Ohio Geology

Ohio Department of Natural Resources, Division of Geological Survey • 2008, No. 1

# How oceans, rivers, and glaciers created the geology of the Dayton region

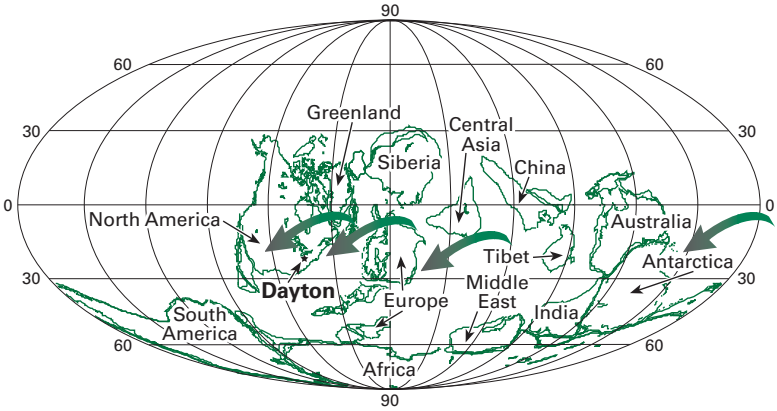
*By Gregory A. Schumacher*

To learn about the geology of the Dayton region and its economic impact on western Ohio, we will begin a trip through time about 40 years ago, travel to about 440 million years ago, and then end our trip today. Attractions on our trip include sailing on vast tropical seas during one of the warmest times in earth's history, experiencing extreme global cooling that created vast continental glaciers, witnessing one of the great mass extinctions in earth's history, and canoeing down the mighty Teays River before it was buried under hundreds of feet of clay, sand, and gravel.

As a youth growing up in Kettering, Ohio, my friends and I spent many hours searching for crayfish, frogs, snakes, and other aquatic life while wading in Little Beaver Creek. These creatures could avoid being caught as long as they burrowed into the soft clay that lined the creek banks. We quickly learned, after a painful pinch or two, that it was much easier to capture these creatures from under the boulders resting in the stream bed. These boulders consisted of limestone, dolomite, granite, gneiss, and a variety of other rocks. We discovered that the same clay containing similar types of boulders was present whenever large earthmovers dug foundations of new apartment complexes and businesses in our neighborhood. This clay, or glacial till, blankets much of the Dayton region and contains many of the clues necessary to understand the complex geologic history of the Dayton region.

One type of boulder we found in the creek and construction excavations was a flat gray piece of limestone containing large fossilized remains of sea shells and other creatures that seemed strange to us. These animals were not fresh water organisms like we hunted in Little Beaver Creek, but animals that lived long ago in a vast tropical sea. The sea covered the Dayton region and much of the eastern United States during the Ordovician Period some 440 million years ago.

If you could travel back to Ordovician time (see *Ohio Geology,* Fall 1997 on the Ohio Geological Survey's website), you would need a boat, and its captain would be confused because the boat's compass would be pointing south, toward the south pole, instead of north as it does today. This is because during the Ordovician, Dayton was located between 15° and 20° south of the equator, or about the same geographical location as Lima, Peru; American Samoa; or Port Moresby, New Guinea. The climate was hot and steamy; in fact, the Ordovician Period was one of the warmest periods in Earth's history. Large hurricanes would form in the Ordovician tropics and sweep across the Dayton region. The huge waves created by these hurricanes would scour the sea bottom causing erosion and the transport of sediments. The prolific and diverse types of plants and animals living in or near the sea bottom sediments would be unearthed, dislodged, toppled, and dragged in the sediment-laden water near the sea floor. As the hurricane moved away, the wave energy would wane and coarse sediments and larger plants and animals would settle out of the sediment-laden water into a




Location of the Dayton region in Ordovician time. Large arrows depict the probable Ordovician hurricane tracks as they moved in the southern hemisphere. Modified from Coogan (1996)

Please make a note of our Geologic Records Center's NEW HOURS: 8–11:30 a.m. and 1–4 p.m. weekdays.

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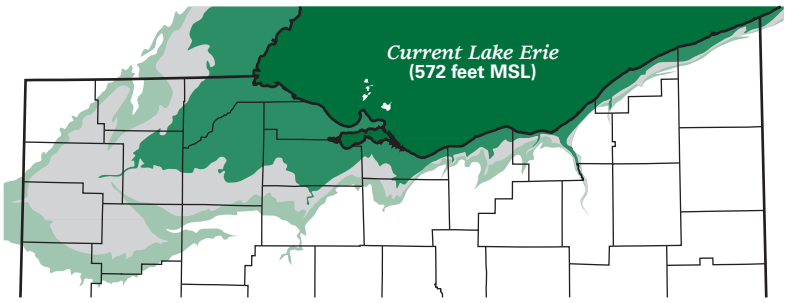
# OHIO ROCKS!

*Larry Wickstrom,*
*Division Chief and State Geologist*

**On January 4th** of this year, the Ohio Geological Survey officially closed its Lake Erie office in Sandusky, Ohio. An accompanying article in this month's *Ohio Geology* traces the long history and many accomplishments of the Lake Erie office. The decision to close the office has been the most difficult I have faced thus far as Chief of the Survey. Confronting the Survey's nearly two decades of rising costs and shrinking budget, I decided that we must reorganize to be as efficient as possible while maintaining as many services as possible to the citizens of this great state. The simple facts were that the Survey had shrunk to twenty-eight staff members (from nearly seventy staff in the late 1980s) with three full-time and one part-time staff in Sandusky, but the Survey was still trying to maintain three separate office locations and six organizational sections. While we will continue our efforts to find new and innovative funding, we must realign ourselves in the interim.

We have closed the office location in Sandusky, but the Survey is by no means abandoning the mission of providing meaningful research on Lake Erie's geology. The Survey still supports other Lake Erie programs of the Ohio Department of Natural Resources (ODNR), as well as the citizenry of the Lake Erie community. Geologic processes are dynamic and a geological survey must be, too. We are developing a partnership with ODNR's Division of Watercraft to share lake facilities and to allow Watercraft to use our remaining research craft; in return, Watercraft will provide personnel to operate the craft when we perform lake-based research. We will also continue to work alongside the ODNR Office of Coastal Management in support of their regulatory programs, and we will reach out to partner with various other agencies and universities that perform Lake Erie research. For now, all Lake Erie work will be run out of the Geologic Mapping and Industrial Minerals Group within the Survey. However, our goal is to establish a Geohazards Group in the near future to programmatically address the many geologic perils (landslides, mine subsidence, earthquakes, radon, and shore erosion) that cost Ohioans hundreds of millions of dollars in damages each year.




Lake Maumee III—Formed about 13,000 years ago at an elevation of 780 feet MSL (mean sea level).

Lake Whittlesey—Formed about 12,800 years ago at an elevation of 735 feet MSL.

Lake Warren—Formed about 12,400 years ago at an elevation of 685 feet MSL.

Lake Erie has gone through many levels as this part of the world's land surface and climate has changed since the retreat of the last continental glaciers about 14,000 years ago.

Ever since the last continental glaciers retreated from our state, the shape and character of Lake Erie has been changing. The accompanying figure illustrates the large-scale changes our great lake has gone through since glacial retreat; however, Ohio's north shore changes on a daily basis through wave erosion and mass wasting processes. It is eroding landward at a rate controlled by many factors, including water levels, storm frequency, and the geologic makeup of the shore face.

Ohio's coast is more developed by humans than any other Great Lake, and people living near the shore want to protect their property, homes, roads, and businesses from the powers of erosion, as well as their sandy beaches. Thus, a myriad of shore protection structures, sand trapping structures, and sand by-pass structures have been built along the shore, which in some counties cover more than 90% of the shore. Each structure, while temporarily accomplishing its purpose, obstructs the natural processes of the lake system, such as sediment supply, sediment movement along the shore, and wildlife habitats dependent upon coastal ecosystems with fluctuating water levels.

The face of Ohio is ever changing by geological processes, and more and more by humankind's interactions with it. Nowhere in Ohio are these processes more evident than at Lake Erie and its shore. As the state agency charged to research and provide information and support to the citizenry on our state's geology, we have been active within the Lake Erie community for decades and will continue to do so to the best of our abilities in these changing economic times.

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shelly layer on the sea floor; then the shelly layer would be buried under a fine sandy layer and capped by a thin layer of mud.

This process occurred hundreds—if not thousands—of times during the Ordovician Period, producing over 900 feet of alternating coarse-grained, fossiliferous limestone and sparsely fossiliferous shale beds generally a few inches thick each. The limestone beds have limited economic value because they tend to have a high percentage of shale impurities and a lower calcium content than the abundant, high-calcium limestones of the overlying Brassfield Formation. Ordovician limestone is used for decorative garden walls, stepping stones, and patios. The shale beds have no economic value and the Dayton region has not experienced the major landslides caused by rapid weathering of Ordovician shale beds like in the Cincinnati region. The limited exposure of Ordovician rocks, extensive burial of Ordovician rocks by thick blankets of glacial sediments, and the lower topographic relief of the Dayton region are major factors in reducing the landslide hazard.

The ancient, warm tropical seas teeming with life produced some of the earth's most fossiliferous rocks. Hurricane waves probably buried one of the largest and best preserved specimens of Ohio's state fossil, the trilobite *Isotelus* (see *GeoFacts 6* on the Geological Survey's website), found during excavations for Huffman Dam on the Mad River in 1919. A cast of this specimen is on display at the Boonshoft Museum of Discovery in Dayton.

Adjacent to Huffman Dam and State Route 444 is a large railroad cut that exposes about 100 feet of the uppermost Ordovician rocks and the basal 20 feet of the overlying Silurian rocks. Examining this section of rocks in detail reveals that about midway through the Ordovician section, the fossiliferous limestone and shale beds are replaced by less fossiliferous to non-fossiliferous shale beds that contain colorful purple or maroon zones and well-preserved mud cracks. These rocks show the dramatic changes that occurred in the latest Ordovician Period as the tropical seas retreated from the Dayton region.

Near the end of the Ordovician Period, the earth's climate cooled to the point that the Earth's polar region expanded considerably in the southern hemisphere. The winters became harsh and prolonged, which led to an Ice Age. Vast continental glaciers, many hundreds of feet thick, formed on many of the earth's continents. Huge quantities of water were frozen into continental glaciers and

Norfork Southern railroad cut adjacent to State Route 444 exposing the uppermost Ordovician rocks and the basal Silurian rocks of the Dayton region. *State Route 444 is a very busy road; stopping along this road is not recommended. Also, please do not trespass on railroad property.* Photo courtesy of Michael A. Schumacher

caused the sea level around the world to lower. Over time, vast areas of shallow sea teeming with marine life were drained and became dry land. The loss of this shallow marine habitat caused one of the major extinction events in Earth's history. The colorful zones observed in the railroad cut section were formed as the sea bed dried up and mud cracks formed, allowing the iron minerals deposited in the mud to oxidize or rust.

Other places you can see exposed Ordovician rocks in the Dayton region are the dam and spillway areas at Caesar Creek State Park, Germantown MetroPark, and Martindale and Patty Falls in Englewood MetroPark. Fossil collection is allowed in the spillway at Caesar Creek after obtaining permission and collection instructions at the U.S. Army Corps of Engineers Visitor Center < http://www.lrl.usace.army.mil/ccl/ > .

The retreat of the seas from the Dayton region resulted in a period of extensive erosion of the uppermost Ordovician rocks for approximately 1 million years. During this time, the earth warmed again and the glaciers slowly melted, causing the sea level to rise and once again flood the landscape of the Dayton region. By this time, the Dayton region had migrated northward to about 10° south of the equator.

Living in these crystal clear, warm waters were marine creatures that survived the Late Ordovician mass extinction and completely new creatures that evolved in the Early Silurian. The calcium carbonate skeletons of echinoderms, corals, clams, snails, brachiopods, stromatoporoids, and cephalopods accumulated on the sea floor. Over time, these beds of shelly mate-

rial were buried under many feet of overlying sediments and slowly consolidated to form the limestone beds of the Brassfield Formation.

The fossil creatures collected from the Brassfield Formation exposed in quarries near Fairborn, Ohio, are very abundant and represent many different genera and species. This Early Silurian fossil assemblage represents one of the world's best preserved and most diverse. For example, Dr. William Ausich of The Ohio State University identified 26 different genera and 29 species of crinoids, an echinoderm related to starfish, sand dollars, and sea urchins, from the Brassfield Formation of the Fairborn region.

The Brassfield Formation derived its name from the town of Brassfield in Madison County, Kentucky, where it was first described. These limestone beds are rich in calcium, making them the main ingredient in the manufacture of Portland cement. The abundance of inexpensive Portland cement has stimulated construction throughout the Dayton region since the 1920s: It was used to build the modern interstate highway system and to bind together the bricks of many homes and buildings throughout the region.

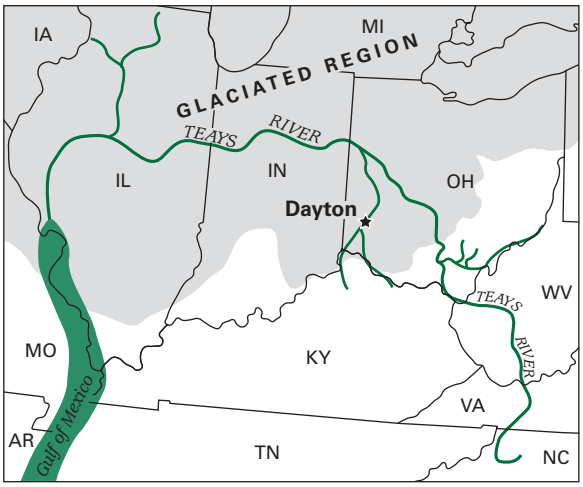
Some of the best places to examine Brassfield exposures in the region are Oakes Quarry Park, Charleston Falls, Ludlow Falls, and John Bryan State Park. Multiple maps and reports on the distribution, character, thickness, and chemical properties of the Brassfield Formation are available from the Geological Survey.

Overlying the Brassfield Limestone is the Dayton Formation, which has been quarried and used to make building stone for nearly 200 years. Many quarries were operated throughout the 1800s in southern Dayton, Van Buren Township (Kettering), and Centerville. Foundation stone was a common product of the Dayton Formation, but the strength and durability of the Dayton made it suitable for cemetery monuments, stone walls, canal locks, and buildings, too. The old Courthouse built in 1850, now the home of the Montgomery County Historical Society, is an excellent example of Dayton Formation stone used for building. The Courthouse's exterior walls were made from the stone.

There is no doubt that younger rocks were deposited above the Dayton Formation. These younger rocks have largely been eroded away because the sea in the Dayton region retreated and the landscape was eroded by rain and wind for millions of years. During this long period that lasted approximately 400 million years, the earth saw the extinction of trilobites and many other marine creatures, the evolution and extinction of dinosaurs, and the rise of mammals.

Also, the Dayton region migrated northward from about 10° south of the equator to our modern location of about 39° north of the equator: Our boat captain would no longer be confused because the boat's compass would be pointing toward the north pole again. During this 400-million-year northward migration, geologists can only speculate what was occurring in the Dayton region because no known rocks from this time period are available for study.

The geologic record resumes some 2 to 3 million years ago, as sand and gravel were deposited by ancient rivers draining the Dayton region. These ancient rivers were part of the Teays River System that originated in the mountains of North Carolina, flowed into Ohio from West Virginia, then through west-central Ohio and across central Indiana and Illinois (see *GeoFacts 10* on the Geological Survey's website). A canoe trip down one of these ancient rivers would have us traveling north and northwest instead of south as the Great Miami River flows today.




The preglacial Teays River. Repeated glacial advances, as shown by the shaded area, buried the Teays River and its tributaries beneath thick glacial drift. Neither the Great Lakes nor the Ohio River existed prior to Ohio's Ice Age. Modified from Hansen (1995)

From about 2 million to 16,000 years ago, the climate of the Dayton region cooled as the earth entered a major Ice Age. Large continental glaciers—perhaps as much as a mile thick—advanced southward across Ohio at least four times. The repeated advances of these glaciers buried the Teays River Valley under hundreds of feet of gravel, sand, and clay. The sediments left by the melting ice caused the north-flowing streams to be rerouted into the newly formed south-flowing Great Miami and Ohio River systems. Large quantities of melt water originating from the continental glaciers during brief warm periods flooded

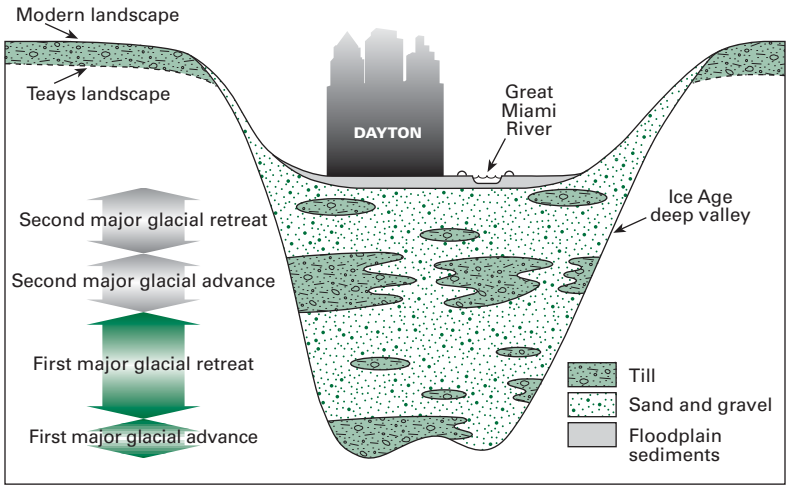
down the Great Miami River and cut a deep valley some 200 to 300 feet below the old Teays-age landscape, which left adjacent uplands intact. Additional glacial advances and recessions eroded and deposited new sediments into the Great Miami Valley causing partial filling of the valley with clay-rich sediments known as glacial till, which was overlain with sand and gravel layers.

For those readers interested in additional details about the bedrock geology, depth to bedrock, and sediments filling the buried valley beneath the modern Great Miami River, the Geological Survey has many reports and maps available, as well as staff members to answer questions about them.

Complex layering of sediments in the buried valley below the Great Miami River in Dayton has recorded at least two major glacial advances and retreats. As the glacier advanced down the Great Miami Valley, sediment in the ice melted out and was deposited as a layer of till (poorly sorted clay, silt, sand, gravel, and cobbles). A brief warming period resulted in a temporary retreat of the ice and produced large amounts of melt water flowing from the glacier. The melt water transported a tremendous quantity of sand and gravel downstream from the glacier and deposited it on top of the till layer. The glaciers advanced and retreated many times, as there are two major and many minor sand and gravel layers separated by till deposits within the sediments. Modern flood plain sediments cap this stratigraphic sequence with a relatively thin layer of fine-grained sediments.

Abundant pore spaces in these sand and gravel deposits are saturated with ground water. A typical industrial, commercial, or municipal well in these deposits will yield between 100 and 3,000 gallons of water per minute. Few cities in Ohio or across the nation can pump the majority of their municipal water from underground sand and gravel deposits like Dayton. Additionally, the abundance of sand and gravel in the glacial deposits of the region, combined with the abundance of Portland cement manufactured from the Brassfield Formation, have provided relatively inexpensive building materials necessary for the economic growth of the Dayton region. For example, in 2006, more than 1 million tons of sand and gravel were mined in Montgomery County for use in making asphalt, road and building construction, road resurfacing, and in the manufacture of concrete that added over 10 million dollars to the Dayton region's economy.

The final retreat of the last ice sheet about 16,000 years ago left behind the blanket of till that covers much of the Dayton region outside of the Great Miami River Valley. In this till are a wide variety of rocks and minerals that, upon weathering, have formed a fertile, deep soil ideal for farming. Farming continues to be one of the major components of the Dayton region's economy.




A generalized cross section illustrating the sediments filling the buried Great Miami River Valley under Dayton, Ohio. Two major glacial advances and retreats are evident. The till lining the base of the valley represents the first major glacial advance followed by warming, glacier melting and retreat, and deposition of thick sand and gravel beds. The second discontinuous till layer occurring about midway through the valley fill indicates a second major advance of the glacier. Minor glacial advances and retreats over the Dayton Region deposited the thinner till beds overlain by sand and gravel beds.

Our trip is now complete as we return to the glacial till lining Little Beaver Creek. The till continues to provide refuge for crayfish trying to avoid capture by young boys, but it has also provided many geologic clues necessary for geologists to understand the long and complex geologic history of the Dayton region. As the science of geology continues to advance and geologists learn new ways to interpret clues, the till lining Little Beaver Creek may provide even more stories about the past in the future.

## Further reading

Coogan, A.H., 1996, Ohio's surface rocks and sediments, *in* Feldmann, R.M., and Hackathorn, Merrianne, eds., Fossils of Ohio: Ohio Department of Natural Resources, Division of Geological Survey Bulletin 70, p. 31–50.

Hansen, M.C., 1995, The Teays River: Ohio Department of Natural Resources, Division of Geological Survey GeoFacts 10.

Hansen, M.C., 1997, The geology of Ohio—The Ordovician: Ohio Department of Natural Resources, Division of Geological Survey, Ohio Geology newsletter, Fall, p. 1–6.

Shrake, D.L., 2005, *Isotelus*: Ohio's state fossil: Ohio Department of Natural Resources, Division of Geological Survey GeoFacts 6.

## Lake Erie geology office closes

Owing to ongoing budget constraints, the Ohio Department of Natural Resources (ODNR) Division of Geological Survey closed the Sandusky office of the Lake Erie Geology Group in January. The Geological Survey will continue to perform geologic investigations in and around Lake Erie, as well as from its Columbus offices and in partnerships with others. The closing of the Lake Erie office represents a significant change for the Geological Survey, thus it is appropriate to recap some of the history and accomplishments of our Lake Erie research.

The Geological Survey began studying the geology and geologic processes of Lake Erie in 1838. In 1949, the Geological Survey and newly formed ODNR Division of Beach Erosion jointly supported an official Lake Erie Geological Research Program, which was mostly funded by the Division of Beach Erosion (soon renamed the Division of Shore Erosion). In the November 1961 reorganization of ODNR, the geologic research and mineral-extraction permitting of the Division of Shore Erosion became the Lake Erie Section of the Division of Geological Survey, an association that has lasted 46 years. The Geological Survey gained five new staff members and a variety of research equipment from the reorganization, including the 48-foot research vessel, *GS-1*.

Don Guy, a geologist with the Lake Erie group for more than 33 years, says "several research themes thread through geologic research on Lake Erie": sediment distribution and stratigraphy, water quality and currents, shore erosion and erosion forecasts, riverine and near-shore habitat studies, and management of shoreward, or littoral, sand resources.

In the 1950s and 1960s, the group studied and collected data on water quality, water properties, water currents, and water-mass movement in the Ohio portion of Lake Erie. Dale Liebenthal, a researcher for the group and its boat captain for 29 years, recalls that some of the earliest significant water pollution studies of the lake were done from the *GS-1* using conductivity meters, which were an early method of assessing pollutants.

The 48-foot research vessel, *GS-1*.

The lake experienced record high-water levels between 1973 and 1998. A primary objective of the Lake Erie Geology Group during this time was to document erosion rates and predict future erosion. The group prepared erosion recession maps and forecasts in 1973, 1998, and 2007. The group also conducted research related to Ohio's coastal sand resources and strongly advocated better sand management practices to conserve beaches and near-shore habitats. The Lake Erie Geology Group and their years of research were a predominant force in forming Ohio's coastal management program (OCMP) and coastal management laws in the 1990s. The formation of the OCMP has resulted in millions of dollars becoming available to Ohio's coastal communities and researchers through the National Oceanic and Atmospheric Administration (NOAA) and the federal Coastal Zone Management Act.

Liebenthal notes that many fine people were associated with the group. During his career, section heads Charles Herdendorf and Scudder Mackey were "central to providing information on the stewardship of the natural resources of Lake Erie and the Ohio coastline…Both of these leaders had the ability to get on the cutting edge of the day's issues and developed excellent working arrangements with scientists of other disciplines." Section head Charles Carter's contributions to the group included overseeing erosion studies in Ohio's eight lake shore counties, calculating sediment loading, and initiating a 10-year study of wave erosion processes. These studies are now important benchmarks for all present-day shore erosion investigations.

The first full-time supervisor of the Lake Erie section, James Verber, faced mineral resource issues. In particular, there was commercial interest in the mineral resources within and under the bed of the Ohio portion of Lake Erie. The Ohio Revised Code places permitting for the extraction of these commodities with the Division of Geological Survey (the Division of Shore Erosion prior to 1961). After long negotiations, the Division granted permits for two underground salt mines in 1957 and 1959. Operators have also been permitted to commercially dredge

sand and gravel from the bottom of the lake. In 1955, legislation was passed to allow for oil and gas extraction under the bed of Lake Erie. The section was involved in a number of issues while preparing for a permitting system, but in 1968, public concerns about potential pollution issues led to drilling being banned within the Ohio boundaries of Lake Erie.

Ohio's Lake Erie shore contains valuable lakefront property, important industrial facilities, and commercial and recreational harbors—Lake Erie has long been a mecca for recreational activities. Rapid shoreline recession has destroyed beachfront homes, roads, and other structures. According to a 1996 *Ohio Coastal Management Program Newsletter* (v. 1, no. 3), the annual loss of homes, roadways, infrastructure, and tax base is estimated at $26 million. Approximately 75 percent of the lake's Ohio shoreline is subject to significant erosion from the continuous onslaught of waves, particularly during storms.

Increased armoring of the shore now reduces or prevents shore erosion, but it also limits the amount of sand and gravel that shore erosion can contribute to the littoral system. In addition, sand trapped behind dams and sand and gravel dredged from channels and disposed of in deep lake water have significantly reduced the volume of sand and gravel contributed to the littoral system. This limited input of sand and gravel causes further beach erosion and degradation of near-shore habitats like wetlands that fish use for spawning.

The Geological Survey thanks the past staff of the Lake Erie group for their many valuable contributions to the public and scientific communities of Ohio. The responsibilities of the group, such as determining the risk of coastal erosion and advocating better management of coastal sand resources, continue to be important issues to Ohio citizens.

| Administrative heads/supervisors of the Lake Erie Geology Group | Years served |
|---|---|
| Howard J. Pincus (directed program until 1960) | 1950–1953 (part-time program) |
| James L. Verber | 1953–1957 |
| Robert P. Hartley | 1957–1964 |
| Charles E. Herdendorf | 1964–1971 |
| Charles H. Carter | 1972–1983 |
| Robert Van Horn | 1983–1989 |
| Richard R. Pavey | 1989–1992 |
| Scudder D. Mackey | 1992–2001 |
| Constance J. Livchak | 2001–2008 |

| Boat captains | Years served |
|---|---|
| Walter R. Lemke | 1953–1976 |
| Dale L. Liebenthal | 1976–2005 |

(Data source for the years 1950–1971: Herdendorf, C.E., 1979, The Lake Erie Geological Research Program: The Ohio State University, CLEAR Technical Report 252)

Thanks to Don Guy, Dale Liebenthal, and Mike Hansen for their thoughtful assistance in compiling and reviewing this article.

## LOOKING BACK

| | |
|---|---|
| 1942–1961: | Control points along 262 miles of the Lake Erie shoreline were established for studies on erosion and accretion rates. |
| 1950s and 1960s: | Erosion reconnaissance and site-specific studies; studies of sediment and sand distributions; engineering geology studies (bluffs, near-shore deposits, and littoral drift). |
| 1952: | Lake Erie reaches record-high level. |
| 1960s: | Focus on water quality and physical characteristics of reef areas that serve as fish habitat. |
| 1970s: | Recession-line maps and forecasts of erosion; county erosion studies; sand resources assessed with seismic-reflection equipment and lake bottom cores. |
| 1972: | In November, severe northeast storm causes catastrophic flooding and erosion along the Ohio lake shore, particularly along western Lake Erie. |
| 1973: | Lake Erie sets new record-high levels. Above-normal lake levels persist through 1998. |
| 1973–1976: | Shore erosion studies conducted for each lake shore county. |
| 1979: | Greatest recorded elevation difference (16.7 ft) in the level of Lake Erie at Toledo and Buffalo. |
| 1980s: | More lake bottom cores collected to study sand resources; 10-year study of wave erosion. |
| 1985–1986: | Lake Erie breaks record high levels set in 1973. |
| 1990s: | Recession-line maps and forecasts of erosion; 5-year cooperative study with the USGS builds on past research themes to address current issues—new sampling methods can continually update data. |
| 1998: | Lake Erie rises within 0.06 ft of record levels set in 1986. Two spring storms cause extensive erosion and flooding along western Lake Erie. |

## Survey staff changes

**Comings:**

- Paul D. Hoeffler—Geographic Information Management Systems Specialist 1 (project employee), Energy Resources Group

**Goings:**

- Katie L. Cade—Secretary, Lake Erie Geology (transferred to ODNR Office of Coastal Management)
- Bruce E. Gerke—Geologist 2, Lake Erie Geology (transferred to ODNR Office of Coastal Management)
- Sharon L. Lingle—Geologist 3, Lake Erie Geology
- Constance J. Livchak—Geology Program Supervisor, Lake Erie Geology
- Josh D. Will—Geographic Information Management Systems Specialist 1 (project employee), Energy Resources Group

## Ordering information

To order any of the Survey's publications or maps, contact the Geologic Records Center, 2045 Morse Road, Bldg. C-1, Columbus, Ohio 43229-6693; telephone: (614) 265-6576; fax: (614) 447-1918; email: geo.survey@dnr.state.oh.us. In-state sales tax rates are based upon the county where the map is shipped. Handling charges apply to all mailed orders (please call for rates). Visa and MasterCard are accepted.

Please make a note of our **Geologic Records Center's NEW HOURS: 8–11:30 a.m. and 1–4 p.m. weekdays;** see the Survey's website for more information about this change.

## Topo maps revised for southeastern Ohio areas

The U.S. Geological Survey (USGS) has revised forty-eight 7.5-minute topographic maps covering portions of southeastern Ohio, including some areas of the Hocking Hills region. The U.S. Forest Service worked with the USGS to delineate Wayne National Forest holdings in detail on the maps. The revised maps are now available from the Ohio Geological Survey for $6.00 each (plus sales tax and shipping). Ordering information at left.

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