Assessing seismic risk in western Kentucky

Expansion of the Kentucky Seismic and Strong-Motion Network

The Kentucky Geological Survey has received $157,000 in funding from the U.S. Department of Energy through the Tracy Farmer Center for the Environment at the University of Kentucky to add three new seismic stations in western Kentucky to the Kentucky Seismic and Strong-Motion Network. The network is jointly operated and maintained by KGS and the UK Department of Geological Sciences. The funding is for KGS to conduct research to improve the scientific understanding of seismic risk in western Kentucky, the area surrounding the Paducah Gaseous Diffusion Plant in particular. Of critical importance is the true location and nature of the northern terminus of the New Madrid Seismic Zone and its relation to the Wabash Valley Seismic Zone to the north. Although the number of documented earthquakes is limited, there is some evidence that the signature of earthquakes occurring in western Kentucky may differ from those occurring within the main region of the New Madrid Seismic Zone. This research is important for seismologists, engineers, building-code officials, emergency managers, and Federal, State, and local government agencies interested in assessing seismic risk in western Kentucky, especially in Paducah. For more information, contact John Kiefer at 859.257.5500 ext. 145 or by e-mail at kiefer@uky.edu or Zhenming Wang at 859.257.5500 ext. 142 or by e-mail at zmwang@uky.edu.

Mitigating climate change

Midwest Regional Carbon Sequestration Partnership

The Kentucky Geological Survey is a partner in a multiagency, multistate research project to investigate the viability of carbon sequestration as a key technology to mitigate climate change. KGS is collaborating with Battelle National Energy Technology Laboratory; the state geological surveys of Indiana, Ohio, Pennsylvania, and West Virginia; Ohio State University; Pennsylvania State University; Purdue University; West Virginia University; and seven energy companies. The U.S. Department of Energy announced on August 18, 2003, that it is awarding KGS $50,066.

The consortium will compile and update data on the major carbon dioxide (CO$_2$) sources and geologic sinks in the Appalachian region. GIS data are being included for infrastructure components (e.g., pipelines). The geologic framework of the region will be investigated for a better understanding of storage options. This is phase one of a two-phase project that may result in drilling a well to demonstrate the feasibility of sequestering CO$_2$ in geologic sinks. By demonstrating the success of geologic sequestration strategies, the project will contribute to limiting the effects of CO$_2$ on global climate change. For more information, contact Jim Drahovzal at 859.257.5500 ext. 175 or by e-mail at drahovzal@uky.edu.

Isopach of the Devonian New Albany Shale in the Illinois Basin study area. The gray area shows the extent of the subsurface occurrence of the shale. The shale exceeds 400 feet thick in the Union County and adjacent Illinois areas south of the Rough Creek Fault.
**Director’s Desk**

The Kentucky Geological Survey is not a large state geological survey, but at the 2003 annual meeting of the Geological Society of America we presented 12 scientific papers, participated in 10 national organizations, served as officers in six of these, and launched a new GSA division: Geology and Society. GSA is considered the nexus for geological research and an incubator for geologic ideas. A total of 7,000 geologists attended this meeting, and I think KGS’s impact was significantly above what is typical. KGS’s participation in this meeting ranged from a young scientist giving his first scientific paper to a 40 year veteran. Topics presented by us included coal, geologic mapping, coalbed methane, CO$_2$ sequestration, scientific communications, and technology advances in computer geology.

National scientific meetings are where ideas are tested in an atmosphere of “trial by fire.” Healthy scientific skepticism and debate are exchanged between researchers whose work is critiqued and criticized by those engaged in similar work. Ideas, concepts, methods, and conclusions that pass this scrutiny continue to be pursued; those that don’t go back for a new approach. This is the healthy advance of science, and gives confidence to those who prevail as they take their work to the public at large.

The Kentucky Geological Survey is gaining a reputation for proactive involvement in national academic activities at national scientific meetings. Typically, state geological surveys are known for the applied nature of their work: being the practitioners of the geological sciences, making maps, assessing resources and hazards, and archiving records. But the Kentucky Geological Survey has recently been very active in academic affairs on the national scene. It is continuing education and professional development rolled into one. It gives the young scientist an opportunity to present ideas to more experienced ones and vice versa. Both are necessary to keep the science moving forward.

I am very pleased that our staff members are involved nationally in scientific organizations and try out new ideas in this arena. I am pleased that our staff members are selected by their peers in leadership roles, and that our young scientists are getting a chance for professional development. These are all signs of progress.

---

**John Kiefer will chair new GSA Division for Geology and Society**

John Kiefer, assistant state geologist, was selected in the spring of 2003 as the first chair of a newly created national Division for Geology and Society of the Geological Society of America. Founded in 1888, GSA has a global membership of more than 16,000 members in more than 85 countries. Kiefer has been an active GSA member, serving on numerous committees, including the national GSA Committee on Geology and Public Policy, and holding numerous executive positions during the last 20 years. The creation of this new division is a tribute to decades of work by Kiefer to promote increased understanding of the importance of earth science in shaping and informing public policy.

The new division will have its own section on the GSA Web site and a listserv shared with the Committee on Geology and Public Policy. An electronic newsletter is being prepared. The division is planning booths at GSA sectional and national meetings, and several symposia will be sponsored by the division at the annual GSA meeting in Denver, Colo., November 7–10, 2004. A theme session on public policy issues, jointly sponsored by the Geology and Society and the Hydrogeology Divisions, has been proposed.

GSA members can sign up as members of the new division when they renew their membership or by contacting GSA headquarters. For more information, contact John Kiefer at 859.257.5500 ext. 145 or by e-mail at kiefer@uky.edu.

---

**Assessing mine-void hazards**

With support from a recent $120,000 enhancement grant from the University of Kentucky Dean of Arts and Sciences, researchers at the UK Department of Geological Sciences and KGS are expanding the use of engineering geophysics to seek innovative ways to mitigate the enormous losses associated with nonseismic geologic hazards in Kentucky.

The research group’s initial effort, in cooperation with the UK Department of Mining Engineering and Carnegie Mellon University, calls for pilot field studies to assess an integrated state-of-the-art geophysical and robotic exploration technique for identifying and delineating mine voids in eastern Kentucky. Disasters associated with mine voids pose significant economic and safety threats for citizens residing in the coal fields. For more information, contact Ed Woolery at 859.257.3016 or by e-mail at woolery@uky.edu.
**Overview**

Recently, the state geological surveys of Kentucky, Illinois, and Indiana, which collectively make up the Illinois Basin Consortium, were awarded a 1-year grant of $500,000 from the U.S. Department of Energy to evaluate the coalbed methane potential of Illinois Basin coal beds. The project has the potential of being extended for 2 more years, depending on results obtained during 2004. There has been a surge of nationwide interest in coalbed methane (CBM) in recent years because of increasing gas prices, declining conventional natural gas reserves, environmental concerns, and the realization that previously overlooked coal basins may have significant CBM reserves. As of the end of 2000, CBM met approximately 7 percent of the natural gas demand in the United States.

The Illinois Basin has more than 200 billion tons of remaining coal resources, which are estimated to contain 11 trillion cubic feet (tcf) or more of methane. As coal production in the basin continues to decline, mainly because of the high sulfur contents of most Illinois Basin coals, production of CBM may be an effective way to use this vast resource. Although there is currently little commercial CBM activity in the basin, CBM research at the state surveys of Illinois, Indiana, and Kentucky has been quite active.

**Illinois Basin coal and coalbed methane**

Although the Illinois Basin has historically been a major coal-producing region, air-quality standards for sulfur emissions outlined in the Clean Air Act Amendments of 1990 (CAA90) have had a serious impact on production. For example, coal production in Illinois in 1991 was 60.3 million short tons, but by 2000, production had decreased to 33.4 million tons, a 45 percent decrease. Likewise, production in Kentucky declined 38 percent during the same period. The reason for this dramatic decrease is the high sulfur content of most Illinois Basin coals, commonly greater than 3 percent, and the fact that most coal-fired electric utilities have mainly switched from burning high-sulfur to low-sulfur coal to comply with CAAA90 SOx emission limitations. Although new “clean coal” technologies, such as fluidized bed combustion, and integrated gasification combined cycle, can readily use high-sulfur Illinois Basin coal in an environmentally acceptable manner, the widespread implementation of these technologies will not be seen for several years. As such, Illinois Basin coal is a vast energy resource that is being progressively idled.

**CBM: an important energy resource**

Coalbed methane is a natural byproduct of coalification, the geologic process that changes peat into coal, and also through a later process that involves bacterial generation of

---

*Estimated CBM resources in Kentucky, in billions of cubic feet, from the USGS 1995 national assessment.*
methane. Historically, methane gas in underground coal mines has been regarded as a hazard rather than a resource, being the cause of mine explosions that have killed and injured many miners. In fact, underground mines routinely vent the gas to the atmosphere in advance of mining to help prevent explosions. Only recently has the value of CBM been recognized, with annual U.S. production in 2000 being 1,379 billion cubic feet (bcf), or about 7 percent of the total U.S. gas production.

Recently, there has been considerable interest in expanding the role of hydrogen fuel cells to produce emission-free electricity for businesses, homes, and vehicles. If fuel cells begin to be widely used, then even more methane will be needed. Methane is a natural choice for obtaining hydrogen because of its hydrogen-rich methane molecule (CH₄). As the demand for natural gas continues to rise, CBM will likely play a role in satisfying this increased demand.

**Environmental benefits**

Coalbed methane has several environmental benefits. Methane is the cleanest-burning fossil fuel, with essentially zero emissions of sulfur dioxide (SO₂) and nitrogen oxides (NOx). Methane also produces the least carbon dioxide (CO₂) for the amount of energy produced of any fossil fuel when burned. When considered on a heat-equivalent basis, methane produces about 1.4 pounds of CO₂ per million Btu generated, whereas coal emits about 2.2 pounds of CO₂ per million Btu. In addition, methane is a significant “greenhouse gas,” with a far greater heat-trapping capability than CO₂, and active and abandoned coal mines are sources of methane emissions worldwide. Recovering the methane in coal prior to mining can significantly reduce methane emissions from coal mining, and improve underground mine safety as well.

**Historical negative bias**

Historically, the Illinois Basin has not been regarded as a significant CBM resource, mainly because the thermal maturity (rank) of the coal was thought to be insufficient for economic CBM, and the few coal samples that were tested for gas content showed low CBM contents (often less than 50 scf/ton). More recently acquired data by the Illinois and Indiana Geological Surveys, however, indicate far greater CBM contents in many coals (often greater than 150 scf/ton) from unstimulated test cores. According to the new data, the actual gas content of Illinois coals appears to be at least 50 percent greater than indicated by the historical data. Another factor previously unknown was the presence of significant quantities of biogenically derived methane in many coal beds (such as Powder River Basin coals), that do not require high thermal maturity levels to form. Preliminary data indicate that a significant portion of the methane in Illinois Basin coals may be of biogenic origin, making the gas content independent of the coal rank.

**Program implementation**

Illinois Basin Consortium geologists will evaluate all available data to select the best areas where coalbed methane potential is high. Once these areas have been identified, exploration wells will be drilled and cored, one for each state during the first year. If funding is extended for years 2 and 3, then additional test wells will be drilled.

Samples from coal beds that are encountered during the drilling and coring program will be placed in specially designed canisters to accurately measure the amount of gas being released from the coal. This release of gas is referred to as desorption, and can take several weeks, or even months. Some of the desorbed gas will be tested further for composition (relative proportions of methane, nitrogen, carbon dioxide, etc.) and origin (how much thermogenic versus biogenic gas). Other analyses, such as adsorption and petrographic composition analysis, will also be performed to help us better understand the nature and distribution of CBM in the Illinois Basin.

**Anticipated products**

All of the collected data will be made available to the public through publications, and presentations made available on the Web and in hard copy. Information will also be transferred through a series of workshops specifically aimed at the Illinois Basin energy industry (coal, oil, and natural gas).
Spotlight on new publication

Jim Cobb, director and state geologist, presented a new 1:100,000-scale, 30 x 60 minute geologic quadrangle map of the Louisville area to Joan Riehm, deputy mayor of the Louisville Metro Government, at the closing luncheon of the Kentucky 2003 Geographic Information System conference in Louisville on Wednesday, August 20.

Representing a 1,443-square-mile area of central Kentucky, the map illustrates all or parts of nine counties. This area has a population of more than 800,000, and includes the Louisville/Jefferson County metropolitan area and Shelbyville, Taylorsville, New Castle, La Grange, Mount Washington, Jeffersontown, Middletown, Prospect, and Smithfield.

The map, the fourth in a new 1:100,000-scale series, provides a high degree of accuracy and detail, as well as a perspective on regional trends in geology. It has information about the location and specific mineral composition of different types of rock in the region. It is useful for planning decisions related to urban and rural development, construction and transportation, water and resource management, land use, and mitigation of hazards (for example, floods, landslides, and slope instability).

The digital files used to create the map are available on CD-ROM for use in GIS and other software. The map and CD may be ordered by calling 859.257.3896 or toll free at 1.877.778.7827. A PDF version of the publication is available at www.uky.edu/KGS/pubs/lop.htm.

Field notes from across Kentucky

Meteorite impact structures attract the interest of Air and Space magazine and NASA

Mark Thompson, a geologist in the Energy and Minerals Section, is studying the meteorite structure at Jeptha Knob for his master’s degree in the UK Department of Geological Sciences. On November 5, he took Tony Reichhardt of Air and Space magazine to visit the Jeptha Knob and Versailles “cryptoexplosion structures.” Reichhardt is writing a story for the magazine on the lesser-known (doubtful or possible) meteorite impacts found in the United States that lack the currently accepted scientific criteria to be classified along with structures whose origins by impact are based upon indisputable evidence.

On November 22, Thompson took Dr. Pascal Lee, of the NASA Haughton-Mars Project and the Mars Institute, to visit the Jeptha Knob and Versailles structures. In addition to his professional duties, Dr. Lee plans to visit and study every known or suspected impact crater on Earth during his lifetime. For more information about meteorites, see the KGS fact sheet on meteorites (www.uky.edu/KGS/education/education) or contact Mark Thompson at 859.257.5500 ext. 348 or by e-mail at thompson@uky.edu.

Awards

Jim Currens, a hydrogeologist in the Water Resources Section, was given an award for Meritorious Contributions in Environmental Geoscience by the Eastern Section of the American Association of Petroleum Geologists in September 2003.

Don Chestnut, retired head of the Coal Resources Section of KGS, was presented the Gordon Wood Memorial Award for excellence in coal geology. The award was granted by the Eastern Section of the American Association of Petroleum Geologists in September 2003.

Middlesboro–Cumberland Gap area designated as Distinguished Geologic Site

The Kentucky Society of Professional Geologists designated the Middlesboro–Cumberland Gap area in Bell County as the third Distinguished Geologic Site in Kentucky. A ceremony was held in Middlesboro in conjunction with KSPG’s fall field trip, September 18–20.

Middlesboro is the site of the best-developed of three possible meteor-impact craters in Kentucky. The broad crater basin has provided developable land for Middlesboro to grow to a sizeable city, and local coal and iron deposits have supported the area economy. The geology of nearby Cumberland Gap has also played a key role in the area’s transportation history and the history of the Commonwealth as a whole.

KSPG initiated this project to designate distinguished geologic sites in Kentucky in 1998. The society designated Pound Gap in Letcher County in 1998 and the Camp Nelson area in Jessamine and Garrard Counties in 2002 as distinguished geologic sites. For more information, contact Drew Andrews at 859.257.5500 ext. 138 or by e-mail at wandrews@uky.edu.

Field trip party returning from Pinnacle Overlook, Cumberland Gap National Historical Park. Photo by Brandon Nuttall.
**KGS mailing list**

Would you like to receive the KGS newsletter and announcements of meetings and new publications? Please call us at 859.257.5500 ext. 128 or send an e-mail message to Carol Ruthven at cruthven@uky.edu—simply type “Electronic-Mailing List Addition” in the subject line of your message, type your mailing address and phone and fax number in the message—and we will include your name and address in our mailing list.

**Calendar of events**

- **February 3**: AAPG Distinguished Lecturer, Luis Pomar, Universitat de les Illes Balera, Spain; lecture at 7 p.m. in room 102, Mining and Mineral Resources Building, University of Kentucky, Lexington
- **February 26**: KGS Donald C. Haney Distinguished Lecture, Lexington, Ky.
- **April 18–21**: AAPG annual meeting, Dallas, Tex., [www.aapg.org/meetings/dallas04/index.html](http://www.aapg.org/meetings/dallas04/index.html)
- **October 3–6**: Eastern Section AAPG, annual meeting, Columbus, Ohio, [www.ohiodnr.com/geosurvey/aapg04.htm](http://www.ohiodnr.com/geosurvey/aapg04.htm)
- **Nov. 17**: GIS Day, [www.gisday.com](http://www.gisday.com)

**Appointments**

C[arol Ruthven](http://www.uky.edu/~cruthven), manager of communications and technology transfer at KGS, became the president of the Association of Earth Science Editors ([www.aese.org](http://www.aese.org)) in November; she is serving a 1-year term. AESE is an organization of editors, journal managers, and others involved with publications in the earth sciences. AESE has members from the United States and Canada, as well as other countries. Its purpose is to facilitate cooperation among editors and promote effective dissemination of earth science information.

M[eg Smath](http://www.uky.edu/~cruthven), geologic editor at KGS, became a member of the AESE Board of Directors in November; she is serving a 3-year term. She is also serving on the Web Committee and Membership Development Committee of AESE.

J[im Drahozal](http://www.uky.edu/~cruthven), head of the Energy and Minerals Section at KGS, was elected treasurer of the Eastern Section of the American Association of Petroleum Geologists ([www.aapg.org](http://www.aapg.org)) on September 8, 2003.

**Kentucky Geological Survey**

228 Mining & Mineral Resources Bldg.
University of Kentucky
Lexington, KY 40506-0107

*Address service requested*