Kentucky Geological Survey
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Earth Resources—Our Common Wealth

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Kentucky Geological Survey
228 Mining & Mineral Resources Bldg.
University of Kentucky
Lexington, KY
40506-0107
859.257.5500
fax 859.257.1147
www.uky.edu/KGS

Jim Cobb, State Geologist and Director
John Kiefer, Assistant State Geologist
Mike Lynch, Editor, *Kentucky Geology,* mike.lynch@uky.edu
Meg Smath, Copy Editor

Our mission is to increase knowledge and understanding of the mineral, energy, and water resources, geologic hazards, and geology of Kentucky for the benefit of the Commonwealth and Nation.

Deep seismic borehole drilled in western Kentucky

The deepest seismic borehole east of the Rocky Mountains has been drilled in rural Fulton County, Ky., by KGS and several partners. When the 4-inch-wide steel-cased borehole is equipped with instruments, it will serve as a permanent observatory for earthquake studies and research on earthquake-resistant construction in the central United States. The borehole was drilled to a depth of 1,948 feet at Sassafras Ridge by contractor Layne Christensen Inc.

KGS Geologic Hazards Section Head Zhenming Wang and Ed Woolery of the University of Kentucky Department of Earth and Environmental Sciences oversaw the effort to plan and secure funding for the project. Once the funding was approved, Jonathan McIntyre of the Geologic Hazards Section managed the contracting and drilling phase.

"This station, to be called the Central U.S. Seismic Observatory, will become the flagship of the Kentucky Seismic and Strong-Motion Network," said KGS Director Jim Cobb.

Five partners involved in the project have committed a total of $295,652; a substantial amount of the funding comes from the U.S. Department of Energy through the Kentucky Research Consortium for Energy and Environment.

Photo by John Kiefer.

Instruments placed in the new seismic hole will allow rigorous evaluation of the effects of earthquakes on bedrock and soil and the resulting ground motions in the region.

The observatory will capture an abundance of new data on the origin, location, magnitude, and depth of earthquakes in this region and the propagation of earthquake waves to the surface.

"Western Kentucky and the central United States will

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Drahovzal retires as Energy and Minerals Section head

Jim Drahovzal came to KGS in 1989, becoming the head of what was then the Petroleum and Stratigraphy Section. On September 30, he officially retired as the head of the same section, now known as Energy and Minerals. "I've not raised myself at all," he says with a laugh.

Drahovzal's career, which began in 1965, included work with several oil companies, a dozen years with the Alabama Geological Survey, where he become assistant state geologist, and almost 18 years at KGS.

Both he and then-director Don Haney were interested in basin analysis and in cooperative work with other state surveys. The combination of these interests resulted in the creation of the Illinois Basin Consortium, followed by numerous other projects conducted in cooperation with other states and the U.S. Geological Survey.

"As a result," Drahovzal says, "we're really beginning to understand some of the deep parts of the Illinois Basin, especially the Rough Creek Graben. That was the sort of thing we started doing—beginning to work more and more with other state surveys."

In the early 1990's, he worked with Ohio and Indiana to form the Cincinnati Arch Consortium. The three state surveys conducted research to develop an understanding

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Director's Desk

The Kentucky Geological Survey is the state's clearinghouse for geology, mineral resources, groundwater, and geologic hazards information, and we provide information and conduct research projects to shed light on these topics. Another aspect of KGS is its role as an organizer, facilitator, and leader for earth science initiatives in the state. Although there are a number of very capable and motivated professional geological societies and associations in the state, all of them appreciate the assistance of KGS when organizing meetings, field trips, and advocating various programs. KGS benefits from the efforts of these groups in their public service and education missions, and in turn helps whenever possible to assist them.

One person at KGS who has been a real leader in the state for research and public service is Jim Drahovzal, head of the Energy and Minerals Section. Jim retired last fall and deserves special mention for his efforts above and beyond the call of duty. Jim is well known in the private sector for his knowledge of Kentucky geology, oil, and gas. He has also been recognized by the professional societies that he worked with. Few people have had as large an impact on our knowledge of Kentucky geology as Jim has had.

At the end of 2006, we completed a deep hole in western Kentucky that will become the Central United States Seismic Observatory. It is just across the Mississippi River from the town of New Madrid, Missouri. The 4-inch-diameter hole reached a depth of 1,948 feet before bedrock was encountered. The location is near the most active part of the New Madrid Seismic Zone. This location will allow collection of the maximum amount of data from the region's earthquakes for thorough evaluation of their effects on bedrock and soil and the resulting ground motions.

Kentucky may not be on the "short list" for the FutureGen project, but we continue to do important research on related issues, including carbon sequestration in Devonian shale. The final report on Brandon Nuttall's project on this topic has been completed and has attracted regional and national interest (a national syndicated news service distributed a story about this research recently).

Our leadership has placed us in a position to be trusted by Kentucky's State agencies and communities, several of which have turned to our experienced staff to meet their needs in areas ranging from groundwater investigations to data

management. In addition, the Eastern Section of the American Association of Professional Geologists has asked us to organize its annual meeting in September. We look forward to another year of partnership with these and other local, state, and regional entities in 2007.

I am always glad to hear from customers and friends of the Survey. Feedback helps us keep our services relevant and responsive to the needs of our clients. Feel free to contact me at cobb@uky.edu.

James C. Cobb

Overfield developing rock guide for Transportation Cabinet

Bethany Overfield takes notes as she chooses samples from core boxes. Photo by Mike Lynch.

Hovering over a row of core boxes, KGS geologist Bethany Overfield looks for representative samples of core from each box. About 150 of the boxes, each containing roughly 10 feet of core, have been delivered to the KGS Well Sample and Core Library by the State Transportation Cabinet for a project funded by the Cabinet that began this summer. As many as 80 more boxes of core from transportation project sites will be delivered before she finishes the first phase of sampling early in 2007. Her study area includes over 30 counties in central and northern Kentucky.

"I'll open each box and look at the different units and sample each rock type from those units," she says. "I want to make sure I sample everything, even if it occurs repeatedly, so we have a good representation of all rock types."

After sampling is completed, she will categorize the samples on the basis of visual and tactile properties. The samples will be grouped to classify the specimens into a small number of classes that have similar geologic characteristics and geotechnical properties.

This new project is intended to develop a prototype core description manual to relate rock properties to geotechnical behavior.

Although there is a general understanding that different kinds of rock have specific behaviors, more information is needed about the properties of all the varieties of rock encountered in transportation projects, and standard descriptions are needed in the logging of the cores.

To move toward those goals, the project will create a reference collection of the types of rock found in central and

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Study finds plenty of carbon dioxide storage capacity underground in Kentucky

In a 3-year project funded by the National Energy Technology Laboratory of the U.S. Department of Energy, KGS geologist Brandon Nuttall has determined that the deeper and thicker parts of the Devonian shales in Kentucky could provide a potentially large geologic reservoir for captured carbon dioxide. Devonian black shales are organic-rich rocks found beneath about two-thirds of Kentucky.

Capturing and geologically storing CO_2, a process known as carbon sequestration, is one proposed method for reducing the amount of human-produced CO_2 in the atmosphere. The extensive occurrence of shales in geologic basins across North America could make them an attractive regional reservoir for economic CO_2 sequestration.

Analysis of 43 shale samples from 11 recently drilled wells in the Appalachian Basin of eastern Kentucky and the Illinois Basin in Indiana demonstrated that Devonian black shales in Kentucky could sequester as much as 28 billion tons of injected CO_2. The analyses done for Nuttall's project indicate that in the five-county Big Sandy Gas Field in eastern Kentucky alone, 6.2 billion tons of CO_2 could be sequestered.

"In the sequestration process, carbon dioxide is 'adsorbed' by the shales, which means the CO_2 forms a molecular bond with the shale," Nuttall says. "The shale may, in turn, 'desorb' natural gas when carbon dioxide is present. Natural gas fields in shaly areas are therefore considered potential candidate sites for carbon sequestration because the injection of CO_2 for permanent storage may also help extract additional natural gas."

The project's final report, entitled "Analysis of the Devonian Black Shale in Kentucky for Potential Carbon Dioxide Sequestration and Enhanced Natural Gas Production," is available online at the KGS Web site, www.uky.edu/KGS/emsweb/devsh/devshseq.html.

Nuttall's Devonian shale research is continuing, in an effort to demonstrate the economic viability of the production of natural gas displaced by CO_2 injection. He's working with geologists from several surrounding states on research funded by the Department of Energy's Regional Carbon Sequestration Partnerships programs, which are active nationwide. These efforts will result in a better understanding of shales as gas reservoirs, sequestration targets, and seals for deeper reservoirs.❖

Glynn Beck assists well-camera training in Texas

Glynn Beck of the KGS office in Henderson went to Texas A&M University Oct. 30–Nov. 1 to help conduct a well-camera training course for Texas A&M staff. He's the lead team member for Kentucky on the Southern Region Well Camera Team, which is funded by the USDA to promote proper domestic well maintenance. The team includes members from Kentucky, Georgia, Tennessee, Oklahoma, Louisiana, and Texas. Its purpose is to promote more thorough well inspections that go beyond traditional examinations (above-ground visual inspections) by using a well camera to scrutinize the inside walls of a well. This method of inspection can reveal hidden problems such as cracked and leaky casings and the presence of foreign objects in wells. Once these problems are identified, measures can be taken to protect local groundwater resources from possible contamination while maintaining a safe drinking-water source for the well owner.

The team also hopes to expand the information base of down-well videos across the southern region and work toward a regional publication on water-well maintenance and abandonment. Members share experiences, case studies, and videos identifying well construction and maintenance problems through the Internet. The team believes state groundwater protection agencies may need to revise water-well construction standards in some cases to correct recurring problems.

KGS has two well cameras, used mostly upon request by well owners or drillers when problems arise, but also for research by KGS and University of Kentucky staff. A 500-foot-deep camera is mostly used in the Jackson Purchase Region, but can be used throughout the state. A 1,000-foot camera is currently being used to conduct research on the Knox Formation in eastern Kentucky and the Cumberland Gap Tunnel.❖

Paul Vendrell, of the University of Georgia, provides instructions on the use of a well camera during the training course at Texas A&M University. Nine water wells were videotaped during the training. Glynn Beck, who took the photo, was also an instructor for the course.

Changes being made to KGS Internet maps

Visitors to the KGS Web site who use the online maps to get coal information or oil, gas, and water well data will see some changes in the format of those maps. In some cases, more than one map service has been available, depending on where a user entered the Web site. Petroleum well and coal maps will now use the new Geologic Map Information Service for their base, and water well and spring data will now use only the Groundwater Data Repository map. For more information about these changes, see the "What's new on the KGS Web" link on our home page, www.uky.edu/kgs.

KGS has also begun a new service for requesting the scanning of oil and gas records. The new system, available since January 1, 2007, is accessible from the oil and gas well search results page. It allows users to request up to 25 wells in one request and will give KGS the ability to keep users informed about the status of their requests. More information will be available under "KGS Policy for Handling Customer Scanning Request" on our home page.❖

Board sets priorities for KGS mapping program

Members of the KGS Advisory Board, which also acts as the State Mapping Advisory Committee, met twice in August and September to hear comments on the state's mapping needs and to set priorities for next year's USGS-funded mapping program.

At a day-long August 30 meeting at the KGS office in Henderson, William Andrews and Warren Anderson, of the Geospatial Analysis Section, described the history and status of the KGS geologic mapping program. They explained that gathering comments from agencies outside KGS is required for receiving STATEMAP funding, so speakers were invited to share their ideas with the Board about the state's and region's mapping needs.

The speakers represented Kentucky's Transportation Cabinet and Division of Water, the University of Louisville Center for Hazards Research, the Illinois State Geological Survey, and several KGS sections. Written comments and ideas were also received from the Natural Resources Conservation Service and other agencies.

Their concerns included hazards mapping, which would help in planning transportation projects, groundwater mapping for water-quality and water-supply issues, and surficial mapping to better understand landslide potential and liquefaction.

Groundwater Branch Manager Pete Goodmann, of the Kentucky Division of Water, speaks to the Henderson mapping gathering on August 30. Photo by Mike Lynch.

The Board met again on September 29 to consider priorities for the mapping program proposal, which would be sent to the USGS. The Board heard a presentation from Randy Orndorff and Lydia Quintana, who coordinate the STATEMAP program for USGS. They discussed the funding status of the STATEMAP program and the process for reviewing mapping proposals from states.

Board members voted to approve three mapping priorities: continued surficial mapping of the lower Ohio River Valley, to support geotechnical planning and seismic hazard assessment; surficial mapping of McCracken County, to support environmental management; and surficial mapping in eastern and northern Kentucky, to support landslide hazard assessment.

In other Board business, the members elected Karen Thompson of Lexington as vice chair and recognized Roseanne Kruzich and Mark Gormley, whose terms had expired. ❖

Winnie Dooley found this large fossil tooth at Sterling Materials in Gallatin County, Ky., earlier this autumn. Steve Greb of the KGS Energy and Minerals Section identified it as the tooth of an ice age (Pleistocene) mammoth. Mammoths were large, hairy elephants that roamed the Ohio River Valley 10,000 years ago. Ms. Dooley graciously donated the fossil to the Kentucky Geological Survey, where it will be displayed after it has been prepared. Photo by Steve Greb.

KGS laboratory scientist on UK Staff Senate

Steve Mock, a staff scientist in the KGS laboratory, is now a member of the University of Kentucky Staff Senate, representing over 400 university research employees.

Photo by Mike Lynch.

Earlier in 2006, he ran for one of the five seats representing research departments and institutes in the Senate, but fell just short of winning the election. When the newly elected senator chose not to serve, Mock successfully petitioned the Staff Senate to be allowed to occupy the seat for a 3-year term.

He says the major issues before the Senate now include UK retiree benefits and the expansion of educational benefits to family members of UK staff. ❖

Western Kentucky deep exploration research project

About four dozen energy-industry representatives attended a pilot meeting September 14 to discuss the formation of a private-public consortium to study the deep natural gas potential of the Rough Creek Graben in western Kentucky. KGS received a grant from the Governor's Office of Energy Policy to organize the consortium and seek industry partners. The consortium is being formed to provide a structural and stratigraphic framework for exploration in the rift basin, much of which is unexplored.

As a result of industry comments at the September meeting, KGS refined the scope of work for the consortium. Five industry partners have signed written agreements to participate in the consortium, and several others have made oral commitments to join.

The Survey's Energy and Minerals Section hopes to attract enough private partners to fund the project's $324,370 scope of work. Of that amount, $197,339 would come from the industry partners over a 2-year period, and the remaining $127,031 would be provided by the Governor's Office of Energy Policy. About $22,000 of the budget will be used to pay for lab tests on well cuttings and oil samples from wells in the Rough Creek Graben region. The remainder of the funding will be used to pay for the salaries of KGS researchers to interpret seismic, well log, and well cuttings samples "in house" at KGS.

Jim Drahovzal, Dave Harris, and John Hickman conduct the Rough Creek Graben consortium initial meeting in September. Photo by Mike Lynch.

Examples of the many project deliverables expected to come from the effort are a well database, lithology calculations from digital logs and maps (including structure and thickness), and paleogeographic maps that will integrate both seismic and well stratigraphic tops. ❖

—"Drahovzal," continued from page 1

of what turned out to be a newly recognized basin. "You don't get a chance very often to be in on the ground floor of finding something as significant as this," he says. "We're still putting the story together. Not everybody agrees with our interpretation, but that's OK. The fact that there is so much sedimentary rock beneath Kentucky and parts of Ohio and Indiana in the basement indicates that there is a major basin there; we call it the East Continent Rift Basin." It had been previously assumed that the basement in the region, about 3,500 feet deep, is granite. "It's significantly changing how we understand the Precambrian geology of this part of the country."

"Few people have had the impact he has had on our understanding of the subsurface geology of Kentucky," says KGS Director Jim Cobb. "Jim Drahovzal has added so much to the science of petroleum geology in the state." Cobb points to several other research projects and publications as evidence of Drahovzal's impact, including the publication of a structural cross section of the geology along a 200-mile path through western Kentucky, known as KY-1, and the "Atlas of Major Appalachian Gas Plays."

Drahovzal says he's glad he aggressively went after as much seismic information as he could, most of it contributed by oil companies. "Often we can derive data from it and make interpretations that help our subsurface mapping."

As interest in the issue of carbon sequestration grew in the 1990's, he began making research proposals, again in cooperation with other states in the region, helping to create projects such as the Midcontinent Interactive Digital Carbon Atlas and Relational Database and other regional sequestration partnerships.

In the past few years, Drahovzal has been instrumental in developing a research relationship with the Governor's Office of Energy Policy. That relationship resulted in Kentucky's FutureGen submission, coalbed methane research, and the Rough Creek Graben Consortium (see story, page 5). "I have high hopes that it is going to be a continuing relationship," Drahovzal says.

Drahovzal believes he's leaving the Energy and Minerals Section in a good position to continue taking advantage of the interest in carbon sequestration, coal to liquids, and other energy-related research topics. He is currently working on a half-time basis and hoping to do some more work and publishing on the East Continent Rift Basin, the Rough Creek Graben, and other research projects. ❖

—"Overfield," continued from page 2

northern Kentucky and classify them by their geologic and geotechnical properties.

"We hope that when rock is brought to the surface at a site, Transportation Cabinet geologists can look at it and know what formation the rocks belong to based on some of the information that we have given them," says Overfield.

A printed or Web-based guide will be produced to allow easier comparison of information collected by different agencies or their contractors; it will also serve as a training tool for new Transportation staff involved in materials description.

"It's a really good experience for me," says Overfield,. "I was in coal research for a while, and I enjoyed it. This is switching gears for me, but it's a good switch."

The first phase of the project is scheduled to be completed in June of 2007. Future phases will expand sampling to other regions and geologic units in Kentucky. ❖

Calendar of events

- **March 29–30, 2007:** GSA Southeastern Section annual meeting, Savannah, Ga., www.geosociety.org/sectdiv/southe/07semtg.htm
- **April 19, 2007:** Fifth Donald C. Haney Lecture, Lexington, Ky.
- **April 20, 2007:** KGS 47th annual seminar, Lexington, Ky.
- **September 16–18, 2007:** Eastern Section AAPG annual meeting, Lexington, Ky., www.esaapg07.org ❖

—"Seismic," continued from page 1

benefit from this observatory because data collected will help geologists and engineers better define the earthquake hazards," adds Cobb. "This has significant implications for economic development in the region as well as specific scientific and engineering applications for ongoing activities at the Paducah Gaseous Diffusion Plant."

The next step in completing the project will be a workshop of the partners to gather input into the number and type of instruments to be placed in the observatory. The partners will apply to agencies such as the Department of Energy and the National Science Foundation for the purchase and installation of the instruments.❖

Crowd turns out for KGS open house

Nearly 200 people visited the Mining and Mineral Resources Building on the University of Kentucky campus Oct. 11 for the annual KGS open house. The event was scheduled as part of the ninth Earth Science Week, sponsored nationally by the American Geological Institute. Displays were set up by KGS staff, the Kentucky Paleontological Society, the Kentucky Water Resources Research Institute, and other organizations. Gov. Ernie Fletcher also declared the week of Oct. 8–14 Kentucky Earth Science Week. Above, Kathy Takacs talks about her display on carbon dioxide with a group of visitors to the open house. Photo by Collie Rulo.

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University of Kentucky
Lexington, KY 40506-0107

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