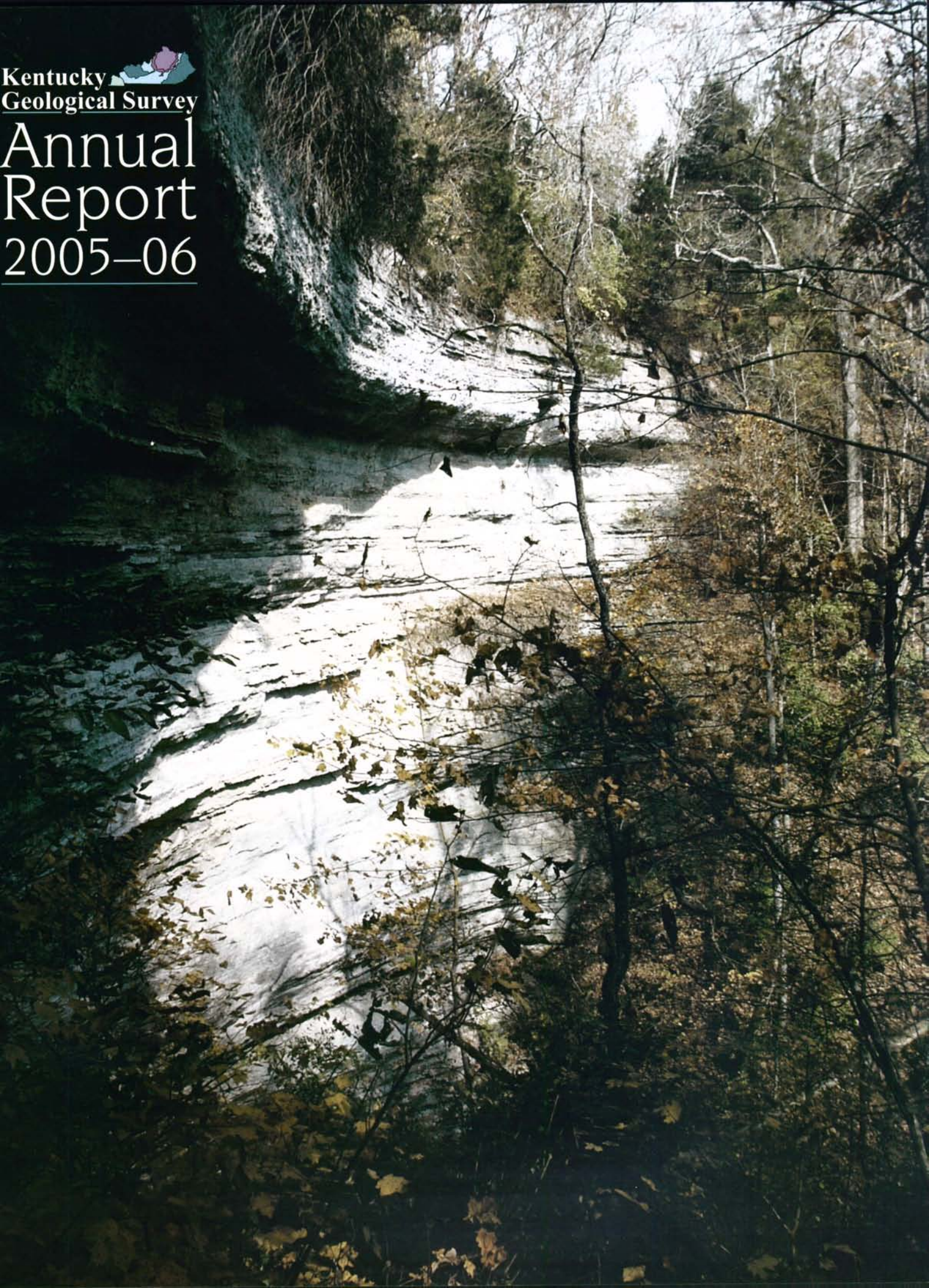


Kentucky  
Geological Survey

# Annual Report 2005–06





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

Cover Photo by Mike Lynch, KGS.

*Panther Rock, Anderson County.  
A steep limestone cliff  
formed and maintained by an  
actively eroding cave at its base.*

The mission of the Kentucky Geological Survey is to serve the people of Kentucky with information about resources, groundwater, and geologic hazards. The demands for this information have never been greater.

We measure our progress in part by the publications we produce and the numbers of requests we get for our information. In fiscal year 2005–06, KGS published 87 new reports and maps, perhaps the largest number ever for any 12-month period since KGS was established in 1854. Moreover, nearly 2 million visitors came to our Web site and 1 million were provided information from our Internet map server and publicly available databases. Never in history has geologic information been so available, and never before has such a diversity of new information been put before the public.

In the past year, fears in the United States about petroleum shortages and global climate change were the major earth science issues in the news. Coal was being debated as both a partial solution to U.S. energy concerns as well as partially responsible for global climate change. The Energy Information Administration has a number of scenarios or projections for coal use for the next 25 years that show production could significantly increase or decrease, depending on a number of factors. Although most authorities agree that coal will continue as a major energy resource, the extent to which it might be used for transportation fuel is still an unknown. Bills were introduced in several state legislatures and Congress, however, to give incentives for the use of domestic coal to produce liquid fuels to help offset imported oil.

As part of the national focus on energy and the environment, the National Research Council of the National Academy of Science was mandated by Congress to study research and technology needs for coal use in the United States. I am a member of the NRC committee, "Coal Research, Technology, and Resource Assessments to Inform Energy Policy," and have heard presentations on coal from many government agencies and private companies about the issues involved in maintaining or increasing the use of coal. Our committee will submit its findings and recommendations by July 2007.



On the environmental side, the capture and geologic storage of carbon dioxide from coal burning moved a step closer with the selection of four sites for DOE's FutureGen project, which includes carbon sequestration.

KGS played a significant role in Kentucky's bid to be a finalist for FutureGen by assessing the sequestration potential of geologic reservoirs in Kentucky.

KGS's generalized county geologic maps are our newest best sellers. These are being created from geologic maps that are too technical for use by nongeologists. The generalized geologic maps are made especially to help nongeologists recognize what impediments there may be in a county from geologic features for foundations, septic systems, water wells, flooding, karst and landslide hazards, and potential seismic hazards. Thousands of these maps have been distributed. KGS is also working with the Kentucky Transportation Cabinet to organize databases on rock falls and landslides that threaten roads. This is a long-term project that will benefit both agencies.

KGS continues its groundwater monitoring, karst hydrology investigations, seismic monitoring, mineral investigations, and mapping. A number of new geologic maps were published during the year, and several quadrangles were mapped for surficial geology. A new seismic monitoring station at our Henderson office was added to the Kentucky Seismic and Strong-Motion Network.

I don't think anyone familiar with geological surveys ever imagined that in a year's time, responses to our users would approach 1 million. As an agency of the University of Kentucky and a mandated program of the State of Kentucky, the Survey constantly strives to be relevant to society's needs and fulfill our mission to investigate the geology of the commonwealth for the benefit of its citizens. We could not be more pleased that the citizens of Kentucky have found our information to be so useful.

James Cobb  
State Geologist and Director



Whether it's considered a flood hazard or a necessity for life, water is an issue across Kentucky. The KGS Water Resources Section investigates the state's water-related hazards and its water-supply needs.

KGS researchers continued their work on karst groundwater systems and geologic hazards associated with karst terrain. These activities contribute to the Karst Atlas, a long-term project to summarize karst systems and associated hazards throughout Kentucky.

### Transportation Project Investigations

Karst groundwater basins were investigated by KGS staff to determine the potential for geologic hazards resulting from the relocation of Ky. 163 in Monroe County and the proposed I-66 corridor in Pulaski County. In both projects, done for the Kentucky Transportation Cabinet, dye traces were used to determine local karst groundwater flow systems.

KGS began dye-tracing and drilling programs to determine the groundwater flow path, levels, and velocities in the gravels and bedrock beneath the road surface in the Cumberland Gap Tunnel. Road-surface problems in the tunnel are thought to be related to movement of the underlying materials. The project is being coordinated with the Cumberland Gap Tunnel Authority, Federal Highways Administration, Kentucky Transportation Cabinet, University of Kentucky Transportation Center, and Vaughn and Melton Engineers Inc.



Jim Dinger and Lifeng Guo, of the Water Resources Section, investigate a sinkhole in Trigg County as a part of a joint project with the State Division of Geographic Information on locating cover-collapse sinkholes using remote imaging.



Jim Currens, of the Water Resources Section, checks a water-level recorder in a stilling well installed for the Radcliff groundwater project.

### Groundwater Basin Maps

Groundwater in karst systems sometimes flows beneath the topographic divides that are used to define river basins, surface-water drainage patterns, and groundwater basins in nonkarst regions. As a result, dye tracing is needed to delineate groundwater basins in karst systems so that the potential for flooding and contaminant transport can be assessed. The major project related to this type of activity during the past year focused on defining groundwater flow systems in Hardin County near the city of Radcliff to help resolve flooding issues in the city.

### Kentucky Groundwater Data Repository

KGS has been in the process of restructuring the Kentucky Groundwater Data Repository database during the fiscal year. Updated information has been obtained from the Kentucky Division of Water, the U.S. Geological Survey, and the Environmental Protection Agency. Following

completion of the new database, the repository, managed by **Rick Sergeant**, will have the most complete data set available on groundwater in Kentucky. It will provide these data to the public through the KGS Web site. The data will include information on over 70,000 water wells, 6,000 springs, and 58,000 groundwater quality samples containing over 1.3 million individual analyte results.

### Raw Water Supplies

The Survey continued work in conjunction with the Kentucky Infrastructure Authority to identify sources





Clifton Gadbois replaces a dye receptor along a stream in a Water Resources project.

of public water supplies for small communities and rural neighborhoods. Drilling and hydraulic testing of the Corbin Sandstone in Long Branch, Magoffin County, was completed to help plan future water supplies for the city of Salyersville and the Magoffin County Water District. In addition, a report was completed on the use of abandoned underground coal mines as sources of water supply in the Eastern Kentucky Coal Field. Initial efforts have begun to help the cities of Campton (Wolfe County) and Evarts (Harlan County) locate additional groundwater supplies. Investigations at these sites are being done in cooperation with the Kentucky Rural Water Association.

### Groundwater Quality Studies in Western Kentucky

In the Jackson Purchase Region, 54 domestic water wells were sampled to determine the sources

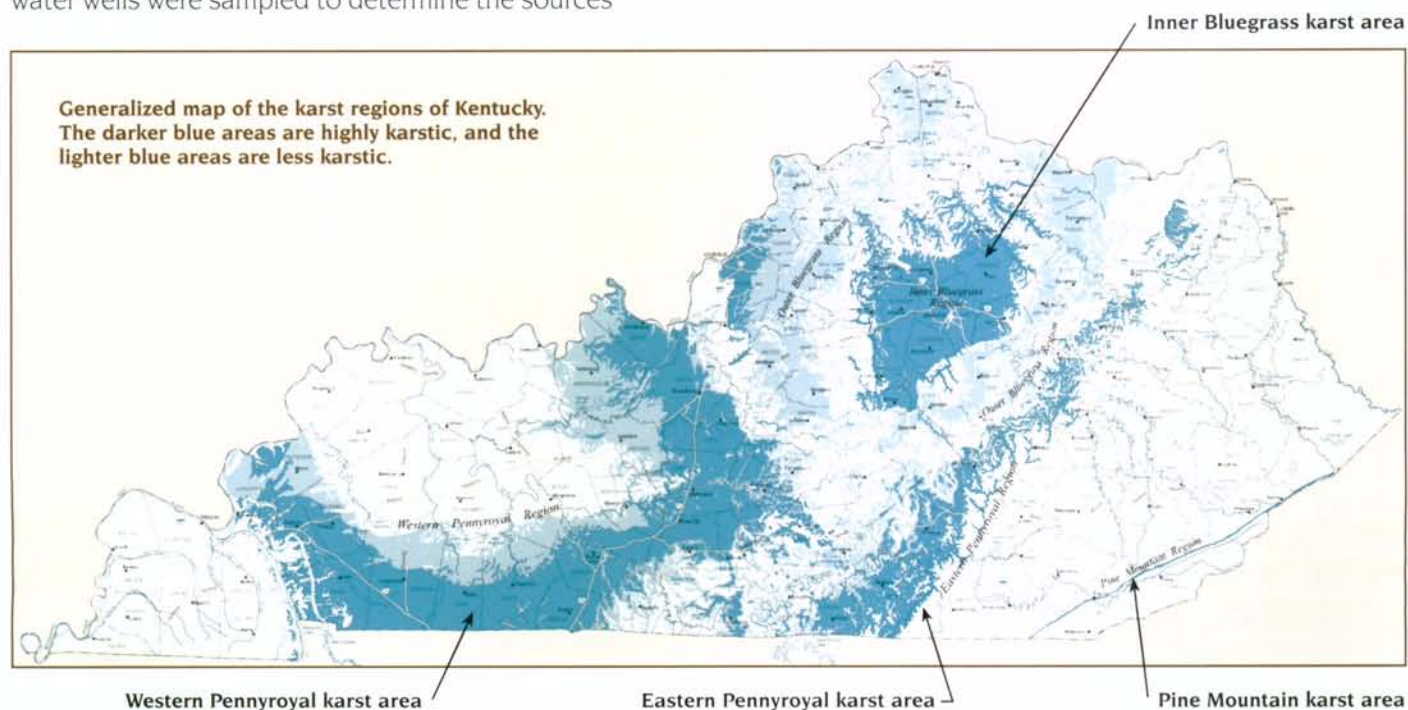
and the extent of nitrate and pesticide contamination in shallow groundwater systems in various hydrologic settings. Fifty-one previously sampled domestic wells were sampled for total dissolved metals, sulfate, fluoride, and bicarbonate.

Preliminary data from this ongoing project managed by **Glynn Beck** indicate that the possible sources of elevated nitrate to the shallow groundwater system in the region are nitrogen fertilizers, septic waste, and animal waste.

On a Henderson County farm, a domestic well and seven monitoring wells were sampled monthly for nitrate and chloride to determine if concentrations are decreasing following the remediation of an abandoned dairy feedlot. Since remediation, nitrate and chloride concentrations in the shallow groundwater system beneath the feedlot have dropped approximately 70 and 170 milligrams per liter, respectively.

### Karst Potential Index

In an ongoing project, KGS researchers **Jim Currens**, **Matt Crawford**, and **Randy Paylor** have developed a karst potential index, which rates the solubility of bedrock based on geologic descriptions from maps or other publications. This index can then be used to assign an attribute for karst-related hazards and used in a geographic information system. The researchers hope to create a method to rank karst potential and development, anticipate karst hazards, and mitigate the impact of human activity on karst aquifers. ■





KGS staff continue to develop maps and other publications, focusing on digitizing geologic quadrangle maps, surficial mapping, land-use maps, and other products useful for technical, professional, and general audiences.

### Digital Geologic Mapping Program

KGS recently completed the digitization of all 1:24,000-scale geologic quadrangle maps and is compiling all of those maps into a Geologic Map series of 1:100,000-scale maps. Many of these maps have already been released for central, eastern, and southwestern Kentucky, and others are in the process of final compilation and editorial review.

The compilation of these maps has many benefits, including preservation of map data, creation of databases, and creating regional geologic maps for planning and development purposes. The digital data from these maps are released as digitally vectorized geologic quadrangle data (DVGQs) so that the user can have easy access to digital information. Some of these digital data are already available via the KGS GeoPortal, and others are added annually.

### Surficial Mapping

This year **Drew Andrews** received a 1-year grant from the U.S. Geological Survey to continue surficial mapping in western Kentucky. This is the

11th year of renewed funding from the U.S. Geological Survey National Cooperative Geologic Mapping Program (STATEMAP), which supports KGS efforts to convert geologic maps into digital format.

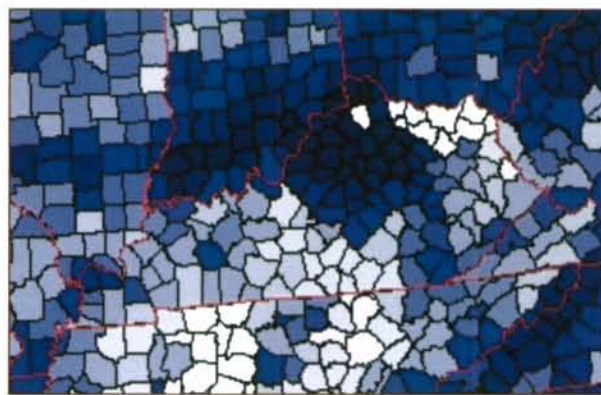
In future years, KGS plans to generate a bedrock geologic map of the Evansville 30x60 minute quadrangle, which had previously been mapped as a surficial geologic map. KGS also hopes to work

cooperatively with adjacent states to map quadrangles along our common borders.

### National Geochemical Survey

The National Geochemical Survey is a federal program designed to collect and analyze rock, soil,

and stream sediment samples for the entire United States. Kentucky's contribution involves sampling parts of northern and southwestern Kentucky over a 2-year period. Samples gathered are then provided to the U.S. Geological Survey for analysis. This sampling was completed during May 2006. Some data have already been analyzed and can be viewed at the National Geochemical Web site, [tin.er.usgs.gov/geochem/doc/home.htm](http://tin.er.usgs.gov/geochem/doc/home.htm).



An example of the geochemical maps, showing arsenic values in the eastern United States. Dark blue areas have higher arsenic values, and light blue areas have lower values. White areas have not yet been analyzed.

Sampling and data compilation have been completed for Kentucky; interpretation of the data remains to be done. Funding will be sought to create a statewide background geochemical database and make it available on the Web.

### Estill County Foundation Problems

Several commercial buildings and a middle school in Estill County have had severe foundation problems, and KGS has initiated an investigation into the causes of these geotechnical problems. These buildings have their foundations in the Chattanooga Shale. Floors, walls, ceilings, sidewalks, and roadways have heaved and buckled in response to changes in foundation bedrock geochemistry.



Excavation and repairs were necessary at this Estill County school, where expanding shales damaged the foundation. KGS researchers are studying the problem in this and other buildings in the county.

### KGS Publications Fiscal Year 2005–06

- 37 County Reports
- 2 Geologic Maps
- 4 Information Circulars
- 41 Maps and Charts
- 1 Report of Investigations
- 1 Thesis
- 1 Open-File Report
- 87 TOTAL



KGS scientists have investigated several structures, examined cores and outcrops, and are conducting analyses of the Chattanooga Shale. Preliminary chemical, mineralogical, and geologic analysis suggests that pyrite oxidation and sulfate formation are the cause of the shale heaving. Detailed analysis and results of the study will be available in the future.

### Land-Use Maps

KGS published 34 new Generalized Geologic Maps for Land-Use Planning during the fiscal year, bringing the total number of these county maps developed in the past few years to 74. The series of maps will help local planning officials, developers, and the public recognize how geologic conditions in each county may support planned developments or may not be suitable for development.

Paper copies of the maps can be purchased from the KGS Public Information Center. They are also available as downloads from the KGS Web site, where they are among the most popular items for viewing and downloading.

### New Coal Publication

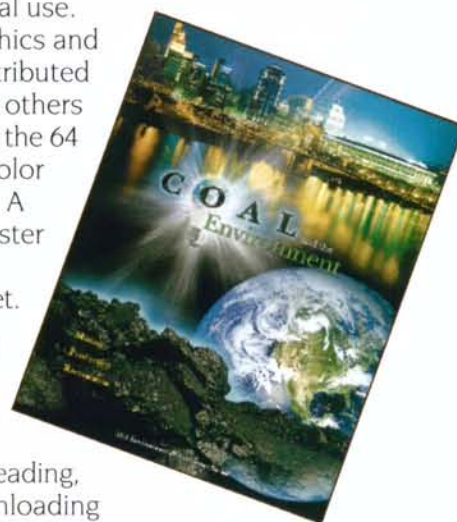
Though it was not published by KGS, a new booklet entitled *Coal and the Environment* relied heavily on contributions by **Steve Greb** and **Cortland Eble**, who are listed first among the publication's four authors. The booklet published by the American Geological Institute deals with all aspects of coal, from the natural processes that

create it to the methods of mining, transporting, and using it and the environmental concerns associated with coal use.

Numerous graphics and photos, many contributed by Greb, Eble, and others from KGS, illustrate the 64 pages of this full-color glossy publication. A two-sided color poster is attached in the center of the booklet.

### Online Services

KGS makes many publications, maps, and other data available for reading, research, and downloading available at its Web site. The Earth Science Education Network, linked from the home page, provides a wealth of resources for teachers. An online interactive map service allows the creation of customized maps of a defined area with a variety of data layers. A surge of interest in energy exploration in Kentucky resulted in many visits to the KGS online inventory of oil and gas databases and maps.



The KGS **Public Information Center** staff processes requests for publications and data via telephone and computer, and from walk-in customers. **Anna Watson** (left), geologist, provides technical geologic information to customers and assists the Kentucky Division of Oil and Gas in the State oil and gas permitting process. **Roger Banks** (right), is the primary telephone and walk-in customer sales representative. He is very knowledgeable of KGS publications and can usually find customers the exact resource they need. **Theola Evans**



(below right), is the primary contact for customers needing assistance using KGS online services.

KGS is proud of this team that sets the standard for public service.





KGS reaches out to specific audiences, as well as the general public, to share its expertise on issues ranging from energy to geologic hazards to hydrogeology. Two of the KGS annual outreach events were scheduled on successive days in April 2006, and each drew a large crowd to the Survey.

### Distinguished Lecture and Annual Seminar

The fourth Donald C. Haney Distinguished Lecture drew about 70 people on the evening of April 20, as New Mexico State Geologist **Peter Scholle** discussed the geology of the Persian Gulf. Using maps and photos from his own extensive travels in the region, Scholle showed how the growth of barrier islands and spits has changed the region's shoreline environments.



Peter Scholle gave the Haney Distinguished Lecture.

The next morning, KGS staff hosted the 46th annual seminar, entitled "Kentucky's Energy Resources: Fueling the Future." Director **Jim Cobb** and UK Vice President of Research **Wendy Baldwin** welcomed over 120 attendees to the Survey's Well Sample and Core Library. Guest speakers discussed Kentucky energy issues, and KGS Energy and Minerals Section staff summarized ongoing coal



UK Vice President of Research Wendy Baldwin welcomed over 120 attendees to the KGS annual seminar.

and carbon sequestration research. Staff in the KGS Geospatial Analysis Section held an afternoon workshop on finding and using energy-related data on the KGS Web site.

### Karst Hydrogeology Workshop

**Glynn Beck**, of the KGS office in Henderson, organized a karst hydrogeology workshop during the Southern Region Water Quality Conference in Lexington. **Jim Currens**, of the Water Resources Section, made a presentation on karst and conducted a dye-trace demonstration. The event was intended to help participants assess drinking-water wells.



Jim Currens demonstrates a dye test during a karst workshop.

### Earth Science Week

Earth sciences and science careers were promoted during activities organized by KGS for Earth Science Week, October 9–15. It was the eighth year of the observance, nationally sponsored by the American Geological Institute. Governor **Ernie Fletcher** signed an official proclamation of the week, and dozens of schools in central Kentucky were sent copies of educational materials contained in AGI's "Earth Science Week Kit."

Four of the Survey's staff went to Lexington's McConnell Springs during the week to talk to a class from Sayre Middle School about earth science. **Bart Davidson** and **Richard Smath** made indoor presentations while **John Kiefer** and **Matt Crawford** took students for a tour of the nature and historic preserve.

Hundreds of students and adults from schools in the Lexington area attended the annual KGS open house on October 12 (see photos on next page). Educational displays were set up by KGS staff, the Kentucky Paleontological Society, the Kentucky Water Resources Research Institute, McConnell Springs, and others on the first and second floors of the Mining and Mineral Resources Building. The displays featured a variety of topics, from karst and water to dinosaurs and iguanas.

KGS geologist **Steve Greb** appeared on an October 13 noon talk segment during a Lexington television station's news programming to promote an understanding of geology and other related sciences. State Geologist and KGS Director **Jim**



**Cobb** discussed the importance to everyday life of earth science and science careers in a special

news segment entitled "Natural Resources Report" on the UK campus radio station, WUKY-FM.

## Earth Science Week Open House at KGS, October 12, 2005



# Outreach and Education



The growing energy needs of the nation and the world have spurred efforts to both find new sources of traditional fuels, such as coal, oil, and natural gas, and to reduce the harmful effects of using these fuels. KGS research has focused on both of these areas.

A mutually beneficial partnership between Kentucky's Office of Energy Policy and KGS resulted in the start-up or completion of several energy-related projects during the fiscal year.

Research projects conducted by the KGS Energy and Minerals Section involve a variety of Kentucky's available energy resources and their future use to meet the nation's growing energy demands.

### FutureGen Proposal

KGS is one of several project partners who provided major technical assistance to Kentucky Office of Energy Policy for the preparation of Kentucky's proposal to the FutureGen Industrial Alliance, an international non-profit consortium of coal producers, utility companies, and the U.S. Department of Energy. Its goal is a \$1 billion public-private project to build and operate a coal-fueled electric generating plant that will have essentially no harmful emissions.

Kentucky's proposal would have put the cutting-edge plant at a 215-acre site in Henderson County along the Green River in the western coal fields of the state. The KGS Energy and Minerals Section provided technical assistance to the State for selecting the site, which is situated above a 7,400-foot-deep geologic formation suitable for carbon sequestration.

Seven states submitted proposals with a dozen possible sites. Kentucky's proposal was not among those chosen by the alliance for the second round of consideration.

### Carbon Sequestration

Carbon sequestration refers to options for reducing carbon dioxide emissions to the atmosphere by preventing the greenhouse gas from being emitted or by capturing and storing it. Several strategies are being studied: terrestrial storage in plants and soils, ocean storage, and storage in deep geologic formations. Sequestered CO<sub>2</sub> can also increase oil recovery by repressurizing shallow oil fields or serving as an organic solvent to mobilize oil in deeper fields. CO<sub>2</sub> has also been used for enhanced gas recovery in coals.

The Kentucky Geological Survey has participated in research projects to identify sources of carbon emissions in the commonwealth and inventory and characterize possible geologic storage options.

Current DOE-funded cooperative projects include the Midwest Regional Carbon Sequestration Partnership (Appalachian and Michigan Basin states), Midwest Geologic Sequestration Consortium (Illinois Basin states), and Southeast Regional Carbon Sequestration Partnership (Southern Appalachian and Gulf Coast states). These consortia are conducting research to implement pilot carbon dioxide injection projects for testing the storage concepts identified in previous studies.



Carbon dioxide being injected into a well in Lee County, eastern Kentucky, as part of a cyclic nitrogen and CO<sub>2</sub> repressurization enhanced oil-recovery project.

During the fiscal year, **Marty Parris** completed the first round of sampling for soil gas composition and the rate of gas migration between soils and the atmosphere in his 2-year project to characterize such activity at four test sites in the state. Over 700 samples were taken from the sites. Understanding the existing background activity of carbon dioxide and methane will be important for monitoring sites where carbon dioxide may be sequestered in the deeper geologic formations.



Mike Solis watches as Kathy Takacs extracts gas from a soil probe with an airtight syringe for laboratory analysis. Their field work is associated with a KGS project managed by Marty Parris to monitor existing carbon dioxide levels.

### Rough Creek Graben Consortium

Seed money from Kentucky's Office of Energy Policy was also instrumental in the development



of a project to create a consortium of oil and gas industry partners to encourage long-term natural-gas exploration in Kentucky. The partnership will seek private funding and federal grants to focus on a major study of the Rough Creek Graben in western Kentucky to assess its natural-gas production potential. An initial meeting to form the consortium was scheduled for September 2006.

Led by KGS Energy and Minerals Section Head **Jim Drahovzal**, the project will help to meet Governor **Ernie Fletcher's** Comprehensive Energy Strategy goals of keeping Kentucky's energy costs low and responsibly developing the state's energy resources.

### Coalbed Methane Research

The Eastern Kentucky Coal Field will be the site of a new coalbed methane project whose goals and funding were finalized during the fiscal year. **Cortland Eble**, the principal investigator for an earlier coalbed methane project in western Kentucky, will lead this project, funded in part by Kentucky's Office of Energy Policy and Daugherty Petroleum Inc.

Its objective is to collect information on gas content, composition, and origin for eastern Kentucky coal beds that lie below the level of regional stream drainage. The accumulated data can be evaluated by private industry for possible commercial development and production of coalbed methane in eastern Kentucky.

Such production could be one way to use the region's extensive coal resources that are increasingly being idled. The production of methane would also be beneficial in terms of new job opportunities in eastern Kentucky and additional State tax revenues from the gas production.

### Trenton/Black River Appalachian Basin Exploration

The Kentucky Geological Survey participated in a regional evaluation of the Ordovician Trenton (Lexington) Limestone and Black River (High Bridge) Group in the Appalachian Basin, which was completed in April 2006. This study resulted in a comprehensive play book for hydrocarbon exploration that includes the stratigraphy, structure, diagenesis, and geochemistry of these important Ordovician carbonates. The Trenton/Black River interval has been an active natural-gas exploration play in the Appalachian Basin in the last 5 years. A key goal of the study was to gain a better understanding of the controls and timing of hydrothermal dolomitization.

The research was carried out by

five state geological surveys (West Virginia, Kentucky, Ohio, Pennsylvania, and New York). It was funded by the U.S. Department of Energy and 18 energy companies. Researchers at KGS included **John Hickman, Paul Lake, Jim Drahovzal**, and **Dave Harris**. KGS had primary responsibility for structural and stratigraphic interpretation of reflection seismic data for the entire project area. A new regional fault map of the basin also resulted from this work.

### Washability Characteristics of Eastern Kentucky Coals

An increasingly large percentage of coal mined in eastern Kentucky must be processed to remove impurities—primarily ash and sulfur—in order to meet utility contract specifications. These processes use mechanical sizing and gravity flotation to isolate various components of the product, and their effectiveness varies according to the feedstock.

**Bethany Overfield** and **Jerry Weisenfluh** worked on a research study with the U.S. Geological Survey to characterize the washability properties of Kentucky coals to better understand these variations. Analyses of core samples obtained from coal companies used to predict washability behavior have been compiled into a database so that raw coal quality can be compared to that of the washed product.

Results of the study indicate that ash reduction is generally predictable, but that sulfur reduction varies widely. The 25 studied coals fall into about five distinct patterns of sulfur reduction that are likely related to the magnitude of raw sulfur and the mineral forms of sulfur present. ■

Prolific gas wells in New York, Pennsylvania, Ohio, and West Virginia were the focus of the Trenton/Black River Consortium study, which included eastern and central Kentucky. This West Virginia well, shown during a production test, burned gas before a pipeline was installed.  
(Photo by Dick Stollar, Columbia Natural Resources)





The KGS office in Henderson, managed by **Dave Williams**, was able to conduct several research projects with cooperation from counterparts in Indiana and Illinois and the Central U.S. Earthquake Consortium in Memphis, Tenn.

With help from staff and instrumentation at the Indiana Geological Survey, gamma-ray logging of wells on the Scott Keach farm in Henderson County was conducted by **Glynn Beck**. The wells had been drilled several years ago for groundwater monitoring near an abandoned dairy feedlot.

The logging instrument measured natural radiation from three isotopes in rocks and sediment to gather details about the lithology of the units. Combined with additional work planned for the wells, this will help to interpret the earthquake hazard in the area.

In the spring of 2006, a drill rig from the Illinois State Geological Survey was used to bore five holes to bedrock in Henderson and Union Counties. About 600 feet of core was obtained for analysis, as well as gamma-ray logs to help in surficial mapping and to improve the understanding of the depositional system in the area.

The Illinois Survey also provided a geophysical truck and staff to help **Ron Counts**, of the Henderson, office gather high-resolution, shallow seismic-reflection data in five locations in Henderson and Daviess Counties. The information will provide a better delineation of the subsurface stratigraphy, as well as a view of the topography of the bedrock in the area, which ranges from 30 to 140 feet below the surface.

Counts also drilled about 400 feet of soil cores during the year for the STATEMAP project (see p.4). Specific areas for which there are little existing data were targeted for the work, which involves drilling cores from 10 to 45 feet deep.

For 3 years, **Carrie Pulliam** has been sorting, cataloging, and integrating a large collection of regional oil and gas well information donated by the University of Southern Indiana to the Henderson office. Combined with other private donations, these records represent a wealth of data on oil and gas exploration in the Illinois Basin in Kentucky, Illinois, and Indiana. The Henderson office now has production reports available for

Illinois ranging from 1936 to 2002, for Indiana from 1941 to 2002, and for Kentucky from 1946 to the present. Since the difficult process of sorting, cataloging, correcting, and incorporating the donated materials began, approximately 200 wells have been added to the files in the Henderson office. This information is the definitive source for Illinois Basin petroleum research in the tristate. ■



**Ron Counts of the Henderson office does surficial mapping field work.**



KGS and the UK Cooperative Extension Service recognized Henderson County farmer **Scott Keach** for allowing both agencies access to his 500-acre farm for over a decade for research and groundwater-monitoring. **Glynn Beck** of the KGS Henderson office oversees the work, which has improved the understanding of the effects of agricultural practices, while also assisting geologic mapping of the region.

State Geologist and KGS Director **Jim Cobb** (right) presented Mr. Keach (center) with a plaque and thanked him for his cooperation as Glynn Beck looked on.



The KGS Well Sample and Core Library promotes the collection, preservation, and utilization of rock samples and cores and the information directly attributable to them. The samples and cores help in the discovery of oil, gas, coal, lead, zinc, and other minerals, as well as the understanding of the evolution and history of the earth. Staff at the facility regularly receive

rock samples and cores from outside donors, catalog them, and store the samples at the facility. Hundreds of people call or visit the Well Sample and Core Library each year looking for information. They include academic researchers and students, engineers, consultants, and others associated with energy exploration and other industries.

The facility also hosts a number of meetings each year. During the fiscal year, the meetings included the KGS annual seminar, the Kentucky Mining Institute Mine Rescue Contest, the Central Kentucky ESRI Workshop, a coal and petroleum coke-making seminar, the Southern Region Water Quality Conference and Workshop, and the KSPG Professional Geologist Exam Review Class. ■



Members of the Webster County Coal Dotiki Mine Rescue Team dressed in full gear and ready for competition. The Kentucky State Mine Safety Contest was held by the Kentucky Mining Institute and the University of Kentucky. The Core Library was used to sequester over 20 teams of miners during competition that was held adjacent to the facility. It was also used for demonstrations, a short course, and testing.



Patrick Gooding, Manager of the Well Sample and Core Library, presented research results at an American Association of Petroleum Geologist's annual meeting. Over 200 polished core samples from throughout the state, ranging in age from 400 to 600 million years, were used to support his conclusions. Gooding hopes that this will bring greater awareness for the use of this material for research and will promote collection, preservation, and utilization of geoscience data.

### Activities:

Fiscal Year 2005–06

1. Over 700 telephone requests for information
2. More than 200 researchers, geologists, consultants, and students used the facilities of the Well Sample and Core Library
3. More than 175,000 feet of cores and well cuttings examined
4. More than 215,000 feet of core and well cuttings donated to the library

Examples of polished rock samples from the collection housed at the Well Sample and Core Library. Detailed examination of these samples yields information such as grain size, fossil content, mineralogy, deformation structures, porosity, and permeability.





Staff scientists in the KGS laboratory serve the analytical needs of KGS researchers while also helping to meet the needs of departments of the University of Kentucky and State government agencies. A total of 2,576 samples were sent to the lab for analysis during the fiscal year.

Several projects being run by KGS staff and other university researchers involve analyzing samples of water from wells around Kentucky to determine levels of chemicals, including nitrates, chlorides, and herbicides. For 8 years, hundreds of water samples from Kentucky's Jackson Purchase Region have been analyzed to determine contamination sources for domestic water-well users in the region's rural areas.



UK graduate student Rachel Galvin and Steve Webb, of the KGS Water Resources Section, work at a Woodford County well site where Galvin gathered deep groundwater samples, which were analyzed in the KGS laboratory for her master's degree project.

*A total of  
2,576 samples  
were analyzed  
by the KGS lab  
during this  
fiscal year.*



Henry Francis, KGS Laboratory Manager, and Harry Rowe, of the Department of Earth and Environmental Sciences, inspect the new X-ray diffraction instrument.

A major customer outside the Survey has been the Water Watch Program of the Kentucky Division of Water, which samples selected streams twice annually.

In its Coal and Minerals section, the lab analyzes coal samples for quality and rock samples for their mineral content.

The lab also serves the needs of other departments of the University by providing analyses for them or making laboratory instruments available for their educational needs.

A new instrument was installed at the lab during the fiscal year. The X-ray diffraction instrument was purchased and installed as a result of the efforts of several UK colleges and KGS. **Harry Rowe**, of the Department of Earth and Environmental Sciences, headed a group of UK faculty members who applied for a \$289,497 grant from the National Science Foundation for the instrument. The University contributed \$9,900 for the purchase. KGS and the Earth and Environmental Sciences Department use the instrument for identification and analysis of geologic samples. Students from other colleges conduct activities such as texture or thin-film analysis. The instrument allows analysis of up to nine samples simultaneously. ■

Laboratory Manager Henry Francis takes the KGS Advisory Board for a tour of the facility.





A network of 19 seismic instruments placed across Kentucky forms the Kentucky Seismic and Strong-Motion Network. Operated jointly by KGS and UK's Department of Earth and Environmental Sciences, the network monitors earthquakes in the central United States and records larger earthquakes occurring elsewhere. One of these instruments, a seismic station in Henderson, was added to the network on January 12, 2006. The instrument is located just outside a building at the KGS office in Henderson.

Five earthquakes were recorded within Kentucky with a Richter magnitude of 2.0 or greater during the fiscal year. Eight other earthquakes with Richter magnitudes of 2.0 or greater were also recorded in Illinois, Missouri, Tennessee, and North Carolina.

The public can view earthquake recordings from a dozen of the instruments in near-real time on the KGS Web site. The network's instruments have recorded not only seismic activity in the central United States, but also strong earthquakes that occur elsewhere in the country and the world. Several times in the past few years, earthquakes as far away as Indonesia have been clearly recorded by the instruments.

Nine other network devices, called strong-motion instruments, are located in the New Madrid Seismic Zone to record stronger earthquakes in the region. They collect recordings for a database to study the effects of larger tremors on central

U.S. soils. This information is important for long-term studies of the appropriate seismic strength needed to make buildings in the central United States earthquake-resistant.



Jonathan McIntyre and State Geologist Jim Cobb examine one of the instruments in the seismic network.

### Chinese Visiting Scholar

In another step in the continuing relationship between KGS and China's Lanzhou Institute of Seismology, a visiting scholar from the institute, Wu Zhijian, arrived at the KGS Geologic Hazards Section in late January.

Wu has done extensive studies on the interaction of a Chinese railway bed and the underlying permafrost, as well as earthquake ground motions on frozen soil. During a year-long stay at KGS, he will work on analysis of data from the strong-motion instruments in the Kentucky Seismic and Strong-Motion Network. ■



In May 2006, KGS presented Fulton County landowner **Austin Voorhees** a plaque of appreciation for his willingness to allow KGS access to his agricultural property at Sassafras Ridge since 2002. Several deep holes have been drilled on the property for seismic instruments in the network. Pictured with Voorhees (*right*) are **Jonathan McIntyre**, of the KGS Geologic Hazards Section, Assistant State Geologist **John Kiefer**, and State Geologist **Jim Cobb**. The presentation was made at Voorhees's home in Hickman.



## Summary of Grants and Contracts in Effect Fiscal Year 2005–2006

The research and information needs of the Survey's partners—and the valuable expertise of its staff—are reflected in the variety of grants and contracts the Survey managed during the fiscal year.

### Participation of KGS in Grants and Contracts Funded by State and Federal Agencies

**1. Computerized Coal Resources Data for the National Coal Resources Data System.** Budget period 7/1/05–6/30/06. Award \$59,392. This is funding for an additional year of multi-year projects on coal resources data. Total award to date \$1,282,789. Funding agency – U.S. Geological Survey.

**2. Chemical Analysis of Groundwater Samples Taken from the Kentucky Groundwater Network.** Budget period 7/1/04–6/30/06. This is a continuation of a project started 2/1/95. Current year prorated award \$15,700. Total award \$31,400 for current project. Total award to date \$868,512. Funding agency – Kentucky Natural Resources and Environmental Protection Cabinet.

**3. Generation of 1:100,000 Geologic Maps from Digital 1:24,000 Geologic Quadrangle Maps in the Kentucky River Basin, Kentucky.** Award of \$197,373 for budget period 4/15/06–4/14/07. This is the 11th year funding of the project. Total award to date \$2,017,369. Funding agency – U.S. Geological Survey.

**4. Communications Specialist for the Kentucky Board of Registration for Professional Geologists.** Budget period 7/1/05–6/30/06. Award \$15,000. Funding agency – Kentucky Board of Registration for Professional Geologists.

**5. Analysis of Devonian Black Shales in Kentucky for Potential Carbon Dioxide Sequestration and Enhanced Natural Gas Production.** Budget period 5/12/02–5/14/05 with no cost extension to 9/30/05 and no additional funding. Total award \$364,453. Funding agency – U.S. Department of Energy.

**6. Groundwater Education, Training, and Technology Transfer.** Budget period 7/1/03–6/30/10. Current year prorated \$64,286. Total award \$450,000. Funding agency – Kentucky Natural Resources and Environmental Protection Cabinet.

**7. Midwest Geological Sequestration Consortium.** Budget period 10/1/05–9/30/07. Current year prorated \$74,631. Total award \$99,509. Funding agency – U.S. Department of Energy through the Illinois State Geological Survey.

**8. Creating a Geologic Play Book for Trenton–Black River Appalachian Basin Exploration.** Budget period 10/1/03–3/31/06. Current year prorated \$50,234. Total award \$319,234. Funding agency – U.S. Department of Energy through West Virginia University.

**9. Mid-America Integrated Seismic Network – UK.** Budget period 1/1/04–1/31/07. Current year award prorated \$35,000. Total award \$107,921. Funding agency – U.S. Geological Survey.

**10. Midwest Regional Carbon Partnership.** Budget period 11/17/03–9/30/05. Current year award prorated \$6,435. Total award \$51,566. Funding agency – U.S. Department of Energy.

**11. Delineation of Karst Groundwater Basins along the Proposed I-66 Corridor, Pulaski County.** Project period 12/1/04–4/30/06. Current year prorated \$54,325. Total award \$130,380. Funding agency – Kentucky Transportation Cabinet.

**12. Groundwater Quality Monitoring for Nonpoint-Source Chemicals in the Jackson Purchase Region of Kentucky.** Budget period 11/1/04–6/30/06. Current year prorated \$42,500. Total award \$85,000. Funding agency – Kentucky Natural Resources and Environmental Protection Cabinet.

**13. Development of Community Water Supplies.** Budget period 7/1/05–6/30/06. Total award \$50,000. Funding agency – Kentucky Infrastructure Authority.

**14. A Systems Approach to Identifying Exploration and Development Opportunities in the Illinois Basin: Digital Portfolio Plays in Under-Explored Lower Paleozoic Rock.** Budget period 9/24/05–9/23/06. Current year award \$103,433. Project period 9/24/04–9/27/07 with total award of \$197,498. Funding agency – U.S. Department of Energy through University of Illinois.

**15. Analysis of Washability Data for Eastern Kentucky Coals.** Budget period 7/1/05–6/30/06. Total award \$44,392. Funding agency – U.S. Geological Survey.

**16. Geochemical Analysis of Surface and Shallow Gas Flux and Composition over a Proposed Carbon Sequestration Site in Eastern Kentucky.** Budget period 7/15/05–7/14/06 with current year award of \$124,888. Project period 7/15/05–1/14/08 with total award of \$277,989. Funding agency – U.S. Department of Energy.

**17. Hydrogeology of Karst Related Flooding, Happy Valley Karst Valley (Quiggins Sinkhole), Radcliff, Ky.** Budget period 8/1/05–7/31/06. Total award \$77,588. Funding agency – U.S. Army Corps of Engineers.

**18. Southeast Kentucky: Coals as CO<sub>2</sub> Sequestration Reservoirs (part of Southeast Regional Carbon Sequestration Partnership Phase 2 Project).** Budget period 10/1/05–9/30/06 with current award of \$15,000. Project period 10/1/05–9/30/06. Total award of \$66,000. Funding agency – Virginia Polytechnic Institute and State University.

**19. Seed Grant—Consortium Development for Western Kentucky Deep Gas Exploration.** Budget period 1/1/06–6/30/06. Total award \$46,914. Funding agency – Kentucky Office of Energy Policy.

**20. Seed Grant—Exploring for Economic Coalbed Methane in Eastern Kentucky.** Budget period 2/15/06–2/14/07. Total award \$86,250. Funding agency – Kentucky Office of Energy Policy.

**21. Kentucky Part of Phase 2 of the Midwest Regional Carbon Sequestration Partnership.** Budget period 10/1/05–9/30/06 for current year prorated \$50,317. Project period 10/1/05–9/30/09. Total award \$266,824. Funding agency – Battelle Memorial Institute.

**22. Kentucky Transportation Cabinet Geotechnical Reports on the Web.** Budget period 7/1/05–6/30/06. Total award \$50,000. Funding agency – Kentucky Transportation Cabinet.

**23. Matching Grant – An Assessment of Geological Carbon Sequestration Options in the Illinois Basin: Phase 2 (Midwest Geologic Sequestration Consortium, Kentucky, 4 year project).** Budget period 1/1/06–6/30/06. Total award \$172,431. Funding agency – Kentucky Office of Energy Policy.

**24. Matching Grant—Coals as Sequestration Reservoirs (Kentucky Part of SECARB, Phase 2).** Budget period 10/1/05–6/30/06. Total award \$23,338. Funding agency – Kentucky Office of Energy Policy.

**25. Matching Grant—Building and Refining a Geologic Sequestration Framework for the Region (Kentucky Part of MRCSP, Phase 2).** Budget period 1/1/06–6/30/06. Total award \$72,625. Funding agency – Kentucky Office of Energy Policy.

**26. Matching grant—Geochemical Analysis of Surface and Shallow Gas Flux and Composition over a Proposed Carbon Sequestration Site in Eastern Kentucky.** Budget period 1/1/06–6/30/06. Total award \$69,497. Funding agency – Kentucky Office of Energy Policy.

**27. Evaluation of Potential FutureGen Sites in Kentucky.** Budget period 1/1/06–6/30/06. Total award \$200,000. Funding agency – Kentucky Office of Energy Policy.

**28. Investigation of the Hydrogeochemical Issues Leading to Roadbed Subsidence in the Cumberland Gap Tunnel.** Budget period 4/15/06–10/15/06. Total award \$77,316. Funding agency – Tunnel Management Inc.

### Participation in Grants Administered by Other Units of the University of Kentucky

**1. Nonpoint-Source Assessment of Groundwater.** Funding agency – Commonwealth of Kentucky. Cooperative study with University of Kentucky College of Agriculture. At Animal Research Center – Woodford County. Budget period 7/1/05–6/30/06. Award \$63,017. At High-Nitrate Wells. Budget period 7/1/05–6/30/06. Award \$53,080.

**2. Kentucky Research Consortium for Energy and Environment.** Budget period 10/1/03–9/30/05. Current year prorated \$14,686. Total award \$117,485. Funding agency – U.S. Department of Energy through University of Kentucky Tracy Farmer Center on the Environment.

**3. Paducah Gaseous Diffusion Plant.** Budget period 5/1/06–8/30/2006. Award \$200,000. Funding Agency – U.S. Department of Energy through Kentucky Water Resources Research Institute.

### Total Amount of Grants and Contracts Awarded—\$2,209,648



The people who make KGS a well-known and respected institution also participate in civic and professional organizations at the local, state, and national level. A number of them received recognition for their work and their contributions during the year.

■ Energy and Minerals Section Head **Jim Drahovzal** received the *Ralph L. Miller Best Energy and Minerals Division 2004 Paper Award* from the Eastern Section of the American Association of Petroleum Geologists. The paper, entitled "Potential Reservoirs for Geologic Sequestration in the East Continent Rift Basin", was co-authored by **Dave Harris**.

■ Former State Geologist and KGS Director **Donald C. Haney**, who earned his doctoral degree in geology from the University of Tennessee, received the *Distinguished Alumnus Award* from the university's Department of Earth and Planetary Sciences. In addition, a series of 10 talks on geologic mapping was held in his honor during the Southeastern Section of the Geological Society of America's March meeting in Knoxville.

■ Assistant State Geologist **John Kiefer** was awarded the *National Public Outreach Award* by the American Association of Petroleum Geologists' Division of Environmental Geology. The award cites Kiefer's efforts and accomplishments in promoting and presenting environmental concerns to the public. He was also chairman of the Geological Society of America Division of Geology and Society, and chairman of the Southeastern Section of the Geological Society of America Committee on Geology and Public Policy.



Theola Evans

■ **Theola Evans**, a 16-year veteran of the Survey and stores supervisor in the Public Information Center, received a *Spirit of the Survey* award in December 2005 for her exemplary work.

■ **Glynn Beck** was named field coordinator for a National Science Foundation EPSCoR (Experimental Program to Stimulate Competitive Research) grant administered by the UK Civil Engineering Department. The grant is intended to initiate undergraduate and graduate-student environmental research in rural western Kentucky.



Glynn Beck

■ **Patrick Gooding** was elected by the Kentucky Society of Professional Geologists to another 3-year term as the delegate to the American Association of Petroleum Geologists. He chaired the Credentials Committee in AAPG's House of Delegates for a second year. He continues to serve as vice chairman of the AAPG Committee on Preservation of Samples and Cores.



Jim Drahovzal



Patrick Gooding

■ Eleven KGS staff authored a paper that received the Division of Environmental Geosciences' *Best Paper Award* from the Eastern Section of AAPG at the Section's 2005 meeting. They were **Steve Greb, Brandon Nuttall, Mike Solis, Marty Parris, Jim Drahovzal, Cortland Eble, Dave Harris, John Hickman, Paul Lake, Bethany Overfield, and Kathy Takacs**. The paper was "Siting Coal-Fired Power Plants in a Carbon-Managed Future; the Importance of Geologic Sequestration Reservoirs."



Donald C. Haney



Dan Carey

■ **Dan Carey** was recognized as a showcase presenter at the annual Kentucky GIS Conference for his invited talk, "A Sense of Place: Generalized Geologic Maps for Land-Use Planning."



John Kiefer



Jerry Weisenfluh

■ Geospatial Analysis Section Head **Jerry Weisenfluh** was appointed to the Kentucky Geospatial Board (formerly the Geographic Information Advisory Council).



# KGS staff members during fiscal year 2005–06

## State Geologist's Office

**Cobb, Jim**  
Geologist / State Director  
**Kiefer, John**  
Assistant State Geologist  
**Haney, Donald C.**  
State Geologist Emeritus  
Lynch, Mike  
Technology Transfer Officer  
Hower, Judy  
Temp Technician

## Administrative Section

Silvers, Jackie  
Administrative Staff Officer II  
Long, Mandy  
Administrative Support Associate I  
Phillips, Gwen  
Staff Support Associate II  
Nolan, Tim  
Student worker

## Energy and Minerals Section

**Drahovzal, Jim**  
Section Head  
Barth, Leah  
Geological Technician  
Daugherty, Shannon  
Student worker  
Eble, Cortland  
Geologist V  
Greb, Steve  
Geologist V  
Harris, Dave  
Geologist V  
Hickman, John  
Geologist III  
Lake, Paul  
Geologist II  
Nuttall, Brandon  
Geologist IV  
Parris, Marty  
Geologist IV  
Solis, Mike  
Geologist I  
Takacs, Kathy  
Geologist I

## Geologic Hazards Section

McIntyre, Jonathan  
Geologist III  
Shi, Baoping  
Geologist III  
Vance, Dave  
Student worker  
Wang, Zhenming  
Geologist V  
Woolery, Ed  
Temporary researcher  
Wu, Zhijian  
Temporary researcher

## Geoscience Information Section

**Cordiviola, Steve**  
Section Head  
Alluri, Sandeep  
Student worker  
Banks, Roger  
Account Clerk I

Coleman, Matt  
Student worker  
Davis, Luanne  
Geological Technician  
Evans, Theola  
Stores Supervisor  
Farwell, Mike  
Student worker  
Hounshell, Terry  
Chief Cartographic Illustrator  
McElhone, Jim  
Information Technology Manager I  
Nanduri, Surya  
Student Worker  
Rulo, Collie  
Graphic Design Technician  
Smath, Meg  
Geologist III  
Thompson, Mark C.  
Information Technology Manager I  
Watson, Anna  
Geologist II  
Williams, Sidney  
Student worker

## Geospatial Analysis Section

**Weisenfluh, Jerry**  
Section Head  
Anderson, Warren  
Geologist V  
Andrews, William  
Geologist IV  
Carey, Dan  
Geologist V  
Crawford, Matt  
Geologist II  
Curl, Doug  
Geologist III  
Heck, Jason  
Student worker  
Lambert, Jason  
Student worker  
Luckett, Brad  
Student worker  
Martin, Steve  
Geologist III  
Murphy, Mike  
Geologist I  
Overfield, Bethany  
Geologist II  
Petersen, Carl  
Geologist II  
Poole, William  
Student worker  
Ramsey, Carolyn  
Student worker  
Reynolds, Joshua  
Student worker  
Sergeant, Rick  
Geologist IV  
Smath, Richard  
Geologist III  
Sparks, Tom  
Geologist III  
Strickling, Erica  
Student worker  
Thompson, Mark F.  
Geologist II  
Wang, Rebecca  
Information Systems Support Specialist III

## Laboratory Services

**Francis, Henry**  
Scientist II / Laboratory Manager  
Backus, Jason  
Scientist II  
Mitchell, Andrea  
Scientist I  
Mock, Steve  
Scientist I

## Water Resources Section

**Dinger, Jim**  
Section Head  
Cumbie, Dennis  
Geologist III  
Currens, Jim  
Geologist V  
Davidson, Bart  
Geologist IV  
Fisher, Steve  
Geologist V  
Fogle, Alex  
Geologist III  
Gadbois, Clifton  
Temporary Technician  
Gulley, Jason  
Temporary Technician  
Guo, Lifeng  
Geologist IV  
Paylor, Randy  
Geologist II  
Spears, Anita  
Temporary Technician  
Webb, Steve  
Geologist I  
Wilhelm, Brent  
Temporary Technician

## Well Sample and Core Library

**Gooding, Patrick**  
Geologist IV / Manager  
Daniel, Ray  
Principal Research Analyst  
Eversole, Mark  
Senior Laboratory Technician  
Pinkston, Ryan  
Senior Laboratory Technician

## Western Kentucky Office at Henderson

**Williams, Dave**  
Section Head  
Beck, Glynn  
Geologist IV  
Counts, Ron  
Geologist II  
Inkenbrandt, Paul  
Geological Technician  
Kelley, Amy  
Temporary Technician  
Kotter, Dan  
Temporary Technician  
McMeans, Megan  
Geological Technician  
Pulliam, Carrie  
Senior Geological Technician  
Waninger, Scott  
Temp Technician



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