Ohio Geology

A Quarterly Publication of the Ohio Department of Natural Resources, Division of Geological Survey 2000, Nos. 2, 3, 4

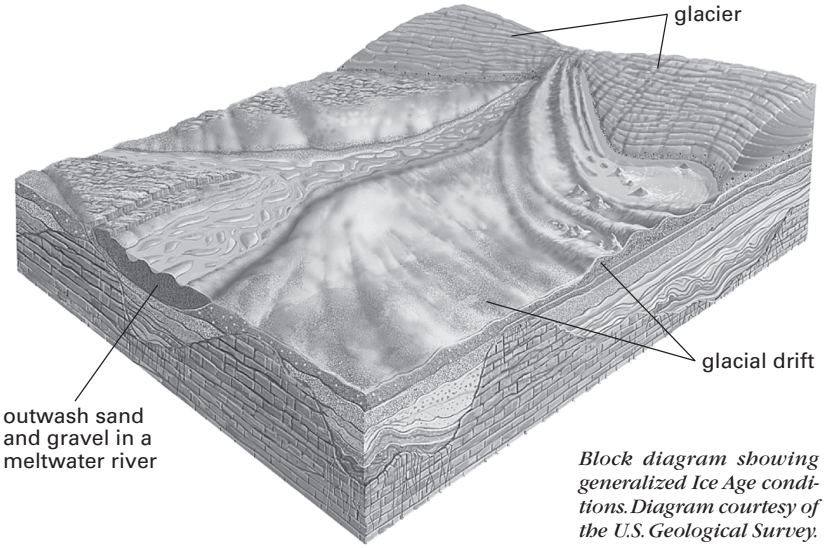
CATCH OUR DRIFT— THE CENTRAL GREAT LAKES GEOLOGIC MAPPING COALITION

by Thomas M. Berg, Dennis N. Hull, and Merrianne Hackathorn[1]

The glaciers that repeatedly advanced and retreated across Ohio and other Midwestern states during the past million or so years left a large calling card: glacial "drift," unconsolidated deposits ranging in thickness from a few inches to hundreds of feet. This drift consists of clay, silt, sand, gravel, and boulders in complex stratified and unstratified deposits. The critical importance of these deposits cannot be overemphasized, for they are (1) the parent materials of our fertile Midwestern soils; (2) a major source of raw material (sand and gravel) for construction of highways, buildings, and other elements of our infrastructure; (3) sources of abundant ground water for our homes, businesses, and industry; and (4) the materials in which many of our waste-management facilities are developed. The locations of these surficial deposits also are highly susceptible to natural hazards such as floods, erosion, landslides, indoor radon, and earthquakes, and to environmental problems such as soil and water contamination.

Developers, agriculture, industry, mining, environmental groups, conservationists, communities, and private citizens commonly place conflicting demands on an area's land and water resources. In addition to conflicting demands, inadequate information about the character and three-dimensional distribution of the surficial deposits leads to poor land-use decisions. Decisions made without an adequate base of Earth-science information increase the cost and risks to the environment and to society.

Despite their critical importance to our lives, these drift deposits have not been mapped in a consistent, widespread, and three-dimensional manner. Individual state geological surveys have investigated glacial drift within their boundaries, but their reports and maps commonly have resulted in "state-line faults"—not matching across borders because of differences in mapping approaches and terminology. In a historic effort to map the ground beneath our feet, the state geological surveys of Illinois, Indiana, Michigan, and Ohio and the U.S. Geological Survey (USGS) established the Central Great Lakes Geologic Mapping Coalition. The purpose of the Coalition is to standardize mapping techniques and stratigraphic nomenclature and to provide three-dimensional maps of the glacial deposits. According to Dr. Charles G. Groat, Director of the USGS, the Coalition is "a new model for State-Federal collaboration in research, information delivery, and outreach, as well as a most welcome opportunity to work more closely with the various information-user communities."



Block diagram showing generalized Ice Age conditions. Diagram courtesy of the U.S. Geological Survey.

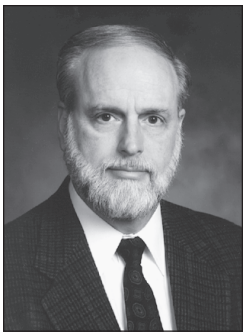
THE NEED FOR A COALITION

On a national basis, Illinois, Indiana, Michigan, and Ohio have five of the 25 largest cities, 15 percent of the population, 18 percent of the land, 20 percent of the employees, more than 30 percent of the corn and soybean production, and half of the heavy industry. These four states also have a similar geologic heritage and are confronted by common societal issues regarding land and water resources, the environment, and geologic hazards. By pooling their expertise and resources, the four state geological surveys, with the support and cooperation the USGS, can address common issues more effectively than could any one survey alone.

Understanding the distribution and characteristics of the glacial drift in three dimensions, through geologic mapping, is the key to continued prosperity and sustainable quality of life in the region. Detailed maps of the complex drift materials are essential for decision-makers in government and business to make sensible natural resource decisions. Detailed mapping will enable decision-makers in the four-state area to: (1) identify and

continued on page 3

[1]Much of the introductory text of this article has been extracted from previously published reports by the U.S. Geological Survey and state Coalition partners. These reports are listed at the end of this article under Further Reading.



Thomas M. Berg, Division Chief and State Geologist

From The State Geologist...

Thomas M. Berg

SUSTAINING THE OHIO DIVISION OF GEOLOGICAL SURVEY

Many readers of *Ohio Geology* have asked what happened to this quarterly publication, as only issue number 1 was mailed in the year 2000. Quite frankly, our periodical has fallen victim to the concept of "doing more with less" which prevails in government today. When you do more and more with less and less, common sense tells you that eventually you will "do less with less." This issue of *Ohio Geology* is a combined issue (2000, Nos. 2, 3, 4). We hope to get back to our quarterly schedule for the year 2001.

In prioritizing the work of the Geological Survey, we must always consider the health, safety, and welfare of Ohio citizens. Dr. Michael C. Hansen, long-time editor of *Ohio Geology*, has been deeply involved with the establishment of the Ohio Seismic Network (OhioSeis), and that has become more than a full-time assignment for him. Setting up and managing OhioSeis is vital for the safety and welfare of Ohioans. Mike is prepared to respond to Ohio earthquakes 24 hours a day, 7 days a week, working in cooperation with the Ohio Emergency Management Agency. Prior to his involvement with OhioSeis, one of Mike's most important assignments was the editing of *Ohio Geology*. He faithfully compiled the quarterly publication for almost 20 years, writing many dozens of major articles on all aspects of Ohio's geology. Because of the work on the seismic network, Mike no longer has time to manage all the duties of *Ohio Geology*. Merrianne Hackathorn, Geological Survey editor, will now be responsible for gathering articles for *Ohio Geology*. Mike will continue to contribute articles as his time permits.

Sustaining a strong state geological survey during these times of curtailed state government spending is frustrating because the demands and need for geological information increase every day. More and more, the Ohio Geological Survey is asked to provide information to decision-makers from all over the state. We are required to assist in locating specific mineral commodities. We are asked to evaluate foundation conditions for homes, large buildings, highways, and other components of our infrastructure. We are obliged to identify the causes of geologic hazards such as landslides, sinkholes, erosion and subsidence areas, earthquakes, and indoor radon. We are expected to provide geologic maps that can be used to accurately locate and characterize aquifers. We are required to supply accurate geologic information for the proper management of municipal and toxic waste sites. Under these constantly growing pressures, educational products like *Ohio Geology* suffer.

Funding a strong state geological survey is an enormous challenge. For more than a decade, we have struggled to stay strong in the face of tightened budgets and falling minerals severance-tax income by obtaining federal and other outside grants. We have been rather successful and have accomplished some very important tasks such as the bedrock mapping of Ohio, development of oil and gas databases and analysis of natural gas fields, mapping of Lake Erie's coastal erosion area, computerizing the state's coal information and determining the availability of coal, and initiating a massive program of mapping Ohio's glacial deposits in three dimensions. Meeting the contractual obligations of concurrent grants, however, does not allow extra time to give presentations at schools or prepare articles for *Ohio Geology*.

I do feel a strong commitment to you, our readers. I want to continue this quarterly publication, and will do so by all means possible. We have set a high standard for *Ohio Geology* and will maintain that standard to the best of our ability.

Newly created Division of Mineral Resources Management

House Bill 601, signed by Governor Bob Taft in June 2000, consolidated the Ohio Department of Natural Resources Division of Oil and Gas and Division of Mines and Reclamation into the Division of Mineral Resources Management. Michael L. Sponsler is the chief of the new, consolidated division. Mr. Sponsler left his position as director of the Indiana Department of Natural Resources Division of Reclamation to come to Ohio. Ohio Department of Natural Resources Director Sam Speck stated that the consolidation of these two regulatory divisions will provide improved management efficiency and oversight of Ohio's $1.8 billion mineral resources industry. The Division of Mineral Resources Management is located in Building H of the ODNR Fountain Square complex. The street address is 1855 Fountain Square Ct., Columbus, OH 43224-1383. The main phone number is 614-265-6633.

Ohio Geology

A quarterly publication of the

Ohio Department of Natural Resources
Division of Geological Survey
4383 Fountain Square Drive
Columbus, Ohio 43224-1362

614-265-6576
614-447-1918 (FAX)

e-mail: geo.survey@dnr.state.oh.us

World Wide Web: http://www.dnr.state.oh.us/odnr/geo_survey/

Ohio Geology is a free publication. To become a subscriber please contact the Division of Geological Survey at the above address, phone numbers, or e-mail.

Editor: Michael C. Hansen
Layout/Design: Lisa Van Doren

Administration/State Geologist
614-265-6988

Geologic Records Center
614-265-6576 or 614-265-6585

Bedrock Geology Mapping Group
614-265-6473

Cartography & Editing Group
614-265-6593

Coal Geology Group
614-265-6594

Environmental & Surficial Geology Group
614-265-6599

Industrial Minerals Group
740-548-7348
740-657-1979 (FAX)

Lake Erie Geology Group
419-626-4296
419-626-8767 (FAX)

Petroleum Geology Group
614-265-6598

Bob Taft, Governor
Sam Speck, Director

An Equal Opportunity Employer - M/F/H

continued from page 1

safeguard underground and surface water sources; (2) provide better planning for and protection against floods, earthquakes, and soil and lakeshore erosion; (3) more safely site landfills and other waste-disposal facilities; (4) reclaim previously contaminated land; and (5) maintain or restore natural areas and wetlands for recreation and preservation of habitats that are essential for biodiversity.

Environmental and Surficial Geology Group Supervisor Rick Pavey working the rig at the training session in Antioch, Illinois. U.S. Geological Survey geologist Byron Stone (center) looks on.

Only a small part—less than 2 percent—of the region's surficial deposits has been mapped in sufficient detail to support truly informed decisions on land use, water-resource development and protection, and other critical issues. The Coalition, through a collaborative agreement, will pool the resources of the five agencies to address common problems in the region. The Coalition agreement provides for the sharing of equipment and laboratories and, more importantly, the experience and expertise of the scientists in the partner agencies. As an example, in July 2000, Ohio Survey geologists attended a training session on geophysical mapping techniques in Antioch, Illinois. This training will help advance staff capability for detailed surficial-geology mapping in Ohio as part of the Coalition initiative.

THE COALITION PLAN

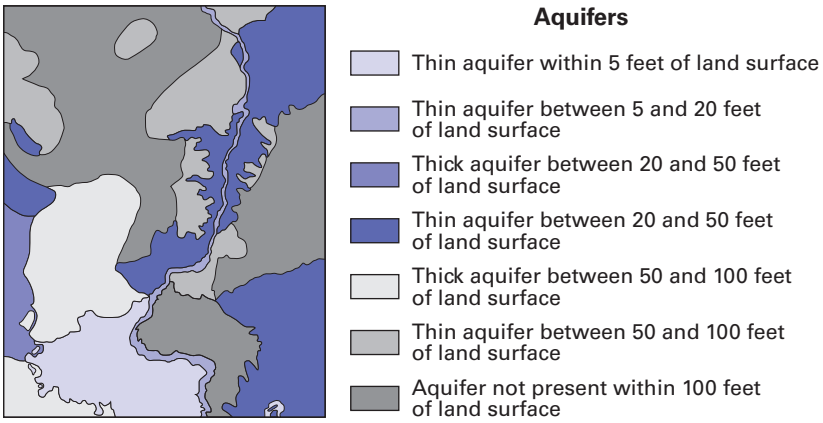
As funding becomes available, the Coalition will use advanced computer technology and new scientific capabilities to determine the three-dimensional geologic framework of surficial deposits below the surface of the land. This information will then be used to produce a digital database of surficial-geology information; detailed, digital, 3-D maps of surficial geology; and derivative products for specific geotechnical, environmental, ground-water, and mineral-resource applications.

Geophysical tools, developed primarily by the petroleum and mineral exploration industries, increasingly are being adapted for use in ground-water, environmental, and geologic-mapping applications. New coring techniques for obtaining relatively undisturbed samples of unconsolidated surficial materials, even in previously inaccessible locations, have recently become available. Data obtained using these advanced technologies will be collected by Coalition geologists, encoded into digital databases, and processed by modern geographic information systems (GIS) for production of 3-D depictions of subsurface deposits. Such maps provide an amount of geologic information that greatly exceeds what can be imparted by traditional, two-dimensional maps, and establish a science-based foundation for determination of land-use options that are sustainable and environmentally and economically balanced. GIS also will be used to produce derivative maps that address specific customer needs, such as a map that allows hydrogeologists to visualize the shape of an aquifer and to manage and protect the ground-water resource.

The Coalition's plan for surficial-geology mapping is described in USGS Open-File Report 99-349. The plan has prioritized study areas on the basis of the needs of more than 500 city, county, state, federal, and private map users who attended geologic mapping forums in Indianapolis, Indiana, and Columbus, Ohio. In a three-year, $20.1-million pilot phase, new mapping techniques will be devised, staff will be trained, drilling and geophysical data will be collected, proposed customer needs will be refined, and the first products will be prepared. A 14-year intensive phase, at an estimated cost of $11.9 million per year, will follow for production of the maps and the digital database. The Coalition plans to produce more than 500 3-D geologic maps in digital format.

Detailed mapping in high-priority areas will be completed at a scale of 1:24,000 (1 inch equals 2,000 feet). In areas where data are sparse or where detailed mapping is unlikely in the immediate future, regional geologic maps will be produced at a scale of 1:100,000 (1 inch equals 1.6 miles). In Ohio, the areas to be mapped under a fully funded three-year pilot study include the lower Huron River watershed in north-central Ohio and an area along the Ohio-Indiana border near Richmond, Indiana. Areas to be mapped in the intensive mapping phase include the Cincinnati-Dayton corridor and the Columbus metropolitan area, as well as northwestern and northeastern Ohio.

The Coalition plans an extensive public outreach program to bring its products to the attention of all stakeholders. Coalition scientists will provide map products in easy-to-understand formats that can be tailored to specific local areas.



A representative map showing aquifers.

Coalition personnel will help users develop skills in using the information and use feedback to make modifications or extensions to the information. The list of potential users is long and varied:

- city, county, and state planners,
- water management agencies and utilities,
- public health agencies,
- county and state transportation departments,
- state and federal environmental protection agencies,
- builders and developers,
- agricultural agencies,
- insurance companies,
- U.S. Army Corps of Engineers,
- environmental and geological consultants,
- engineering firms,
- the general public.

COOPERATION IS THE KEY

The objective of the Coalition is to provide Earth-science information that can support sound, unbiased, and cost-effective land-use decisions. The magnitude of the proposed work will require the cooperation and input of scientists from many Earth-science disciplines and from other state and federal agencies, academia, and the private sector. Increased communication between scientists and the user community will help assure that the information is understood and appropriately used.

Data sharing, equipment sharing, and sharing of services are a few of the cooperative devices by which the Coalition will reduce the cost of surficial-geology mapping through increased efficiency. In Ohio, much valuable data on surficial deposits are on file at the Ohio Environmental Protection Agency, Ohio Department of Transportation, Ohio Department of Commerce (Bureau of Underground Storage Tank Regulation), the district office of the U.S. Geological Survey Water Resources Division, the ODNR Division of Water and Division of Soil and Water Conservation, and the offices of private consulting firms. Utilization of these existing data by the Coalition, as opposed to the collection of new, but equivalent data, can save the Coalition many thousands of dollars. Sharing of highly specialized technical services and equipment among Coalition members also will provide substantial savings. For example, the radiocarbon laboratory at the Illinois State Geological Survey can provide radiometric dating services to other Coalition members and thereby eliminate the need by other members to develop this expensive capability or to purchase radiometric dating services at commercial rates. Cooperative development of standard analytical procedures will ensure uniformity and comparability of key analytical data used to establish regional stratigraphic correlations and important geotechnical properties. Close cooperation with the geology departments of colleges and universities in the region is critical for accessing the considerable mapping talents available from academia and for ensuring that an adequate pool of trained Quaternary geologists will be available to perform the highly demanding task of mapping and characterizing surficial deposits over the next 15 to 20 years.

GETTING THE COALITION BALL ROLLING IN OHIO

Total federal funding for first-year pilot-phase Coalition investigations was $500,000. While this was far short of the $6.7 million requested for full implementation of pilot-phase projects by the four Coalition states, the Ohio Division of Geological Survey was awarded $119,000 for initiation of limited pilot-phase investigations.

First-year, pilot-phase work in Ohio began in September 2000 and is part of a multi-year pilot project to produce detailed, 3-D surficial-geology maps for the lower Huron River watershed in Erie and Huron Counties. This region of the state is undergoing significant development pressure and is vulnerable to critical land-use decisions being made without sufficient geologic information. Detailed, 3-D surficial-geology mapping information for this rapidly urbanizing area is critical for (1) accurate hydrogeological and geotechnical investigations; (2) site assessments, including highways, solid-waste facilities, and other construction projects; (3) determination of nonpoint-source contamination and sediment-loading sources; (4) evaluation of ground-water/surface-water interactions; (5) coastal erosion mitigation; and (6) aggregate-resource, wetland, and ecosystem planning.

Current Coalition investigations by the Ohio Division of Geological Survey include: (1) development of sediment-analysis laboratory capabilities, and (2) development of digital databases of geologic information for the lower Huron River watershed that was collected for earlier Survey investigations and by other public- and private-sector entities. Industrial Mineral Resources Group Supervisor David A. Stith is responsible for coordinating with counterparts in other Coalition states to establish uniform protocols for sediment analysis. He also is coordinating acquisition and set-up of analytical equipment in the Survey's new sediment laboratory at the Horace R. Collins Laboratory at Alum Creek State Park (see *Ohio Geology*, 1999, No. 4). Analysis of surficial samples collected during the 1980's in the lower Huron project area will provide a means to "test drive" analytical equipment and processes and develop useful data for

pilot-phase mapping. Several nondigital data sets of geologic and geotechnical information for the project area have been developed from previous work in the area. Geographic Information Management Systems Specialist James McDonald and Environmental and Surficial Geology Group Supervisor Richard R. Pavey will coordinate the encoding of these data into electronic databases that will support digital production of 3-D surficial-geology maps of the lower Huron River watershed beginning in 2001.

Total federal funding in 2001 for second-year pilot-phase Coalition investigations is again $500,000. If the Ohio Survey receives its requested portion of these funds, it will initiate a 3-D surficial-mapping project in an area along the Ohio-Indiana border between Richmond, Indiana, and Union City, Ohio/Indiana in 2001. The primary source of Richmond's ground water is within a complex system of interlobate morainal deposits that extend northeastward into Ohio. Developing a coherent geologic framework for this area to support ground-water development and protection programs will require a coordinated effort between the Ohio and Indiana Geological Surveys.

Special projects also will be performed by the Coalition to address critical, societal issues arising from surficial geologic conditions. An example of such a project is the U.S. Geological Survey's drilling of a deep, exploratory core hole in Sharon Woods—a north Columbus neighborhood where several homes have been destroyed by unstable foundation conditions. Information derived from the core will be evaluated by Coalition scientists and used to identify other areas where similar geologic conditions, if not properly addressed, could threaten homes and businesses.

The objective of the Coalition is to provide Earth-science information that can support sound, unbiased, and cost-effective land-use decisions.

FURTHER READING

Berg, R. C., Bleuer, N. K., Jones, B. E., Kincare, K. A., Pavey, R. R., and Stone, B. D., 2000, Mapping the glacial geology of the central Great Lakes region in three dimensions—a model for state-federal cooperation: U.S. Geological Survey Open-File Report 99-349, 40 p.

Central Great Lakes Geologic Mapping Coalition, 1999, Sustainable growth in America's heartland—3-D geologic maps as the foundation: U.S. Geological Survey Circular 1190, 17 p.; available on line in Adobe Acrobat PDF (portable document format) at <http://pubs.usgs.gov/circular/c1190/c1190-72.pdf>.

Illinois State Geological Survey, no date, The Central Great Lakes Geologic Mapping Coalition: folded brochure.

U.S. Geological Survey, 1999, The Central Great Lakes Geologic Mapping Coalition: U.S. Geological Survey Fact Sheet 153-99; available on line at <http://pubs.usgs.gov/factsheet/fs153-99/>.

Historical outline of surficial-geology mapping in Ohio from 1837 to the present

Investigation of glacial processes and surficial-geology mapping in Ohio has a long history beginning with the first organization of the Ohio Geological Survey in 1837-38. In the Second Annual Report of the Geological Survey of Ohio in 1838, Dr. John Locke considered the origin of *diluvial* striations and surficial materials in southwestern Ohio, and Charles Whittlesey puzzled over what forces of nature could have dammed water in the Lake Erie basin to create a series of beach scarps and ridges at elevations far above that of the current lake. During the late 19th and early 20th centuries, distinguished pioneers in the field of glacial geology such as T. C. Chamberlin, Frank Leverett, and Frank B. Taylor elucidated major aspects of Ohio's glacial history and produced regional geomorphology maps depicting many of the state's most prominent glacial features.

By the mid-20th century, and continuing into the early 1980's, geologists investigated the glacial geology of the state in greater detail than previous researchers, commonly mapping geomorphology and uppermost surficial units on 15-minute (1:62,500-scale) quadrangles or topographic base maps of counties at 1:62,500 and 1:63,360 scale (1 inch = 1 mile). During this period, numerous geologists, including Richard P. Goldthwait, George W. White, Jane L. Forsyth, Stanley M. Totten, several graduate students, and Ohio Geological Survey staff, produced many published and unpublished maps and reports on the glacial geology of Ohio counties. Some of this work was compiled at 1:500,000 scale (1 inch = about 8 miles) for publication as the 1961 U.S. Geological Survey (USGS) Miscellaneous Geologic Investigations Map I-316, *Glacial map of Ohio* (reprinted with appended revisions in 1967 but now out of print). Accompanying the glacial-geology mapping effort at this time was an Ohio Geological Survey program to produce 1:62,500-scale maps of buried bedrock topography (32 open-file maps produced) and drift thickness (30 open-file maps produced) for glaciated counties. In the early 1980's, Richard P. Goldthwait began compilation of post-1961 surficial–geology information for Ohio with the intent of replacing USGS Map I-316. This work was assumed by staff of the Ohio Geological Survey in 1989, and was released in 1993 as a series of 1:250,000-scale (1 inch = about 4 miles) open-file maps. In 1999, the 1:250,000-scale maps were compiled at 1:500,000 scale and published as Ohio Geological Survey Map No. 2, *Quaternary geology of Ohio*.

In the mid-1980's, the Ohio Geological Survey initiated a program to produce county maps depicting the dominant material in the uppermost 5 feet of Earth's surface. Manuscript reports that included 1:62,500-scale maps showing dominant materials were produced for eight counties by the late 1980's. In the early 1990's, the 1:62,500-scale bedrock-topography maps that had been produced over the preceding 20 years were photo-enlarged to 1:24,000 scale (1 inch = 2,000 feet) and revised

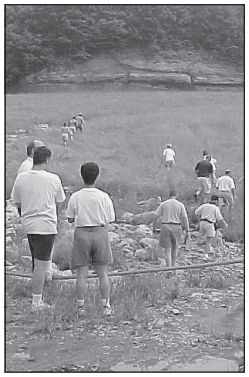
for use in a statewide, 1:24,000-scale, bedrock-geology mapping program. At the same time, 1:24,000-scale bedrock-topography maps were drawn for those areas of the state, including nonglaciated southeastern Ohio, for which 1:62,500-scale bedrock-topography maps had never been produced. Today, an open-file bedrock-topography map is available for each of the 788 Ohio 7.5-minute (1:24,000-scale) quadrangles.

At the dawn of the 21st century, Ohio is experiencing unprecedented economic growth and development. New construction associated with this prosperity is occurring primarily on glaciated terrain and is accompanied by an increased demand for ground water from glacial-sediment aquifers and a need to protect these aquifers from industrial, agricultural, and waste-disposal-related contamination. Effective ground-water management in glaciated terrain requires accurate and comprehensive information on the nature of unconsolidated materials from the surface down to bedrock. In response to this need, Ohio Geological Survey geologists initiated a statewide program in 1997 to produce reconnaissance-detail, 1:100,000-scale (1 inch = 1.6 miles), three-dimensional (3-D) surficial-geology maps for the 32 Ohio 30 x 60 minute quadrangles. This work is being supported with funding from the National Cooperative Geologic Mapping Program's STATEMAP Program and from the U.S. Environmental Protection Agency's Nonpoint-Source Pollution (319) Program. Open-file and/or print-on-demand, reconnaissance-detail, surficial-geology maps have been completed for the Ohio portions of the Falmouth, Cincinnati, Dayton, Lorain, Put-in-Bay, and Cleveland South 30 x 60-minute quadrangles, and a portion of the Scioto River watershed in central Ohio. Mapping of the Canton and East Liverpool 30 x 60 minute quadrangles and the Mad River watershed is in progress. Completion of the statewide, reconnaissance-detail, 3-D surficial-geology mapping program is expected by 2010.

In July 2000, the Ohio Geological Survey began preparatory work for pilot-phase, detailed, 1:24,000-scale, 3-D surficial-geology mapping in the lower Huron River watershed under the Central Great Lakes Geologic Mapping Coalition. Possible pilot-phase projects in the Akron area (Hartville 7.5-minute quadrangle) and along the Ohio-Indiana border near Richmond, Indiana, are under consideration. If the Coalition is provided full funding for the entire 14-year program, detailed, 3-D surficial-geology maps will be produced for approximately 150 Ohio 7.5-minute quadrangles in the rapidly developing areas of Cincinnati, Dayton, Springfield, Columbus, Toledo, Cleveland, Akron, Canton, Youngstown, and coastal Lake Erie.

—Dennis N. Hull

Ohio's Mineral Industries & the Environment—North and South Teachers Workshops



Teachers viewing reclaimed coal-slurry disposal site in Jackson County.

Thirty-two K-12 teachers from Ohio explored the issues surrounding Ohio's mineral resources, mining, reclamation, and environmental protection during the 14th annual Ohio's Mineral Industries & the Environment—North and South workshops. The annual workshops are sponsored by the Ohio Department of Natural Resources, Division of Geological Survey and the University of Akron, Department of Geology. The 2000 northern Ohio workshop was conducted June 26-30 and was based at the University of Akron. The 2000 southern Ohio workshop was conducted July 10-14 and was based in the Columbus area; the classroom sessions were held at the offices of the Ohio Aggregates & Industrial Minerals Association.

For a second consecutive year, a large number of sponsors provided financial assistance that covered about three-fourths of each participant's tuition cost. The Ohio Aggregates & Industrial Minerals Association and 11 of its member companies contributed grants totaling over $14,700: American Sand & Gravel Co., Belden Brick Co., Hanson Aggregates Midwest, Kimble Clay and Limestone Co., Martin Marietta Aggregates, Melvin Stone Co., Olen Corp., S & S Aggregates, Shelly Materials, Inc., Ward Materials, Inc., and Watson Gravel, Inc. Additional financial assistance was provided by the American Coal Foundation, the Eastern Section of American Association of Petroleum Geologists, Ohio Coal Association, Ohio Oil and Gas Association, Ohio Chapter of the Society for Mining, Metallurgy, and Exploration; Ohio Section of the American Institute of Professional Geologists, and Women in Mining. The American Coal Foundation, American Electric Power, American Geological Institute, Mineral Information Institute, Ohio Oil and Gas Association, National Energy Foundation, National Mining Association, and U.S. Geological Survey supplied educational materials.

In two half-day inquiry-based classroom sessions taught by professionals from academia, industry, and state regulatory agencies, the workshop participants learned about Ohio's geology, mining and use of Ohio's fuel and nonfuel mineral resources, and the regulations that govern mineral extraction in Ohio. During three full days and two half days of field trips, the workshop participants had a first-hand look at current mining and reclamation practices, talked with industry representatives, and sampled a variety of rocks and fossils.

The 18 participants in the northern Ohio workshop observed the mining and reclamation activities at the following operations: American Sand & Gravel Co. (Stark County), Belden Brick Co. (Tuscarawas County), Kimble Clay & Limestone Co. (Tuscarawas County), Sandusky Crushed Stone Co. (Rogers Group, Inc.) (Erie County), Celotex Corp. (Ottawa County), Martin Marietta Magnesia Specialties Corp. (Sandusky County), and Briar Hill Stone Co. (Holmes County). Doug Core, a geolo-

gist and oil and gas consultant, led a tour of a working oil and gas pump in Holmes County and explained the economics and environmental concerns of the oil and gas industry. The teachers also toured a former surface-mine site that is being developed for private housing.

The 14 teachers in@the southern Ohio workshop visited the following mining operations: Olen Corp. (Franklin County), Waterloo Coal Co. (Vinton County), Bowerston Shale Co. (Licking County), Martin Marietta Aggregates (Franklin County), and Olgebay Norton Industrial Sands, Inc. (Perry County). Doug Core led a tour of a working oil and gas pump in Licking County. The teachers also toured Buckeye Furnace State Memorial, a reconstructed charcoal-iron furnace in Jackson County, and a nearby manmade wetland constructed to mitigate acid mine drainage from surface and underground abandoned-mine land.

The schedule and the application form for the two 2001 teachers workshops—Ohio Mineral Industries & the Environment, North and South—can be downloaded from the Survey Web site: <http://www.dnr.state.oh.us/odnr/geo_survey/edu/teacshop.htm>. The northern workshop will be June 25-29, 2001. The southern workshop will be July 9-13, 2000. To enroll for either workshop, participants must register for two semester hours of graduate or undergraduate credit through the University of Akron. The estimated fee is $180 per undergraduate credit hour and $206 per graduate credit hour (fees subject to change). Following completion of the workshops, participants will be reimbursed a portion of their tuition fees from a fund underwritten by Ohio mineral industry companies and organizations.

For additional information, please contact Dr. Dave McConnell, Department of Geology, University of Akron, Akron, OH 44325-4101; telephone: 330-972-8047, fax: 330-972-7611, e-mail: dam6@uakron.edu; or Doug Crowell, Division of Geological Survey, Ohio Department of Natural Resources, 4383 Fountain Square Drive, Columbus, OH 43224-1362; telephone: 614-265-6594, e-mail: doug.crowell@dnr.state.oh.us.

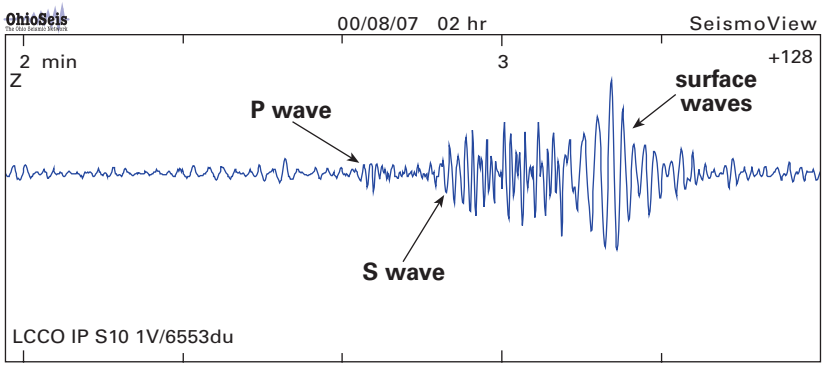
—Douglas L. Crowell

The Alliance earthquake

Residents of the Stark County city of Alliance and neighboring areas were startled on the evening of August 6, 2000, by a 3.0-magnitude earthquake. Although the temblor did no reported damage, it caused general interest and alarm throughout a 70-square-mile felt area that included portions of three counties. In addition, the event provided the first significant test of the detection and location capabilities of the Ohio Seismic Network (OhioSeis) since it became fully operational (see *Ohio Geology*, 2000, No. 1).

Many residents in Alliance reported a sharp jolt, lasting only a few seconds, at 10:02 p.m. local time (2:02, August 7, Universal Time). Some people thought that a vehicle had struck their house and, upon going outside to look for the source of the jolt, discovered their neighbors engaged in the same investigation. The Alliance police department was flooded with phone calls in response to the shock. A severe thunderstorm went through the area two hours after the earthquake, perhaps giving some residents apocalyptic thoughts.

As part of a cooperative program with the U.S. Geological Survey's National Earthquake Information Center in Golden, Colorado, an automatic pager alert to the earthquake was received by Michael C. Hansen, OhioSeis Coordinator, soon after the event. This alert system relies on software that constantly scans incoming seismic waveforms for possible earthquakes. The software sends an automatic message via pager that has preliminary computer-calculated origin time, magnitude, and location of the potential earthquake. The waveforms are then reviewed by a seismologist to determine if there was an earthquake and to precisely locate the event and determine its magnitude.



Seismogram of the Alliance earthquake recorded at OhioSeis station LCCO (Lakeland Community College), Kirtland, Ohio.

The Alliance earthquake was recorded on OhioSeis stations throughout the state, including the most distant station at the University of Cincinnati (UOCO), more than 200 miles from the epicenter. A surface-wave magnitude (mbLg) of 3.0 was calculated for the event from OhioSeis seismograms. The final epicenter location was determined to be about 3 miles northeast of Alliance in Mahoning County, near the junction of Mahoning, Portage, and Stark Counties.

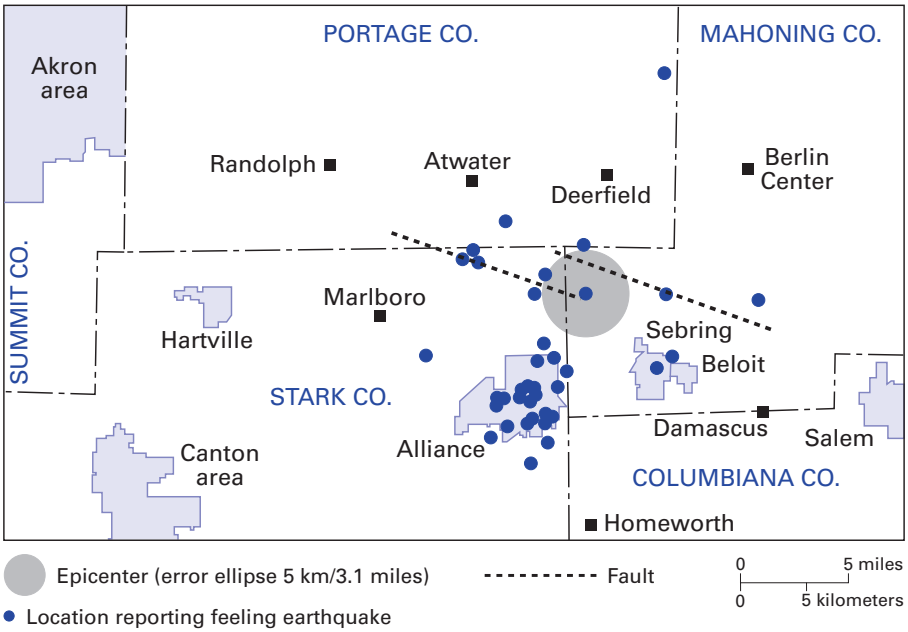
PARAMETERS FOR THE ALLIANCE EARTHQUAKE

- Epicenter: 40.96 N, 81.08 W
- Depth: 10 km (6.2 miles) (fixed)
- Origin time: 02:02:30.3 Universal Time, August 7, 2000
- Magnitude: 3.0 mbLg
- Stations used in solution: 9

The August 6 earthquake was the first historic one to be recorded near Alliance. A small event in 1885 occurred in Portage County, north of Alliance. However, the epicentral locations for small, noninstrumentally located earthquakes are notoriously inaccurate in many cases. The instrumental location of the August earthquake coincides with a northwest-southeast-trending fault zone that was identified long ago from historic oil- and gas-well drilling data.

The Alliance earthquake is one of the first small earthquakes in Ohio that can be reliably attributed to a known fault zone. The preciseness of the location based on OhioSeis stations clearly demonstrates the value of a multistation network in attributing earthquakes to known fault zones or, conversely, identifying an area where a previously unknown fault zone may exist. All historic, noninstrumentally located earthquakes and the majority of historic, instrumentally located events have sufficiently tenuous locations that their attribution to known faults, or postulating the existence of an unknown fault in a precise area, is speculative at best.

Coincidentally, the new OhioSeis station MUCO at Mount Union College in Alliance had been deployed just three weeks before the August earthquake. The seismometer at MUCO was so close to the epicenter that it was overwhelmed ("saturated") by the earthquake. However, the saturated seismogram at MUCO provided sufficient information for Dr. Larry J. Ruff of the University of Michigan, seismological advisor to the OhioSeis network, to determine the depth of the earthquake to be about 10 km (6.2 miles), which is deep within crystalline rocks of Precambrian age. Most small Midwest earthquakes are constrained at a depth of 5 km (3.1 miles) because of insufficient data to accurately calculate the depth of the event.



Epicenter, error ellipse, felt reports, and faults for the August 6, 2000, Alliance earthquake.

Dr. Mark McNaught of the Department of Geology at Mount Union College, operator of station MUCO, began collecting felt reports of the earthquake in the Alliance area to determine the extent of the felt area and variations in Modified Mercalli intensities. With the assistance of several students, Dr. McNaught is preparing an isoseismal (equal intensity) map for the earthquake and will correlate these data with the distribution and thickness of unconsolidated sediments in the area that have been mapped by the Division of Geological Survey. This information will provide a valuable insight on the response of various surficial sediments to an earthquake of known magnitude and location. Such studies will be a valuable aid in evaluation of seismic risk in Ohio. The wide distribution of OhioSeis stations, run by on-site volunteer operators, will promote detailed gathering of local felt reports for future earthquakes in nearly any part of the state.

Although the Alliance earthquake was a relatively minor event, it has provided more information than probably any other event of similar size in Ohio. At the very least, it demonstrated the capabilities of the Ohio Seismic Network to detect and precisely locate such events, which in turn provides rapid, accurate information to the public and brings us one small step closer to understanding the periodic and unpredictable movements of the unseen rocks deep beneath us.

—Michael C. Hansen
OhioSeis Coordinator

Ohio Geology

Ohio Department of Natural Resources
Division of Geological Survey
4383 Fountain Square Drive
Columbus, Ohio 43224-1362

PRSRT STD
U.S. Postage
PAID
Columbus, OH
Permit No. 5767

Ohio Bicentennial 1803 2003

DIVISION OF GEOLOGICAL SURVEY
OHIO DEPARTMENT OF NATURAL RESOURCES

recycled paper