Ohio Geology

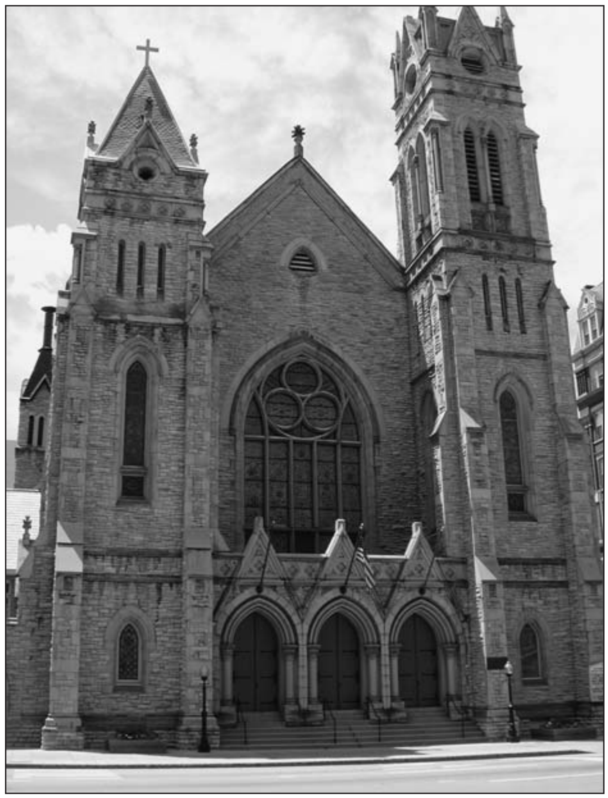
A Biannual Publication of the Ohio Department of Natural Resources, Division of Geological Survey 2005, No. 2

HISTORIC ROCK QUARRIES AND MODERN LANDSLIDES IN PRICE HILL, CINCINNATI

by Tim Agnello, P.G.

A chisel, hammer, and a strong back were all that was necessary to work the rock quarries that peppered the greater Cincinnati landscape at the close of the 19th century. Numerous small rock quarries existed on the hillsides of Cincinnati in the 1800s and early 1900s when one of the nation's most rapidly growing cities had a tremendous need for the local building stone. Now these historic quarries can be directly associated with modern-day landslide problems.

Local sources of limestone for construction of buildings and city infrastructure were as vital for a growing economy in the 1800s as they are today, and perhaps more so. Early in Cincinnati's history, numerous small limestone quarries sprang up across the region near local population centers where there was a need for building stone. Concrete had not yet come into widespread use as a building material, so dimension stone (stone that is quarried or cut to a required dimension) was the main building material for foundations, basement walls, and facings on buildings. The limited ability to transport heavy stone products great distances in those days demanded that quarries be developed in close proximity to end-use markets. This is in contrast to modern quarries, where railroad, truck, and boat transportation of quarried stone allow a few large quarries to serve markets that may be a considerable distance away. Some modern uses of stone include aggregate (i.e., crushed stone) used in construction projects for road and foundation base, and dimension stone for walls and building facades. Today's builders are highly dependent on limestone resources, much as the early inhabitants of Cincinnati depended upon the local stone resources.



The Covenant First Presbyterian Church, built in 1875 and located at the corner of Eighth Street and Elm Street in downtown Cincinnati (Mill Creek Valley), was constructed of limestone taken from the Neff quarry located on the Cincinnati Bible College property in Price Hill, a suburb of Cincinnati about 2 miles west of the church. Photo by Agnello, 2002.

The preferred building stone in 19th-century Cincinnati was Ordovician-age limestone of the Fairview Formation—a 70- to 120-foot-thick interval of interbedded limestone and shale. The upper 75 feet of the Fairview is dominated by planar beds of limestone, commonly four to seven inches thick, and ideal for use as dimension stone. The strong local demand for this stone is readily apparent today, as evidenced by its widespread use in numerous pre-1920-era residential foundations, retaining walls, and buildings throughout Cincinnati.

Numerous local quarries mining this interval were in operation and dotted the hillsides of Cincinnati to supply the stone. In 1916, Nevin M. Fenneman, a well-known geology professor at the University of Cincinnati, stated that the Fairview Formation could be readily identified in the field because of the numerous quarries developed in it. Fenneman also remarked that the stone had little use outside the localities where it was quarried, and that the interbedded shale was discarded downslope as mine spoil. Today, these long-abandoned quarries with their associated shale-waste piles have contributed to past and ongoing landsliding and only marginally stable landscapes.

The shale-rich bedrock and clayey glacial deposits of Hamilton County and the City of Cincinnati are highly conducive to landslides (See *Ohio Geology,* Spring 1986). The Ordovician-age Kope Formation underlies the broad, steep slopes around Cincinnati and weathers to form a clay-rich colluvium (unconsolidated material derived from weathered/eroded bedrock, transported downslope by water and the force of gravity, and commonly accumulating

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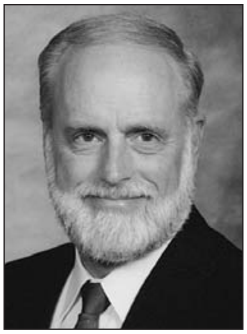

Thomas M. Berg, Division Chief and State Geologist

From The State Geologist...

Thomas M. Berg

RESPONDING TO THE "PIGLET"

Last August, the Buckeye Institute for Public Policy Solutions and Citizens Against Government Waste (CAGW)—two nonpartisan government-waste watchdog organizations—released a report titled, ***2005 Ohio Piglet Book***. This report is the first all-inclusive scrutiny of the State of Ohio budget by these organizations. I commend them for assuming and carrying out their hunt as government watchdogs. In these severely tight economic times, we certainly need our watchdogs. The ***Piglet*** was assembled by Matthew Carr—a policy analyst with the Buckeye Institute—and may be viewed at http://www.buckeyeinstitute.org/. Of the ***Piglet***, the Institute says: "After ferreting out almost $3.5 billion of pork and waste in this budget, it is clear that our elected officials may not understand what fiscal constraint means to those who have to pay the tab." The Institute further claims that an "...important task is pointing out the agencies and programs that exist which provide wasteful and duplicative services year in and year out."

Young Mr. Carr has done a very thorough job sniffing out organizations and programs that he thinks we taxpayers shouldn't have to pay for. Appendix A of the report lists programs that Carr judges to be examples of profligate, duplicative, and ineffective spending—**and**—points the finger at the Department of Natural Resources' "Geologic Records and Publications." So, here we are, identified as pork, along with pesticide regulation, cemetery registration, abstinence education, the Ohio Historical Society, the State Board of Engineers and Surveyors, and a horde of other agencies and programs. I am somewhat mystified that the Division of Geological Survey's legislative mandate to collect, archive, and make available all information regarding Ohio's geology is on Carr's pork list. In the face of literally thousands of highly complimentary and appreciative, mailed-in, customer-satisfaction cards, I am hard-pressed to understand why we made our watchdog's pork list. Nobody at the survey was contacted by Carr to help him understand what we do and why. He certainly never called the State Geologist to learn the survey's mission.

The survey's Geologic Record Center (GRC) is responsible for distributing maps, reports and geologic information regarding Ohio to the public. GRC staff members Madge Fitak, Sharon Lundy, and supervisor Garry Yates do an outstanding job of processing orders, answering questions, keeping records properly filed for later use, and putting customers in contact with appropriate staff to answer geologic questions. GRC staff have sold 10,000 copies of *Fossils of Ohio* since 1997. (We will soon be reprinting this award-winning book.) The GRC has been the point of sale for hundreds of thousands of USGS topographic maps for Ohio and is one of the top outlets for topographic maps sales in the nation. It has sent out over 25,000, prison-inmate-made, Ohio rock and mineral sets to teachers and students. The GRC maintains thousands upon thousands of geologic records relating to such things as oil and gas (greater than 250,000 wells in Ohio), coal, aggregates, and geologic hazards, and distributes county geologic reports, geologic maps showing bedrock, glacial deposits, and structure, and educational materials in an organized and easy-to-use manner.

I personally know that not having access to or ignoring geologic information can be very expensive and cause great heartache. For instance, colossal overspending on construction projects because of unforeseen or ignored geological hazards (landslides and debris flows, floods, earthquakes, sinkholes and paleokarst, coastal erosion, collapsing earth, indoor radon and carbon dioxide/monoxide, and reactive minerals) can be avoided if engineers and designers have good geologic maps that identify particular problems. The modest amount of state funds allotted to the GRC to continue as the chief outlet for Ohioans to gain access to regional geologic-framework information is a much-needed investment that makes Ohio more efficient and better prepared for the future. Correct, sequential, land-use planning cannot be accomplished without the regional geologic framework provided by the geological survey and transmitted through the GRC. Furthermore, this service cannot be privatized at a lesser price. Publications and maps made public through the GRC would cost two to five times more if released by way of the profit-making private sector. Additionally, products created by the geological survey and released through the GRC would not carry the value of the institutional knowledge and memory of the survey that extends back to 1837! Not long ago, I obtained an estimate for private-sector preparation of a bedrock-topography map of a 7½-minute quadrangle in central Ohio. (A complete series for the whole state is available at the GRC.) The geological consultant wanted about $10,000 to prepare one quadrangle in a 3-month period. Our geologists cranked out a final 7½-minute, bedrock-topography map product for about $1,400 in one week.

The Division of Geological Survey came into being 168 years ago because wise government officials realized the huge value in having a fundamental understanding of Ohio's geology, topography, and mineral resources prepared by an independent, neutral, unbiased, and objective state agency. The Buckeye Institute and Matthew Carr should reflect on that wisdom and not make hasty, uninformed judgments on matters they don't bother to research. Having said that, I still urge our readers to download a copy of the ***Piglet*** and reflect on "The Book Columbus Doesn't Want You to Read."

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A biannual publication of the

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

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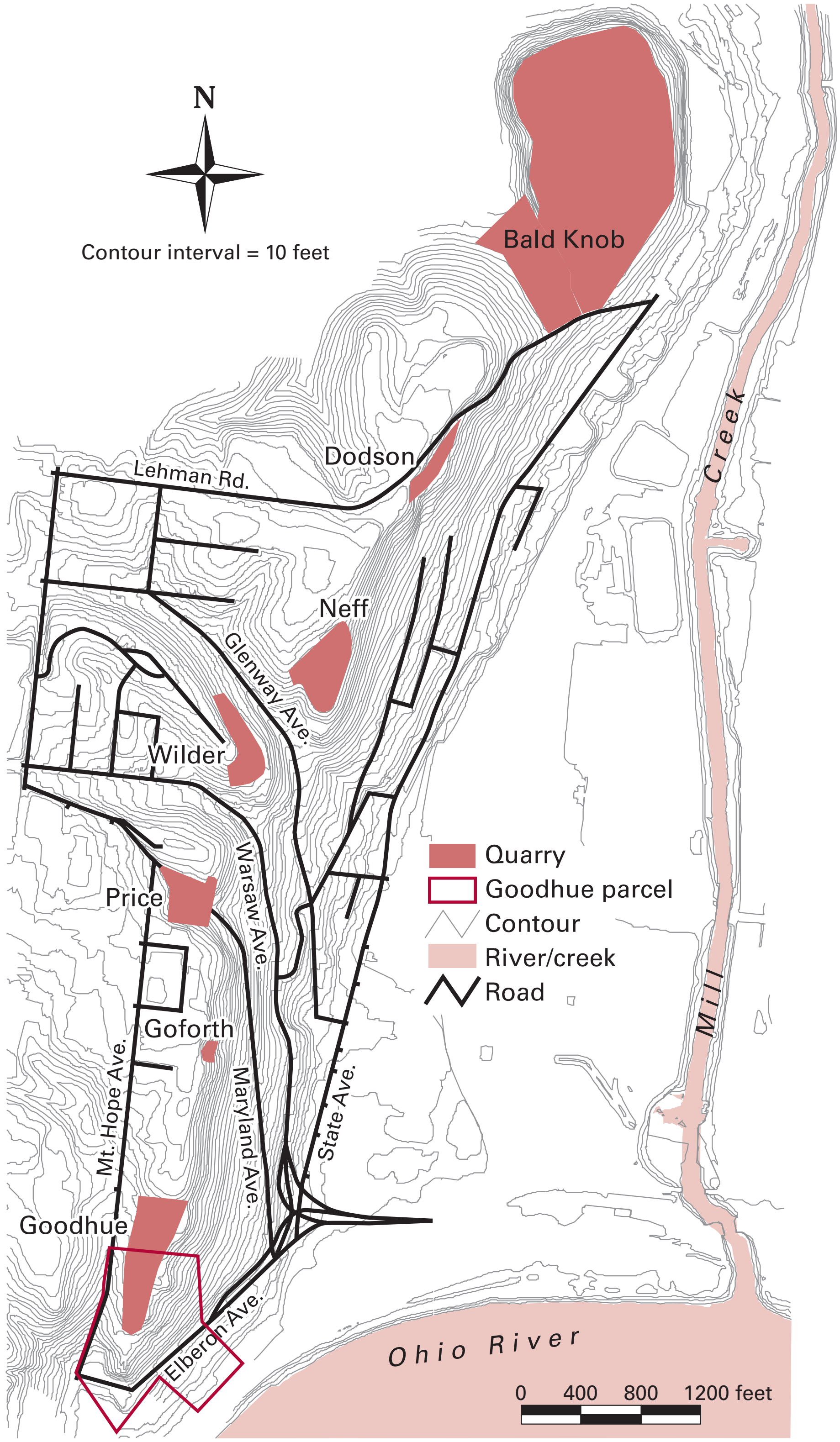
at the base of slopes) that is unstable and prone to landslides. The interface between unweathered bedrock and overlying colluvium is typically the zone of slippage; however, slip surfaces in deep landslides can be entirely located in colluvium. Landslide movement in colluvium is most common during spring and winter when high levels of precipitation dramatically increase the weight of the colluvium, and hydrostatic pressure builds up within the colluvium and at the bedrock-colluvium interface.

Another type of landslide-prone deposit in this area is clay- and silt-rich lacustrine sediment deposited at the bottoms of Ice Age lakes. Landslides in lacustrine sediment can develop on relatively low-slope gradients, which is in sharp contrast to landslides on steeper colluvial slopes. These ancient lake sediments are common along the courses of major stream valleys in which water at one time flowed predominantly from the south to the north in the vicinity of Cincinnati and were dammed up by the southward advancing glaciers, effectively ponding water in front of them and forming lakes. Silt and clay deposited on the bottoms of these lakes occur in almost any topographic setting, from the base of hillsides to flat-lying upland areas, and are notoriously unstable.

An engineering-geology study of a 168-acre hillslope in Price Hill, a western suburban area of Cincinnati, located 3 miles from the central business district and on the west side of the Mill Creek Valley, was undertaken by the author to determine the cause of chronic landsliding in this area. The majority of landslides in the study area were found to be associated with historic quarry operations along with other historic human activities (such as the construction of roads and houses) that destabilized the hillside.

The quarries identified in the study area probably operated from the early 1800s to 1920 with the exception of Bald Knob, which was worked until the early 1930s. Bald Knob, it is interesting to note, was stripped of four million cubic yards of limestone and shale for use as fill material for Union Terminal (now home of the Cincinnati Museum of Natural History) and the associated rail yard. More than 240 acres of the Mill Creek Valley were infilled an average of 16 feet (some areas were filled in up to 58 feet) to elevate rail lines and the terminal above flood level.

Most of Cincinnati's hillside quarries were significantly smaller than the Bald Knob quarry and probably were worked by a handful of men using picks, hammers, and chisels to produce valuable dimension-stone products. The quarries typically were excavated at the tops of hills or along the colluvium-mantled midslopes of hillsides using the contour-strip-mining method. The shale between limestone layers was generally treated as

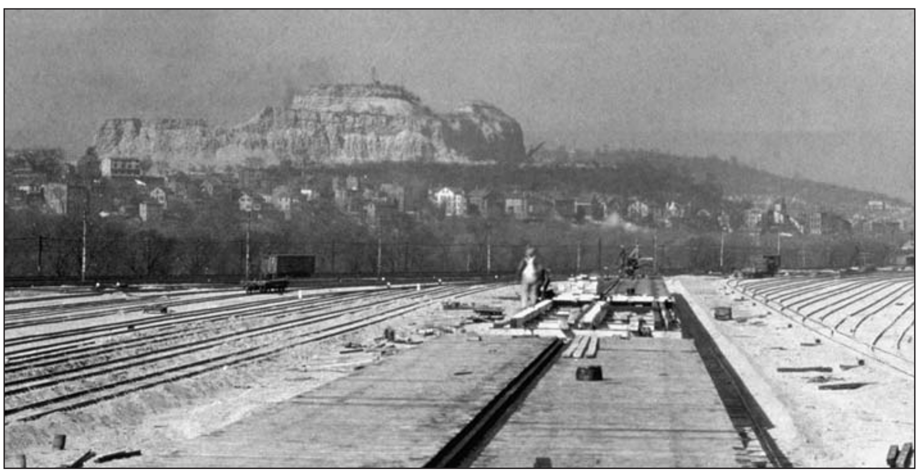


Seven Price Hill rock quarries identified by the author and worked between 1800 and 1930. Note that the Goodhue parcel boundaries extend to the Ohio River, possibly facilitating transportation of limestone. Prior to the study, only two quarries (Bald Knob and Neff) were well known.

mine spoil and dumped onto the hillside slopes below the quarry. The spoil added weight to the colluvial "soil" wedge (natural slope deposit developed over bedrock by solifluction, and varying in thickness from 2 to 70 feet), unnaturally oversteepened the slope below the quarry operation, and made the slopes more susceptible to movement. Detailed geologic mapping by the author determined that landsliding caused by spoil is common downslope of most of the historic quarries in the mapping area. It should be noted that other human activity such as grading for road and house construction also set the stage for landsliding below the quarries.

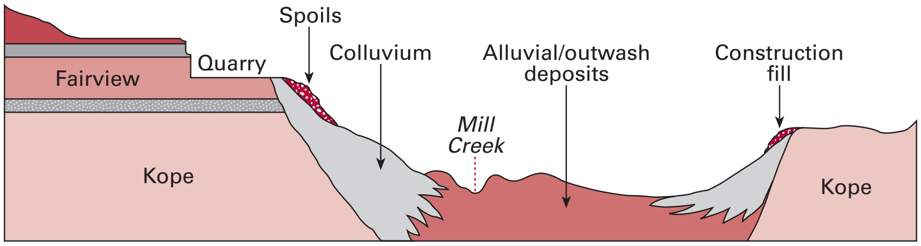
Fenneman noted in 1916 that 20 rock quarries existed on the upper portion of the hillslope in the Mill Creek Valley in the vicinity of downtown Cincinnati. While Fenneman did not report the exact locations of these quarries, evidence for rock quarries in the field consists of thick deposits of unconsolidated material (i.e., quarry spoil) on hillsides downslope from unnaturally squared-off topography (i.e., benches), and vertical rock exposures of the upper Fairview Formation. Unnaturally thick surficial deposits at the top of hillsides where the colluvial cover typically is thin are sometimes recognized in the field by the presence of extensive piering and walls that have been built to hold back the material. Retaining walls at the southern end of the study area in the vicinity of the Goodhue rock quarry surround a substantial portion of the upper hillside and quarry. The Goodhue rock quarry terminates at the northern end in an abrupt 30-foot-high vertical limestone and shale exposure, marking the last working face of the quarry. Examination of historical records indicates that two large tracts of ground encompassing the quarry operation extended down to the Ohio River, and were owned by D. F. Goodhue and G. W. Goodhue. The Goodhues may have utilized the Ohio River to transport rock. The Goodhue's business interests are listed under the categories: "freestone," "stoneyards," and "real estate" in the *Williams Cincinnati Directory* from 1867 to 1880 (comparable to our telephone directory today).

Elberon Avenue, located at the southern end of the study area, was constructed in the early 1890s to connect Mt. Hope and Maryland Avenues. At the time, Elberon Avenue crossed over the Goodhue parcels and below the Goodhue rock quarry on a hillside that was "loaded" with quarry spoils and thus predisposed to landsliding. Funds for construction of Elberon Avenue were provided by a $100,000 county bond, however, an additional $75,000 was needed to complete the road because of a landslide that developed in mine spoil and colluvium during construction of the road. In April-May of 1963, a landslide described by the Cincinnati City Engineer (*Cincinnati Enquirer* 1963) as "an act of God" encompassed an area 300 feet parallel to Elberon Avenue and extended more than 200 feet upslope to the base of the former quarry. Newspaper reports stated that landslide debris rose above and topped the Elberon Avenue retaining wall at a rate of between 2 to 12 inches per hour. The landslide blocked three of four lanes of traffic on Elberon Avenue, and required clean-up crews to remove 400 to 500 cubic yards of landslide debris per day. The landslide damaged a home at the southern end of the former rock

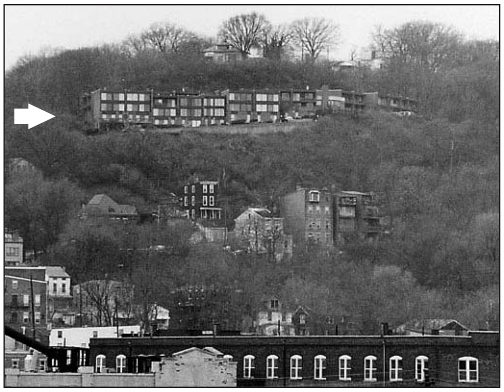


1930 photo showing construction of rail facilities at Cincinnati's Union Terminal. Bald Knob is located in the middle background of the photo. This photo illustrates the extent to which mining and stripping of bedrock for fill material had impacted Bald Knob prior to and during the Union Terminal project. Photo from the University of Cincinnati archives.

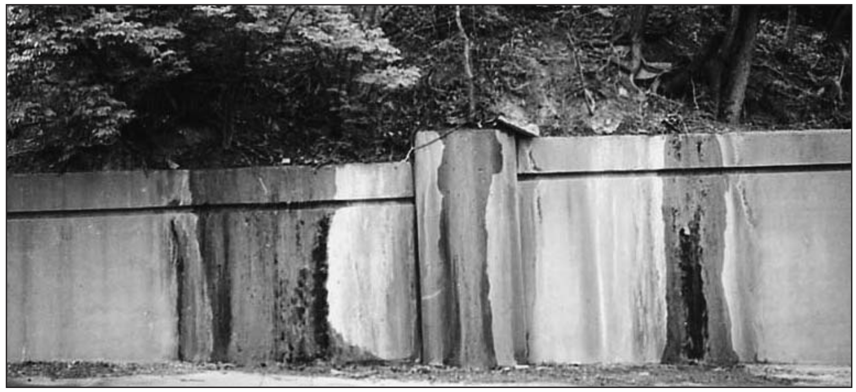
Railroad cars dumping rock stripped from Bald Knob and used as fill material on the Union Terminal project. More than 240 acres of natural wetlands adjacent to Mill Creek were lost in construction of the terminal. Photo from the University of Cincinnati archives.



Schematic cross section of the Mill Creek Valley illustrating the shale-rich Kope Formation (200-plus feet thick), colluvial wedges that commonly develop on Kope Formation hillsides, a quarry in the Fairview Formation, and mine spoils and construction fill loading the landslide-prone colluvial wedges. Added weight of mine spoils and construction fill destabilize the hillside and are prone to landsliding. Agnello 2005.



The West View condominium complex (indicated by arrow) on the west wall of the Mill Creek Valley is located on the former site of the Wilder quarry. It is easy to picture a working quarry here instead of the condominium building. In fact, the last working face of the former quarry is exposed behind the building. A large landslide has developed in mine spoil on the vegetated hillslope below the former rock quarry. Photo by Agnello, 2002.



Landslide toe resting on and overtopping the concrete retaining wall on Elberon Avenue located just west of Maryland Avenue. Note the water seeping out at the bottom of the landslide, and the earth and rock resting on top of the concrete wall. Photo by Agnello, 2002.

quarry and eventually led to the home being condemned. The toe (bottom) of the landslide can still be seen, and is located just behind and on top of the Elberon retaining wall.

In the relatively short time span of about 150 years, humans have reshaped the hillsides in the Price Hill area of Cincinnati through quarrying, oversteepening, and overloading the hillslopes with discarded mine spoil, which has initiated subsequent landsliding of the marginally stable preexisting colluvium. Human activity has disturbed the natural geologic processes that shaped the hillsides of the area over the course of thousands of years, and have created conditions conducive to landslide development**.** Detailed mapping of the locations of old quarries (and other historic activity) can help explain the cause of persistent landslides in areas downslope of the operations and provide engineers and professionals vital information to allow efficient mitigation or avoidance of problematic areas. Rock quarries are not unique to Price Hill, and perhaps landslide risk identified through this study can be applied to similar geologic terrain in other areas of southwestern Ohio, northern Kentucky, and southeastern Indiana.

FURTHER READING

Agnello, T.J., 2002, Land use and landsliding in Price Hill, Cincinnati, Ohio: Unpublished M.S. Thesis, University of Cincinnati, 169 p.

Fenneman, N.M., 1916, Geology of Cincinnati and vicinity: Ohio Geological Survey Bulletin 19, 207 p.

Hansen, M.C., 1986, When the hills came tumbling down—Landslides in Ohio: Ohio Division of Geological Survey, Ohio Geology, Spring, p. 1-7.

Tim Agnello, a real-estate broker in Cincinnati with a University of Cincinnati masters degree in geology, is interested in increasing public awareness of landslides. He can be contacted at 513-321-3391 or at agnello@cinci.rr.com.

New educational leaflet on clay and shale in Ohio released

The Division of Geological Survey has released an updated version of Educational Leaflet 12 “Clay and shale in Ohio” by Mark E. Wolfe and Steven D. Blankenbeker. The leaflet describes the geologic origin, properties, and uses of clay and shale in Ohio. The leaflet also provides a short summary of the history and production trends of the clay and shale industry in the state with emphasis on decorative pottery, brick, sewer pipe, and drainage tile. A map showing the location of clay and shale mining operations in Ohio and the type of the deposit is included. Educational Leaflet 12 is free and can be obtained by calling the Geologic Records Center at 614-265-6576, or by writing the ODNR Division of Geological Survey, 2045 Morse Road, Bldg. C-1, Columbus, OH 43229-6693. A pdf format version of this leaflet is available for viewing or downloading from the Division of Geological Survey’s website at http://www.ohiodnr.com/geosurvey/pdf/el12.pdf.

DENNIS N. HULL, EMPLOYEE OF THE YEAR FOR 2004

Assistant State Geologist and Assistant Chief, Dennis N. Hull, received the Survey Employee of the Year Award for 2004. Division Chief, Thomas M. Berg, presented Dennis with a plaque recognizing his achievement at the division's annual holiday luncheon and awards ceremony. Dennis was chosen as the 2004 recipient by a special committee selected to review nominations submitted by fellow staff members.

Dennis has contributed to the mission of the survey as both a geologist and supervisor over his 28-year survey career and has consistently done so in a thoughtful and professional manner. He was recognized for providing accurate and timely geologic information to the public and for his contributions to the increased understanding of Ohio's geology. The breadth of his geologic investigations range from mapping surficial geology, sand and gravel resources, and landfill suitability to writing reports on carbonate rocks in Ohio for use as sulfur dioxide sorbents, karst features in Ohio, guides to geology along Interstates 70 and 75 and a variety of other topics. Dennis oversaw the development of the statewide mapping program, which has resulted in the remapping of Ohio's bedrock geology and bedrock topography and produced numerous surficial-geology maps. Dennis continues to perform a major role in guiding the division's surface and subsurface geologic mapping, publication production, and sales efforts that benefit the public in need of geologic information.

Dennis N. Hull (left) receives the 2004 Employee of the Year Award from Thomas M. Berg (right), Chief of the Division of Geological Survey.

Dennis joined the survey in 1977 and is a graduate of Wright State University in Dayton, where he received an M.S. degree in geology in 1976. Dennis, his wife, Shirley, and son and daughter, Oliver and April, live in Union County. The Hulls also have a son, David, who lives in central Ohio, allowing Dennis close access to his two grandchildren.

Scott Brockman retires

On June 30, 2005, Scott Brockman retired from the Ohio Division of Geological Survey (DGS), after nearly 21years of service. Scott is originally from Cincinnati and began his long career in geology by collecting fossils from highly fossiliferous Upper Ordovician rocks exposed in the Cincinnati region. He later pursued his formal geologic training at the University of Cincinnati (UC) where he earned a Bachelor of Science degree in geology in 1972. From 1972 to 1975, Scott served as an electronic-equipment repairman in the U.S. Army at Schweinfurt, Germany. After his military service, Scott returned to Ohio and taught science courses in the Cincinnati school system. Between 1980 and 1983, Scott earned a Master of Education degree in secondary science, and a Master of Science degree in geology from UC. In 1983, Scott worked as a computer geologist for Exxon Corporation in Houston, Texas.

Scott Brockman

Scott joined the Ohio Survey in 1984 and was assigned responsibility for mapping the glacial geology of Hamilton County. By 1988, Scott had completed 15 open-file 1:24,000-scale maps—the first, systematic, detailed mapping of the glacial geology of Hamilton County. In subsequent years, Scott compiled glacial-geology maps for other areas of southwestern Ohio. This information, together with his work in Hamilton County, was published in 1999 as part of DGS Map No. 2, *Quaternary Geology of Ohio*.

In 1995, Scott began work on a U. S. Forest Service (USFS)-funded project to map and characterize Ohio physiography as part of a larger program to define the ecoregions of a multi-state area. This work resulted in a new, page-size, full-color map entitled: *The Physiographic Regions of Ohio* (see *Ohio Geology,* Summer 1998), and also was incorporated in *The Indiana-Ohio Ecoregion Map*, published in 1998 by the USFS.

Beginning in 1998, and continuing up to his retirement, Scott was one of the principal investigators in the DGS's ongoing program to produce 1:100,000-scale, three-dimensional surficial-geology maps of the state. Scott played a vital role in the success of this program through his own mapping efforts, and his willingness to share his vast knowledge of Ohio's glacial geology with his mapping colleagues. Also during this time period, Scott assisted with the completion of a map of the *Known and Probable Karst in Ohio* (DGS Map EG-1) and was one of a team of scientists studying fractures in till and ground-water movement through these fractures. This work was published in 2000 as special issue of *The Ohio Journal* *of Science* entitled: "Fractures in Ohio's Glacial Tills".

Throughout his career, Scott has often returned to his first love of teaching by making geologic presentations and leading field trips for audiences ranging from elementary-school children to professional geologists. His Wooly Mammoth dolls, have become a favorite of the children at the Annual Earth Science Week Expo held each fall at High Banks Metro Park. Recently, Scott has been teaching a course describing the environmental aspects of soils at Columbus State Community College.

For many years, Scott was a co-leader of the Ohio Mineral Industries and the Environment Teachers Workshop. In 2003, Scott and his co-leaders were honored with the *National Mineral Education Award-Public Outreach Category* from the Interstate Mining Compact Commission.

Scott is missed not only by his survey co-workers, but also by the many Ohio teachers, academic colleagues, geologic consultants, landowners, and public officials who over the years looked to him for information on Ohio's glacial geology and landforms. Scott plans to enter his "second career" by exploring some small business opportunities, teaching a course on the geology of America's National Parks at The Ohio State University Marion Campus, and continuing his teaching at Columbus State Community College. In his spare time, Scott and his wife, Cheryl, will be busy remodeling their new home.

Douglas L. Crowell retires

Douglas L. Crowell, geologist and supervisor of the Survey's Coal and Industrial Minerals Group retired on February 28, 2005 after 28 years of service to the division. Doug grew up in Hudson, Ohio, and came to the Survey in February 1977 after earning bachelor's and master's degrees in geology at Miami University in Oxford, Ohio.

Douglas L. Crowell

Doug served in a variety of capacities during his career with the Division of Geological Survey. As a very capable research geologist he participated in, conducted, or supervised several major coal-resource investigations. The first of these investigations, informally referred to as Deep-Core II, focused on identification and characterization of low- to medium-sulfur coals in several eastern Ohio counties. Subsequent investigations under Doug's direction characterized coal resources on a county, quadrangle, or seam basis.

Doug also spent many years collecting, compiling, and interpreting field and archival data on Ohio's abandoned underground mines. Through this work, he developed into one of Ohio's leading experts on Ohio mining history, giving innumerable public presentations on mining history and mining issues at university seminars, trade-association meetings, professional-society meetings, and historical-society meetings. In 1995, the survey published Bulletin 72, *History of the Coal Mining Industry in Ohio*, a comprehensive, profusely illustrated report in which Doug put into print his vast personal knowledge of coal-mining lore, coal-mining history, and historic coal production. Bulletin 72 remains one of the survey's most popular, interesting, and useful technical publications.

Beginning in 1982, and continuing through 1993, Doug was responsible for managing the division's statewide core-drilling operations. In this capacity, he directly supervised daily operations of a Mobile B-61 drill, a Longyear Hydro-33 drill, and a CME-55 drill. Under Doug's supervision, Survey drill crews established several depth records for continuously cored holes drilled east of the Mississippi River.

Beginning in the late 1990s, and continuing through 2002, Doug served as co-leader of the Ohio Mineral Industries and the Environment Teachers Workshop. This cooperative program with the University of Akron served hundreds of Ohio teachers, and equipped them with information and experiences that will enable them to objectively instruct their pupils about society's dependence on mineral resources and responsible mining practice. In 2003, this workshop received the *National Mineral Education Award-Public Outreach Category* from the Interstate Mining Compact Commission.

More recently, Doug's duties were expanded to include: management of stream- and soil-sediment collection in Ohio under the U. S. Geological Survey's (USGS) National Geochemical Database Program; conversion of USGS maps of landslides and related features into a GIS coverage; oversight of division work to encode Ohio coal-resource information into the USGS National Coal Resources Data System; and development of GIS coverages for state and federal highways overlying or adjacent to abandoned underground mines.

Doug is missed both by his survey co-workers, and by the many Ohio teachers, realtors, landowners, public officials, and miners, who for many years looked to him as a reliable source of information on Ohio coal resources and abandoned underground mines. All who knew and worked with Doug wish him well in his post-retirement pursuits, including his current quest for the finest tennis courts and beaches in sunny southern Florida, where he now resides.

CHANGES AT THE H. R. COLLINS LABORATORY

On June 30, 2005, Ron Rea retired as manager of the H. R. Collins Laboratory after 21 years of public service. A full description of Ron's career and his professional accomplishments will be included in the next issue of *Ohio Geology*.

Effective with Ron's retirement, Greg Schumacher transferred from Ohio Survey headquarters in Columbus to the H. R. Collins Laboratory, located at Alum Creek State Park, and became the new laboratory coordinator. New business hours also went into effect: 8 a.m. to 4:30 p.m., Monday through Friday. Please check the division's website (http://www.ohiodnr.com/geosurvey/) for our updated Core-Use Policy.

All non-ODNR groups are required to complete a new form outlining conditions for use of the H. R. Collins Classroom/Learning Center and Core and Sample Repository. Forms are available on the division's website. If you have any questions about the H. R. Collins Laboratory, please contact Greg Schumacher (telephone: 740-548-7348, ext. 25; email: greg.schumacher@dnr.state.oh.us).

Test your knowledge answers for *Ohio Geology* 2005, No. 1

To refresh your memory of the images in the last issue, see our web site http://www.ohiodnr.com/geosurvey/oh_geol/05_No_1/05_no1_c.htm.

A *Artist's depiction of a living bryozoan colony.* Bryozoans are common, aquatic invertebrate animals that are preserved in the fossil record and that inhabit modern fresh, brackish, and marine environments. Each bryozoan animal or zooid secretes a calcareous tube or box that partially encases the soft parts and joins with the calcareous tubes of each neighboring zooids. Each bryozoan animal is basically cylindrical with a ring of tentacles that capture tiny organisms from the water column above the colony.

Most bryozoan colonies grow to about one inch in diameter. Extraordinarily large colonies, like those described by Cuffey and Fine, are very rare. Bryozoans will colonize any hard substrate including the outer surface of boat and ship hulls and the inner surface of water-intake pipes for ships and power-station cooling systems. Accumulations of bryozoans in intake pipes restrict water flow and can become a serious problem, if not periodically removed.

B *Seismogram of northern Sumatra earthquake.* On December 26, 2004, a massive earthquake measuring at least 9.0 on the Richter Scale occurred along the Sunda Trench in the Indian Ocean about 100 miles off the west coast of northern Sumatra, Indonesia. The quake caused a 620-mile-long section of the Burma Plate to be thrust over the adjacent Indian Plate by as much as 20 feet, creating tsunamis. The sudden vertical movement of the Burma Plate caused the ocean surface to rise as much as 20 feet above the plate. Waves spilling away from this mound of water raced across the Indian Ocean in all directions, reaching speeds of more than 400 miles per hour. The first tsunami crashed into the Sumatra coastline in a mere 15 minutes after the quake; others reached the coastlines of Sri Lanka and India in 3 to 4 hours. These massive tsunamis, some as high as 50 feet, killed an estimated 180,000 people (50,000 are still missing), and destroyed or heavily damaged nearly every building as much as two miles inland.

The seismic waves generated by the December 2004 Sumatra earthquake reverberated throughout the earth. The Ohio Earthquake Information Center, located at Alum Creek State Park near Delaware, Ohio, recorded the initial arrival of the Sumatra earthquake at 8:18 p.m. (December 25, 2004) Eastern Standard Time and recorded significant surface waves for nearly 6 hours. The seismogram represents the initial 25 minutes of seismic waves recorded at the Alum Creek station. The huge surface (Rayleigh) waves did not arrive at Alum Creek until 44 minutes after initial primary and secondary waves came in.

Did you know . . .?

Did you know . . . that landslides in the United States are a major, widespread geologic hazard that occur each year in all 50 states, cause $1-2 billion in damages, and take the lives of more than 25 people? In Ohio, landslides are most common in clay-rich geologic units exposed along the shoreline of Lake Erie and the valley walls of the Ohio River and its tributaries. Ohio landslides typically creep down the hillside only a few feet or less per day, but still cause millions of dollars in damages to homes, buildings, and highways each year. To learn more about landslides, visit the U.S. Geological Survey website at http://www.landslides.usgs.gov and see Ohio Division of Geological Survey *GeoFacts* 8, *Landslides in Ohio.*

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