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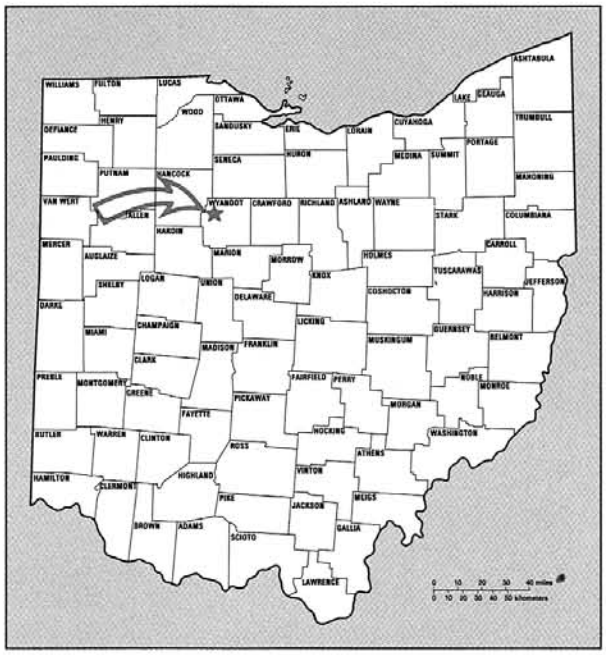
INDIAN TRAIL CAVERNS—A WINDOW ON OHIO'S PLEISTOCENE BESTIARY

by Michael C. Hansen

A new chapter has been added to the record of Pleistocene vertebrates in Ohio with the discovery of a fossil-bearing sinkhole at Indian Trail Caverns, in Wyandot County. In many other areas of the country, caves and associated karst features such as sinkholes have yielded a rich assemblage of bones of Pleistocene animals that lived and died or became trapped in these features. Although carbonate rocks are extensive in the western half of Ohio, caves and other karst features are not well developed over a wide area, probably because the region was extensively glaciated.

There are, however, scattered areas in western Ohio where small cave systems, with accompanying sinkholes, are developed. One such area is in Wyandot County, northwest of Carey, where a northwest-southeast-oriented bedrock ridge rises nearly 50 feet above the surrounding till plain in, appropriately named, Ridge Township. Ohio Route 568 traverses this ridge.

Although this ridge was covered by ice during Pleistocene glaciation, till or other glacial deposits are very thin, thus exposing the bedrock to direct surface weathering. The ridge appears to be a reef of Middle Silurian Lockport Dolomite. It is probable that various phases of Pleistocene glaciation, including the most recent phase, the Wisconsinan, sculpted the ridge into a positive topographic feature because of the reef carbonate's greater resistance to erosion. Interestingly, the reef appears to have developed on the upthrown block of a northwest-southeast-trending fault.



Location of Indian Trail Caverns in Wyandot County.

Cave systems on this ridge have long been known, and in 1927 one of these caves was opened for commercial purposes as Wyandot Caverns. Within 10 years this venture failed, and it was not until 1973 that Richard Hendricks of Vanlue reopened this cave commercially as Indian Trail Caverns. Mr. Hendricks made considerable effort to reopen and extend the cave, which has necessitated the removal of many tons of fill material in order to provide easy passage through the nearly 600-foot-long chamber.

In July 1990, Mr. Hendricks began excavation of a sinkhole, known as the Sheriden pit, adjacent to the entrance of the commercial cave. A crane and other power equipment were used to remove many tons of fill material from the 30-foot-deep pit. It was during this digging that Mr. Hendricks noticed unusual bones mixed with the fill. Within a short time Dr. Gregory McDonald of the Cincinnati Museum of Natural History was notified and soon after began excavations of the Sheriden pit at Indian Trail Caverns.

These excavations have yielded a remarkable fauna of Late Pleistocene animals, some of which are new records for Ohio. Particularly interesting are a number of small animals that rarely, if ever, show up in bog sites. Many of these animals, such as raccoon, skunk, woodchuck, muskrat, shrew, and mouse, live in Ohio today. It is McDonald's interpretation that many of the small mammal remains were introduced into the sinkhole site from owl pellets or remains of prey of hawks and eagles.

Extinct animals that have been recovered so far include flat-headed peccary, giant beaver, elkmoose (stagmoose), and short-faced bear. This bear, *Arctodus simus,* is a new record for Ohio. All of these species are known from only a few bones, which probably represent only one individual, except for peccary. Remains of at least 23 individual peccaries have been recovered so far. Caribou is known from an antler fragment, which McDonald speculates might have been washed into the sinkhole.

Dr. McDonald, with the assistance of volunteers, is systematically removing sediment from the sinkhole and washing it through a series of screens so that even tiny bones can be recovered. This is a slow and laborious process but an absolutely neccessary one in order to insure that important material is not lost. McDonald and a volunteer crew have been spending nearly every weekend during the warm months of the year excavating the Sheriden pit. The impressive assemblage of bones is being curated and identified at the Cincinnati Museum of Natural History.

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OHIO Department of Natural Resources

George V. Voinovich, Governor • Mike DeWine, Lt. Governor • Frances S. Buchholzer, Director

FROM THE STATE GEOLOGIST . . . by Thomas M. Berg

THE GEOSCIENCES, GEOLOGICAL SURVEYS, AND PUBLIC RESPONSIBILITY

In this decade of the 1990's, the time has come for all citizens, government administrators, and legislators to pay close attention to what is being done—and said—by the state geological surveys and the U.S. Geological Survey. Geologists working in the public sector have the important responsibility of communicating information about the location, quantity, and quality of mineral and rock materials at the surface and into the subsurface as far as drilling and geophysical techniques will allow. They also have the responsibility of communicating the same kind of information about fluids and gases contained in those materials.

It is unfortunate that the average citizen is only minimally aware that the geologic framework surrounding everyone profoundly influences the quality of life we enjoy as Americans. The availability and quality of ground water which is so essential to life is a function of aquifer location and character—a geological phenomenon. The construction materials we use and depend upon for dwellings, schools, factories, and transportation routes are a function of geologic occurrence. Hazards such as earthquakes, landslides, indoor radon, and coastal erosion are all consequences of our geologic framework. The energy we use for heat, air conditioning, light, manufacturing, and transportation comes mostly from coal, natural gas, and oil—all natural resources controlled by complex geologic conditions. One of the hottest environmental issues today concerns the safe disposal of our waste products. The production of waste must first of all be reduced, principally by recycling. All remaining liquids or solids classified as waste, whether they be nonhazardous, hazardous, or radioactive wastes, must be disposed of safely. Such disposal can only be done with full and detailed knowledge of the geologic framework at each waste site.

Like many other public sector geologists, I am deeply concerned about bringing the importance of deciphering and characterizing our geologic environment to the attention of citizens, legislators, decision-makers, and policymakers. I want to hear from our readers! Please take time to write to me letting me know how you would raise public awareness of our geologic framework. How would you convey the importance of geologic information so that our citizens can responsibly participate in formulation of public policy? At the Ohio Division of Geological Survey we are committed to communicating the importance of the geosciences in our daily lives to as broad an audience as possible. Please share your ideas with us! Thank you for your help.

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GUIDEBOOKS AVAILABLE FROM 1981 CINCINNATI GSA MEETING

The Survey has acquired from the American Geological Institute the remaining field-trip guidebooks from the 1981 Geological Society of America annual meeting held in Cincinnati. The paperbound guidebooks are now available from the Survey as individual volumes or as a set of three.

Volume I, Stratigraphy, sedimentology

—Paleoenvironmental interpretation of the Middle Ordovician High Bridge Group in central Kentucky (G. L. Kuhnhenn, G. J. Grabowski, and others).

—Stratigraphy, sedimentology, and paleoecology of the Cincinnatian Series (Upper Ordovician) in the vicinity of Cincinnati, Ohio (D. L. Meyer, R. C. Tobin, W. A. Pryor, W. B. Harrison, R. G. Osgood, and others).

—Lithostratigraphy, cyclic sedimentation, and paleoecology of the Cincinnatian Series in southwestern Ohio and southeastern Indiana (H. B. Hay, J. K. Pope, and R. C. Frey).

—Devonian and Early Mississippian smaller foraminiferans of southern Indiana and northwestern Kentucky (J. E. Conkin, B. M. Conkin, M. M. Walton, and E. D. Neff).

—Early Mississippian deltaic sedimentation in central and northeastern Ohio (A. H. Coogan, R. A. Heimlich, R. J. Malcuit, K. B. Bork, and T. L. Lewis).

—Mississippian-Pennsylvanian boundary in the central part of the Appalachian Basin. Part I: Southwestern Virginia-southern West Virginia (K. J. Englund, T. W. Henry, and others). Part II: Mississippian-Pennsylvanian boundary in northeastern Kentucky (F. R. Ettensohn).

Volume II, Economic geology, structure

—Chattanooga and Ohio Shales of the southern Appalachian Basin (R. C. Kepferle, J. B. Roen, and others).

—Structure and stratigraphy of the Pine Mountain thrust sheet (T. D. Coskren).

—Stratigraphic and structural geology of the Hot Springs traverse, Tennessee-North Carolina (Nicholas Rast and J. C. Bolton).

—The Serpent Mound cryptoexplosion structure, southwestern Ohio (S. P. Reidel and F. L. Koucky).

—Coal and the related Pennsylvanian strata of eastern Kentucky (J. C. Cobb, D. R. Chesnut, N. C. Hester, and J. C. Hower).

—Geology and ore deposits of the St. Francois Mountains, Missouri (E. B. Kisvarsanyi, A. W. Hebrank, and R. F. Ryan) (abstract only).

Volume III, Geomorphology, hydrogeology, geoarcheology, engineering geology

—Quaternary deposits of southwestern Ohio (R. P. Goldthwait, D. P. Stewart, and others).

—Coastal geomorphology and geology of the Ohio shore of Lake Erie (C. H. Carter, D. E. Guy, Jr., and J. A. Fuller).

—Hydrogeology of the Mammoth Cave region, Kentucky (J. F. Quinlan and R. O. Ewers).

—Geoarcheology of the Flint Mammoth Cave system and the Green River, western Kentucky (J. K. Stein, P. J. Watson, W. B. White).

—Engineering geology of the Cincinnati area (R. W. Fleming, A. M. Johnson, J. E. Hough, and others).

—Geohydrology of the Ohio River alluvial aquifer (D. S. Mull and R. J. Faust) (abstract only).

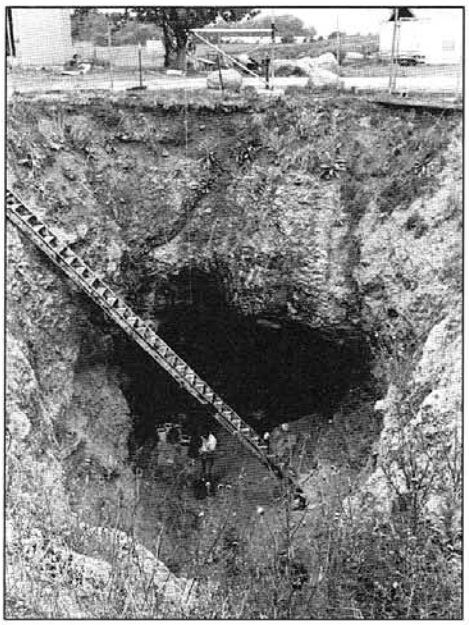
The guidebooks are available from the Survey for $6.00 each or $15.00 for the three-volume set. Single-volume orders should include $1.75 mailing and $0.35 tax (Ohio orders). Two-volume orders should include $2.25 mailing plus $0.69 tax (Ohio orders). The three-volume set should include $2.25 mailing plus $0.87 tax (Ohio orders).

continued from page 1

McDonald will publish these data once excavations are completed.

The sinkhole from which these remains are being extracted is a funnel-shaped pit about 30 feet deep that apparently acted as a natural trap for hapless animals during early postglacial time. The bones are in a sediment composed of a reddish clay mixed with limestone cobbles and boulders. The mixing of sediment and disarticulated skeletal material indicates that water has flowed into the pit and through a horizontal cave connection at the bottom of the pit. A layer of laminated silt and clay above the main bone-bearing layer suggests a period of standing water in the sinkhole, probably after the lower cave opening became plugged with sediment. A charcoal layer, probably from a forest fire, near the top of the bone-bearing layer has yielded a radiocarbon date of approximately 11,700 years before present. Wyandot County was ice free about 14,000 years ago, so it is probable that the animals that were trapped in this sinkhole met their fate during the period between about 12,000 and 14,000 years ago.

The discovery of *Arctodus,* a large, long-legged bear comparable in size to the modern Alaskan brown bear, is not only the first record of this animal from Ohio but also one of the few records of any large predator from Ohio's Pleistocene sediments. Other top-level predators that should be expected but are yet to be discovered include sabertooth cat (*Smilodon fatalis*) and dire wolf (*Canis dirus*). Remains of both of these animals have been found in nearby states and there is little doubt that they roamed Ohio, preying on the young, sick, and weak among the various large herbivores.



View of the sinkhole at Indian Trail Caverns that is producing an abundant fauna of Pleistocene vertebrates.

The only other records of large predators from Ohio are a skull of a grizzly bear *(Ursus arctos horribilis)* described from a Pleistocene gravel deposit in Butler County in 1899 and bones of a black bear (*Ursus americanus*) from the Indian Trail Caverns site.

But why have so few large Pleistocene predators been found in Ohio? The answer to this question is multifaceted. First of all, large predators, the top of the food chain, characteristically have much smaller populations than do their prey animals—large herbivores such as mastodon, mammoth, peccary, and ground sloth. Therefore, we should expect the occurrence of these predators to be much less frequent than the occurrence of large herbivores. Secondly, large predators are probably less likely to become trapped or entombed in typical situations where we find Pleistocene vertebrates in Ohio, that is, bogs and early postglacial lakes. Large herbivores such as mastodon and mammoth not only frequented such wet areas but probably were more likely to become trapped in mud or break through winter ice because of their bulk, and perhaps because of their inability to extricate themselves. Predators were not only smaller, and therefore less likely to sink so deeply into the soft sediment, but they were also more agile. Of course, the famous tar pits of Rancho La Brea are an exception to this observation because both predator and prey fell victim to the sticky tar.

We should be extremely surprised if we do find a predator such as sabertooth cat or dire wolf in bog or lake sediments. Cave and sinkhole situations, such as Indian Trail Caverns, have much greater potential to yield remains of sabertooth cat, dire wolf, or short-faced bear because these animals may have used these rock cavities as dens and, in the case of steep-sided sinkholes, they may have been attracted to injured or dead herbivores that fell into these natural traps. Even if remains of these large predators are not found, we can infer their presence by tooth marks on bones of their prey.

Continued excavations at Indian Trail Caverns may produce our first records of additional predators of Ohio's Pleistocene. Undoubtedly, there are other potentially productive sites in the state. It would be prudent for anyone observing bones in cave or sinkhole sediments to report these occurrences to the nearest natural history museum or university or to the Survey. These sinkholes are tiny windows into our Pleistocene past, but they yield a magnificent view of a vanished scene.

PRELIMINARY FAUNAL LIST FOR INDIAN TRAIL CAVERNS

Compiled by Dr. H. Gregory McDonald, Cincinnati Museum of Natural History
**denotes extinct species*

Osteichthyes (bony fish)
- small minnow

Amphibia (frogs, toads, salamanders)
- frog, small and large species

Reptilia (lizards, snakes, turtles)
- snake - two species
- turtle - snapping turtle, small pond turtle

Aves (birds)
- turkey - *Meleagris gallopavo*
- small species

Mammalia (mammals)

Insectivora
- shrew - *Sorex* sp., *Microsorex* sp., *Blarina* sp.

Chiroptera
- bat - *Myotis* sp.

Lagomorpha
- rabbit

Rodentia
- meadow vole - *Microtus* sp.
- red-backed vole - *Clethrionomys* sp.
- muskrat - *Ondatra zibethica*
- field mouse - *?Peromyscus* sp.
- chipmunk - *Tamias* sp.
- red squirrel - *Tamiastriatus* sp.
- tree squirrel - *Sciurus* sp.
- woodchuck - *Marmota monax*
- porcupine - *Erethizon dorsatum*
- modern beaver - *Castor canadensis*
- giant beaver - **Castoroides ohioensis*

Carnivora
- raccoon - *Procyon lotor*
- short-faced bear - **Arctodus simus*
- black bear - *Ursus americanus*
- weasel - *Mustela* cf. *M. erminea*
- pine marten - *Martes americana*
- striped skunk - *Mephitis mephitis*

Artiodactyla
- flat-headed peccary - **Platygonus compressus*
- elkmoose (stagmoose) - **Cervalces scotti*
- white-tailed deer - *Odocoileus virginianus*
- caribou - *Rangifer tarandus*

PHIL CELNAR RETIRES

Philip J. Celnar, Head of the Survey's Technical Publications Section since 1976, retired on March 31, 1992, after 26 years of service to the Division. Phil took advantage of an early retirement offer by the Department of Natural Resources.

Phil joined the Survey as a cartographer in 1966 after receiving a Bachelor of Fine Arts degree from The Ohio State University and two years of service in the U.S. Army as an illustrator at the Pentagon. As a Survey cartographer, he was responsible for production of a number of maps and publications and has always been involved with Survey promotional activities such as the annual display at the Ohio State Fair.

Even after assuming administrative responsibilities as Head of the Technical Publications Section, Phil continued to produce various Survey publications. Phil did all layout and design of *Ohio Geology* during its early years. Perhaps one of his most ambitious projects was the map of the Serpent Mound cryptoexplosion structure (Report of Investigations 95). This complex map, published in 1975 and now out of print, is probably the most complex map produced by the Survey.

Phil's graphic skills seem to be in evidence nearly everywhere throughout the Survey. Many displays of geologic information, publications, and other graphics bear the influence of Phil's talents. We have come to depend on these skills for so long that we tend to assume that they will always be there. However, it will be difficult, if not impossible, to replicate these talents. Phil has given many years of dedicated service to the Survey and has been a true professional in every respect.

Phil plans to pursue his hobby of golf with a new vigor and to seek part-time employment. He and his wife, Fran, anticipate more opportunities to travel.

SEISMIC HAZARDS ADVISORY BOARD APPOINTED

Governor George V. Voinovich has appointed a 12-person Seismic Hazards Advisory Board to advise him on all aspects of seismic risk in Ohio. The board will address a wide range of topics including frequency and intensity of earthquakes in the state, monitoring of earthquakes, building codes, risk to transportation arteries and utilities, emergency planning, and insurance considerations. The board is composed of representatives of various branches of state government, academic institutions, and private research and draws together a wide range of expertise in order to address the multifaceted aspects of earthquake risk. The board will meet quarterly and assign subcommittees to investigate various aspects of seismic risk in Ohio.

The following members have been appointed to the Ohio Seismic Hazards Advisory Board:

Thomas M. Berg—Department of Natural Resources

Harold T. Duryee—Department of Insurance

Mary Lou Hodnett—Environmental Protection Agency

Peter J. McGeoch—Department of Administrative Services

James McNamee—Department of Commerce

Thomas I. McSweeney—Battelle Memorial Institute

W. Richard Ott—John Carroll University

Steve Regoli—Department of Industrial Relations

Dale W. Shipley—Adjutant General's Office

James E. Sullivan—Public Utilities Commission

Keith Swearingen—Department of Transportation

Ralph R. B. von Frese—The Ohio State University

NEW GEOLOGIC QUADRANGLE MAPS RELEASED

The following open-file 1:24,000-scale maps are now available as part of the Survey's statewide mapping program. Blueline copies of these maps are $5.48 per map, which includes tax and mailing. Add $1.00 per order for unfolded copies mailed in a tube. Please order by quadrangle name and map title. An index to topographic quadrangle maps in Ohio is available at no charge from the Survey.

Ash Ridge *(Brown County)* bedrock geology, bedrock topography, two structure contour maps.

Christiansburg *(Miami, Champaign, Clark Counties)* bedrock geology, bedrock topography, three structure contour maps.

DeGraff *(Logan, Champaign Counties)* bedrock geology, bedrock topography, three structure contour maps.

Dixon (Ohio portion only) *(Van Wert, Paulding Counties)* bedrock geology, bedrock topography.

Erastus *(Mercer County)* bedrock geology, bedrock topography, one structure contour map.

Fletcher *(Miami, Shelby, Champaign Counties)* bedrock geology, bedrock topography, three structure contour maps.

Gettysburg *(Darke, Miami Counties)* bedrock geology, bedrock topography, two structure contour maps.

Hamersville *(Brown County)* bedrock geology, bedrock topography, five structure contour maps.

Higginsport *(Brown County)* bedrock geology, bedrock topography, two structure contour maps.

Huntsville *(Logan County)* bedrock geology, bedrock topography, four structure contour maps.

Maysville West (Ohio portion only) *(Brown County)* bedrock geology, bedrock topography, three structure contour maps.

Moulton *(Auglaize County)* bedrock geology, bedrock topography, four structure contour maps.

Mt. Victory *(Hardin, Logan Counties)* bedrock geology, bedrock topography, two structure contour maps.

Peebles *(Adams County)* bedrock geology and surficial geology.

Pleasant Hill *(Miami County)* bedrock geology, bedrock topography, two structure contour maps.

Rawson *(Hancock County)* bedrock geology, bedrock topography, one structure contour map.

Richmond *(Jefferson County)* bedrock geology, three structure contour maps.

Rockford *(Mercer, Van Wert Counties)* bedrock geology, bedrock topography, three structure maps.

Roundhead *(Hardin, Logan Counties)* bedrock geology, bedrock topography, three structure contour maps.

Silver Creek *(Hardin, Logan Counties)* bedrock geology, bedrock topography, three structure contour maps.

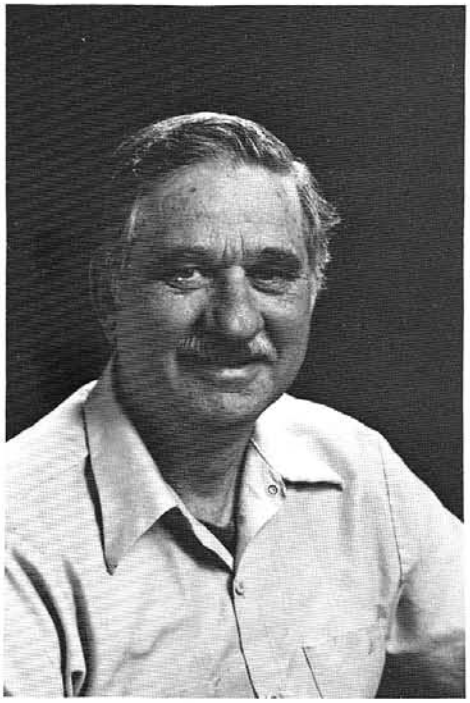
Spencerville *(Allen, Auglaize Counties)* bedrock geology, bedrock topography, one structure contour map.

Uniopolis *(Auglaize County)* bedrock geology, bedrock topography, four structure contour maps.

Weirton (Ohio portion only) *(Jefferson County)* bedrock geology, two structure contour maps.

Wellsville (Ohio portion only) *(Columbiana, Jefferson Counties)* bedrock geology (Jefferson County portion only), three structure contour maps.

JIM WOOTEN RETIRES



James Wooten, Geology Technician in the Subsurface Stratigraphy and Petroleum Geology Section, retired on March 31, 1992, after 27 years of service to the Survey. Jim participated in the early retirement option offered by the Department of Natural Resources after his position was abolished due to budget cuts.

Through the years, Jim has performed a variety of duties including collecting, washing, labeling, and storing samples of well cuttings from oil and gas wells and various other duties in the Subsurface Stratigraphy and Petroleum Geology Section. In recent years, Jim has overseen the day-to-day operations of the Survey's core-storage facility on Phillipi Road in southwest Columbus. He has also performed a variety of tasks relating to the Survey's vast holdings of oil and gas well data.

Jim is a veteran of the Korean conflict and retired in 1991 from the Ohio National Guard after 20 years of service. He was always willing to assist staff and the public and to provide them with the benefit of his extensive knowledge of the Survey's core and sample holdings. Jim will be greatly missed by all of those who have worked with him during his many years of service to the Survey.

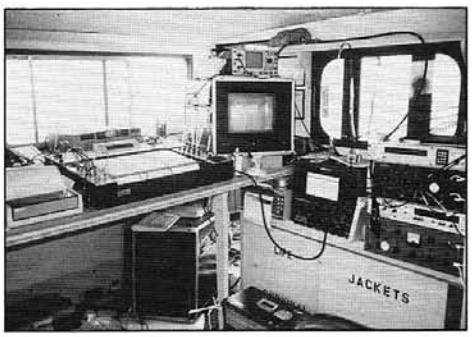
SURVEY BEGINS COOPERATIVE LAKE ERIE EROSION INVESTIGATION WITH USGS

Last summer the Ohio Division of Geological Survey began a five-year cooperative project with the U.S. Geological Survey under the umbrella of the USGS Coastal Geology Program. The aim of this federal program is better understanding of the significant problems of coastal erosion and pollution and the distribution of mineral resources in the coastal areas of the United States, including the shores of the Great Lakes. Ohio became involved in the Coastal Geology Program primarily because of severe erosion of the Ohio portion of the Lake Erie coast. Hundreds of millions of dollars have been invested in coastal residences, recreational facilities, and industrial development. However, more than 95 percent of Ohio's 344 miles of Lake Erie shoreline is suffering from ongoing erosion, and 75 percent of the shore is classified as easily erodible. Nearly half of the 5,000 lakefront structures in Ohio are located within 50 feet of destruction. In many areas, bluffs of unconsolidated glacial deposits are eroding at rates up to 10 feet per year. Such circumstances result in substantial economic losses to property owners and coastal communities and intangible recreational losses to the general public. It is estimated that total losses along the Ohio shoreline in 1985 may have been as high as $100 million.

Ohio's cooperative program is designed to examine the dynamics of erosion along the shore of Lake Erie. The program will include detailed investigations of how and why coastal erosion occurs, how fast it has occurred in the past, and the effects of sand transport and deposition on erosion rates. The geologic framework in both offshore and onshore areas is being delineated to assist in understanding the dynamics and processes of the lake.

The initial geologic framework effort began in September 1991 with a two-week cruise of the Survey's 48-foot research vessel, the *GS-1*. The objective of this cruise was to obtain an acoustic view of the surface of the lake bottom using side-scan sonar and acoustic cross sections of lake-bottom sediments using two types of sub-bottom profilers (known as a "pinger" and a "boomer"). The cruise was hampered by unfavorable weather, but about 140 miles of track lines were completed. This figure represents about 20 percent of the track lines planned for the Ohio portion of Lake Erie. The geophysical equipment and some of the navigation equipment were provided by the U.S. Geological Survey. The data were recorded on paper and also on digital tape for future processing enhancements. Navigation during the cruise utilized a satellite Global Positioning System (GPS) with LORAN-C as a secondary system. This equipment package produced a state-of-the-art data set that will be used throughout the cooperative effort and in future research.

Geophysical data were collected for two small areas—an area northeast of Cleveland and an area between Sandusky and Lorain. Preliminary interpretation suggests that the high-quality geophysical data can be used to delineate mappable geologic units.



Geophysical and navigational equipment in the cabin of the Division of Geological Survey's research vessel, the GS-1, during a scientific cruise in September 1991.

Cruises to gather additional geophysical data are planned for June and September 1992. After this reconnaissance geophysical field work is completed, bottom sediments will be sampled by grab sampling, coring, and hand collection using SCUBA equipment. These samples will be used to substantiate the interpretations derived from geophysical data. Additional detailed, site-specific investigations may be carried out in areas where reconnaissance data suggest complex geologic relationships.

Results from this cooperative research program are expected to develop a better understanding of the geologic settings and processes that affect the coastal area. The potential economic and recreational benefits of a more complete understanding are enormous.

—Jonathan A. Fuller
Lake Erie Section
Division of Geological Survey

—Ronald Circé
U.S. Geological Survey

NEW APPOINTMENTS TO THE OHIO GEOLOGY ADVISORY COUNCIL

Governor George V. Voinovich has appointed three new members to the Ohio Geology Advisory Council to replace Arie Janssens, Thomas Lewis, and Linda Aller, whose terms expired. The new councillors introduced at the January 14, 1992, quarterly meeting are: Mark R. Rowland, hydrogeologist for Burgess & Niple, Columbus, representing environmental geology; Lon C. Ruedisili, Professor of Geology at the University of Toledo, representing higher education; and Gary W. Sitler, geologist for Stocker & Sitler, Inc., representing oil and gas. They join Council members E. Scott Bair, J. Barry Maynard, Michael T. Puskarich, and Robert A. Wilkinson.

OHIO'S OLDEST FOSSILS

The deep core completed by the Survey in 1989 in Warren County (see *Ohio Geology,* Summer 1989) continues to yield information that changes the traditional picture of Ohio geology. Dr. Loren E. Babcock, an assistant professor in the Department of Geological Sciences at The Ohio State University and an expert on Cambrian trilobites, recently examined a lengthy section of the core for fossils of Cambrian age. A 201-foot interval between a depth of 2,620 feet and 2,821 feet yielded a fauna dominated by disarticulated trilobites and less common remains of inarticulate brachiopods, echinoderms, graptolites, and trace fossils.

The fossiliferous interval spans the lower part of the Knox Dolomite and the upper part of the Eau Claire Formation, an interval that has traditionally been interpreted to be latest Cambrian in age. The discovery of relatively well preserved specimens of a trilobite, *Cedaria* cf. *C. prolifica,* indicates that these rocks are late Middle Cambrian (Dresbachian) to early Late Cambrian (Franconian) in age, and thus older than previously supposed. This trilobite is an index fossil of the *Cedaria* Zone, which is widely recognized in North America.

Other fossils found in the sampled interval of the Warren County core include a pygidium (tail) of a polymeroid trilobite similar to *Pterocephalia,* numerous unidentifiable pieces of trilobites, unidentifiable acrotretid brachiopods, brachiopods referable to *"Lingulella,"*

Partial cephalon (head) of a trilobite, Cedaria *cf.* C. prolifica *on a bedding plane from a depth of 2,821 feet (upper Eau Claire Formation) in Ohio Geological Survey core 2627 from Warren County, Ohio. Note the circular edge of the core on the left side of the photo. Magnification x 3.2. Photo by Loren E. Babcock.*

ossicles of echinoderms, a single fragment of an undetermined dendroid graptolite, and various trace fossils.

Cambrian rocks are not exposed in the state; therefore, our only samples of them are derived from scientific cores or cores drilled by industry. The fossils discovered by Dr. Babcock in the Warren County core are the oldest fossils known from Ohio. It is probable that other cores from this interval would yield additional specimens.

The information on the age of this fossiliferous zone in the Eau Claire/Knox interval suggests that Ohio's lowermost Cambrian unit, the unfossiliferous Mount Simon Sandstone, is Middle Cambrian or older in age, instead of Late Cambrian, as has traditionally been determined. The age of the Middle Run Formation, the thick unit discovered in the Warren County core below the Mount Simon Sandstone, is at least Middle Cambrian in age, although it is probably even older (Precambrian).

—Michael C. Hansen

FURTHER READING

Janssens, Arie, 1973, Stratigraphy of the Cambrian and Lower Ordovician rocks in Ohio: Ohio Division of Geological Survey Bulletin 64, 197 p.

Shrake, D. L., and Hansen, M. C., 1989, Warren County deep core: Ohio Geology, Summer, p. 1, 3.

Shrake, D. L., Wolfe, P. J., Richard, B. H., Swinford, E. M., Wickstrom, L. H., Potter, P. E., and Sitler, G. W., 1990, Lithologic and geophysical description of a continuously cored hole in Warren County, Ohio, including description of the Middle Run Formation (Precambrian?) and a seismic profile across the core site: Ohio Division of Geological Survey Information Circular 56, 11 p.

FLINT LEAFLET REVISED

The Survey's Educational Leaflet No. 6, *Flint, Ohio's official gemstone,* first published in 1967, has recently been revised. The text has been rewritten in order to provide more information on the geology of flint, including references for additional information. The cover and many of the illustrations remain the same as in previous versions of the leaflet; however, a map depicting the occurrences of flint deposits in rocks of Pennsylvanian age and a map of roads and flint deposits on Flint Ridge have been added. These maps are from Dr. Ernest H. Carlson's recently published Survey Bulletin No. 69, *Minerals of Ohio.*

This educational leaflet on flint has been extremely popular during its nearly 25-year existence. Single copies of Educational Leaflet No. 6 are available at no charge from the Survey. To order multiple copies of this leaflet, please contact the ODNR Publications Center, 4383 Fountain Square Drive, Columbus, OH 43224-1362 (telephone 614-265-6605).

UPCOMING EVENTS

May 1-3, 1992—Ohio Academy of Science Annual Meeting. University of Akron. Contact: Ohio Academy of Science, 445 King Ave., Columbus, OH 43201. Telephone: 614-424-6045.

May 2-3, 1992—28th Annual Gem, Mineral, Fossil, and Jewelry Show and Sale, sponsored by the Cincinnati Mineral Society. Cincinnati Gardens, 2250 Seymour Ave., Cincinnati. Contact: John and Regina Fischer, 2437 Dorian Drive, Cincinnati, OH 45212. Telephone: 513-533-3612.

July 23-26, 1992—American and Midwest Federations of Mineral Societies Convention and Show, sponsored by the Brunswick High School Geology Society and others. Brunswick High School, Brunswick. Contact: Joel B. O'Sickey, 305 Monroe Ave., Cuyahoga Falls, OH 44221.

October 26-29, 1992—Geological Society of America Annual Meeting, Cincinnati Convention Center, Cincinnati. Contact: Geological Society of America, 3300 Penrose Place, Boulder, CO 80301. Telephone: 303-447-2020.

JEAN LESHER RETIRES

Jean M. Lesher, typesetting and printing technician in the Technical Publications Section, retired on March 31, 1992, after 30 years of service to the Survey. At the time of her retirement Jean had longer service with the Survey than any other current employee.

Jean was responsible for typesetting and layout of all Survey publications, text for displays and exhibits, and any other Survey products that utilize typeset lettering, including every issue of *Ohio Geology*. She has produced over 170 Survey publications in her career at the Survey. The high quality of these publications has been in large part due to Jean's skills and attention to detail in producing type for layout. Through the years, Jean has used a variety of typesetting equipment, including the current computerized system. Such equipment is complex and requires considerable knowledge and concentration in order to produce the desired final product. She recalls the early typesetting equipment that required each line to be typed twice in order to produce right justification of columns and feels fortunate to have had the opportunity to use a computerized system.

Many people do not realize the amount of work and effort that is involved in producing a Survey publication after the manuscript and illustrations are submitted by a geologist. Survey staff have long admired Jean's abilities in this process and, in 1989, honored her with the Employee of the Year award. Jean recalls that it has always been rewarding to see the final, printed publication.

Jean's retirement will be short lived, at least for the near future. She plans to return to the Survey on a part-time basis to assist with typesetting. She also plans to travel, enjoy her grandchildren, and spend more time caring for her horse. Jean says that she will miss the daily contact with Survey staff and reflects that the 30 years went quickly.

SILURIAN-DEVONIAN CORRELATION CHART

The Survey recently released Open-File Report 91-1, *Development of Silurian and Devonian lithostratigraphic nomenclature, central-western and northwestern Ohio,* which was compiled by Survey geologist Glenn E. Larsen. The chart measures 50 by 25 inches and contains 30 columns, each of which summarizes the terminology for Silurian and Devonian rocks as used by various authors ranging from the initial reports of the First Geological Survey of Ohio by Charles Briggs, Jr. and John Locke in 1838 to the terminology currently used by the Division of Geological Survey. The chart contains 50 annotations which include the original references to various rock units and a comprehensive bibliography.

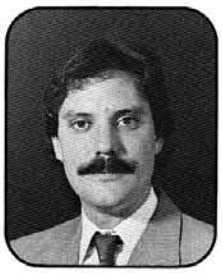
The chart was constructed in preparation for geologic mapping of western Ohio as part of the National Cooperative Geologic Mapping Program (COGEOMAP) and the new state bedrock geologic map. It provides a means to evaluate the significance of the existing published nomenclature of central-western and northwestern Ohio, to correlate the antiquated nomenclature first published in the 1800's with modern nomenclature, and to assist in developing a suitable stratigraphic framework for evaluating future problems. The chart will be a valuable aid to geologists working with Silurian and Devonian rocks in this portion of the state.

Blueline paper copies of Open-File Report 91-1 are available from the Survey for $8.10 each, which includes tax and mailing.

1992 GSA MEETING IN CINCINNATI

The Geological Society of America will hold its 1992 annual meeting in Cincinnati on October 26-29 at the Cincinnati Convention Center in downtown Cincinnati. Eighteen field trips to various areas in the region will be conducted before, during, and after the meeting. For more information, contact the Geological Society of America, 3300 Penrose Place, Boulder, CO 80301-9140 (telephone: 303-447-2020).

SURVEY STAFF NOTES



James McDonald

Allan G. Axon

Jim McDonald is a geologist in the Subsurface Stratigraphy and Petroleum Geology Section with responsibility for the computerization efforts of the Division. He is originally from Deptford, New Jersey. After receiving a bachelor's degree in geology from the University of Delaware, Jim came to The Ohio State University, where he completed a master's degree in geology, specializing in glaciology. During that program he made two trips to Antarctica and a trip to Greenland.

Jim began working for the Survey in 1990 as an intern assisting with computerization and became a full-time employee in early 1991. He is involved with training Survey employees on various computer systems and progressing towards the goal of eventually computerizing all Survey data. It is Jim's thinking that such a goal will become a necessity in order for the Survey to quickly and efficiently provide the citizens of the state with geologic information in a rapid fashion.

Jim's research interests include computer applications in geology, geostatistics, geophysics, and petroleum geology. Jim lives in Columbus and likes backpacking, running, and travelling as hobbies.

Allan Axon is a geologist in the Mineral Resources and Geochemistry Section and recently began his career with the Survey under a federal grant from the U.S. Geological Survey for the National Coal Resources Data System (NCRDS), a program that is assessing coal availability on a national basis. Allan's familiarity with computers and coal databases, much of which he learned while working part-time for Island Creek Coal Company in Kentucky, will be a great asset for this program.

Allan grew up in Charlotte, North Carolina, and obtained a bachelor's degree in geology from the University of North Carolina. He obtained his master's degree from the University of Kentucky and will obtain a Ph.D. from that university in the spring of 1992. His dissertation is on the paleoecology of crinoids from Ordovician rocks in southwestern Ohio.

Although his research interests are diverse, Allan hopes to concentrate on the stratigraphy of Pennsylvanian coal-bearing rocks in eastern Ohio. Allan is married and his wife is a geologist with the Ohio Environmental Protection Agency. They live in Westerville.

HYDROLOGIC ATLAS FOR OHIO

The Ohio Department of Natural Resources, Division of Water recently published *Hydrologic atlas for Ohio.* This report, authored by Leonard J. Harstine, provides detailed information on average annual precipitation, temperature, streamflow, and water loss for the state based on a 50-year record from 1931 to 1980. These data are depicted on separate 1:1,000,000-scale maps. The 13-page report also provides data on snowfall and evaporation from water surfaces.

The hydrologic atlas is designed as a source of hydrologic data for a wide variety of investigations and will be of particular interest to environmental and ground-water scientists, water-supply engineers, dam construction and design engineers, and other environmental consultants and planners.

The *Hydrologic atlas for Ohio,* known as Water Inventory Report No. 28, can be ordered from the ODNR Publications Center, 4383 Fountain Square Drive, Columbus, OH 43224-1362 (telephone 614-265-6605). The cost is $6.54, which includes tax and mailing. Please make checks payable to ODNR Publications Center.

QUARTERLY MINERAL SALES, OCTOBER—NOVEMBER—DECEMBER 1991

compiled by Sherry L. Weisgarber

Commodity	Tonnage sold this quarter[1]	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	6,700,494	136	$179,908,543
Limestone/dolomite[2]	11,651,240	99[3]	44,544,491
Sand and gravel[2]	10,204,017	222[3]	34,119,531
Salt	477,340	5[4]	8,503,213
Sandstone/conglomerate[2]	356,042	15[3]	5,972,052
Clay[2]	503,909	26[3]	1,169,417
Shale[2]	346,919	24[3]	526,685
Gypsum[2]	53,866	1	511,727
Peat	1,439	4[3]	27,717

[1]These figures are preliminary and subject to change.
[2]*Tonnage sold* and *Value of tonnage sold* include material used for captive purposes. *Number of mines reporting sales* includes mines producing material for captive use only.
[3]Includes some mines which are producing multiple commodities.
[4]Includes solution mining.

1991 OHIO MINERAL SALES[1]

compiled by Sherry L. Weisgarber

Commodity	Tonnage sold in 1991[2]	Number of mines reporting sales[2]	Value of tonnage sold[2] (dollars)	Percent change of tonnage sold from 1990[2]
Coal	29,263,501	198	$820,764,882	-10.79
Limestone/dolomite[3]	48,066,827	117[4]	178,778,851	-8.79
Sand and gravel[3]	39,458,778	255[4]	133,516,830	-10.44
Salt	2,670,240	5[5]	42,029,361	-35.48
Sandstone/conglomerate[3]	1,457,871	23[4]	25,487,571	-20.15
Clay[3]	1,802,184	44[4]	5,188,592	+14.22
Shale[3]	1,821,025	37[4]	3,144,079	+32.48
Gypsum[3]	199,857	1	1,898,642	-2.29
Peat	18,530	4[4]	276,199	-59.45

[1]The sums of previously reported quarterly totals may not necessarily equal the annual totals reported here owing to the receipt of additional information or corrections to previously reported figures.
[2]These figures are preliminary and subject to change.
[3]*Tonnage sold* and *Value of tonnage sold* include material used for captive purposes. *Number of mines reporting sales* includes mines producing material for captive use only.
[4]Includes some mines which are producing multiple commodities.
[5]Includes solution mining.

NATURAL GAS INFORMATION CENTER ESTABLISHED AT MARIETTA COLLEGE

The Gas Research Institute (GRI), a not-for-profit research and development organization that funds research that will benefit the natural gas industry and its customers, has announced the opening of the Northeast Natural Gas Supply Information Center at Marietta College in Marietta, Ohio. The purpose of the center is to collect and provide the most up-to-date research results on natural gas production, gas shales, coal seams, and tight gas sands in order to enhance industry production.

The center is located on the second floor of the Dawes Memorial Library at Marietta College. Tamra Armstrong, information specialist, will assemble requested information by researching the GRI database as well as Marietta College's collection of natural gas exploration and production information. Clients pay only for photocopying.

The Northeast Natural Gas Supply Information Center can be contacted at Dawes Memorial Library, Marietta College, Marietta, OH 45750 (telephone: 614-374-4742, fax: 614-374-4843).

Ohio Department of Natural Resources
Division of Geological Survey
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OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

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