Ohio Geology

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THE VALUE OF GEOLOGIC MAPS TO OHIO HOMEOWNERS

by *Gregory A. Schumacher and Dennis N. Hull*

One of the questions most commonly asked by Ohio homeowners calling the Division of Geological Survey (DGS) for geologic information is "What is the depth to bedrock on my property?" This question is usually followed by: "What is the bedrock under my property?"

DGS geologists have thousands of published geologic maps and reports, open-file geologic maps, and considerable personal knowledge and field experience at their fingertips to answer many of the geologic questions commonly asked by Ohio homeowners. Digitally scanned images of DGS open-file geologic maps, accessed via desktop computers, enable a DGS geologist to quickly and efficiently answer most questions with just a few clicks of his/her computer mouse.

What is an open-file geologic map? Open-file geologic maps of the DGS generally consist of hand-drawn data and interpretations of bedrock formations or surficial deposits portrayed on 1:24,000-scale (1 inch = 2,000 feet), 7.5-minute topographic quadrangle maps issued by the U.S. Geological Survey (see DGS *Educational Leaflet* 16). The land area of Ohio is subdivided into 788 7.5-minute quadrangles, each about $6^3/_4$ miles wide (east to west) and $8^3/_5$ miles long (north to south). Quadrangle maps show the locations of cultural features such as schools, homes, barns, places of worship, fence lines, roads, rail lines, and pipelines; political boundaries such as county, township and section boundaries, boundaries of cities and towns; and natural features such as lakes, ponds, rivers, streams, and forested areas.

Quadrangle maps, commonly referred to as "topo maps," also depict topographic contours. Topographic contours (generally brown in color) represent lines of equal surface elevation above mean (i.e., average) sea level. For example, all points along a line labeled "800" are 800 feet above sea level. Because of the wealth of information portrayed on a topographic map and the relationship of topography to geology, topographic quadrangles are the primary base maps used by DGS geologists for compilation and presentation of geologic-map information.

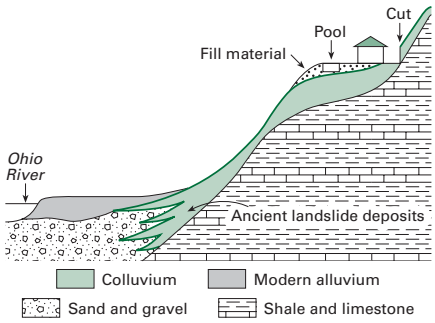
Beginning in 1990 and continuing through 1997, DGS geologists produced bedrock-geology, bedrock-topography, and structure-contour maps for each of Ohio's 788 topographic quadrangles. Beginning in 1997 and continuing through today, surficial-geology maps have been produced for many topographic quadrangles in the course of developing small-scale (1:100,000-scale), print-on-demand surficial-geology maps such as DGS Map SG-2 *Surficial geology of the Ohio portions of the Cincinnati-Falmouth 30 X 60 minute quadrangles.*

What are bedrock-geology, bedrock-topography, and surficial-geology maps? Bedrock-geology maps show the distribution of the hard, layered sedimentary rocks that may be exposed at the land surface or, more commonly, buried beneath a blanket of soil and surficial materials (e.g., glacial deposits) overlying the bedrock. Ohio's bedrock units consist primarily of shale, sandstone, limestone, dolomite, coal, and claystone. These bedrock units can be thought of as the layers of a devil's food cake. The icing on top of the cake would represent the surficial materials, primarily glacial sediments, and modern alluvium (e.g., stream sediments), which have been deposited over the western and northern 3/4s of Ohio (See *Ohio Geology* 2002, No. 2).

Bedrock-topography maps depict the irregular upper surface of bedrock buried under the overlying surficial materials (see *Ohio Geology* 2003, No. 1 and *Geofacts* 1). Elevation contours are used to represent equal elevations on the buried bedrock surface in the same manner that contours are used to depict elevations on the land surface of topographic quadrangles. In other words, the bedrock-topography map is analogous to producing a contour map of the irregular upper surface of our devil's food cake underlying the chocolate icing. Surficial-geology maps delineate the composition and distribution of unconsolidated sediments, deposited by rivers, streams, and Ice-Age continental glaciers upon the bedrock surface.

So, how are bedrock-geology, bedrock-topography, and surficial-geology maps useful in answering geologic questions received from Ohio homeowners? Perhaps the best way to answer this question is to present some examples of homeowners' requests for geologic information received by DGS geologists over the years.

One afternoon in 1990, a Clermont County resident called the DGS seeking geologic information about a piece of property overlooking the Ohio River that he was considering buying for construction of a new house. Specifically, the man was considering building a new home on a relatively flat area located on the steep, wooded wall of the river valley. His plan was to enhance the site by excavating a shallow cut into the hillslope



Cross section showing the valley-wall setting of a proposed home overlooking the Ohio River in Clermont County. Highlighted are the factors that increase landslide risk. Cut-and-fill construction methods can increase risk by over-steepening slopes, by removing colluvial materials that support upslope deposits, and by destabilizing hillside colluvial deposits with the addition of heavy fill deposits. Water from home downspouts and swimming-pool overflows can initiate landsliding by saturating colluvial deposits, adding additional weight, reducing shear strength, and lubricating failure zones.

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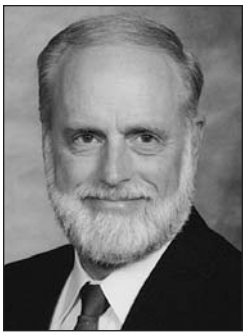

Thomas M. Berg, Division Chief and State Geologist

From The State Geologist...

Thomas M. Berg

THE GEOLOGICAL SURVEY OF OHIO—WHEN WILL IT EVER END?

When I was working for the Pennsylvania Survey, I remember State Geologist Art Socolow complaining about being questioned on the cost of detailed topographic mapping in that state during a legislative budget hearing. The learned legislator shook a state highway map in the air and said, "What's wrong with this map? Can't you plot your geology on this? It's good enough for me!" Art sure had a challenge with that mentality.

I had a similar challenge in 1989 when I took on the job of Ohio State Geologist. At a Senate budget hearing, I was questioned by a revered, cigar-puffing senator about the cost of geologic mapping in Ohio. Gruffly, he asked, "Why can't you do like they do in Illinois? They've got all their geology mapped from outer space!" Instantly, I knew the senator was referring to a very nice, recent, satellite image of Illinois—basically a composite photograph of Illinois' surface taken from an orbiting satellite. I politely tried to reason with the good senator and explained that it was only a photograph, and didn't show geologic formations. He cut me off, and said, "Never mind!"

High-ranking state officials who know little or nothing about the science of geology frequently challenge state geologists. Lack of geoscientific understanding by government decision-makers causes exasperating communication problems, but the situation, I think, is magnified by use of the word "survey." Thirty-five of the state-government geological agencies in the United States identify themselves as "surveys," but in non-geological circles, I believe most people think of a "survey" as an activity in which something is measured, appraised, delineated, and described. It is an activity, which has a beginning, a duration, and an end. And so, those who have to make decisions about government funding may easily be tempted to say, "OK, this survey has to be done by now, so let's cut the funding." Perhaps it would be better to identify state geological agencies as, "services." "Ohio Geological Service" has a nice ring to it.

Edward Orton (third Ohio State Geologist from 1882 to 1899) faced up to the question of continuation of the Geological Survey of Ohio with great wisdom. He summed up the accomplishments of the survey at that time in his *Preface* to *Report of the Geological Survey of Ohio—Volume VII*, published in 1893 (p. xi):

> *In conclusion, a few words will be devoted to a review of what has been already accomplished by the several geological surveys of this State, and to a brief consideration of what remains to be done.*
>
> 1. *The general stratigraphical order of our several formations is now fairly well determined; so far, at least, as their occurrence within our State boundaries is concerned. Their correlation with the series of neighboring states leaves something to be desired. This is especially true of the northeastern corner of Ohio.*
> 2. *The leading features of our economic geology have been set before the people of the State so that land owners of ordinary intelligence can acquaint themselves with the probable value of their mineral resources. They are no longer at the mercy of men who are able to take advantage of their ignorance.*
> 3. *The salient features of our paleontology have been made intelligible to all of our people who take an interest therein.*
>
> *As to what remains to be done in Ohio Geology, it is difficult to speak. The science of geology is constantly lengthening its cords and strengthening its stakes. Every line of investigation opens up larger questions than those which it directly undertakes to settle. New methods of research are coming into use, and old problems must be reconsidered by their aid. It is only the generalities of our geology that have been thus far attacked. Deeper and more thorough work will be demanded in every subdivision of every field. It remains to be seen how much of this more refined study will be carried on at the public expense under State direction. Speculation upon this point is unnecessary.*

In his *Preface*, Orton continued a discussion of all the work he felt still needed to be done for the good of Ohio. Much of what he expressed is still applicable today. Indeed, the science of geology has undergone tremendous revolutions during the more than 41 years that I have been involved in state geological-survey work. The wonderful concept of global plate tectonics has come to be accepted by virtually all in this profession. It is an amazing, unifying concept that helps us in the state geological surveys understand and predict the location and characteristics of strata that contain many of the resources needed by our society. It helps us understand structures such as bedrock fractures that partly control the movement of ground water and other fluids and gasses. New technologies, especially in remote sensing (e.g., satellite imagery, digital photography, laser measurements) permit geologists to more accurately delineate natural features that impact our lives. Recognition of geologic hazards such as indoor radon, toxic elements in soils, karst and paleokarst, collapsing earth, landslides, and other dangerous geologic features allow us at the state geological surveys to assist in better land-use planning. Use of digital databases and geographic information systems (GIS) makes integration of numerous layers of spatial data more achievable than ever before. The geoscientific capabilities at today's state geological surveys (and the U.S. Geological Survey) would make Edward Orton's head spin, but he would not be surprised!

So how would I answer the question in my editorial title, "The Geological Survey of Ohio—when will it ever end?" My answer for my readers, especially government administrators and legislators, as well as self-appointed government watchdogs, is a resounding "NEVER!" The State of Ohio urgently needs the fundamental geological information and geospatial data generated and managed by the Division of Geological Survey. It needs the unbiased, impartial, and accurate geologic mapping of bedrock and surficial deposits, and the interpretations and representations of our subsurface environment. Reasonable public-policy formulation, wise land-use planning, geologic-hazard assessments, and sensible development of fossil-fuel and ground-water resources simply CANNOT be done without the services of the Division of Geological Survey. Support your State Geological Survey and let your support be heard. Help persude decision-makers that it's time to restore the Survey's capabilities following so many years of budget cuts.

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continued from page 1

above the homesite and then using the excavated material as fill downslope from the homesite. Also, the potential homeowner was thinking of placing a large swimming pool downslope from the homesite and clearing a swath of trees below the pool to create a spectacular view of the Ohio River.

Past experience and geologic intuition suggested that this future homesite could be headed for major landslide problems without proper site evaluation, planning, and construction methods. Field maps of the area confirmed the initial apprehensions about the area. Bedrock-geology and bedrock-topography maps indicated the future homesite was covered by as much as 5 feet of landslide-prone colluvium derived from the underlying Kope Formation—a Late Ordovician-age bedrock unit composed of thick beds of shale with thin interbeds of limestone. The shale beds of the Kope weather rapidly, producing relatively thick, clay-rich deposits containing abundant limestone slabs, referred to as colluvium. Colluvial deposits generally increase in thickness from a few feet thick at the top of the Ohio River Valley walls to as much as 50 feet at the base. Winter and spring precipitation commonly cause colluvial deposits to become saturated with water, thereby adding considerably to the weight of the material. This added water also acts as an efficient lubricant that lowers the shear strength of the material. Under such conditions, colluvial deposits are ripe for failure and landsliding (See *Ohio Geology* 1986, spring issue, *Ohio Geology* 2005, No. 2, and *GeoFacts 8*).

Cut-and-fill construction methods to create hillside home sites often enhance landslide risk by oversteepening slopes, removing colluvial materials that support additional deposits upslope, and destabilizing hillside colluvial deposits with the addition of heavy fill materials. The discharge of water from the downspouts of the proposed new home and swimming-pool overflow would add additional water to the downslope colluvium and fill deposits. All these factors set the stage for potential disaster in the future.

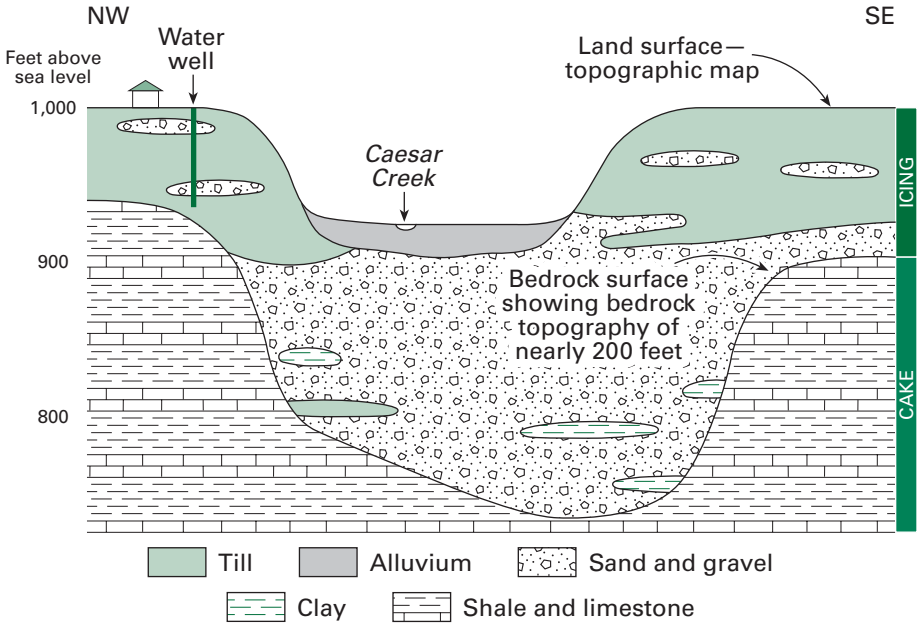
The DGS advised the potential homeowner to obtain the services of an engineering geologist or a geotechnical engineer for creation of a site-development plan that acknowledges the landslide hazard of the Kope and incorporates construction techniques to reduce landslide risk. Such techniques include: (1) installation of proper drainage systems that route surface water and discharge from downspouts away from the home; (2) removal of existing colluvium prior to adding fill material; (3) proper compaction of fill deposits; (4) seating home foundations on unweathered bedrock; and (5) retaining as many trees on the homesite as possible because tree roots remove water from the soil and stabilize colluvium.

A few years ago, a discouraged homeowner telephoned the DGS to complain about problems with her water well. The home is located on a high bluff overlooking the meandering valley of Caesar Creek in southwestern Greene County, Ohio. The water well, located adjacent to the house, was producing less and less water over time, and was becoming increasingly contaminated by brown, silty mud in the water. The homeowner was seeking information to aid in the decision about whether to deepen her existing well or to choose the more expensive option of drilling a new well.

The DGS provided the homeowner with the telephone number of the ODNR, Division of Water (DOW) and urged the homeowner to contact the DOW for assistance. The hydrogeologists of the DOW are the statewide experts concerning water-well-related issues. The DGS geologist offered to research geologic conditions in the area and to provide the caller with information that could be useful in understanding and addressing the problem.

Bedrock-topography and surficial-geology maps for the area revealed that Caesar Creek is flowing in an ancient stream valley that is partially infilled with nearly 250 feet of glacially derived sediments. The surficial-geology map showed that the ancient valley was filled with as much as 200 feet of outwash sand and gravel deposited by torrents of meltwater flowing away from Ice-Age glaciers. The problematic water well was located just off the lip of the ancient bedrock-valley wall in about 100 feet of clayey glacial sediment. The well had been drilled to a depth of 90 feet, about 10 feet above the Ordovician-age bedrock forming the buried-valley wall, and likely produced water from thin lenses of sand and gravel within the clayey sediments.

The geology depicted by bedrock-topography and surficial-geology maps suggested that deepening the existing well into the underlying Ordovician-age bedrock would not be the best option as DOW studies have documented that such bedrock generally yields only 3



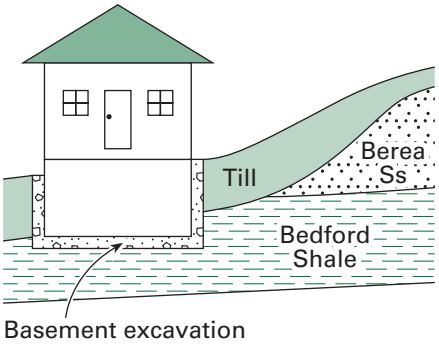
Cross section illustrating the modern Caesar Creek Valley located in the older, ancient Caesar Creek valley in Greene County, Ohio. The ancient Caesar Creek Valley, partially infilled with sand and gravel, and the adjacent uplands are defined by the buried bedrock surface and the contact between the limestone and shale bedrock (the "cake") and the overlying surficial deposits (the "icing"). The problematic water well is drilled into the upland till deposits that contain small amounts of ground water generally in thin lenses of sand and gravel. A new water well, drilled into a thick deposit of sand-and-gravel outwash filling the ancient Caesar Creek Valley should yield abundant, high-quality ground water.

to 5 gallons per minute. The sand-and-gravel outwash filling the ancient valley, on the other hand, had the potential to provide the homeowner not only much larger quantities of water, but also water of much higher quality than the very hard, mineral-laden water commonly produced from the bedrock. DGS staff therefore advised the homeowner that a new well, drilled on the flood plain of Caesar Creek and into the sand-and-gravel deposits of the buried valley might provide large quantities of high-quality water. The homeowner confirmed many of the ideas suggested by the DGS staff by stating that neighbors had drilled water wells into the flood plain (overlying the outwash) of Caesar Creek with excellent results.

Last year, the DGS received a request for bedrock-geology and bedrock-topography information from a homeowner who wondered whether the excavation for the basement of his future home would encounter hard, resistant-sandstone bedrock that might require blasting with explosives to remove, or some other type of bedrock.

The bedrock-geology map showed that the contact between the thin-bedded shales and occasional sandstones of the Bedford Shale, and the overlying resistant, thick-bedded Berea Sandstone, crossed the property on the hillslope above the proposed homesite. The bedrock-topography map for the area in question indicated that the bedrock surface was just 3 to 7 feet below the present-day land surface. The DGS was thus able to advise the homeowner that geologic data and mapping indicated that excavations for a basement and septic system should not encounter resistant bedrock that would require expensive blasting to remove. Thus in this case, a brief examination of bedrock-geology and bedrock-topography maps enabled DGS staff to quickly allay the homeowner's concerns and confirm the soundness of preliminary siting plans.

A central Ohio homeowner recently contacted the DGS to determine if the sinkholes that were developing in her community were the result of karst development. The person had visited the Division's Web site (www.ohiodnr.com/geosurvey), found a map of Ohio karst areas, and asked if the sinkholes in her neighborhood might be caused by soil collapsing into a subterranean cavern. Using a bedrock-geology map, a DGS geologist quickly determined that the type of bedrock underlying the properties in question was shale—a rock unit that rarely is subject to dissolution (i.e., karstification). In addition, the bedrock-topography map indicated that bedrock in the community was buried by nearly 200 feet of glacial till (a relatively impermeable mixture of clay, silt, sand, pebbles, cobbles, and boulders) with occasional interbeds of outwash (primarily sand and/or gravel). Experience in Ohio has shown that active formation of karst features rarely occurs in areas where soluble bedrock is buried by more than 20 feet of relatively impermeable glacial sediments or relatively impermeable bedrock. Any possibility of karst as a cause of the subsidence was ruled out quickly using information portrayed on bedrock-topography and bedrock-geology maps. Could the subsidence be related to the presence of organic subsoils that shrink during periods of drought (collapsing earth)? Probably not, because surficial-geology information for the area did not suggest the presence of subsidence-prone organic deposits. Could the collapse of an abandoned-underground mine be responsible for the subsidence? Again, probably not, as there are no known mineral commodities that can be economically mined underground at this location, and no type of underground mining is known to have ever occurred in the area.

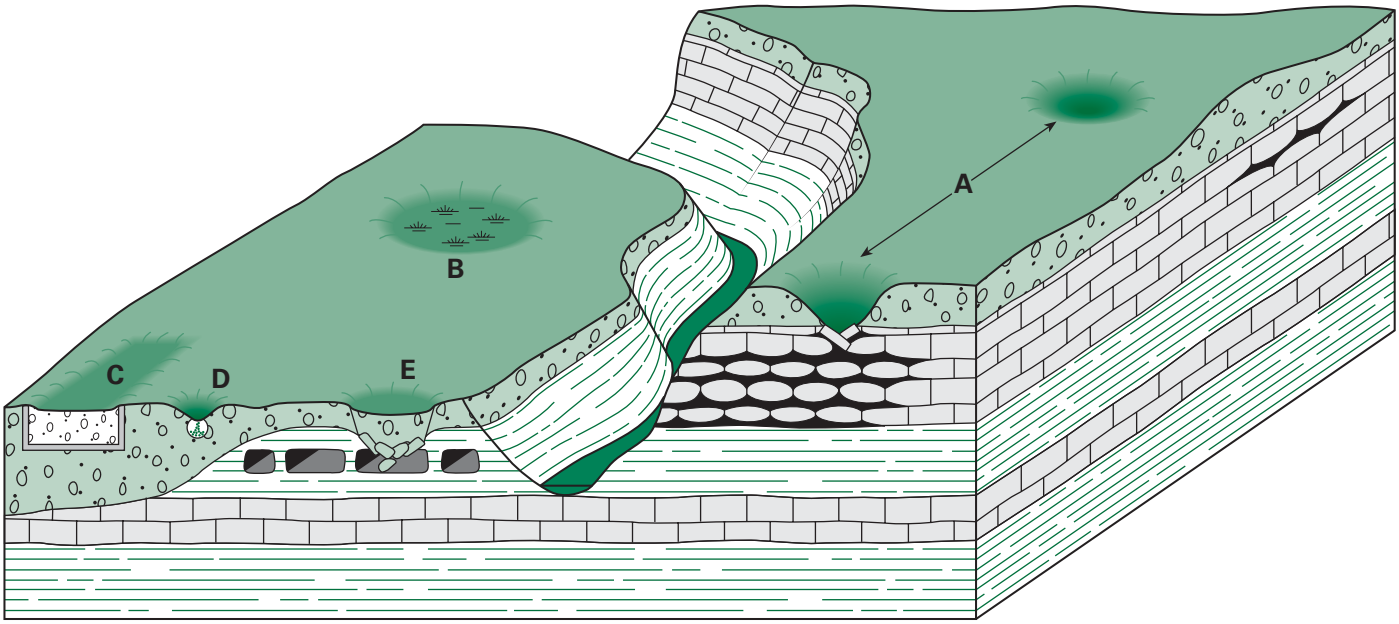


Geologic setting of a proposed home site in central Ohio. Bedrock-geology and bedrock-topography maps were used to confirm that excavation for the home's basement would encounter only easily excavated Bedford Shale and glacial till as opposed to much harder Berea Sandstone, which might require blasting with explosives and/or heavy equipment to excavate.

Information depicted on a topographic map, however, provided some clues as to possible causes of the mystery subsidence. Photo revisions to the 7.5-minute topographic map depicting the area indicated the affected homes had been built since 1964 in an area that previously had been in agricultural production. The topographic map also indicated that two pipelines cross the community. Such human modifications of the land can be possible causes of subsidence. For example, ceramic field tiles, commonly used many decades ago to improve the drainage characteristics of cropland, sometimes break down and allow overlying soil to be carried away through a process called *piping* (i.e., the erosion and movement of soil through an underground passageway or permeable material). Piping of soils via ground water moving through pore spaces in crushed stone placed under and around pipelines, storm-water drains, and sewer lines also is remotely conceivable. Subsidence due to compaction (settling) of backfilled materials placed in cisterns, hand-dug wells, old pre-law waste pits for burial of construction materials, and abandoned basements are yet another possibility for subsidence in areas recently converted from agricultural to residential use.

Obviously geologic maps cannot be used to positively identify specific kinds of human activities that might be responsible for the subsidence occurring in this central Ohio neighborhood. However, by referring to geologic maps, the DGS geologist could advise the citizen that there was virtually no possibility of natural karst-forming processes or underground mining in her neighborhood, and that she should focus on human modifications to the landscape to narrow the list of potential causes. The citizen also was advised to contact the Ohio Utilities Protection Service (1-800-362-2764), the "call before you dig" folks, prior to conducting any excavations to positively identify the cause of the subsidence. Failure to take this precaution could be dangerous should a buried electric line, natural-gas line, or water line be severed, and extremely expensive should the owner of the buried utility require the excavator to repair it.

Bedrock-geology maps, bedrock-topography maps, surficial-geology maps, and many other types of geologic maps are available for purchase or public inspection at the Division of Geological Survey's Geologic Records Center located at 2045 Morse Road, Bldg. C-1, Columbus, Ohio, 43229. In addition, Survey geologists will gladly respond to phone-in requests for brief descriptions of the geology for any area of the state. For assistance, call 614-265-6576 and request to be transferred to a geologist in the DGS's Geologic Mapping and Industrial Minerals Group.



Many of the "sinkholes" that develop on the landscape are not caused by karst processes, but rather are a consequence of other natural phenomena or human modifications to the landscape. Naturally formed circular depressions include true sinkholes (A), formed as a consequence of bedrock dissolution (karstification), and kettles (B), formed through the melting of buried blocks of glacial ice entrained in till or outwash. Circular depressions arising from human (i.e., anthropogenic) activities commonly include: 1) settling of earth in backfilled basements (C), wells, and cisterns of abandoned farmsteads, 2) piping of sediments through broken-down drainage tiles (D), and abandoned-underground-mine subsidence (E). In Ohio, active sinkhole development arising from karst processes generally is limited to upland areas underlain by soluble bedrock (e.g., limestone) that is covered by less than 20 feet of relatively impermeable bedrock or unconsolidated materials.

Ron Rea retires

On June 30, 2005, Ron Rea retired from the Division of Geological Survey after nearly 21 years of service. Ron, a native of Fayette County, graduated from Morehead State University (Morehead, KY) in 1970, and then entered the U.S. Air Force where he served more than five years as a weather technician. Upon completion of military service, Ron was hired as a teacher at Jefferson County Public Schools (Louisville, KY) where he taught biology and physical science, and served as a football and judo coach. In 1980, Ron enrolled in graduate school at Eastern Kentucky University (Richmond, KY) and pursued a Masters Degree in Geology. As a graduate student, Ron also worked as a part-time employee of the Kentucky Geological Survey where he was responsible for measuring and mapping coal seams in eastern Kentucky. In 1982, Ron accepted a position as a petroleum geologist with Amoco in Houston, Texas.

In 1984, Ron was hired by the survey as a mapping geologist in the Upper Paleozoic Bedrock Mapping Group—a component of the statewide mapping program. He conducted extensive field investigations and designed a core-drilling project to map the geology and mineral resources of Mahoning County. He was promoted to coordinator of the Upper Paleozoic Mapping Group in 1986. When Richard (Dick) DeLong (now deceased) retired in 1988, Ron assumed Dick's duties assisting the public with coal resource and abandoned-underground-mine inquiries, while continuing his duties as coordinator. In 1991, Ron was made section head of the Subsurface Stratigraphy and Petroleum Geology Section where he supervised Ohio's portion of the Gas Atlas Project.

Ron Rea

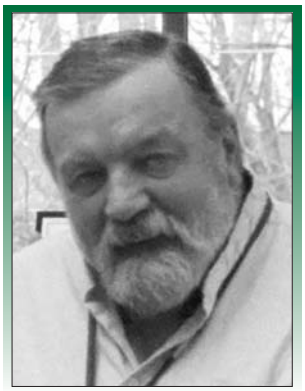
In 1996, Ron was asked to serve as manager of the division's core and sample repository. In this new capacity, he assisted with planning for relocation of materials in the former repository on Phillipi Road (west side of Columbus) to the current location at the H.R. Collins Laboratory at Alum Creek State Park. Upon completion of the Collins Laboratory, Ron developed educational displays, organized the core and sample collection, and coordinated public access to materials in the repository. He gave numerous presentations on the geology of Ohio to groups visiting the Collins Laboratory and was an annual presenter at the Mineral Industries and the Environment Workshops for Teachers, formerly co-sponsored by the survey and the University of Akron.

Ron is an avid fossil collector and continues to have an interest in geology and teaching earth science. Ron's good-natured banter and knack for great story-telling will be missed by personnel at the survey and by the public who always found him willing to listen and explain geologic concepts in plain talk. Ron lives in Delaware County with his wife, Robin, and two sons, Cully and Drew.

Jim Patterson retires

James M. Patterson, an account clerk for the Division of Geological Survey since 2001, retired on June 30, 2005, with 21 years of public service. We are also saddened to report that Jim passed away unexpectedly in August of 2005 at his home in Columbus.

Jim began working at ODNR in 1983 as an account clerk in the Office of Budget and Finance and transferred to the Division of Forestry in 1995. Jim transferred from the Division of Forestry to the Division of Geological Survey in 2001 where he worked until his retirement. Jim was proud of his accounting skills and knew the labyrinth of state accounting rules, which he strictly followed. Soon after Jim arrived at the Survey, personnel quickly learned to have all their purchase, payment, and reimbursement paperwork properly filled out before giving it to Jim. Jim did his job well and the Survey staff appreciated his knowledge.



Jim Patterson

Jim was a private person, but anyone entering his office immediately knew that he was an avid hunter and fisherman. Hunting and fishing memorabilia, trophies, and taxidermic fish adorned the shelves and walls of his office. He also liked to cook and to talk about the latest gourmet meal that he had prepared. Survey staff were saddened to learn of his death so soon after his retirement, which he was looking forward to enjoying. Jim Patterson was 63 years old.

Nate Fuller retires

On June 30, 2005, Jonathan (Nate) Fuller retired from the Ohio Division of Geological Survey (DGS), Lake Erie Geology Group, after nearly 27 years of service. Nate is originally from Columbus and, as son of Dr. J. Osborne Fuller (long-time geology professor at The Ohio State University), decided to pursue a career in geology at an early age. In 1967, Nate began his formal study of geology at Hope College located in Holland, Michigan, and earned a Bachelor of Arts degree in 1971. After graduation, Nate worked as a geology-laboratory assistant for Hope College until 1972 when he traveled to St. Croix, U. S. Virgin Islands to begin work as a geology-laboratory technician for the West Indies Laboratory. Between 1974 and 1978, Nate earned a Master of Science degree in geology from Western Michigan University.

In 1978, Nate joined the Lake Erie Section of the DGS and began a career studying the many facets of the geology of Lake Erie's shorelines, bays, harbors, and lake bottom. Nate's first project involved cutting and describing 58 vibratory cores and interpreting 430 miles of seismic reflection data collected for a joint project with the U. S. Army Corps of Engineers. Subsequently, he developed a simple vibratory corer that was successfully deployed from the Geological Survey's research vessel, the *GS-1*. The vibracores, in conjunction with seismic reflection and side-scan sonar, were used to study the variety, distribution, erosion, transport, and deposition of bottom sediments throughout the Ohio portion of Lake Erie.

Nate Fuller

Nate would do nearly anything to get his core. One day, after a series of frustrating attempts to acquire a critical core, Nate decided that some additional weight would improve penetration into the lake bottom. He stepped from the transom of the *GS-1* onto the top of the vibrating core tube. Nate got his core, but quickly realized he was stranded because the *GS-1* had shifted on her anchor lines. Slowly, Nate was going down with the vibracorer in the finest tradition of the captain of one of His Majesty's Ships. A quick shift of the *GS-1* "saved" Nate for another day.

Later in Nate's career, he came ashore to investigate the destructive effects of near record high lake levels on shoreline erosion and near shore habitats. Over Nate's career he authored or coauthored nearly 100 reports, maps, field-trip guidebooks, and abstracts focusing on the geology of Lake Erie and its adjoining shorelines.

Nate was a member of the American Shore and Beach Preservation Association, Commission on the Coastal Environment, International Association for Great Lakes Research, Marine Technology Society, Ohio Academy of Science, and Society for Sedimentary Geology. In addition, Nate reviewed numerous articles for journal publication.

Nate is active in civic theater and enjoys making wine and traveling. As a member of Harlequins Community Theater in Sandusky, he is involved backstage constructing sets, arranging lighting, and running sound in many plays and musicals. According to his co-workers, it was not uncommon for some office activity to prompt Nate to share a line or lyrics from a play or musical.

Nate is missed not only by his survey co-workers, but also by the many Ohio teachers, professional colleagues, consultants, landowners, and public officials—who, over the years, looked to him for geologic information on Lake Erie and the adjoining shoreline. Although Nate is retired from the DGS, he continues to share his knowledge of geology with many groups and remains an active member of Harlequins.

DIGITAL GEOPHYSICAL LOGS NOW AVAILABLE

Geophysical logging computes various characteristics of the rock section encountered in a well and plots these measurements as a continuous function of depth. Measurements are made by a sonde, a collection of measurement tools, as it is withdrawn from a borehole. Several measurements, such as radioactivity, resistivity, hole diameter, and density of the rock, can be taken at once and plotted on a common depth scale. The oil-and-gas industry uses this technology heavily and most wells drilled for petroleum are geophysically logged. Over the years, the division has collected approximately 70,000 suites of geophysical logs in paper format from all parts of the state and these logs are available for viewing and copying at the division's central-office location.

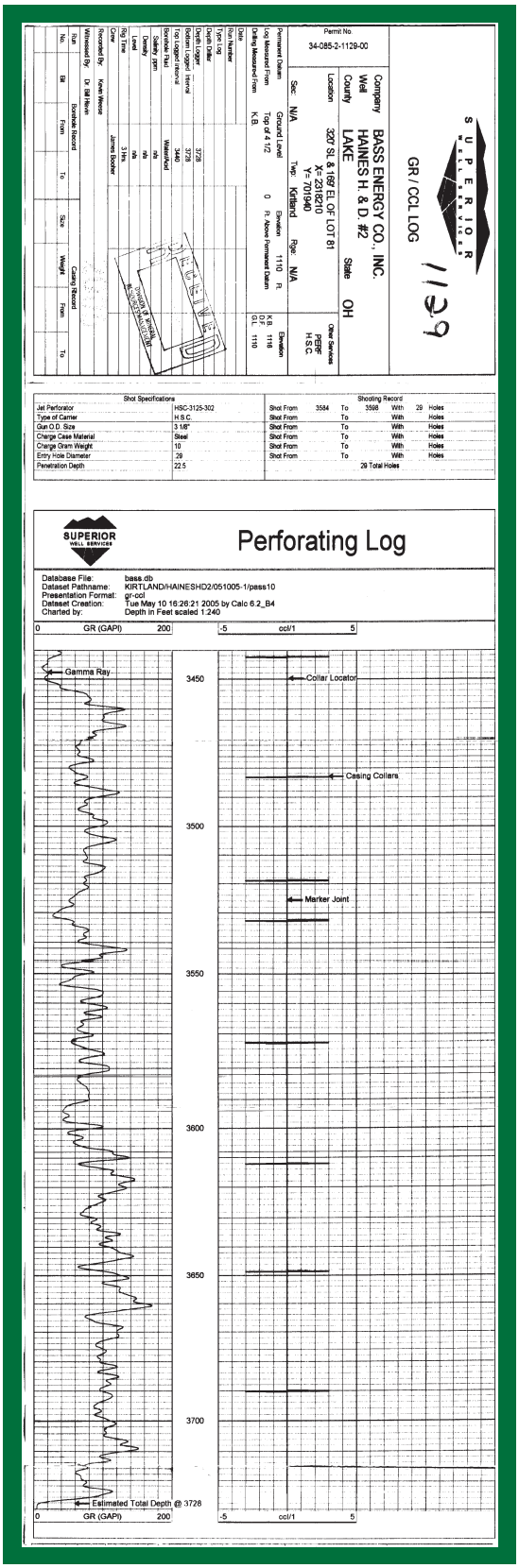
The Division of Geological Survey (DGS) initiated a program to digitally scan paper geophysical logs using a scanning device designed specifically for this application. While it is not possible, as yet, to scan all of the geophysical logs in the division's collection, all geophysical logs submitted from 2002 to present have been scanned. As funding for scanning of archival records becomes available, the division will contract for scanning logs received prior to 2002.

The microfilm reader-printers that the survey had used for many years to view and print geophysical logs are no longer operable. The division's only means for log reproduction is page-by-page duplication on a standard office copier. This process is both costly and time consuming for our customers and yields copies that must be taped together. Digital scanning enables the division to: 1) modernize its archival system for geophysical logs, 2) reduce labor-intensive manual copying operations, and 3) effectively respond to increasing oil-and-gas-industry requests for digital log copies.

Geophysical logs can be converted to digital form in two basic formats—vector and raster. The most common file format used for vector digital logs is the Log ASCII Standard (LAS). This is a text file in a specific layout that stores all the standard information from a well log including header information (e.g., operator, location, total depth (TD), and more), and the numeric value of each well-log curve along with the depth information at half-foot increments. Specialized log-analysis software can read these files, recreate the actual log curves, and even perform detailed analyses of the data (e.g., cross plots, porosity calculations, shale volume, and many more). Even with the newest conversion software, the time required to create an LAS file of a well log can range from 45 minutes to more than 2 hours. Thus, it is time prohibitive to convert the division's entire geophysical log library (more than 70,000 logs) to vector format in the near term. The DGS has, however, converted logs of more than 200 of the deepest wells in the state to LAS format. These files can be downloaded from the division's Web site (http://www.dnr.state.oh.us/geosurvey/ogcim/petrol/diglog.htm) or purchased on CD-ROM. The advantages of vector logs are their small file size (ranging from less than 100 kilobytes to about 2 megabytes) and, of course, their great versatility for utilization in a variety of log-analysis/mapping/presentation applications.

Raster-format digital logs are simply images of the logs from a scanner, usually stored in TIF format. Software exists that allow the use of raster logs to create cross sections and other types of custom displays. It is fairly easy to create a raster-log file using a specialized scanner designed for this purpose. However, raster files are large (up to 80 megabytes) compared to vector (LAS) files (up to 2 megabytes), which increase the cost of storing and backing up large collections in this format. The resultant image quality is also dependent on the quality of the original image. If the paper copy of the log is dark, washed out, or smudged, these same deficiencies will be evident in the resultant digital image.

Along with post-2002 well logs, the DGS has scanned numerous other logs used in DGS geological studies. Through these efforts, the raster-log



Example raster log.

collection already includes about 8,000 logs (for 3,800+ wells) and is increasing daily. The DGS will continue to seek funding opportunities from various sources for scanning of all of the logs in its collection. In the meantime, a list of available digital logs will be maintained on the DGS Web site. Customers can view the list and choose which digital logs they would like to order from the division's Geologic Records Center.

The cost of digital (TIF) log files and of paper prints created from the digital log files are as follows:

Digital files on CD
$2.00 per log; $20 minimum order
Paper prints of scanned logs
$4.00 for entire well with TD less than 4,000 feet
$6.00 for entire well with TD between 4,000 and 6,000 feet
$8.00 for entire well with TD greater than 6,000 feet

The cost of paper prints of scanned logs is much less (on a per-log basis) than current charges for logs duplicated on an office copier. Digital-log files are significantly less costly (on a per-log basis) than printed copies and provide the customer with a product that has many more potential uses than a paper copy.

Questions concerning this project should be directed to Larry Wickstrom at 614-265-6598 (larry.wickstrom@dnr.state.oh.us). To order digital geophysical logs contact the Geologic Records Center at 614-265-6576.

The geophysical logs in LAS format can be accessed from the DGS Web site (http://www.dnr.state.oh.us/geosurvey/ogcim/petrol/diglog.htm). This Web site page directs the user to the DGS download directory (ftp) where the geophysical log files are stored by API number. The direct address to the ftp site is: ftp://ftp.dnr.state.oh.us/Geological_Survey/geophysical_logs/.

Before downloading any LAS files, be sure to read the files named: 00readme.txt and Web site_LAS_FILES.xls. The readme file explains the file-naming conventions and the xls file is a spreadsheet listing basic information about each well/LAS file—location, curves in the LAS files, depth intervals, etc. Also within this same ftp folder, there is a file named ScannedLogList.xls. This file lists all the wells with scanned images of geophysical logs. Please use this file to order copies of the TIF files.

New map of Ohio's bedrock geology now available

First updated map of Ohio's bedrock geology since 1920

The Division of Geological Survey is pleased to announce that the new 1:500,000-scale *Bedrock Geologic Map of Ohio* is now available. The map shows the distribution of 46 bedrock formations or combinations of formations occurring at the surface or immediately beneath the surficial deposits (mostly glacial) that commonly conceal much of the bedrock in Ohio. The accompanying text explains not only the characteristics and distribution of the state's various bedrock formations, but also details the many economic mineral commodities, environmental characteristics, and geological hazards associated with the bedrock units. The map legend describes the geologic formations and shows their geologic age. A statewide geologic cross section provides a three-dimensional perspective of the geologic framework of Ohio. An extended article concerning this map will appear in the next issue of *Ohio Geology*.

Copies of the *Bedrock Geologic Map of Ohio* are available in folded versions for $15, plus shipping and handling costs depending on quantity. Unfolded (rolled) versions are available for an additional fee of $1.50. Orders are subject to Ohio state sales tax and applicable county taxes (Ohio addresses only). Orders for the bedrock map can be placed by calling 614-265-6576, or writing: ODNR Division of Geological Survey, 2045 Morse Road, Bldg. C-1, Columbus, OH 43229-6693. Visa and MasterCard are accepted.

Ohio Geology

Ohio Department of Natural Resources
Division of Geological Survey
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