Ohio Geology

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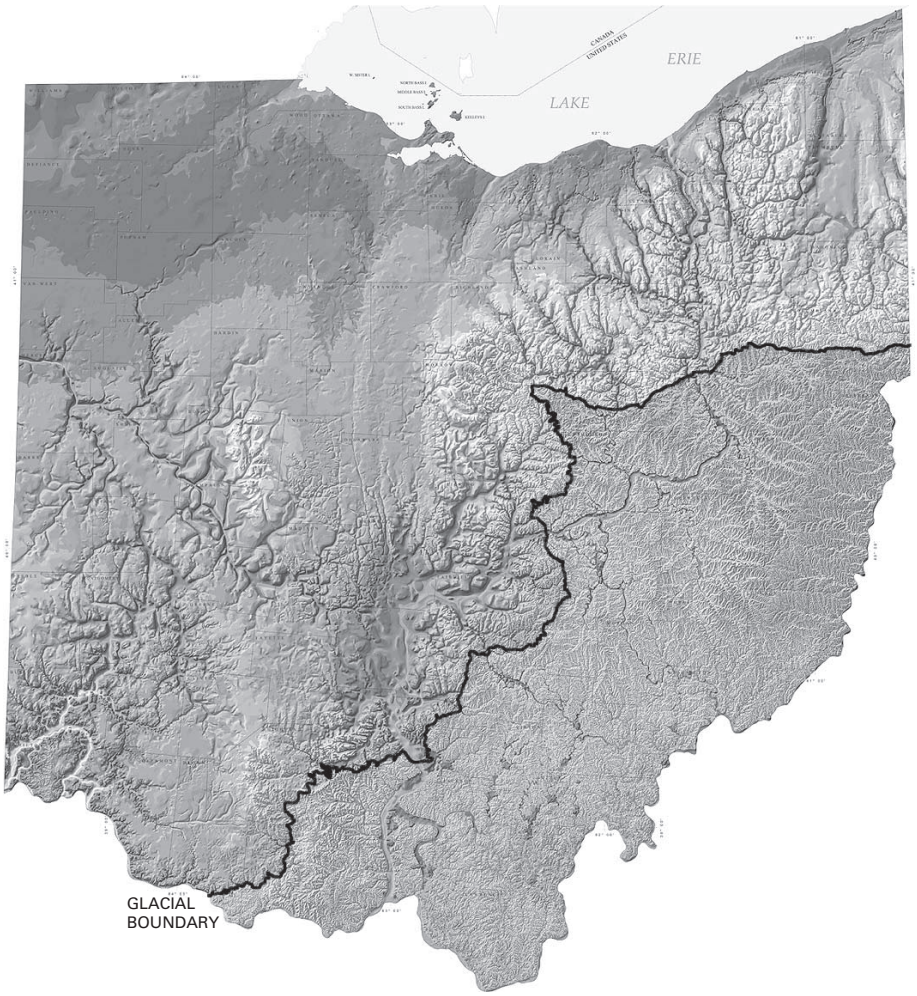
MAPPING OHIO'S HIDDEN LANDSCAPE— THE SHADED BEDROCK-TOPOGRAPHY MAP OF OHIO

by E. Mac Swinford

Everyday Ohioan's, except those in the hills of southeast Ohio, drive, walk, and live above a buried landscape sometimes vastly different than the landscape they actually stand on. The depth to this buried landscape, known as the bedrock surface to geologists, varies from a few feet to up to 700 feet deep in some of the ancient buried river valleys of the western portions of the state. The bedrock surface contains plains, hills, and valleys produced by millions of years of erosion of the limestone, dolomite, shale, sandstone, and coal bedrock of Ohio. Repeated advances of the great continental glaciers sculpted this surface and deposited blankets of unconsolidated glacial till, sand and gravel, and clay (referred to as drift) over the northern and western two-thirds of Ohio.

The Ohio Division of Geological Survey recently completed a statewide remapping of Ohio's buried landscape and released this information as the *Shaded bedrock-topography map of Ohio*. This map allows one to visualize Ohio's buried-bedrock landscape as if all the unconsolidated sediments were removed. It illustrates the location of an ancient buried drainage system that is commonly very different than modern drainage, the location of bedrock hills that emerge from the surrounding plains, and the rugged unglaciated terrain of southeastern Ohio.



Shaded bedrock-topography map of Ohio

The new map is the latest of a series of bedrock-topography maps dating back to the first comprehensive bedrock-topography map of Ohio in the Division of Geological Survey's Bulletin 44, *The Geology of Water in Ohio,* by Wilbur Stout, Karl Ver Steeg, and George Lamb. The map called *Relief on rock surface* displays elevation contour lines, which depict valley bottoms and walls. In 1959, Cummins produced an updated and more detailed version of the bedrock surface of Ohio. Although general in appearance, these early attempts to map the bedrock surface compare favorably with the current interpretation. They also provided a framework for future bedrock-topography maps especially in areas of major buried drainages. Some drawbacks to these early maps include hard-to-read elevation contour lines (lines of equal elevation) at 100-feet intervals, no display of the data used in drawing the map, and no delineation of the deep, sediment-filled valleys beyond the glacial limit.

The Geological Survey began a modern attempt to systematically map the bedrock topography of Ohio on a county-by-county basis in the 1970s. This work, done largely at a scale of 1:62,500, required analyzing thousands of water-well logs on file at the ODNR, Division of Water. The wells had to be accurately geographically

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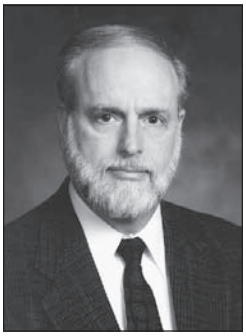

Thomas M. Berg, Division Chief and State Geologist

From The State Geologist...

Thomas M. Berg

CHANGES TO *OHIO GEOLOGY*

Recalling my column in *Ohio Geology* 2002, Nos. 3, 4, I announced the early retirement of Michael Hansen and Merrianne Hackathorn previously this year. In addition to their many other duties, they had served as co-editors of *Ohio Geology* for over 20 years. This quarterly publication has been a very popular and highly respected periodical of the Ohio Division of Geological Survey thanks to the efforts of Mike and Merrianne. We wish them the best in their well-deserved retirements but realize that we have a great challenge ahead to fill their shoes. Staff geologists Mac Swinford and Gregory Schumacher will be the new compilers of *Ohio Geology*.

Starting in 2003, *Ohio Geology* will be released twice a year instead of the four issues as in the past. We plan to release a spring issue in March and a fall issue in October. We hope to continue the *Ohio Geology* format of a lead article, an editorial from the State Geologist, a secondary article, and announcements of Survey activities, new publications, and items of interest to geologists and the public. Even so, some future issues may contain fewer pages than the usual 8 pages.

We regret the necessity of scaling back the publication frequency of *Ohio Geology* to two issues per year. Ongoing budget reductions, additional duties, and grant-driven hourly commitments severely limit the time available to produce *Ohio Geology*. We would welcome any comments and suggestions from our readers. Feel free to contact me at 614-265-6988 or thomas.berg@dnr.state.oh.us. You may also contact Mac or Greg at 614-265-6473 or 614-265-6597 or e-mail them at: mac.swinford@dnr.state.oh.us or greg.schumacher@dnr.state.oh.us.

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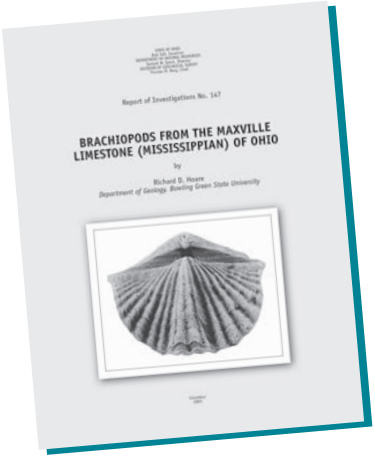
New brachiopod publication



The Ohio Division of Geological Survey recently released Report of Investigations 147, *Brachiopods from the Maxville Limestone (Mississippian) of Ohio* by Richard D. Hoare of Bowling Green State University. In this report, Dr. Hoare describes 14 species of brachiopods including four recognized from the Maxville for the first time. Diagnostic brachiopods present in this fauna are then used by Dr. Hoare to correlate the Maxville Limestone to equivalent Upper Mississippian (Chesterian) rocks exposed in the Upper Mississippi River valley, the Ozark Mountains of Arkansas and Oklahoma and the Appalachian Mountains of the Virginias. The commensal relationships between Maxville brachiopods and encrusting calcareous worms tubes, bryozoans, and juvenile brachiopod spats are discussed. Report of Investigations 147 has 10 figures, 7 tables, 5 plates, and a single appendix listing 17 collecting localities. This report may be ordered from the Geologic Records Center of the Survey, 4383 Fountain Square Dr., B-2, Columbus, OH 43224-1362; telephone: 614-265-6576; fax: 614-447-1918; e-mail: geo.survey@dnr.state.oh.us. Price is $7.00 plus sales tax of 6.75% for all non tax exempt Ohio orders. Handling charges apply to all mailed orders (please call for rates). Visa and MasterCard are accepted.

Pedicle view of Orthotetes kaskaskiensis.

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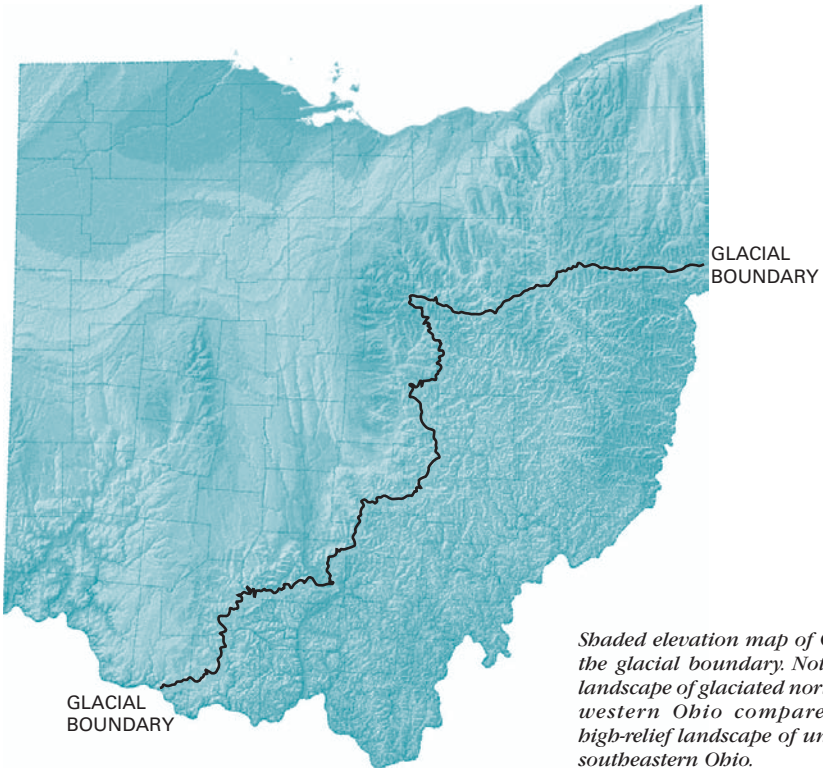
referenced and correctly interpreted to extract bedrock-surface data that could be used to hand contour the bedrock surface. These county investigations eventually resulted in the production of published/open-file bedrock-topography maps for 43 counties and provided the basic framework for the modern bedrock-topography map. Through the 1990's, Survey geologists mapped the remainder of Ohio's bedrock-topography exclusively on 7.5-minute (1:24,000-scale) quadrangles as part of the project to remap the bedrock geology of the state. By the end of the project, twenty-five authors had created bedrock-topography maps of 788 7.5-minute quadrangles.

The *Shaded bedrock-topography map of Ohio* depicts the configuration and elevation of the bedrock surface using a computer generated color scheme which was then shaded to produce a three-dimensional visual effect. In unglaciated portions of southeastern Ohio, the bedrock surface coincides with the present-day land-surface and is depicted by earth-tone hues as seen on the *Shaded elevation map of Ohio* (see *Ohio Geology*, 2002, Nos. 3, 4) to represent elevation intervals. In glaciated western and northern Ohio, the bedrock surface is buried under mainly glacial sediments of unsorted and sorted clay, silt, sand, pebbles, and boulders that can be several hundred feet thick. The continental ice sheets that transported and deposited these sediments are speculated to have been as much as 4,000 feet thick. The land surface in this region was smoothed by glaciation and masks the underlying bedrock surface. This dissected bedrock surface is the result of numerous episodes of erosion before, during, and after glaciation. Spectral hues, shaded from the northwest, depict elevation intervals on the buried-bedrock surface and show the bedrock surface as if the overlying glacial sediments were removed.

One major feature shown on the bedrock-topography map is a series of narrow, deep valleys in western Ohio. Prior to and during glaciation, the north-flowing Teays River system (*GeoFacts 10*; *Ohio Geology*, Summer 1987) dominated surface-water drainage patterns in western and southern Ohio. Water flow direction in the main Teays valley was north from Wheelersburg (Scioto County) to Circleville (Pickaway County) and then northwest to Mercer County where the Teays Valley exited the state. Remnants of the Teays Valley are distinct on the present land surface in southern Ohio and form a continuous valley on the buried-bedrock surface across western Ohio. Modern rivers, such as portions of the Scioto, still occupy parts of this valley system, but typically the modern glaciated land surface hides the Teays Valley system. Water flow in the Teays River system was disrupted by early glaciations as southward-advancing glaciers blocked outlets of the north-flowing river system. Drainageways, both large and small, were abandoned or filled with sediment as ice advanced and retreated. Blockage of the Teays River created immense lakes in southeastern Ohio. Thick accumulations of laminated clay, known as the Minford Clay, were deposited on the lake bottoms and can still be seen today as valley fill. The *Shaded bedrock-topography map of Ohio* allows one to see the final position of the extensive Teays valley system just before it was buried.

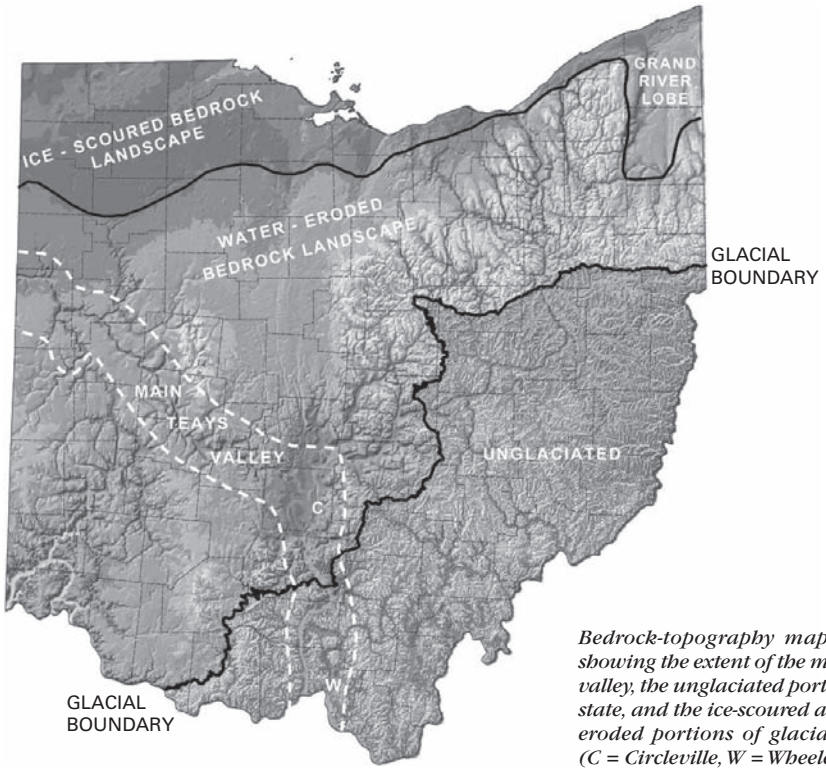


Shaded elevation map of Ohio with the glacial boundary. Note smooth landscape of glaciated northern and western Ohio compared to the high-relief landscape of unglaciated southeastern Ohio.

In northwestern Ohio, the generally smooth buried-bedrock surface is the result of repeated scouring by glacial ice advancing westward out of the Lake Erie basin. Another distinctly scoured bedrock surface is in the Grand River Lobe in northeastern Ohio where smooth north-south trending valleys mirror ice-flow direction. This type of terrain is caused by thick deposits of ice impregnated with sediment ranging in size from clay to boulders that act as powerful sanding machines, scouring the bedrock landscape.

South of the scour-dominated surface of northern Ohio, the bedrock surface has been sculpted by water to create a distinct drainage pattern. Large volumes of glacial meltwater eroded the bedrock surface, widening and deepening existing valleys of the Teays system and creating new valleys. Some modern rivers and creeks flow in unusually wide valleys; evidence that far greater volumes of water generated from melting glaciers once flowed in these valleys. The Scioto River Valley, which flows in a valley commonly 2 miles wide, is a good example. Flow direction in other valleys has been reversed as glacial ice or glacial sediments blocked formerly northward and westward flowing streams.

Southeastern Ohio is unglaciated and devoid of ice-deposited sediment (glacial till). However, many river valleys in south-



Bedrock-topography map of Ohio showing the extent of the main Teays valley, the unglaciated portion of the state, and the ice-scoured and water-eroded portions of glaciated Ohio (C = Circleville, W = Wheelersburg).

eastern Ohio did carry glacial meltwater away from the ice front and toward the Ohio River. In the process, many of these valleys were at times made deeper by the erosive force of fast-flowing meltwater streams, and at other times were partially filled with sediment. Some valleys in unglaciated Ohio contain thick deposits of clay and silt that accumulated on the bottoms of lakes that formed when glacial ice blocked the flow of rivers or when rapidly accumulating meltwater sediments blocked the mouths of rivers.

USES OF BEDROCK-TOPOGRAPHY MAPS

Bedrock-topography maps contain geologic information that has important implications concerning environmental protection, mineral exploration, and land-use planning. The delineation of pre-Pleistocene and Pleistocene valleys and understanding the drainage history of these valleys is of great potential value in locating aquifers that may be sources of large quantities of ground water. Detailed knowledge of the location of buried valleys and the thickness of glacial drift can be used in siting water wells and in selecting building sites for homes and for industries that require a large supply of ground water.

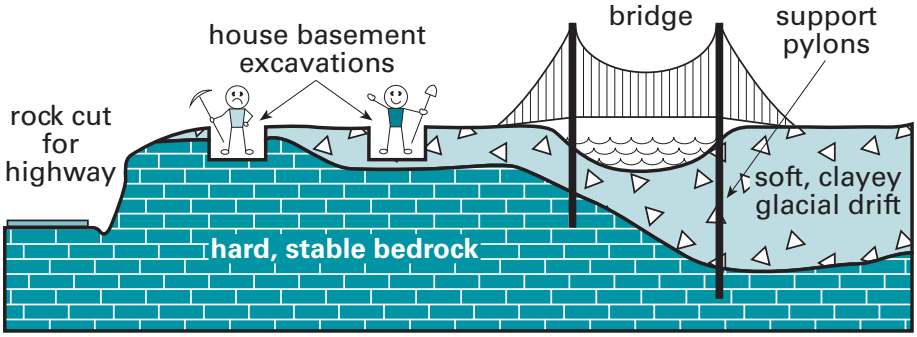
Knowledge of the depth to bedrock in a particular area is valuable information for a variety of users including homeowners, construction companies, and mineral industries; such information can save considerable money and frustration. Consider the difficulty and added expense of digging a basement or a ditch for a pipeline and suddenly discovering that blasting or other expensive excavation techniques must be used to remove rock when it was anticipated that only easily removed unlithified sediments would be encountered. Obviously, prior knowledge of the depth to bedrock would result in the selection of a homesite or route for a pipeline that would avoid shallow bedrock. Alternately, shallow bedrock can be beneficial, as it provides necessary stability for pylons for large construction projects such as bridges or tall buildings.

Bedrock-topography elevations subtracted from land-surface elevations calculates the thickness of drift overlying bedrock. Drift thickness information is essential for siting stone quarries, where sites that have minimal overburden (material overlying a useful mineral deposit) are most desirable. Such information also is needed for establishing the length of surface casing for oil and gas wells, and in siting landfills and other waste-disposal facilities. Drift-thickness information also is valuable for zoning of potential seismic-risk areas because areas of thin drift are less prone to severe ground motion than areas blanketed by thick drift deposits.

It is apparent that bedrock-topography maps are of great value to a large number of Ohio citizens, and they can be of critical importance in locating homes, businesses, and industries and in ensuring that the public health is protected. The wall-size, 1:500,000-scale bedrock-topography map represents an excellent overview of the surface for Ohio. For studies requiring site-specific information, the Division of Geological Survey has the maps at 7.5-minute, 1:24,000 scale for all 788 quadrangles in the state in both paper and digital format.

CREATING THE MAP

This *Shaded bedrock-topography map of Ohio* is the result of a 7-year program by the ODNR, Division of Geological Survey to remap the bedrock geology of Ohio. Bedrock-topography maps



Generalized cross section showing uses of a bedrock-topography map for engineering and building purposes. Depth to bedrock (derived from the difference in elevation between the land elevation and the bedrock elevation) is important when bridge pylons need to be set in solid bedrock; deeper bedrock increases the length of the pylons and the construction cost of the bridge. The cost of building a highway or digging a basement for a house increases if blasting is required to remove hard bedrock, in contrast to using heavy equipment to remove softer glacial drift.

are essential to producing accurate bedrock-geology maps of glaciated Ohio and of partially buried valleys beyond the glacial limit. Data used consists of water-well logs on file at the ODNR, Division of Water, outcrop data, Ohio Department of Transportation bridge-boring data, and oil-and-gas-well data.

Some pre-existing county bedrock-topography maps (1:62,500 scale) and data were photographically enlarged to 1:24,000 scale, revised, and utilized in the compilation of 1:24,000-scale, bedrock-topography maps. Data concentration and contour intervals on the original maps vary widely across the state in response to changing geologic and topographic conditions. The *Shaded bedrock-topography map of Ohio* has been digitally recontoured at one contour interval to smooth areas where differing contour intervals occur.

Elevation contours and over 158,000 data points from the 788 bedrock-topography maps were digitized and compiled for the glaciated portions of the state and for the major valleys beyond the glacial boundary. The bedrock-topography contours were digitally converted in the ARC GIS environment into a continuous grid model (60 meter grid spacing). This surface was shaded from the northwest slightly above the horizon to produce the appearance of a three-dimensional surface.

The land surface represents the topography of the bedrock surface in southeastern Ohio (excluding valleys beyond the glacial boundary) and in some glaciated areas near the glacial limit where meltwater sediments are thin or absent. Land-surface topography is based largely on data derived from the U.S. Geological Survey's National Elevation Dataset (30 meter grid spacing).

A paged-size version of the *Shaded bedrock-topography map of Ohio* is available for viewing or downloading from the Ohio Division of Geological Survey website (map in .pdf format). Copies of the detailed, wall-size version of the map may be ordered for $15 plus $4.00 handling (add $1.50 for mailing tube if map is to be sent rolled) and $1.02 tax (Ohio addresses only). Orders can be placed with the ODNR, Division of Geological Survey, 4383 Fountain Square Drive, Columbus, OH 43224-1362, telephone: 614-265-6576. For assistance in obtaining digital, GIS files of the map and data on CD-ROM, please contact the Division of Geological Survey at the same phone number and address.

FURTHER READING

Cummins, J. W., 1959, Buried river valleys in Ohio: Ohio Division of Water Ohio Water Plan Inventory Report 10, 3 p., 2 maps.

Hansen, M. C., 1995, The Teays River: Ohio Division of Geological Survey, GeoFacts 10, one sheet.

Hansen, M. C., 1987, The Teays River: Ohio Division of Geological Survey, Ohio Geology, Summer 1987, 1-6.

Powers, D.M., Laine, J.F., Pavey, R.R., 2002 (revised 2003), Shaded elevation map of Ohio: Ohio Division of Geological Survey Map MG-1, scale 1:500,000.

Stout, W. E., Ver Steeg, K., and Lamb, G.F., 1943, The Geology of Water in Ohio (a basic report): Ohio Division of Geological Survey Bulletin 44, 694 p., 8 maps, reprinted 1968.

AAPG—EASTERN SECTION 2004 MEETING

The 33rd annual meeting of the Eastern Section of the American Association of Petroleum Geologists (ES-AAPG) will be held October 3-5, 2004 in Columbus, Ohio. The theme of the meeting is "Still Economic after all these Years."

From the historic days of the Drake well and the world's first giant oil-and-gas field (the Lima-Indiana producing trend) to the present-day exploration for new frontier horizons, our region has been contributing to the world's energy resources for nearly 150 years. Geoscientists have led the way in developing the ideas and innovative techniques necessary to sustain our industry, and are the reason our region is "Still Economic after all these Years."

ES-AAPG together with AAPG's Division of Environmental Geosciences (DEG), Energy Minerals Division (EMD), and Division of Professional Affairs (DPA)

will offer two concurrent oral sessions each day of the meeting and two full-day poster sessions. A post-meeting workshop also is being planned.

The 33rd annual meeting not only incorporates our goal of highlighting new exploration plays, but also offers a forum to emphasize new ideas for old plays, new technologies and ideas for finding or developing reserves, and historical perspectives that provide a foundation for new opportunities. The Technical Program Committee encourages petroleum geologists to contribute an oral presentation or poster session and participate in this informative and exciting meeting. Abstracts are due by **APRIL 1, 2004**. Please see our website at http://www.ohiodnr.com/geosurvey/aapg04.htm for additional information regarding abstract submission forms.

For more information contact Co-chair Larry Wickstrom or Technical Program Chair Ron Riley at Ohio Division of Geological Survey, 4383 Fountain Square, Columbus, OH 43224-1362, e-mail: larry.wickstrom@dnr.state.oh.us or ron.riley@dnr.state.oh.us, 614-265-6598 or 614-265-6573.

—Ron Riley

GEOLOGICAL SURVEY AT THE OHIO STATE FAIR

The paving brick industry in Ohio was the theme for the Division of Geological Survey's 2003 Ohio State Fair display. A kiosk in the Natural Resources Pavilion contained photographs of brick kilns, brick streets, brick-laying crews, and a map identifying cities where paving bricks were manufactured in the state. The paving brick industry flourished in Ohio from the 1880's until 1930's and production centers were located close to high-quality clay beds associated with coal seams in eastern Ohio. The fair display had samples of clay and shale (raw material), coal (fuel for the kilns), and salt or halite (used in the glazing process). An assortment of 53 bricks were tightly laid around the display base to simulate road pavement and show the diversity of products and names of the manufacturers. Also displayed were decorative bricks of various designs, and specialty bricks such as beveled bricks used on steep slopes to keep horses from slipping and to abutt railroad tracks at road crossings. This was unquestionably the Survey's heaviest display ever!

Thanks to Electronic Designer Lisa Van Doren for creating the display, and to Dave Buchanan, husband of former Survey Editor, Merrianne Hackathorn, for constructing a frame to hold the paving bricks together.

2003 Ohio State Fair display. Photo by Michael D. Williams.

Changes to the 2002 Report on Ohio mineral industries

In an effort to reduce costs, the Division of Geological Survey will release the *2002 Report on Ohio mineral industries* only as downloadable files on the Division's website. The tables, figures, directories, and 2002 summaries by commodity on the downloadable files will look similar to those in previously printed versions of the report. The *Mineral industries map of Ohio* will be an online interactive map. Unlike the printed reports, however, the online version of the report will not include a lead article highlighting an Ohio mineral industry and interspersed photographs of historic and modern mineral industries. The online report is scheduled to be posted on the Division's website (http://www.ohiodnr.com/geosurvey/) by November 1, 2003, and can be downloaded at no cost.

http://www.ohiodnr.com/geosurvey/

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