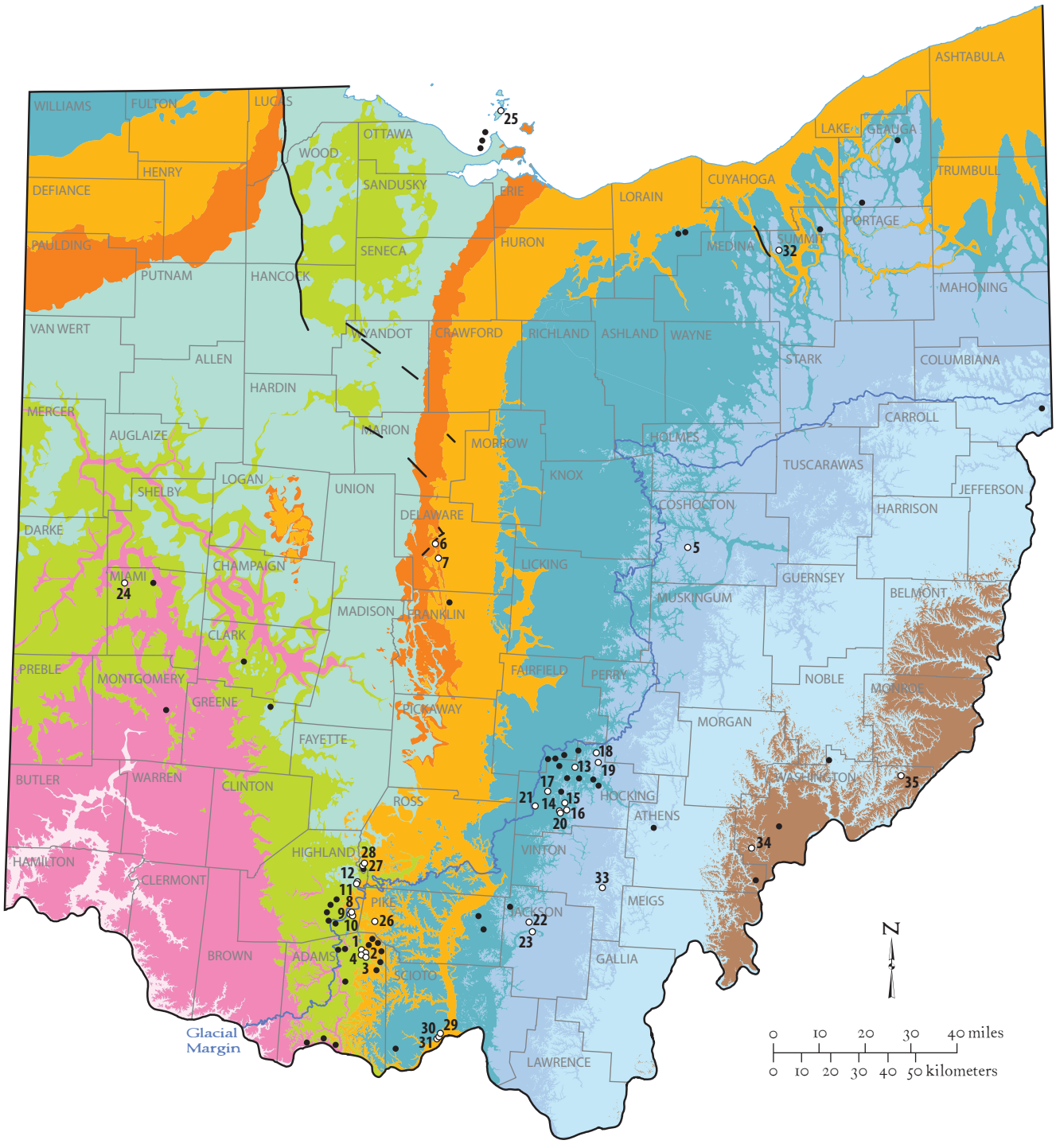
Although much smaller, Raven Rock Arch, in Scioto County, has a spectacular location at the top of a bluff, 500 feet above the Ohio River. Like Ladd Natural Bridge, it formed on the brink of a cliff, but in this case moisture in the air dissolved weakly cemented Mississippian-age sandstone on the underside of a ledge to form a dome that eventually broke through the surface, leaving the edge of the cliff face remaining as a narrow lintel.

The opening of Trimmer Arch (see cover image) formed in the Silurian-age Greenfield Dolomite, which is broken by closely-spaced bedding planes. Located in a narrow tongue of rock marking the junction of two streams, it is the best example of a classic, round-topped arch to be found in Ohio. The Needle's Eye, found on a point of Gibraltar Island in Lake Erie, is the most famous of our sea (or more correctly, lake) arches. Pictured in tourist guides as early as the late 1800s, it has long been a popular attraction. Ohio even has underground arches. For example, Olentangy Arch and Leatherlips Arch are located in Olentangy Caverns, a commercial cave in Delaware County.

The Future of Ohio's Natural Arches

Although natural arches might appear to be permanent features of the landscape, geologically they are ephemeral creations. The same processes that form them eventually destroy them. Once a lintel becomes too thin to hold up its own weight or experiences some other structural failure, the arch collapses. Within a relatively short time, erosion will break the remnants into rubble and all traces of a once interesting feature will disappear. The most readily visible remains of a possible fallen natural arch lie at the base of Ladd Natural Bridge, where several large slump blocks lying in line across the narrow

Natural Arch Locations and Bedrock Geology



Explanation

- Private arch
- 35 Public arch, number corresponds to key on right
- Permian-Pennsylvanian
- Pennsylvanian
- Mississippian
- Devonian
- Silurian
- Ordovician
- Fault

Ohio's Publicly Accessible Natural Arches

Key

N.F. = National Forest S.F. = State Forest S.M. = State Memorial S.N.P = State Nature Preserve
S.P. = State Park S.S.R.A. = State Scenic River Area W.A. = Wildlife Area

No.	Name	Span	Clearance	Category	Age and Formation	County	Access*	Coordinates
1	Cedar Fork Arch	6.5 ft (2.0 m)	14 ft (4.3 m)	Bedrock Texture Remnant	Silurian age Peebles Dolomite	Adams	Shoemaker S.N.P. – Off-trail permit required	Provided with permit
2	Mattress Arch	3 ft (0.9 m)	2 ft (0.6 m)	Bedrock Texture Remnant	Silurian age Peebles Dolomite	Adams	Shoemaker S.N.P. – Off-trail permit required	Provided with permit
3	Crawl Arch	9 ft (2.7 m)	5 ft (1.5 m)	Bedrock Texture Remnant	Silurian age Peebles Dolomite	Adams	Shoemaker S.N.P. – Off-trail permit required	Provided with permit
4	Blocked Arch	7 ft (2.1 m)	5 ft (1.5 m)	Bedrock Texture Remnant	Silurian age Peebles Dolomite	Adams	Shoemaker S.N.P. – Off-trail permit required	Provided with permit
5	Woodbury Natural Bridge	5 ft (1.5 m)	2.2 ft (0.7 m)	Breeched Alcove (Vertical Crevice)	Pennsylvanian age Putnam Hill Limestone	Coshocton	Woodbury W.A. – Open to public	40°16′43.86″N 82° 2′8.28″W
6	Olentangy Caverns Arch	2.25 ft (0.7 m)	3.0 ft (0.9 m)	Bedrock Texture Remnant	Devonian age Delaware Limestone	Delaware	Contact Olentangy Indian Caverns – Fee required	40°11′31.44″N 83° 3′45.18″W
7	Leatherlips Arch	1.6 ft (0.5 m)	5.25 ft (1.6 m)	Bedrock Texture Remnant	Devonian age Delaware Limestone	Delaware	Contact Olentangy Indian Caverns – Fee required	40°11′31.44″N 83° 3′45.18″W
8	Natural Y Arch	29 ft (8.8 m)	5 ft (1.5 m)	Bedrock Texture Remnant	Silurian age Peebles Dolomite	Highland	Fort Hill S.M. – Open to public	39° 6′57.78″N 83°24′42.36″W
9	The Keyhole	2 ft (0.6 m)	35 ft (10.7 m)	Vertical Crevice Enlargement	Silurian age Peebles Dolomite	Highland	Fort Hill S.M. – Open to public	39° 6′34.80″N 83°24′49.56″W
10	Spring Creek Arch	18 ft (5.5 m)	5 ft (1.5 m)	Bedrock Texture Remnant	Silurian age Peebles Dolomite	Highland	Fort Hill S.M. – Open to public	39° 6′19.14″N 83°24′27.60″W
11	Miller Natural Bridge	46 ft (14.0 m)	3.5 ft (1.1 m)	Joint-Bedding Plane Enlargement	Silurian age Peebles Dolomite	Highland	Miller Nature Sanctuary – Access permit required	Provided with permit
12	Miller Arch	9.5 ft (2.9 m)	5 ft (1.5 m)	Bedrock Texture Remnant	Silurian age Peebles Dolomite	Highland	Miller Nature Sanctuary – Access permit required	Provided with permit
13	Rockbridge	92 ft (28 m)	40 ft (12.2 m)	Breeched Alcove	Mississippian age Black Hand Sandstone	Hocking	Rockbridge S.N.P. – Open to public	39°34′35.88″N 82°30′6.84″W
14	Balcony Natural Bridge	11 ft (3.3 m)	17.5 ft (5.5 m)	Breeched Alcove	Mississippian age Black Hand Sandstone	Hocking	Hocking S.F. – Open to public	39°25′42.00″N 82°33′56.04″W
15	Unger Hollow Arch	24 ft (7.3 m)	6 ft (1.8 m)	Breeched Alcove	Mississippian age Black Hand Sandstone	Hocking	Hocking S.F. – Open to public	39°27′15.06″N 82°32′43.50″W
16	Old Man's Pantry	20 ft (6.1 m)	3.7 ft (1.1 m)	Bedrock Texture Remnant	Mississippian age Black Hand Sandstone	Hocking	Hocking Hills S.P. – Open to public	39°26′6.06″N 82°32′25.62″W
17	Rock House	185 ft (56 m)	25 ft (7.6 m)	Enlarged Vertical Crevice	Mississippian age Black Hand Sandstone	Hocking	Hocking Hills S.P. – Open to public	39°29′51.90″N 82°36′50.52″W
18	Saltpetre Cave	11.8 ft (3.6 m)	7.5 ft (2.3 m)	Bedrock Texture Remnant	Mississippian age Black Hand Sandstone	Hocking	Saltpetre Cave S.N.P. – Access permit required	Provided with permit
19	Surprise Arch	15.5 ft (4.7 m)	1.9 ft (0.6 m)	Breeched Alcove	Mississippian age Black Hand Sandstone	Hocking	Saltpetre Cave S.N.P. – Access permit required	Provided with permit
20	Three-Hole Arch	3.5 ft (1.1 m)	1.8 ft (0.5 m)	Bedrock Texture Remnant	Mississippian age Black Hand Sandstone	Hocking	Hocking S.F. – Open to public	39°25′39.36″N 82°33′57.00″W
21	Annex Arch	5.6 ft (1.7 m)	2.6 ft (0.8 m)	Bedrock Texture Remnant	Mississippian age Black Hand Sandstone	Hocking	Hocking Hills S.P. – Open to public	39°29′51.43″N 82°36′47.05″W
22	Lake Katharine Arch	15 ft (4.6 m)	2 ft (0.6 m)	Breeched Alcove	Pennsylvanian age Sharon Formation	Jackson	Lake Katharine S.N.P. – Off-trail permit required	Provided with permit
23	Peephole Arch	3 ft (0.9 m)	22 in (55.9 cm)	Bedrock Texture Remnant	Pennsylvanian age Sharon Formation	Jackson	Lake Katharine S.N.P. – Off-trail permit required	Provided with permit

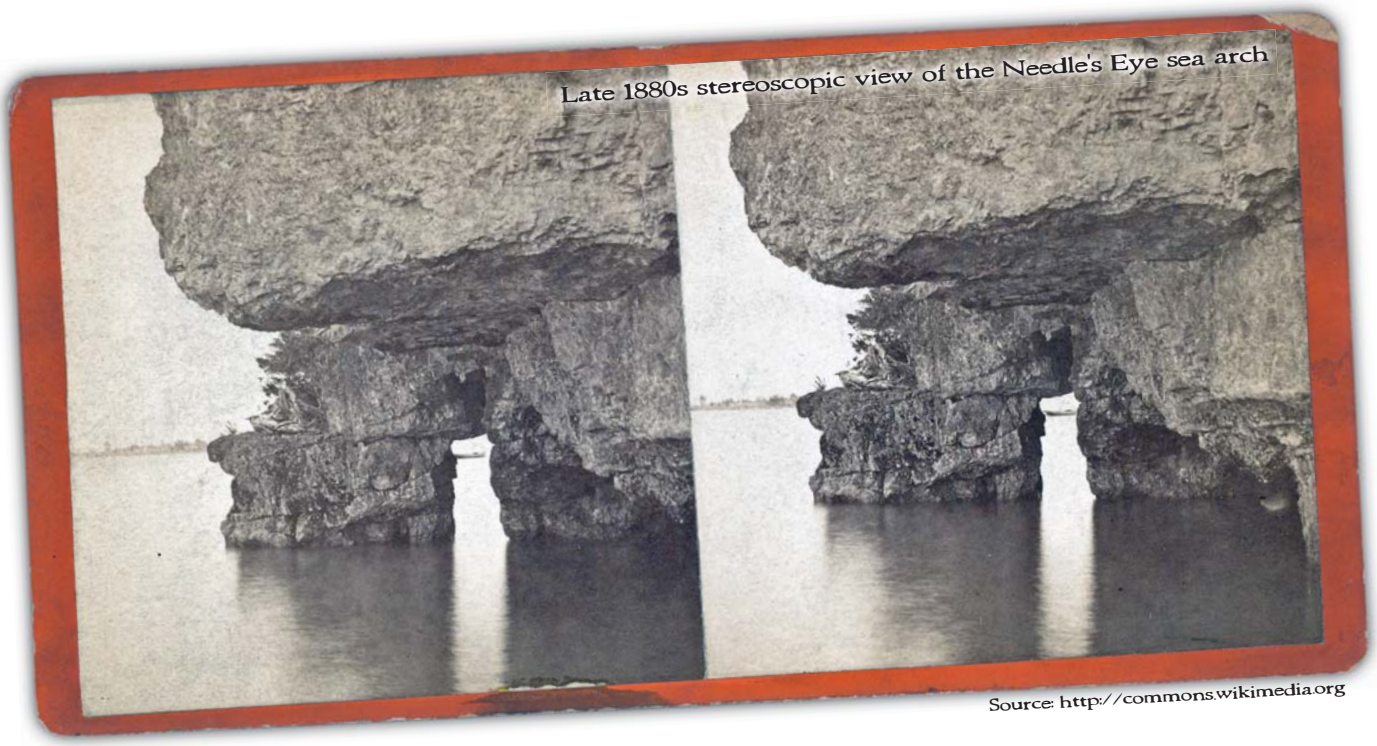
—continued on page 7

24	Greenville Falls Arch	22 ft (3.3 m)	4 ft (1.2 m)	Joint-Bedding Plane Enlargement	Silurian age Cedarville Dolomite	Miami	Greenville Falls S.S.R.A. – Open to public	•40°6′34.12″N 84°22′ 33.46″W
25	Needle's Eye	3 ft (0.9 m)	9.5 ft (2.7 m)	Vertical Crevice Enlargement	Silurian age Salina Group dolomite	Ottawa	Contact Ohio State University, Stone Lab	•41°39′30.00″N 82°49′08.00″W
26	Lions Den Arch	9.5 ft (2.9 m)	4.75 ft (1.4 m)	Bedrock Texture Remnant	Silurian age Tymochtee/Greenfield Dolomite	Pike	Contact Cave Lake Center for Community Leadership	•39° 5′27.41″N 83°20′14.53″W
27	Trimmer Arch	14.0 ft (4.6 m)	8.6 ft (2.6 m)	Bedding Plane Enlargement	Silurian age Greenfield Dolomite	Ross	Paint Creek W.A. – Open to public	39°17′40.74″N 83°22′22.26″W
28	Skull Cave Arch	7.9 ft (2.4 m)	3.6 ft. (1.1 m)	Cave Collapse	Silurian age Greenfield Dolomite	Ross	Paint Creek W.A. – Open to public	39°17′41.86″N 83°22′20.00″W
29	Raven Rock Arch	15 ft (4.6 m)	7 ft (2.1 m)	Bedrock Texture Remnant	Mississippian age sandstone	Scioto	Raven Rock S.N.P. – Access permit required	Provided with permit
30	Rockgrin Arch	5 ft (1.5 m)	1.25 ft (0.4 m)	Bedrock Texture Remnant	Mississippian age sandstone	Scioto	Raven Rock S.N.P. – Access permit required	Provided with permit
31	Slide Arch	3.6 ft (1.1 m)	5 ft (1.5 m)	Bedrock Texture Remnant	Mississippian age sandstone	Scioto	Raven Rock S.N.P. – Access permit required	Provided with permit
32	Camp Christopher Natural Bridge	5 ft (1.5 m)	20 ft (6.1 m)	Vertical Crevice Enlargement	Pennsylvanian age Sharon Formation	Summit	Contact Akron CYO and Community Services	•41°11′20.54″N 81°40′ 2.74″W
33	Arch Rock	9.7 ft (3.0 m)	8.25 ft (2.5 m)	Bedrock Texture Remnant	Pennsylvanian age Conemaugh Group sandstone	Vinton	Contact ODNR Division of Forestry	39°11′26.22″N 82°22′17.82″W
34	Ladd (Big) Natural Bridge	40 ft (12.2 m)	17 ft (5.2 m)	Breeched Alcove (Vertical Crevice)	Permian/Pennsylvanian age Hockingport Sandstone Lentil	Washington	Ladd S.N.P. – Access permit required	Provided with permit
35	Irish Run Natural Bridge	22 ft (6.7 m)	5 ft (1.5 m)	Breeched Alcove (Vertical Crevice & Collapse)	Permian/Pennsylvanian age Dunkard Group sandstone	Washington	Wayne N.F. – Open to public	39°30′51.42″N 81°10′50.40″W

*This list does not convey permission to visit privately owned sites or restricted areas of publicly owned sites. Proper permission and any required permits must be obtained before visiting. Please contact the appropriate agency, business, or land owner in advance (see list on page 8).

•Coordinates are approximate.

•Coordinates are approximate and represent entry point for this location.



Contact List

Akron CYO and Community Services
812 Biruta Street
Akron, OH 44307
(330) 762-2961
(330) 376-2267 Camp Christopher
http://ccdocle.org/camp-christopher

Cave Lake Leadership Center
1132 Bell Hollow Road
Latham, OH 45646
(937) 588-3252
cavelake@hi-y.org
http://www.hi-y.org

Franz Theodore Stone Laboratory
P.O. Box 119
878 Bayview Drive
Put-in-Bay, OH 43456
(419) 285-1800
http://stonelab.osu.edu/

Miami County Park District
2645 East State Route 41
Troy, OH 45373
(937) 335-6273
http://www.miamicountyparks.com/

Ohio Department of Natural Resources Division of Forestry
2045 Morse Road, Bldg. H-1
Columbus, OH 43229
1-877-247-8733; (614) 265-6694
http://forestry.ohiodnr.gov

Ohio Department of Natural Resources Division of Geological Survey
2045 Morse Road, Bldg. C-1
Columbus, OH 43229
(614) 265-6576
http://www.OhioGeology.com

Ohio Department of Natural Resources Division of Natural Areas and Preserves
2045 Morse Road, Bldg. C-3
Columbus, OH 43229
(614) 265-6561
http://dnap.ohiodnr.gov

Ohio Department of Natural Resources Division of Wildlife
2045 Morse Road, Bldg. G
Columbus, OH 43229
1-800-WILDLIFE (945-3543); (614) 265-6300
http://wildlife.ohiodnr.gov

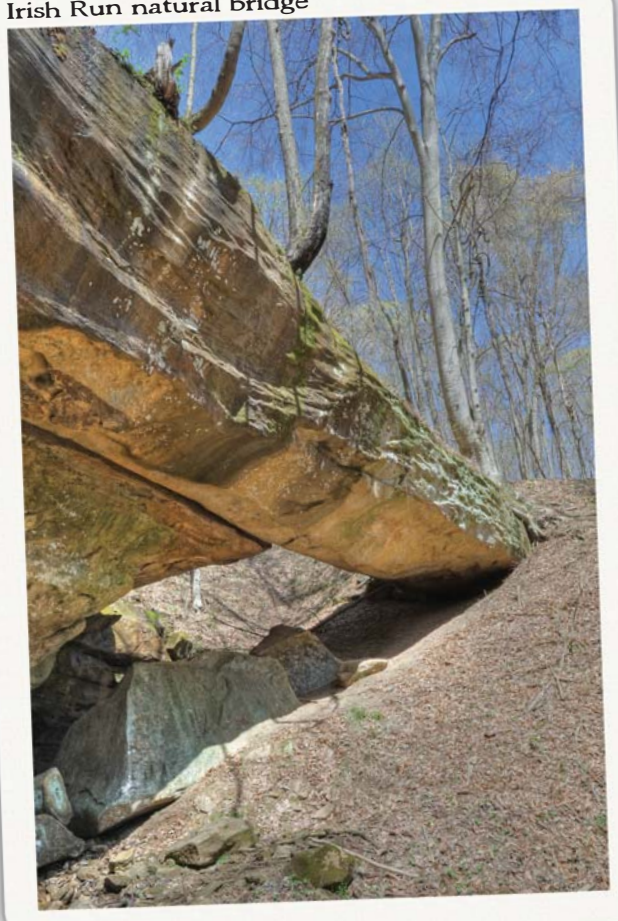
Ohio Historical Society
1982 Velma Avenue
Columbus, OH 43211
1-800-686-6124; (614) 297-2300
http://www.ohiohistory.org

Ohio State Parks
2045 Morse Road, Bldg. C-3
Columbus, OH 43229
1-866-OHIOPARKS (644-6727); (614) 265-6561
http://parks.ohiodnr.gov

Olentangy Indian Caverns
1779 Home Road
Delaware, OH 43015
(740) 548-7917
http://www.olentangyindiancaverns.com

Wayne National Forest
13700 U.S. Highway 33
Nelsonville, OH 45764
(740) 753-0101
http://www.fs.usda.gov/wayne/

Irish Run natural bridge



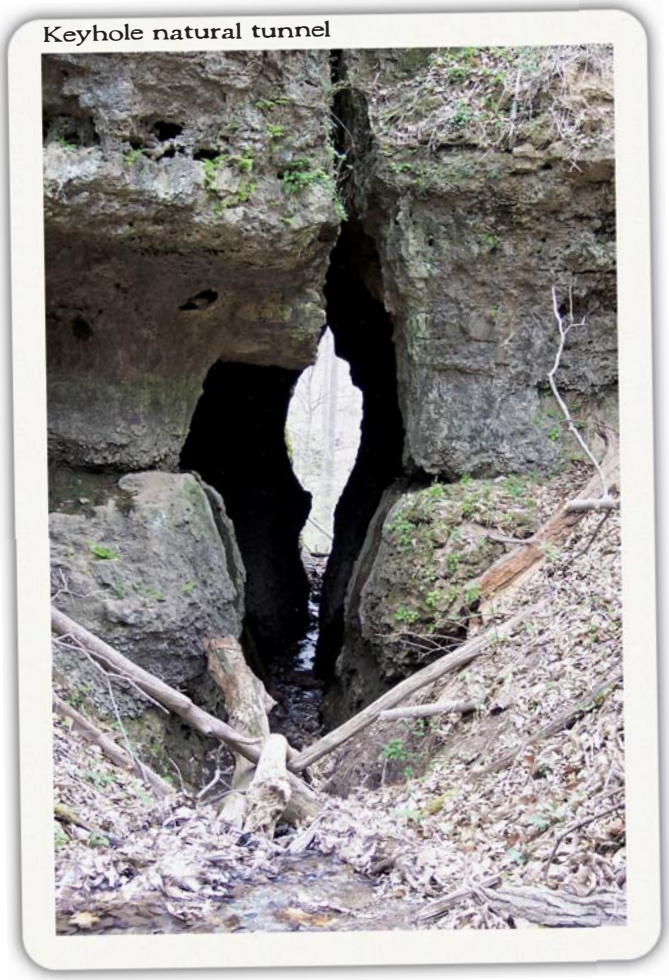
valley may be all that remains of another natural arch that once existed beneath the present one.

Though we may regret losing arches through natural causes, it is downright distressing to see them destroyed by human actions. Like most other natural features, arches are subject to our whims. Construction activities, quarrying, and road building have all reduced natural arches to rubble in other parts of the country. Mansfield Natural Bridge in neighboring Indiana is a sad example. This scenic natural arch was blasted to bits as part of a quarrying operation in advance of the construction of a dam which, as it happened, was never built. Such a tragedy could easily happen in Ohio. Only through the efforts of concerned citizens will these fascinating examples of Ohio's geology remain for future generations to experience and enjoy.

To date, 86 natural arches have been recorded in Ohio, and there are almost certainly more to be found. If you know of any such feature(s) that may qualify for listing, please contact:

ODNR Division of Geological Survey
2045 Morse Road, Bldg. C-1
Columbus, Ohio 43229
(614) 265-6576
geo.survey@dnr.state.oh.us

If possible, please have ready an estimate of the size of the arch's opening, as precise a location as possible, and the property owner's contact information. A picture would also be useful.


Keyhole natural tunnel

Further Reading

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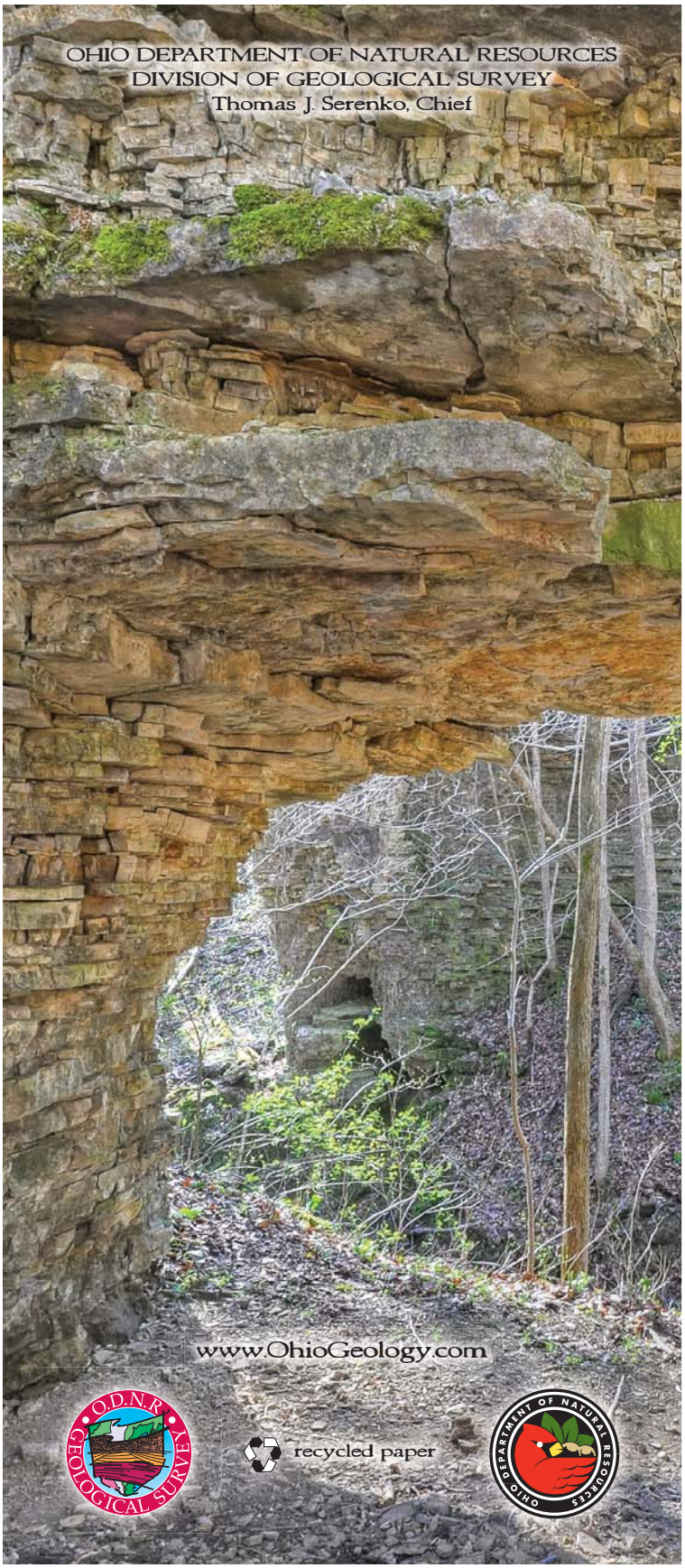

Web Sites

The Natural Arch and Bridge Society—Features a gallery of images, a GIS catalog of arches, formation & classification information, links, and more: **www.naturalarches.org**.

Ohio Department of Natural Resources, Division of Natural Areas and Preserves, "Ohio's Natural Arches"—A short list of publicly accessible natural arches in the state with photographs and brief, detailed descriptions of each: **http://dnap.ohiodnr.gov/natural-features-of-ohio/geologic-features/natural-arches**.

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About the Author

Tim Snyder worked for the Ohio Department of Natural Resources for 25 years, mostly with the Division of Natural Areas and Preserves as a district manager responsible for state preserves and scenic river lands in west-central Ohio. He has studied Ohio's natural arches for more than 25 years and continues to do so today.

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