OHIO GEOLOGY

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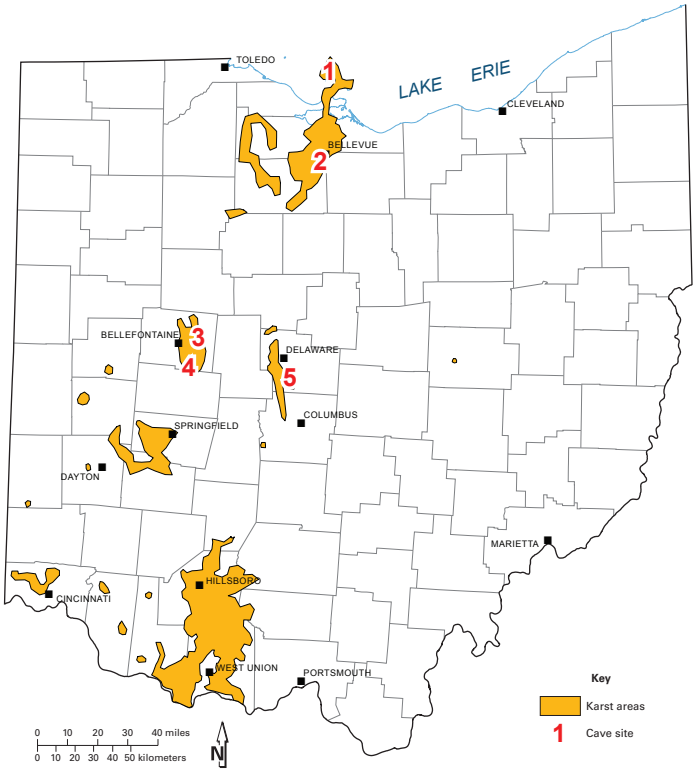
OHIO DEPARTMENT OF NATURAL RESOURCES • DIVISION OF GEOLOGICAL SURVEY

OHIO KARST

Karst is a little-known but unique and important landform that can be found throughout the state of Ohio. Regions that contain sinkholes and other solutional features, such as caves, springs, disappearing streams, and enlarged fractures, are known as *karst terrains*. Sinkholes form as bedrock dissolves and surface materials erode or collapse into the resulting voids. Sinkholes are the main hazard associated with karst landforms in Ohio, and there are thousands of them in the state.

Karst features form in carbonate rocks—limestone and dolostone—that are soluble in soil acid and carbonic acid (an acid that forms as rain and CO_2 mix). Karst may also develop in evaporites including halite (salt) and gypsum. When water drains into it, a sinkhole likely will grow over time, since the water carries away or dissolves material. A stream that is captured by and drains into a sinkhole is known as a *disappearing stream* or *sinking stream*. The water that flows into and through karst systems continues to enlarge fractures which eventually become caves. As water moves through a karst system, it may reemerge at the land surface, forming a spring.

While there are about 200 solutional caves in the karst of Ohio, only a few are open to the public: Crystal Cave, Ohio Caverns, Olentangy Indian Caverns, Perry's Cave, Seneca Caverns, and Zane Shawnee Caverns. Many other caves are found on private property or have been closed to restrict the spread of white-nose syndrome, which has been killing bats throughout North America, and to protect other sensitive cave species. Other caves preserve Native American artifacts and the bones of extinct animals. Animals can become trapped in steep-sided sinkholes or pit caves; for example, Sheriden Cave in Wyandot County contains fossilized skeletons of short-faced bear and giant beaver.



Map of Ohio showing known karst areas. The densest areas are represented by the orange areas shown running north to south through central Ohio: Highland County and south into Adams and Brown Counties; Erie, Huron, Sandusky, and Seneca Counties; and Delaware and Franklin Counties. Publically accessible caves: (1) Crystal Cave and Perry's Cave, (2) Seneca Caverns, (3) Zane Shawnee Caverns, (4) Ohio Caverns, and (5) Olentangy Indian Caverns.

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The majority of Ohio's karst features are formed in carbonates by dissolution. However, many of the features on the Bass Islands of Lake Erie and around Bellevue in northern Ohio are also influenced by evaporites; this is especially evident in the caves of the Bass Islands, which are formed around the perimeter of a collapse dome created by the alteration of gypsum into anhydrite.

In general, the western half of Ohio is dominated by thick limestones and dolostones, while the eastern half is primarily shale, sandstone, and some thin carbonates. Therefore, karst is found primarily in the western half of the state where the rocks are susceptible to dissolution. Karst features in Ohio occur in specific formations, including the Devonian Columbus and Delaware Limestones in central and northern Ohio; the Silurian Salina Group (dolomite) and Lockport Dolomite in northern Ohio; the Silurian Cedarville and Springfield Dolomites in central-western Ohio; and the Silurian Peebles, Lilley, and Bisher Dolomites in southern Ohio. Some documented karst features are found in the more massive Ordovician limestones in southwestern and south-central Ohio. Occasionally, karst features are reported in eastern Ohio, though little is known about these.

Another factor besides bedrock lithology that controls the surface expression of karst is the thickness of the glacial till (drift) that lies on top of the bedrock. When the bedrock is buried beneath more than about 25 ft of glacial material, sinkholes are not expressed at the land surface. This is for one of two reasons: either the glacial material has isolated the bedrock from dissolution or any pre-glacial voids were in-filled and have not had time to dissolve or wash out and thus collapse further.

RISKS ASSOCIATED WITH KARST

Knowing the locations of surficial karst features is important for many reasons. For example, sinkholes are a direct conduit to the water table and thus are a high risk for pollution. In a non-karst area, the surficial soil and rock layers filter or slow contaminants. Conversely, sinkholes funnel water and contaminants directly into the water table. Surface contaminants, such as excess field fertilizer, drain into sinkholes and are often re-expressed at the land surface from springs. It is common to see springs with algae and watercress blooms fed by high concentrations of fertilizer in the water. Houses with a water well in a karst area also have a high risk of surficial contamination from anything that enters a sinkhole, including *E. coli* (dead deer are commonly disposed of in sinkholes), fertilizer, pesticide, and other waste.

Karst features may pose a threat to current or future infrastructure, including roads, railways, pipelines, foundations, and other structures, thus knowing the locations of karst features

continued

is important for planning purposes. In general, Ohio sinkholes are relatively slow growing and, except in the densest and most active areas, only deepen or widen a few inches per year. Most sinkholes have been present in their current locations for as long as anyone can remember and likely thousands of years. In rural settings, farmers often allow areas of fields with sinkholes to remain wooded and unfarmed; this prevents erosion and limits growth of sinkholes. On the other hand, many sinkholes have storm runoff or field drainage directed into sinkholes; this is a sure way to encourage karst development and sinkhole growth as moving water carries away loose material and exposes rock to continued dissolution.

In unusually high rainfall conditions, typical sinkhole drainage can reverse and cause flooding. This happened in Bellevue, Ohio, in 2009 when the water table rose above the land surface in many sinkholes and low areas. The well-developed karst in Bellevue results in a distinct lack of surficial drainage. Without streams to drain water away, the 2009 flooding was extensive and persistent, blocking many roads and flooding basements.

Subsurface karst is present in Ohio and can be a construction concern. For example, karst can be filled with sticky clay that is difficult to drill or tunnel through. Karst is also a source of secondary porosity and can lead to unexpected water input in subsurface excavations and to loss of water on the surface, a significant problem in a reservoir. Geothermal systems can also be influenced by karst when there is more subsurface connectivity than otherwise expected. Karst is an important consideration during the planning phase of a building project.

This small sinkhole, which was located in 2014 in Seneca County, is about 3 feet deep, 85 feet from the house, and 710 feet from the next closest verified sinkhole. The cone-shaped collapse is typical of many Ohio sinkholes and will continue to grow slowly over time. It is unlikely that this sinkhole will affect the house, but its formation is tied to a network of bedrock fractures that allows for the formation of new sinkholes throughout the area.

MAPPING OHIO KARST

In light of these concerns, the Ohio Geological Survey has been field mapping karst regions of Ohio since 2009. Completed projects include karst areas in the vicinities of Delaware, Springfield, Bellevue, and Hillsboro. These features are initially identified remotely using historic data sets (e.g., soil surveys and previous mapping projects), aerial photography, and a digital elevation map produced using LiDAR (Light Distance and Ranging) data. LiDAR data is processed to identify potential depressions (sinkholes). Potential sinkholes are then field checked to differentiate naturally formed sinkholes from other natural or human-induced depressions. Features that are not karst related (false positives), include old house foundations, cisterns, broken field tiles, uprooted trees, steep-sided stream banks, and breached ponds. Field checking is also beneficial for locating other karst features, such as springs, caves, small depressions, and recently formed features, which don't appear on LiDAR. Old mine collapses can appear similar to naturally formed sinkholes; however, most mines in Ohio occur in the shales and sandstones of eastern Ohio and can be distinguished by the bedrock.

Through 2015, the number of karst features—including verified, suspect, and unverified—mapped in Ohio is about 5,700. This number will change as false positives are identified and removed and as unknown sinkholes are located, especially in southern Ohio. Of the 5,700 total suspect or known karst points, 1,800 points have been field verified as karst, along with more than 100 springs. The Survey records, catalogs, and classifies these features and provides the data to interested parties, including public and private land-holders; engineering and construction companies; and local, state, and federal agencies.

The Survey produces detailed map books for specific parts of the state, along with GIS data, metadata, LiDAR depressions, and photographs of many of the features. The GIS data contains the location of each point and a description of what was found there. The metadata provides information on the sources and quality of the data used. The LiDAR depressions layer records the depth and area for many of the sinkholes. In addition, the collection of photographs captured for many of these features can be used to monitor the growth of preexisting sinkholes and development of new karst features, as well as assisting in identification. Identification is important because karst regions are highly susceptible to pollution, and structures built near them may subside. The maps and data allow areas of land development near karst features to be better planned and maintained.

ACKNOWLEDGMENT

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FURTHER READING

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