WINTER 1989

Ohio Geology Newsletter

Division of Geological Survey

And some rin up hill and down dale,
knapping the chucky stanes to pieces wi' hammers,
like sae many road makers run daft.
They say it is to see how the world was made.

—Sir Walter Scott

"HOW THE WORLD WAS MADE"— THE COCORP TRAVERSE OF OHIO

by Michael C. Hansen

The quaint characterization of geologists and their mission by 19th century Scottish poet and novelist Sir Walter Scott captures the essence of geologic investigations—to see how the world was made. Geologists don't begin every investigation with such a profound goal; however, nearly any geologic study, whether it be economic, environmental, or perhaps more academic, must begin with a fundamental understanding of the geologic history of an area.

Geologists still roam the hills and valleys in time-honored tradition with hammers in hand in order to investigate the geologic history of an area, but in recent years new tools have become available that allow us to venture, albeit indirectly, into new and uncharted terrain—namely the deeply buried Precambrian basement rocks that form the foundation of the state. This *terra incognita* is an archive for nearly 90 percent of Ohio's geologic history and may be properly termed the last frontier of geologic exploration.

Just as the foundation shapes the design and stability of a building, so have the Precambrian rocks shaped the depositional patterns and structures in the sedimentary rocks that blanket them. An understanding of the Precambrian rocks is therefore a vital element in exploration for economic resources in the overlying sedimentary rocks.

Our understanding of the Precambrian basement rocks has been characteristically poor because they are nowhere exposed in the state and are buried beneath 2,500 to more than 13,000 feet of sedimentary rock. Until recently, information on Precambrian rocks in the state came from about 160 deep oil and gas wells that penetrated the basement. Most of these wells have been concentrated in western Ohio, where the basement is shallow, and only a few of them have yielded actual rock samples or penetrated more than a few tens of feet into the Precambrian. Analyses of the data from these wells have given us a general paleotopographic interpretation of the configuration of the basement surface and have indicated a complexity of rock types that has been more confusing than enlightening.

The publication of statewide aeromagnetic and gravity maps (see *Ohio Geology*, Summer 1984) provided pro-

COCORP vibrator trucks in tandem in Coshocton County during the fall of 1987.

vocative clues to the configuration of the Precambrian rocks in Ohio and revealed a startling complexity to the distributional pattern of these rocks. However, these data did not provide all of the pieces to the puzzle; therefore, the application of an additional technique of indirect study of the Precambrian rocks was greatly anticipated.

This technique to probe the last frontier is seismic reflection profiling and was described in the Fall 1987 issue of *Ohio Geology*. COCORP (Consortium for Continental Reflection Profiling), a National Science Foundation-supported program directed by Cornell University, conducted this investigation of the deep crustal geology beneath the state to obtain information on rocks to depths approaching 30 miles. The Ohio profile was part of a more extensive traverse from Missouri across Illinois and Indiana.

Seismic reflection profiling, as carried out by COCORP, uses truck-generated vibrations as a source of energy to probe deep into the earth's crust. These vibrations bounce off boundaries, known as reflectors, representing changes in rock types or major structural features and return to the surface, where they are picked up by sensitive recording devices called geophones. The data are recorded and stored on computer tapes and then processed to produce a vertical cross section of the area traversed. The cross section displays the reflectors encountered by the seismic waves.

Once the cross section has been developed, the major and challenging task begins of interpreting the geology as depicted by the reflectors. To decipher the geology, other data, including information from deep drill holes and from gravity and magnetic surveys, are used to supplement the information from reflection profiling. Nevertheless, interpreting a seismic section such as the one produced by COCORP for Ohio is a speculative venture because so little is known about these deeply buried rocks.

ODNR
OHIO DEPARTMENT OF NATURAL RESOURCES

Richard F. Celeste, Governor • Joseph J. Sommer, Director

Presented here are the preliminary results and interpretations of the profile as determined by Thomas L. Pratt and other COCORP scientists. These results will be published in a technical paper in the Geological Society of America's monthly journal, *Geology,* in the spring of 1989. Copies of the computer data tapes and paper copies of the profile are available to the public. Ordering information is given at the end of this article.

Location of COCORP line across Ohio.

PROFILE RESULTS AND INTERPRETATIONS

The Ohio seismic profile illustrates a complexity of basement rocks that was suggested by aeromagnetic and gravity maps of the state (see *Ohio Geology,* Summer 1984). But seismic reflection profiling has the advantage of looking at rock boundaries and structures in the vertical dimension and, with COCORP, to great depths. Some of the features revealed by the COCORP traverse have long been thought to be present in the subsurface of the state, but other features were completely unknown previously and probably will be the subject of much future debate and speculation.

It should be noted that the COCORP profile provides little information on detailed structure of Paleozoic sedimentary rocks. At the scale necessary to obtain images of deep (30 miles or more) crustal rocks, the 2,500 to 13,000 feet of sedimentary rocks covering the state is little more than a thin, indistinct surface coating above the Precambrian rocks that make up most of the 30-mile-thick crust in Ohio.

WESTERN OHIO

Western Ohio, from the Indiana border to about the vicinity of Bellefontaine in Logan County, exhibits an extensive sequence of layered Precambrian rocks that appear to extend westward to southern Illinois. The rocks in this thick, layered sequence are thought to be mostly granites, rhyolite flows, and perhaps ash-flow tuffs. Indeed, samples from deep drill holes penetrating the uppermost portion of these rocks seem to confirm this interpretation. The rocks in this sequence are about 1.5 billion years old and are assigned to the middle Proterozoic of the Precambrian. The upper part of this sequence may also include some Precambrian sedimentary rocks which may have potential for oil and gas deposits.

The COCORP profile also delineates a shallow (about 3 miles deep) Precambrian rift zone in western Ohio. Such rift zones are fault-bounded basins that commonly are the sites for accumulation of sedimentary rocks and basaltic lava flows. Rifts represent areas where the continental plate began to split apart, but in this case the separation was not complete, leaving what is more properly termed a failed rift.

The rift in Ohio delineated by the COCORP profile extends from south of Celina, Mercer County, to near Bellefontaine in Logan County. The rift is thought to be related to an extensive episode of rifting about 1.1 million years ago in the area of the present-day middle United States. These rifts are known as Keweenawan rifts, named after an exposed sequence of rift-accumulated rocks on the southern shore of Lake Superior. The western Ohio rift may be part of a series of similar rifts (known as the Midcontinent rift system) that stretch in an arcuate pattern from Kansas northward through Nebraska, Iowa, and Minnesota to Lake Superior, then southward through Michigan, Ohio, and into Kentucky.

The dimensions and extent of the western Ohio rift zone are poorly known. Recent studies of the gravity and aeromagnetic maps of Ohio by Jeffrey E. Lucius and Ralph R. B. von Frese of Ohio State University suggest that the western Ohio rift has a northwest-southeast orientation in the area traversed by the COCORP profile. They also suggest that the rift is oriented in a north-south direction in southern Ohio.

Perhaps one of the most interesting aspects of the western Ohio rift in the area crossed by the COCORP profile is the relationship of this feature to the moderate-sized earthquakes that periodically strike this region, particularly in Shelby and Auglaize Counties. Although the COCORP profile does not precisely identify the sources of these earthquakes, it is not improbable that ancient faults associated with the rift zone are areas of weakness that periodically fail under crustal stresses. More detailed analysis of the COCORP data in this area may yield additional ideas on earthquake sources and mechanisms in western Ohio.

GRENVILLE FRONT AND GRENVILLE PROVINCE

Radiometric dating of Precambrian rocks from deep wells in Ohio suggested nearly 30 years ago that a major boundary between older (1.3-1.4 billion years old), unmetamorphosed igneous rocks to the west and younger (0.9 to 1.0 billion years old) metamorphic rocks to the east existed in western Ohio. This boundary zone in the subsurface of Ohio was compared to and correlated with an exposed sequence of disturbed rocks on the Canadian Shield known as the Grenville Front.

In the ensuing three decades since it was proposed that the Grenville Front forms a north-south zone in western Ohio, there has been much debate on the exact location of this boundary zone. Information from new wells drilled into Precambrian rocks and aeromagnetic and gravity data generally have supported the original interpretation of the location of the Grenville Front. The COCORP profile not only gives proof of the position of the front but also adds some provocative details about the nature of this boundary zone.

The COCORP profile clearly shows a series of parallel, east-dipping reflectors in a 30-mile-wide zone that stretches from Bellefontaine in Logan County to just west of Magnetic Springs in Union County. These reflectors, which can be traced from the top of the Precambrian rocks to mid-crustal depths, clearly represent the Grenville Front, or more precisely, the Grenville Front Tectonic Zone. The seismic signature of this zone in Ohio is nearly identical to that recently obtained by seismic reflection profiling across Lake Huron near the surface exposure of the Grenville Front in Canada. This profile was acquired under the auspices of the Great Lakes Interna-

OHIO GEOLOGY

A newsletter published quarterly by the Ohio Department Natural Resources, Division of Geological Survey, Fountain Square, Columbus, Ohio 43224. Telephone (614) 265-6605 (Voice) or (614) 265-6994 (TDD).

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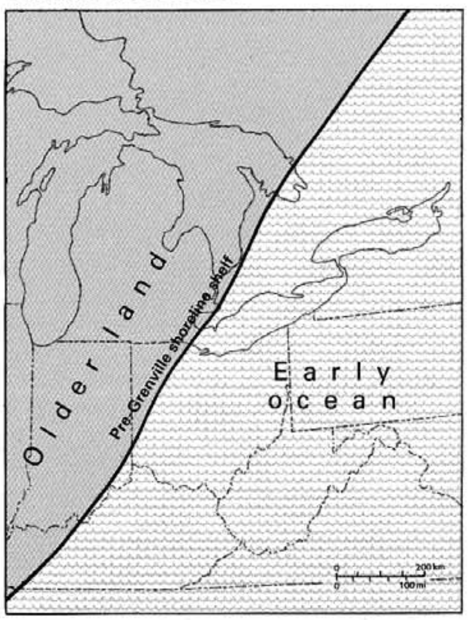
News items, notices of meetings, etc. should be addressed to the attention of the editor. Change of address and new subscriptions should be addressed to the attention of the secretary.

tional Multidisciplinary Program on Crustal Evolution (GLIMPCE).

But what is the Grenville Front? This 2,500-mile-long feature, stretching from the Labrador coast southward to Lake Huron and beyond into Ohio and perhaps farther south, has been termed "one of North America's greatest structural discontinuities." In Canada, the front represents the junction of early Precambrian (Archean) and later Precambrian (Proterozoic) rocks. This great structural discontinuity marks the western edge of a great chain of Precambrian mountains that stretched across eastern Canada into the north-central United States.

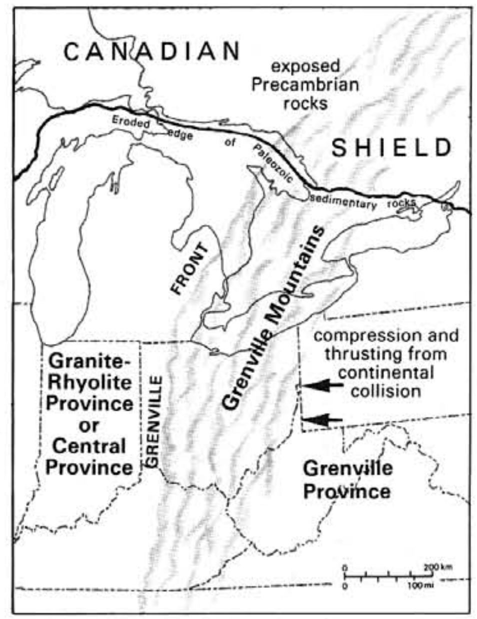


Possible location of ocean and shoreline prior to continental collision that produced the Grenville Mountains.

The geologic history of this mountain chain can be traced in a general way. Prior to the Grenville mountain-building event, a sea blanketed most of Ohio. The shoreline, or perhaps the continental shelf, of this sea may have been located in northwestern Ohio. Collision of the North American continent with a continent to the east about 1.2 billion to 950 million years ago resulted in destruction of the ocean covering Ohio and the thrusting of great slices or wedges of rock over one another. This westward-directed thrusting elevated the Grenville Mountains into a lofty chain perhaps rivalling the modern-day Rocky Mountains.

The 30-mile-wide Grenville Front in west-central Ohio marks the western edge of deformation during the mountain-building event. Eastern Ohio was also involved in this deformation; however, here the COCORP profile and other data suggest the presence of a series of metamorphic rocks that were thrust along low-angle, shallow-dipping thrust planes. All of Ohio east of the Grenville Front is included in the Grenville Province of Precambrian rocks.

The Grenville Front appears to coincide with the western edge of the Appalachian Basin, which extends eastward to the present-day Appalachian Mountains. This basin subsided slowly and episodically throughout the Paleozoic Era and accumulated a great thickness of sediments. The Grenville Front appears to mark the hinge-line of the Appalachian Basin and may be a boundary between two great crustal blocks; the eastern one (Grenville) subsided during the Paleozoic and the western one

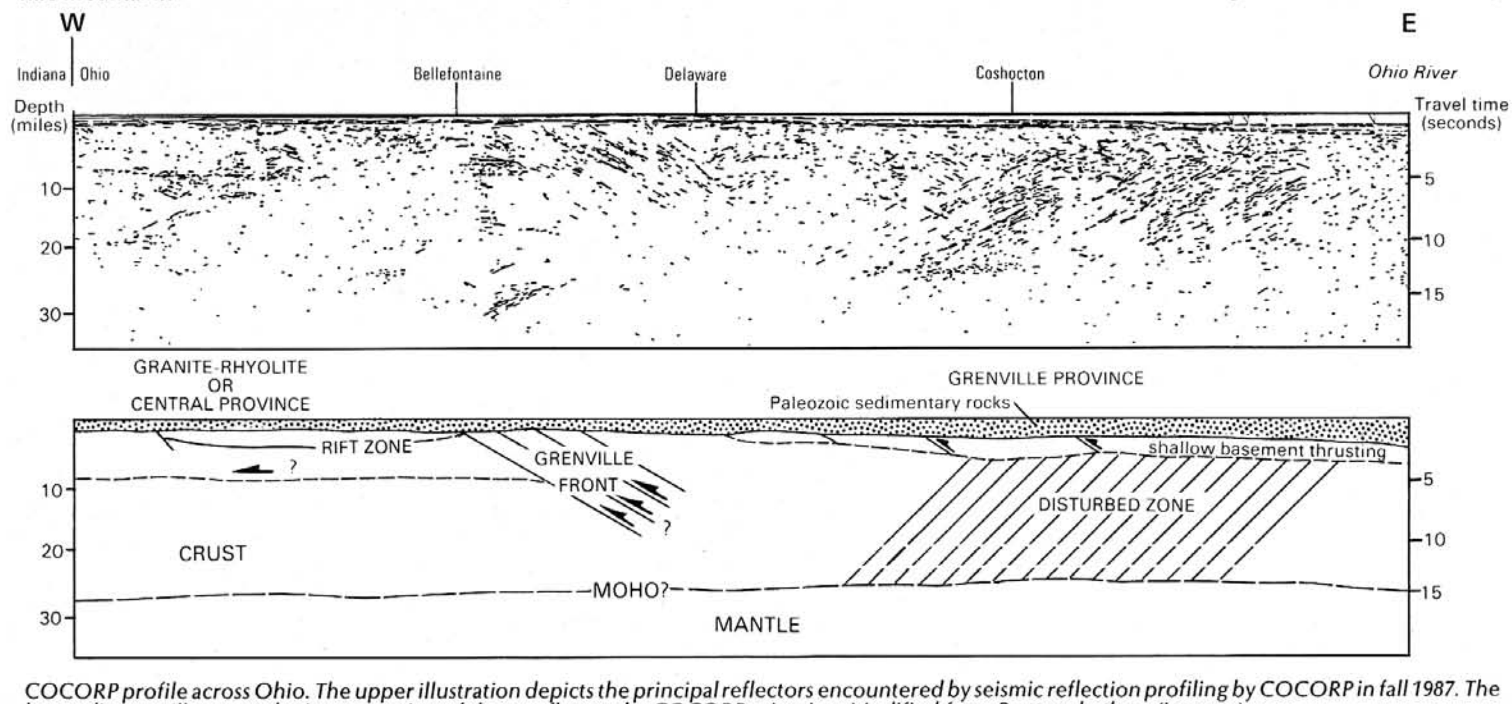


Probable extent of the Grenville Mountains after continental collision.

formed a geologically stable area known as the Ohio-Indiana Platform, more commonly called the Cincinnati Arch. Our knowledge of these features and their relationship to one another and to later geologic history in the state is still in a primitive stage; however, it seems certain that these Precambrian crustal blocks have had a significant and continued influence on later geologic events in the state.

EASTERN DISTURBED ZONE

Perhaps the greatest surprise revealed by the COCORP profile was a 50-mile-wide zone of steep, westward-dipping reflectors stretching from Coshocton County



COCORP profile across Ohio. The upper illustration depicts the principal reflectors encountered by seismic reflection profiling by COCORP in fall 1987. The lower diagram illustrates the interpretation of these reflectors by COCORP scientists. Modified from Pratt and others (in press).

eastward to the Ohio River. These reflectors extend from mid-to-deep crustal depths of about 25 miles or more. This deep zone is in the region of the Mohorovičić discontinuity (MOHO), the boundary between the earth's crust and the underlying mantle. The westward-dipping relectors appear to be truncated in their upper portion at a depth of about 7 miles by the low-angle thrust slices of the Grenville Province. These reflectors do not anywhere appear to reach the base of the overlying Paleozoic sedimentary rocks.

The geologic interpretation of these westward-dipping reflectors is a subject for speculation. COCORP scientists suggest that these reflectors may represent juxtaposed slices of different rock types that were formed during a major continental collision. Was this the collision that produced the Grenville Mountains? Or is this an ancient collision zone that was formed long before Grenville mountain building?

SETTLEMENT OF THE LAST FRONTIER

We have frequently referred to the rocks in the subsurface, and particularly the Precambrian rocks, as the last geological frontier in Ohio. The comparatively few oil and gas wells in the state that have just barely penetrated basement rocks have given us little more than a brief glimpse of this complex suite of rocks. The COCORP profile and the aeromagnetic and gravity maps of Ohio have provided us with a substantial increase in our knowledge of rocks in the last frontier. However, although expeditions into the heart of this unknown terrain provide answers to long-asked questions, perhaps more importantly they also provide many new questions.

The COCORP profile is a milestone in Ohio geology and gives us a mechanism for interpreting more than a billion years of Ohio's geologic history. And this history is more than fanciful musing about days long gone. Indeed, such information is fundamental to exploration for economically valuable mineral and hydrocarbon deposits, in understanding earthquakes and other environmental concerns, and perhaps also to satisfy the human curiosity to "see how the world was made."

ACKNOWLEDGMENTS

We thank the personnel of COCORP at Cornell University, particularly Thomas L. Pratt and Sidney Kaufman, for their continued help and cooperation and for their permission to publish this summary of the Ohio traverse before formal publication of their technical paper. We also thank COCORP for acting on our suggestion that Ohio might yield some interesting results from deep seismic reflection profiling. The results exceeded our expectations and, perhaps, theirs also.

FURTHER READING

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OBTAINING COCORP PROFILES

The COCORP profile for Ohio and the location map of the line are available from either COCORP or the Division of Geological Survey. The Ohio profile consists of the line location map, which depicts the precise location of the line and the primary vibration points for reference to the profile, on a 1:250,000-scale base map, and three separate segments of the seismic profile. These three sheets display a total of 67 inches of reflection data on 11-inch-high paper.

The COCORP sheets for Ohio are:

90 Line location map
91 Ohio 1 (Mercer, Auglaize, Shelby, Logan, Union, Delaware Counties)
92 Ohio 1, continued (Delaware, Knox, Coshocton Counties)
93 Ohio 2 (Coshocton, Muskingum, Guernsey, Harrison, Belmont Counties)

Price (which includes tax and handling) of the COCORP data sheets and location map is $3.00 each ($12.00 for the set). Prepayment is required. Please order by number listed above. Order from either:

Ohio Department of Natural Resources
Division of Geological Survey
Fountain Square, Building B
Columbus, OH 43224
(telephone: 614-265-6605)

or

COCORP
3124 Snee Hall
Cornell University
Ithaca, NY 14853-1504
(telephone: 607-255-7165)

Computer tapes of COCORP data for the Ohio line (and others) are available only from COCORP. Please contact COCORP for prices and other information.

FIREBALLS SEEN IN OHIO

Three fireballs have been reported from Ohio in the past year, one of which was widely seen across a multistate area. This latter one was seen on March 27, 1988, at about 8:10 p.m. (Eastern Standard Time) across much of Ohio travelling in a northwest-southeast path. According to the Scientific Event Alert Network at the Smithsonian Institution, sightings were reported as far north as Milwaukee, Wisconsin, and Grand Rapids, Michigan, and as far south as La Grange, Kentucky. Some observers reported it to be as bright as the full moon, bright enough to cast shadows, and a few reports indicated that it dimmed and then brightened again. Early in its luminous phase, colors were reported to be blue green to white, but by the time it was visible in Ohio the colors had changed to yellow orange and red. The round- to teardrop-shaped fireball cast sparks during its passage. Two observers reported faint sounds and several reported that the fireball broke into fragments.

The fireball was moving at a medium to fast speed and was visible for 1.5 to 3 seconds. Most observers reported it to be at a low altitude (20 to 30 degrees) above the horizon, and many witnesses said that it disappeared above the horizon or passed over the horizon. A number of people who saw the fireball pass over the horizon were confused as to the origin of the bright streak and its apparent altitude and reported it as an airplane crash to local law enforcement agencies.

The fireball was witnessed by Survey fiscal officer Jim Miller as he was driving south on Interstate 71 in the vicinity of Ashland and was also witnessed by Survey geologist Ernie Slucher and his family as they were travelling north on Interstate 71 near the south edge of Columbus. Both individuals submitted reports to the Scientific Event Alert Network, an organization responsible for tabulating such observations so that determinations can be made in regard to the path and other characteristics of any individual fireball.

Another fireball was seen by Earl W. Phillips, Jr., from northwest Columbus on

June 26, 1988, at 11 p.m. (Eastern Daylight Time). This bright, yellow-orange body travelled in a northeast direction and moved downward at a 45-degree angle. It had a duration of about 2 seconds, vanished above the horizon, and left a luminous, yellow-orange trail. This event, reported by the Scientific Event Alert Network, did not generate a large number of reports over a wide area as did the fireball on March 27.

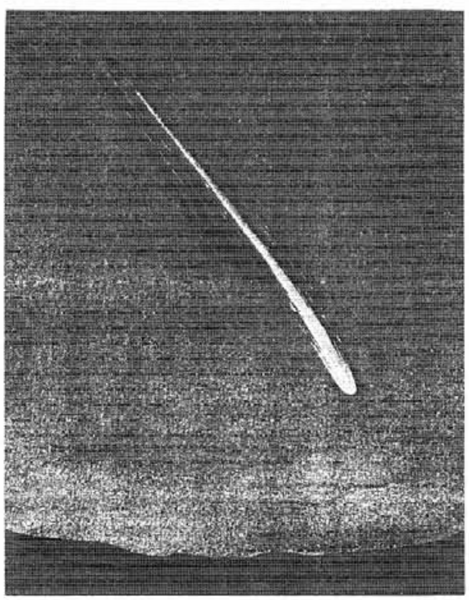
As this issue of *Ohio Geology* was being compiled, a large and spectacular fireball was seen at approximately 6:50 a.m. (Eastern Standard Time) on January 5, 1989. This fireball was witnessed over a wide area of the state, from Cincinnati to the Wheeling, West Virginia, area along the Ohio River. The Scientific Event Alert Network also received a number of reports from Kentucky and Indiana.

Two Survey staff members, environmental technician Henrietta Gaskins and geologist Richard Carlton, witnessed the event as they were driving to the Survey offices. Both described a large, bluish to yellowish-white fireball that suddenly appeared in the northern sky about 30 degrees above the horizon. The fireball was moving east at a low angle of descent and disappeared about 20 degrees above the eastern horizon. Duration of the event was approximately 2 to 3 seconds. A large, bifurcated tail trailed the fireball. A check with U.S. Air Force officials confirmed that this fireball was not due to reentry of satellite or rocket-booster debris into the atmosphere.

But what exactly is a fireball (also known as a bolide) and why tabulate observations of such an ephemeral event? To answer the second part of the query first, tabulation of fireball observations provides a detailed answer to the public's curiosity about a shared experience of a spectacular event. Perhaps more importantly, from a scientific viewpoint, detailed observations of the path of the fireball sometimes can lead to prediction of the probable landing area and even to the recovery of the meteorite responsible for the fireball. Meteorites, the pieces that survive passage through the Earth's atmosphere, are rare and scientifically valuable fragments of our solar system that are unobtainable by any other means.

The answer to the first part of the query—what is a fireball?—is generally known to most people to be a meteor. Most of us as children, and, we hope, a few of us as adults, have taken great delight in watching "shooting stars" on a clear summer night. Shooting stars are miniature versions of fireballs and result from the luminescence of sand-size grains as they vaporize from friction as they plunge through earth's atmosphere. Fireballs are created by larger cosmic particles entering the atmosphere.

Meteoroids (as these masses are termed when they are free-floating bodies in space) are captured by the earth's gravitational field and plunge through the atmosphere as meteors on a regular basis; estimates are that a meteoroid with a mass of 220 pounds enters the atmosphere once every three or four days. Most of these masses begin to luminesce as they encounter the upper layers of the atmosphere at altitudes of about 90 miles when they are travelling at velocities ranging from about 10 to 30 miles per second (36,000 to over 100,000 miles per hour). At altitudes ranging from about 2.5 to 25 miles the atmosphere is sufficiently dense to have slowed the velocity of the meteor so that it no longer is giving off light. At impact with the earth, many meteorites have velocities of only about 200 to 400 miles per hour—considerably slower than their atmospheric entry velocities of 36,000 to 100,000 miles per hour.



A fireball streaks across the night sky.

The velocities, altitudes, brightness, and other phenomena and the sudden appearance of fireballs in the sky commonly cause considerable confusion to some observers. Typically, almost all fireball events are accompanied by reports that it landed only a short distance away. These observers fail to realize that the fireball has disappeared below the horizon rather than crashing just beyond a tree line or a hill and that the meteor responsible for the event, if it survives atmospheric passage, will reach the ground tens or hundreds of miles downrange. An observer who notes that the fireball disappeared directly overhead (near the zenith) is much closer to the probable impact area of a meteorite. Commonly, observers close to the impact area will hear sonic booms as the meteor travels through the lower atmosphere faster than the speed of sound.

Reports on fireballs from many observers over wide areas can enable scientists to predict probable impact areas of meteorites and sometimes a search is launched that may result in the recovery of a meteorite. In most cases, however, meteorites are not recovered from observed fireballs. Estimates are that 500 meteorites land on earth each year but only about seven are recovered annually. Meteorites, of which there are a number of varieties, are important because they are thought to represent primordial rocks of the solar system and are thought to be similar to rocks at the core of the earth.

WHAT TO DO IF YOU SEE A FIREBALL

Any witness to a fireball has important information to contribute and the importance of that information is enhanced if the observer makes immediate note of several facts. Such observations should be sent to the Scientific Event Alert Network, NHB MRC 129, Smithsonian Institution, Washington, D.C. 20560 or to the Division of Geological Survey.

Important observations

1) Time of observation
2) Observation location and name, address, and phone number of observer
3) Direction observer was facing
4) Direction that fireball was moving (left to right, etc.)
5) Path of fireball (parallel to horizon, overhead, etc.)
6) Length of luminous path (estimate in degrees)
7) Duration of fireball (seconds it was visible)
8) Apparent velocity (fast, medium, slow)
9) Brightness (compare with full moon or Venus; include changes in brightness)
10) Color
11) Shape
12) Trail (sparks, smoke, etc.)
13) Termination (flared, fragmented; where in sky it vanished)
14) Sounds (with fireball, after termination; describe sounds)
15) Prepare a sketch of what you saw with the horizon and directions indicated as reference points.

In estimating the height of the fireball in degrees above the horizon, a simple technique of measurement is useful. A clenched fist at arm's length represents about 10 degrees. Therefore, by counting the number of "fists" above the horizon to where the fireball first appeared and where it disappeared and multiplying by 10, an observer can calculate the approximate height of the fireball above the horizon.

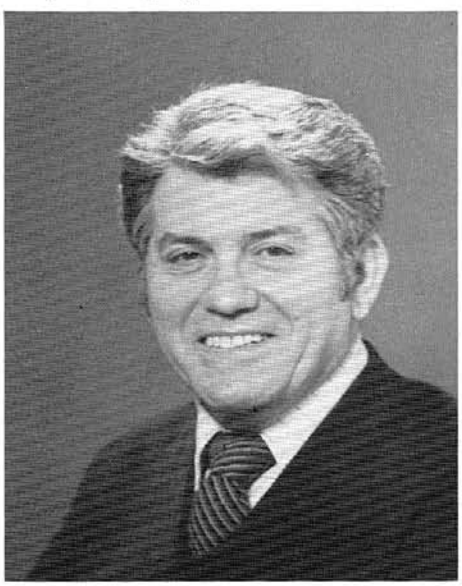
Only seven meteorites have been found in Ohio (see *Ohio Geology*, Summer 1983), but there must be numerous specimens awaiting discovery. Each year about a dozen or so specimens of presumed meteorites are submitted to the Survey for identification. So far, none have proved to be genuine and most specimens represent common rocks or industrial by-products such as furnace slag. If you should find a specimen that appears to meet the following criteria, please contact the Division of Geological Survey for further instructions.

Common meteorite characteristics

1) Extremely heavy in comparison to common rocks of similar size
2) Strongly to weakly attracted to a magnet
3) Dark-brown to black fusion crust in fresh specimens; may be rusty in weathered specimens
4) Irregular shape with dull, rounded edges. Surface may have pits that resemble thumbprints in clay
5) Interior (as revealed on a broken edge) light colored and metallic

GEORGE BOTOMAN RETIRES

George Botoman, a geologist in the Geochemistry Section of the Division of Geological Survey since 1973, retired on October 31, 1988. George devoted a large portion of his career with the Survey to a cooperative program with the U.S. Geological Survey for analyzing Ohio coals. He collected many of the coal samples used for these analyses throughout eastern Ohio and had the opportunity to meet many Ohio coal operators. As a result of this work, George coauthored four Information Circulars on chemical and physical properties of Ohio coals. He was also involved with the Survey's study of the washability characteristics of Ohio coals in the early 1980's.



George Botoman

George Botoman sampling coal in eastern Ohio.

Perhaps George's greatest interest, and passion, was the study of sulfide mineralization in western Ohio. He coauthored a Survey report (RI 104) on the occurrence of sulfide minerals in the state and investigated various ideas and models pertaining to potential economic concentrations of sulfides in Ohio. George undertook an investigation of sulfide mineral occurrence in northwestern Ohio using one of the Survey's core-drilling rigs. This investigation resulted in the Survey drilling, in Seneca County, what was then the deepest continuously drilled core in the state. George coauthored a Survey report (IC 51) on this core.

Although George had a long and productive career with the Division of Geological Survey, it was only the second half of his geological career. The first half of his career was as a geologist with the Romanian Geological Survey for 22 years. During this time George rose to the position of chief of exploration for ore deposits in Romania and had approximately 100 geologists under his leadership.

In 1970, George, his wife, Rodica, and their son decided to seek the freedom and opportunities of America. They soon found their way to Columbus and The Ohio State University, where George began work on a master's degree in geology and Rodica found a position teaching Romanian. George joined the Survey in 1973 and completed his thesis on structural geology of Precambrian rocks of western Ohio in 1975, the year he also became a U.S. citizen.

In reflecting on his years with the Survey, George said he has enjoyed the exchange of ideas and interaction with other geologists and doing field work in Ohio—a very different setting from the Carpathian Mountains of his native Romania. George said that he also developed an appreciation of those Survey geologists who have gone before us in deciphering the geology of the state, particularly former State Geologist Wilber Stout (1928-1946).

George and Rodica have planned several trips, including a visit with their son and his family in Seattle, a winter sojourn to Florida, and a trip back to Romania in the summer. After this respite, George plans to return to geologic work in some capacity while his wife continues her teaching career.

We will miss George's good humor and insightful geologic ideas. George left a mark at the Survey and he will not be easily replaced. We wish him well in his new ventures.

—Michael C. Hansen

OHIO'S MINERAL INDUSTRIES WORKSHOP

Are you a teacher and curious about the mining industries in Ohio? Then maybe the third annual Ohio's Mineral Industries Workshop is for you. The workshop is conducted by the Division of Geological Survey and the University of Akron and carries two semester hours of graduate credit. The 1989 workshop will be held June 26-June 30 at the ODNR Fountain Square complex in Columbus.

The purpose of the workshop is to familiarize participants with the geology of Ohio and the development of mineral industries in the state so that teachers can more effectively communicate this information to their students. Teachers will hear representatives from research, industry, and regulatory agencies present information on the economics, regulations, and geologic origin of mineral resources in the state. Three days of field trips give teachers a firsthand look at the operations of various mineral industries in central and southeastern Ohio.

For more information on the 1989 Ohio's Mineral Industries Workshop, contact Dr. Jim L. Jackson, University of Akron, 4570 Akron-Peninsula Road, Peninsula, Ohio 44264 (telephone 216-657-2815), or Sherry W. Lopez, ODNR, Division of Geological Survey, Fountain Square, Building B, Columbus, Ohio 43224 (telephone 614-265-6588).

—Sherry W. Lopez
Regional Geology Section

CHEMICAL ANALYSES OF LIMESTONES AND DOLOMITES

A report that will be of interest to the limestone industry in Ohio was recently released by the Division of Geological Survey. Open-File Report 88-1, *Limestone and dolomite chemical analyses, 1974-1982* gives standard chemical analyses for 240 samples of carbonate rock collected from outcrops in quarries or aggregate stockpiles at active quarry operations in 26 counties. The rocks sampled range in age from Silurian through Permian.

The original chemical analysis file form is reproduced for each sample locality. In addition to the chemical analyses, these forms identify the name of the quarry operator, date sampled and analyzed, stratigraphic unit, and location information, including the portion of the appropriate 7½-minute topographic quadrangle showing the location of the sample. Open-File Report 88-1 is available from the Survey for $2.86, which includes tax and mailing.

UPCOMING EVENTS

April 1-2, 1989—Wonderful World of Gems, Veterans Memorial Auditorium, 300 W. Broad St., Columbus. Sponsored by Columbus Rock and Mineral Society, Licking County Rock and Mineral Society, Rockwell International Mineral Society, The Rolling Stones.

April 19-20, 1989—Radon in Ohio: Radon Research and Public Policy, short course for scientists, public health professionals, and policymakers. Contact: Ohio Air Quality Development Authority, 1901 LeVeque Tower, 50 W. Broad St., Columbus, OH 43215. Telephone: 614-224-3383.

April 28-30, 1989—Ohio Academy of Science Annual Meeting, Cuyahoga Community College, Cleveland. Contact: Ohio Academy of Science, 445 King Ave., Columbus, OH 43201. Telephone: 614-424-6045.

May 20-21, 1989—25th Annual Gem, Mineral, and Fossil Show, Sabin Convention-Exposition Center, 5th and Elm (Downtown), Cincinnati. Sponsored by Cincinnati Mineral Society.

June 26-30, 1989—Ohio's Mineral Industries Workshop, ODNR Fountain Square complex, Columbus. Sponsored by Division of Geological Survey and University of Akron. See notice elsewhere in this issue.

Editor's note: *Ohio Geology* will print brief notices of upcoming meetings and events that are of interest to our readers. Owing to the vagaries of production and printing, such notices must be received at least four months in advance of the event.

NEW STATE GEOLOGIST NAMED

Joseph J. Sommer, Director of the Ohio Department of Natural Resources, announced on January 19, 1989, the appointment of Thomas M. Berg as the 11th State Geologist of Ohio and Chief of the Division of Geological Survey. He succeeds Horace R. Collins, who retired on April 30, 1988.

Berg has been with the Pennsylvania Geological Survey since 1965 and currently holds the position of Associate State Geologist and Chief of the Mapping Division of that organization. He will officially assume duties with the Ohio Geological Survey on March 13, 1989. The next issue of *Ohio Geology* will include additional information on Tom Berg's experience and his plans for the future of the Division of Geological Survey.

SURVEY STAFF CHANGES

COMINGS

Cathy Cheney, Secretary, Administrative Section.

GOINGS

Michael P. Angle, Geologist, Regional Geology Section, to Division of Water, Ohio Department of Natural Resources.

George Botoman, Geologist, Geochemistry Section, to retirement.

René L. Fernandez, Geologist, Regional Geology Section, to Ohio Groundwater Consultants, Inc., Columbus.

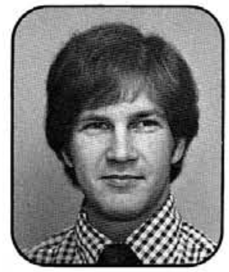
Constance M. Gulley, Secretary, Administrative Section, to Secretary, Deputy Director's Office, Ohio Department of Natural Resources.

FORMER STATE GEOLOGIST HONORED

Former State Geologist Horace R. Collins, who retired at the end of April 1988, was honored by the Ohio Aggregates Association at their November 1988 annual meeting as the recipient of the organization's "Rocky Award." According to Robert Wilkinson, Managing Director of the Ohio Aggregates Association, this award recognizes leadership on a state or national level in regard to the aggregates industry.

Collins was presented with this prestigious award for his assistance to the aggregates industry during his 20-year tenure as State Geologist. Wilkinson cited, in particular, Collins' role in developing the statewide county geologic mapping program at the Division of Geological Survey.

SURVEY STAFF NOTES



Glenn E. Larsen

Douglas L. Shrake

Glenn Larsen is a geologist in the Regional Geology Section and is responsible for mapping Upper Paleozoic rocks as part of the Survey's statewide county geologic mapping program. Currently, he is mapping Pennsylvanian rocks in southern Mahoning and northern Columbiana Counties.

Glenn is from Morton Grove, Illinois, and came to the Survey in 1983. He has a bachelor's degree in geology from Western Illinois University and a master's degree in geology from Ohio State University. He enjoys the variety in Survey work and the opportunity to spend time in the field as well as dealing with the public in answering some of the many questions that come to the Survey on a daily basis. Glenn has become the resident expert on the history of nomenclature of Pennsylvanian rocks in northeastern Ohio.

Glenn lives in Columbus with his wife and two children. He enjoys photography and woodworking as hobbies.

Doug Shrake is a geologist in the Regional Geology Section and is responsible for mapping Lower Paleozoic rocks as part of the Survey's mapping program. Most of Doug's mapping efforts have been with Ordovician rocks in Warren County. Doug's special research interest is the study of trilobites, particularly those from Ordovician and Silurian rocks.

Doug, who is originally from Troy, Ohio, joined the Survey staff in 1985. He has a bachelor's degree in geology from Ohio University and expects to finish his thesis and receive his master's degree in geology from Wright State University in June. He enjoys Survey field work and the opportunity to apply a wide range of geologic knowledge in daily activities.

Doug lives with his wife in the Columbus suburb of Worthington. Hiking and camping are favorite activities.

INTERSTATE 70 ROAD GUIDE

The Division of Geological Survey recently released another in the series of guides to the geology along Ohio's major highways. This publication, Educational Leaflet No. 14, *Guide to the geology along Interstate 70 between the Ohio-Indiana boundary and Columbus,* is authored by Dennis N. Hull.

The color leaflet includes a brief summary of the geology of western Ohio, bedrock and glacial geologic maps, and a cross section of the bedrock and glacial deposits along the route. A geologic highway map depicts the geologic and cultural features and highlights 12 significant features, which are explained in the accompanying text.

This road guide, and others in the series, are designed to provide nontechnical explanations of the geologic features along Ohio's major highways. The road guides have proven to be popular with a varied audience that ranges from individuals with little background in geology through students, teachers, and professional geologists. Additional guides in the series are: Educational Leaflet No. 11, *Guide to the geology along U.S. Route 23 between Columbus and Portsmouth,* and Educational Leaflet No. 13, *Guide to the geology along Interstate 75 between Toledo and Cincinnati.* Educational Leaflet No. 15, *Guide to the geology along Interstate 77 between Marietta and Cleveland,* will be issued in the near future.

Educational Leaflet No. 14, and others in the series, are available without charge from the Division of Geological Survey. There is a handling charge, however, for orders of more than five copies of individual titles.

OHIO EARTH SCIENCE TEACHERS ASSOCIATION

A new educational group, the Ohio Earth Science Teachers Association (OESTA), is now being formed. The objective of the organization is to share information among earth science teachers in the state. Field trips, a newsletter, and other activities are planned. For additional information, contact: Carl N. Bohn, 6422 S. Cleveland-Massillon Rd., Clinton, OH 44216 (telephone 216-825-2867) or Dan Jax, 920 Euclaire Ave., Bexley, OH 43209 (telephone 614-231-9919).

QUARTERLY MINERAL SALES, JULY—AUGUST—SEPTEMBER 1988

compiled by Sherry W. Lopez

Commodity	Tonnage sold this quarter[1]	Number of mines reporting sales[1]	Value of tonnage sold[1] (dollars)
Coal	7,235,731	181	230,518,748
Limestone/dolomite[2]	8,542,753	74[3]	29,732,062
Sand and gravel[2]	10,452,164	186[3]	33,309,782
Salt	712,443	5[4]	5,763,076
Sandstone/conglomerate[2]	468,318	15[3]	7,819,922
Clay[2]	177,578	22[3]	904,153
Shale[2]	531,899	14[3]	877,184
Gypsum[2]	60,452	1	390,520
Peat	8,975	2	40,735

[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.

Ohio Department of Natural Resources
Division of Geological Survey
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Columbus, Ohio 43224

OHIO DEPARTMENT OF NATURAL RESOURCES DIVISION OF GEOLOGICAL SURVEY

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Total copies printed: 3,300
Unit Cost: $.8977
Publication date: 4/89