

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:

Sky Bridge Arch in the Red River Gorge Geological Area

Photo by Steve Martin of the Geologic Mapping Section

Sky Bridge is a shelter natural arch that also contains a smaller pillar natural arch. The arch, like most arches in the Red River Gorge Geological Area, is formed in the Pennsylvanian Corbin Sandstone. Shelter arches are the result of the merging of cavities forming on opposite sides of a narrow sandstone ridge. Joints penetrating the sandstone, gravity, water, and the freezing and thawing cycle cause the ridge to weather from the bottom up and to resist subsequent erosion over time because of compressive strengthening.



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The Kentucky Geolgoical Survey Annual Report Fiscal Year 2009-10

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Dr. James Cobb, Kentucky State Geologist and Director, Kentucky Geological Survey

This annual report covers all the areas in which KGS is active. Although

formal KGS annual reports date back to the middle 1800's, the idea that the public deserves to be informed about the activities and findings of the Survey is modern, so please take the opportunity to look this report over. Visit our Web site at www.uky.edu/kgs for more information and details.

In 2010, the nation was faced with bad economic news and one of the worst environmental accidents in history, the BP oil spill in the Gulf of Mexico. The nation also had one of the worst coal mining disasters in recent history, amplifying adverse public opinion of the use of coal. Headlines were also made in what was referred to as "climategate," allegations of malpractice and misinformation in the climate science community. This served as ammunition for those skeptical about humaninduced global warming and further confused and confounded political and legislative efforts to mitigate global warming. Interest in a carbon cap and trade system for coal to control carbon emissions was also diminished but is likely to reappear at some time in the future. The year also saw a boom in natural gas exploration and production in the eastern United States, some of which was in Kentucky. All of this national and international news related to natural resources affects public opinion on topics that affect Kentucky. This state is rich in natural resources, and our economy depends heavily on the use of these resources. In addition, disastrous earthquakes, landslides, floods, and volcanoes ensured that geology and earth-science topics regularly appeared on the front pages of newspapers. All of this has an impact on KGS too, as our core mission is directly tied to the understanding and production of Kentucky's natural resources and the mitigation of damages from resource production.

In 2009-10, KGS had 19 funded projects for a total grant funding of \$2.6 million. Approximately

\$1.07 million was from federal sources and \$1.48 million from State sources. KGS produced 16 new publications. The KGS Web site continues to be a valuable tool used by many industries, government agencies, and private citizens to gather geologic information. In 2009-10, more than 200,000 online database searches were made for petroleum, coal, and water data and more than 1.0 million such downloads. Users can also view KGS data on interactive Web maps, especially our signature interactive geologic maps. KGS database and map Internet functions serve over 1,000 users each day.

KGS completed its research on carbon sequestration at the Hancock County site with injection of about 700 tons of CO₂. The project was the first of its kind in Kentucky and one of very few of its kind in the world. Because of the size and complexity of the project, the results will take time to properly assess; final reports will be completed in the future. Details about this project and other projects in hazards, water, and minerals can be found in this report.

KGS was reviewed by the University of Kentucky in 2010. The review committee reported that

KGS is a highly effective unit of the university that meets or exceeds the expectations of its various stakeholders at all levels. KGS is viewed as a top-tier program by peer organizations and other state geological surveys, and staff members of KGS are well respected nationally and internationally. The work performed by KGS in mapping and making available geological information to the public is viewed as an exemplary program among all state surveys. The KGS CO2 Sequestration Project is an excellent example of KGS's capabilities, and typical of their efforts on all projects. External stakeholders enthusiastically endorsed KGS as an excellent project partner.

The outcome of this review was overall very good, but a number of suggestions were made to improve performance and effectiveness. These suggestions are being incorporated into KGS policies and procedures and will be implemented to the extent possible and with consideration given to fiscal constraints.



Len Peters, *secretary*, Kentucky Energy and Environment Cabinet

These are interesting times for the world of energy. Our demands for energy

for the world of energy. Our demands for energy are growing, and we must try to meet these growing demands in as environmentally sustainable a manner as possible. Kentucky has been blessed with relatively low electricity rates for decades, and we've been

able to reap the benefits of such low rates by developing a strong, vibrant industrial economy—among the largest in the United States, in fact. These low electricity rates are based primarily on our ability to generate most of the state's electricity from Kentucky's abundant coal resources. This situation is changing—dramatically and quickly—and climate action at the Federal level is progressing, with greenhouse gas regulation moving forward and legislation by no means off the table.

With the governor's energy plan, the goal was to be proactive, and flexible, in moving the state forward in the energy arena. The governor's vision was and is to make Kentucky an energy leader—using our natural resources in an environmentally sensitive manner while creating economic growth. The energy plan serves as a roadmap toward energy independence that is designed to conserve and use energy more efficiently, achieve energy independence for transportation fuels, use coal more cleanly and efficiently, and diversify electricity generation to optimize use of renewable and alternative fuels, in addition to coal, Kentucky's leading fossil fuel.

Because of our vulnerability to Federal actions that will penalize energy production from fossil fuels because of their carbon footprint, carbon dioxide capture and storage will become key to our ongoing utilization of our coal resources—whether to generate electricity or to produce liquid fuels and synthetic natural gas.

Addressing the technological, economic, legal, and policy issues of carbon dioxide capture and storage is of extreme importance for Kentucky and the nation as a whole. Most experts, however, agree these challenges can and must be overcome if the United States is to meet its growing energy needs and at the same time reduce overall greenhouse gas emissions. The Kentucky Geological Survey has been instrumental in advancing research in geologic storage of carbon dioxide emissions in the commonwealth.

The Survey's recently released report that assesses the geologic factors affecting Kentucky's potential for permanent carbon dioxide storage is one example of the ongoing work. The report, "Evaluation of Geologic CO₂ Sequestration Potential and CO₂ Enhanced Oil Recovery in Kentucky," gives us significantly more information on various aspects of geologic storage of carbon dioxide, as well as enhanced oil recovery, and the potential viability of both in the commonwealth. We will be using the information in this document to help us achieve the goals of managing carbon dioxide as outlined in Gov. Beshear's comprehensive energy plan to ensure that we can continue to use our abundant coal resources in a carbon-constrained world.

The Kentucky Geological Survey and its industry partners are to be commended for the successful completion of the deep well drilling project in Hancock County. Preliminary findings from this well show potential for storage, and these data are being used by developers interested in coal-related projects in the western Kentucky coal fields.

KGS is one of the leading entities working on the storage of carbon dioxide in the United States. This is an important part of addressing our vulnerability to Federal action as well as future energy-related economic development opportunities in the commonwealth.



Karen Thompson, chair, KGS Advisory Board

The research programs in energy, water, hazards, and mapping at the Kentucky Geological Survey all contribute to the knowledge base that is essential to the

development of Kentucky's natural resources and its economy. This work benefits all the citizens of the commonwealth. The KGS Advisory Board believes that KGS has accomplished more than most state surveys with fewer resources than many other surveys. Without question, KGS is a vital unit for the geologic, engineering, environmental, coal, petroleum, gas, and other mineral industries in Kentucky, as well as industries in the region and around the world.

KGS is a resource of incalculable value because of outstanding performance in the collection and analysis of such data for the benefit of industry, government, and the public. The past few years have been particularly successful. Noteworthy efforts have involved carbon sequestration research, the Well Sample and Core Library, and geologic mapping. Community outreach is one of the areas in which we think KGS has really excelled in the past decade.

One of the shining stars of the KGS Web site is the investment in GIS capabilities. The Survey has developed GIS capabilities coupled with its mapping capabilities to provide a complete information system that is readily available through Internet access. The quality and accessibility of the information that the citizens of the commonwealth have at their fingertips is exceptional as a result of these efforts.

Board members believe that further investment and improvement in two services is crucial. Improving the Well Sample and Core Library is critically important. Without this facility, well cuttings and core samples that have been recovered from all areas of the state would be lost and unavailable for examination in research projects and studies related to the development of our natural resources, such as oil, gas, and coal. The KGS mission is hampered by a lack of adequate facilities in which to house the existing core and data, as well as future materials, and is in desperate need of funding for expansion of those facilities.

Community outreach is also an area in which KGS must continue to strive for improvement and enhancement. Many of our Board members stress that UK is a land-grant university, and community outreach is one of the main pillars of the land-grant system. We encourage KGS to continue to provide high-quality information to the public through maps, Web sites, and workshops.

Kentucky House Bill 1 Carbon Storage Demonstrations

Western Kentucky Deep CO₂ Storage Test Well

Drilling and phase I testing of the deep carbon storage well in Hancock County were completed in the summer of 2009 to test the potential for permanent storage of carbon dioxide in the Knox Dolomite, a deep formation in western Kentucky. **Rick Bowersox** and **Dave Williams** served as principal investigators on this project. ConocoPhillips, E.ON US, Peabody Energy, and the Tennessee Valley Authority formed the Western Kentucky Carbon Storage Foundation to provide additional funding and technical services to the project. The Illinois Department of Commerce and Economic Opportunity and other organizations also provided funding and services. Total cost of this phase of well drilling and testing was about \$7 million.

Data collected during the project included openhole electric logs, a formation imaging log, cores of potential seals, and Knox reservoir rock. The Precambrian Middle

Carbon dioxide is vented after an equipment pressure test before 323 tons of CO₂ was injected into the Hancock County deep test well.

Run Sandstone was also cored in the well, through a \$250,000 grant from the U.S. Department of Energy, because its reservoir properties were previously unknown. Successful injection of about 18,500 barrels of brine and 323 tons of carbon dioxide into the Knox Dolomite demonstrated that carbon dioxide storage in the Knox is feasible. Analysis of geologic data from the well and other deep wells in western Kentucky suggests a prospective area for carbon dioxide storage in the Knox of about 6,800 square miles. Additional research will be necessary to evaluate how much of this area is suitable for carbon dioxide storage.

After testing is completed, the well will be plugged in accordance with State and Federal regulations, and the well site restored to pasture by the fall of 2010.

Devonian Shale CO₂ Enhanced Gas Recovery Demonstration

Two projects headed by **Brandon Nuttall** are under way to test the hypothesis that Devonian black shales beneath about two-thirds of Kentucky may serve for long-term CO₂ storage as well as enhanced natural gas recovery.

A well was nominated by the Pike County Fiscal Court as a possible injection site to test the concept. Surface and subsurface access agreements for the injection test project are being negotiated. The nominated well, a cased hole with open perforations, presents a challenge for acquiring geophysical logs for monitoring and assessing the fate of CO₂ in the shale reservoir; well logging, data acquisition, and monitoring programs are being designed to address these problems.

The Devonian New Albany Shale in western Kentucky may also offer potential for long-term storage of CO₂. Tests and data from a core taken in 2009 from the Hancock County deep carbon storage well indicate the shale is a low-permeability unit with adequate mechanical properties to act as an effective secondary seal for carbon stored in deeper formations. Preferential adsorption of CO₂ by organic matter can enhance the sealing ability of the shale and suggests a strategy for enhanced natural gas production. These data are also relevant to the storage project in eastern Kentucky.

CO₂ Enhanced Oil Recovery-Sequestration

Two different types of enhanced oil recovery-sequestration projects continued to move forward. At Sugar Creek Field in Hopkins County, 7,268 tons of CO₂ was injected into the Mississippian Jackson Sandstone reservoir from May 9, 2009, to May 10, 2010. The Sugar Creek project was conducted as a pattern flood in which CO₂ was

continuously injected through a centrally located well surrounded by six to eight production wells. Injection of CO_2 was followed with water injection, which continues at the end of this fiscal year. Geochemical monitoring of reservoir fluids and gases conducted by KGS staff successfully documented changes in fluid chemistry. There appears to be a modest increase in oil production because of CO_2 injection, though the field response is still being evaluated.

KGS staff also collected data on water and gas chemistry in the Euterpe Field in Henderson County prior to a new enhanced oil recovery injection project scheduled for fall 2010. Reservoir pressures at Sugar Creek and Euterpe are low enough that CO₂ will largely remain as a gas in the oil reservoir.

Marty Parris is the principal investigator for the projects, and researchers Glynn Beck and Kathy Takacs have conducted most of the fluid and gas monitoring. Measurements of fluid chemistry are being done by Jason Backus, Andrea Conner, and Steve Mock of the KGS laboratory. The Sugar Creek project is part of the Midwest Geological Sequestration Consortium pilot program administered by the Illinois State Geological Survey, and, as such, is supported with funding from the U.S. Department of Energy.

Regional Evaluation of CO₂ Storage and Enhanced Oil Recovery Potential

Energy and Minerals Section staff released the final report of a multifaceted analysis of carbon sequestration potential in Kentucky. The findings are available at the KGS Web site as Report of Investigations 21 (series 12). Funded by the Kentucky Energy and Environment Cabinet, the analysis focused on four diverse topics thematically related by carbon sequestration. The topics, listed as chapters in the report, were (1) a geologic evaluation of the potential



Glynn Beck gathers water samples from the Sugar Creek oil field for an enhanced oil recovery project.

to use CO₂ for enhanced oil recovery (Kathy Takacs, Brandon Nuttall, and Marty Parris), (2) an evaluation of subsurface brine geochemistry and implications for CO₂ sequestration (Parris, Steve Webb, Takacs, Nick Fedorchuk), (3) a broad geologic framework evaluation of CO₂ storage potential with an emphasis along some of the state's major river corridors (Steve Greb and Mike Solis), and (4) a geologic evaluation of CO₂ storage

potential for nominated coal gasification sites (Nuttall, Dave Harris, John Hickman, and Solis). It is intended to provide a critical reference for policy-makers and industry representatives evaluating Kentucky's carbon sequestration potential. The project was coordinated and managed by Parris (principal investigator) and Greb and Nuttall (co-principal investigators).

Evaluating Deep CO₂ Storage in the Illinois and Michigan Basins

Begun in 2010, this 3-year project is a collaborative effort of four research groups: state geological surveys in Illinois, Kentucky, and Indiana, and geologists at Western Michigan University. The project was funded by the U.S. Department of Energy through the American Recovery and Reinvestment Act. It will characterize the carbon sequestration potential of the Cambrian-Ordovician Knox Supergroup and Ordovician St. Peter Sandstone in the Midwest. KGS



Student worker Anne Schumacher and Kathy Takacs gather water samples in preparation for a new enhanced oil recovery project in Henderson County.

is characterizing the Knox Supergroup in western Kentucky, a potentially important subsurface formation for storage of CO₂. KGS's work will consist of five main tasks:

- Conduct a second phase of CO₂ injection in the Knox Group in the Hancock County well (see above) to evaluate a discrete reservoir zone, and image the CO₂ plume with time-lapse three-dimensional vertical seismic profiles (Rick Bowersox and John Hickman).
- Improve our ability to predict high-quality reservoir zones in Knox Group dolostones using two-dimensional seismic modeling techniques, such as seismic inversion. (Hickman).
- Characterize the reservoir types and determine the geologic controls on dolostone and sandstone porosity development and preservation in the Knox Group in western Kentucky. This will benefit prediction of CO₂ storage capacity and containment (Dave Harris and Marty Parris).
- Develop an interpretative geochemical model or models that describe interactions among supercritical carbon dioxide, formation brines, and the rock-forming minerals making up the Knox carbonate reservoir and seal rocks (Parris and Junfeng Zhu).
- Evaluate fault seal capacity of several formations in western Kentucky using both rock-based analysis and geomechanical approaches (**Hickman**).

Regional Carbon Storage Partnerships

The section continued research in three U.S. Department of Energy-funded regional carbon sequestration partnerships: the Midwest Geological Sequestration Consortium (Warren Anderson and Brandon Nuttall), the Midwest Regional Sequestration Partnership (Steve Greb and Mike Solis), and the Southeast Regional Carbon Sequestration Partnership (Greb and Cortland Eble). Phase 2 research in these partnerships included continued characterization of regional CO2 sequestration potential in saline reservoirs, potential for enhanced oil and gas recovery with CO2, and CO2 demonstration injection wells. One of the regional demonstration wells was in Rabbit Hash, Boone County, at Duke Energy's East Bend Station. A 3,500foot-deep well was drilled into the Precambrian Middle Run Sandstone, and 1,000 tons of CO2 was successfully injected into the Cambrian Mount Simon Sandstone during the summer of 2009. This test

marked the first-ever injection of CO₂ into the Mount Simon, a reservoir thought to have significant sequestration potential across the Midwest. Monitoring and analysis of testing results continue.

Rough Creek Graben Consortium

A 3-year study of the Cambrian geology and petroleum potential of the Rough Creek Graben region of the southern Illinois Basin was completed in 2010 by **John Hickman**. This study was funded by a consortium of 12 energy companies, the Kentucky Energy and Environment Cabinet, and KGS. A DVD containing electronic copies of the 103-page final report and other project data (with the exception of proprietary seismic profiles) was distributed to the consortium partners.

As part of the terms of the consortium agreement, the final report will be held confidential by KGS for 24 months following the end of the project. In June 2012 the results of the study will become public and will be published by KGS.

State-Owned Lands' Oil and Gas Potential

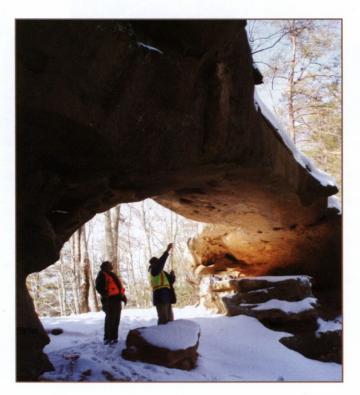
The 2009 regular session of the Kentucky General Assembly called for KGS to collect data on Stateowned lands and assess their oil and gas resources, and Brandon Nuttall led the project to accomplish this. Sarah Briland and Tom Sparks used tract information from several State agencies and universities and integrated the data to the extent possible into a single GIS system to facilitate the assessment. A total of 931 State- and universityowned tracts were assessed, and of those, 758 (81 percent) have no direct indication of oil and gas resources. Oil and gas resources are indicated on 181,074 acres, 54 percent of the assessed acreage. Possible revenue over a 5-year period was projected at \$30.44 million for natural gas producers or \$76.92 million for oil wells by assuming a number of drillable locations, typical success rates, and fixed commodity prices. Actual revenue realized will be a function of acreage made available for resource development, success rate, the mix of oil and gas completions, horizontal and conventional well types, and variations in commodity prices.

Staff in the Geologic Mapping

Section, led by **William Andrews**, coordinates with a number of Federal, State, and local agencies to acquire data, conduct mapping projects and other activities, and to provide technical assistance to local and State agencies. For instance, section staff have provided help to the Jefferson County emergency management agency for the county's natural hazard mitigation planning project.

Mapping staff continued creating new surficial maps with the help of funding from the USGS STATEMAP program. **Mike Murphy**, **Monte Rivers**, and **Matt Crawford** completed a map of the Jackson quadrangle in Breathitt County. **Scott Waninger** and **Ron Counts** mapped the Sturgis and Bordley quadrangles in Union County.

Steve Martin continued his work to measure and map fractures across the state. Since beginning the project, he has added over 1,750 individual features at 95 sites to a database on fractures. This information





Matt Crawford visited this Rowan County landslide that blocked Ky. 801 in May 2010.

is useful for planning transportation projects and for developing natural resources such as water and petroleum. Natural arches and bridges are a laboratory for studying fractures as well. Martin has visited 39 arches and received information on 240 others from other arch enthusiasts.

Matt Crawford continued his project to inventory the numerous landslide locations in the state. He has catalogued a total of 2,146, including locations provided by the Transportation Cabinet and Division of Abandoned Mine Lands. In addition, Monte Rivers worked to digitize a series of older USGS aerial reconnaissance landslide potential maps of eastern and southeastern Kentucky. He has digitized more than 40 of the quadrangle maps.

Bethany Overfield, who now works in the Geologic Mapping Section, continued work on her project to test core samples from Transportation Cabinet project sites for their sonic velocity. The project was nearly complete by the end of the fiscal year.

Drew Andrews and Steve Martin began a project to build a database of subsurface information related to the Paducah Gaseous Diffusion Plant in McCracken County. The information will help create a lithostratigraphic model for a remediation and management plan for the site.

Monte Rivers and Mike Murphy measure Princess Arch as part of Steve Martin's fracture mapping project.

Water Resources Section staff

completed a project funded by the Kentucky Division of Water to sample nutrients and provide field measurements for streams throughout eastern Kentucky. DOW chose 29 sites that would be sampled a total of five times during high- and low-water events. KGS sampled the streams and provided DOW with stream discharge records. The Division of Water will conduct the analysis for this project.

Cane Run Watershed

KGS is working in cooperation with the University of Kentucky's College of Agriculture to monitor the underground conduit through which the Cane Run watershed usually flows from Lexington to Royal Springs, the major water supply for Georgetown, in

and exploratory drilling will be conducted on UK College of Agriculture farm lands in the vicinity of Berea Road and at Main Chance Farm to locate the conduit for monitoring purposes.

Selenium Sampling Analysis

A draft report on the statistical analysis of selenium sampling at 13 surface-water sites in the Eastern Kentucky Coal Field was completed and delivered to the Kentucky Division of Water, which provided funding for the study. Thirty-seven water samples, 25 sediment samples, and 29 fish-tissue samples were collected and analyzed for seven forms of selenium. Sites were selected where selenium concentration in strata were expected to be high, and include active, reclaimed, and abandoned surface coal mines, roadcuts, and undisturbed land. Review of the draft report by



During the KGS annual seminar, Junfeng Zhu set up a demonstration of electrical-resistivity equipment used in the Cane Run watershed and other projects.

Scott County. This watershed is the focus of a U.S. EPA grant to mitigate poor water quality. Electrical-resistivity and spontaneous-potential geophysics were used to help pinpoint the location of the active conduit at the Kentucky Horse Park, where monitoring wells were drilled into the conduit. Water flow and water chemistry will be monitored at this site in the coming year. In addition, further geophysical studies



Jim Currens works on an exploratory well associated with the Cane Run watershed project.



Alex Fogle downloads streamflow data from a cree in the Cane Run watershed, using a handheld computer connected to a data logger in the stream

DOW has been completed and a final report is being prepared.

Cumberland Gap Tunnel

A joint report from the Kentucky Transportation Center, the University of Kentucky, and KGS was written for the Kentucky Transportation Cabinet on the pavement subsidence in the Cumberland Gap Tunnel in southeastern Kentucky. The tunnel carries U.S. 25E under Cumberland Mountain between Kentucky and Tennessee. Conclusions concerning groundwater chemical data and ground penetrating radar readings in the tunnel focused on determining the cause of the subsidence. Continuation funds through 2014 were received to determine the rate at which the roadbase aggregate is being dissolved by the groundwater flow system entering the bottom of the tunnel.

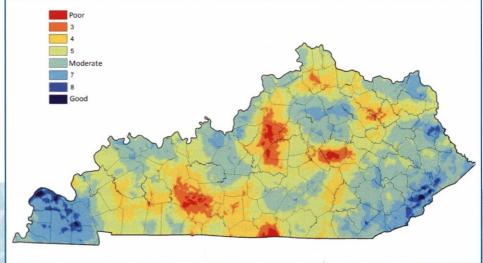
Karst Activities

Work continued on the development of maps depicting the likelihood of occurrence of covercollapse sinkholes. Statistical analyses are being used to link geologic strata to the occurrence of sinkholes and the probability that sinkholes will occur in the future. A paper was submitted on these findings to the Journal of Cave and Karst Studies.

Unregulated Drinking Water Initiative

Water Resources Section staff began work on a new project related to unregulated drinking-water sources. The Centers for Disease Control and Prevention initiated the nationwide project to create a database on water sources, primarily groundwater wells and springs, not covered by the Safe Drinking Water Act. This database will contain water well and water-quality data that can be accessed by researchers and public health professionals to identify and remediate health issues associated with people who drink unregulated water. The CDC used the Kentucky Groundwater Data Repository database framework to assist in designing a data collection tool for the national database.





New Groundwater Resource Maps

Bart Davidson and Alex Fogle began developing a series of new Kentucky groundwater resource maps. They found that the U.S. Geological Survey Hydrologic Atlas series maps for Kentucky, completed in the 1960's, were inaccurate, primarily because of limited water well data at the time. In particular, areas that the "Availability of Groundwater" maps in these series indicated were not considered good sources of groundwater in fact have viable water wells. Those maps were scanned, georeferenced, and compared to water well and digital geologic data, and much more accurate maps are now being generated with GIS. One of the more promising derivative products from this project has been a preliminary "groundwater drilling suitability" map. This map is based on current well data in the Kentucky Groundwater Data Repository, including weighted values of water-well density, groundwater flow from wells at the time of drilling, and static water level. The new atlas will consist of an interactive online Web site featuring numerous groundwater-related maps, in addition to print-on-demand maps.

Water Resources 9

Seismic hazard assessment has

been an important issue for the commonwealth, so it has been the top priority for the Geologic Hazards Section. Economic development in western Kentucky has been affected by extremely high ground motion estimated by the U.S. Geological Survey. For example, the 2008 USGS national hazard maps show ground shaking potential at 408 percent of the acceleration of gravity in the New Madrid Seismic Zone, but only 188 percent of the acceleration of gravity in California.

Earthquakes clearly pose a hazard to Kentucky. But the extremely high ground motion estimates for western Kentucky are not consistent with earthquake science and observations. This inconsistency has also been acknowledged by USGS staff. Studies by KGS have shown that there are problems in the national seismic hazard maps: (1) the methodology (i.e.,

probabilistic seismic hazard analysis) is flawed, (2) some input parameters are not consistent with observations, and (3) there is much confusion about the national hazard maps. The main efforts of the Geologic Hazards Section this fiscal year were to communicate our findings with USGS staff, the Kentucky Congressional delegation, State agencies, and professional and international communities.

The Kentucky Seismic and Strong-Motion Network

Operation and maintainence of the Kentucky Seismic and Strong-Motion Network is one of the section's main tasks. KGS and the University of Kentucky's Department of Earth and Environmental Sciences jointly operate the network of 26 recording stations located throughout the state. The network monitors earthquakes in the central United States

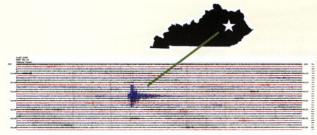
Geologic Hazards in Transportation

The Kentucky Transportation Cabinet spends \$180 to \$240 million annually for highway maintenance of all kinds. Landslide and rockfall costs account for \$4 to \$6.5 million of that total. The cabinet tracks the locations and costs of these maintenance activities in a database, but the format of the location information is not ideal for geospatial analysis. KGS completed the first phase of a 3-year project to develop a computer program to convert the cost data into GIS format so that the geologic context of these costs can be assessed.



This analysis will identify specific areas and routes that have either very high costs or repeated maintenance over time. In either case, knowing the geologic reasons for the hazards is beneficial. In the next phase, field studies will be conducted to characterize the geology of both rocks and soils associated with the problem areas, as well as the geomorphology of the sites. These results will provide the cabinet better predictive tools for future maintenance, as well as criteria for route placement and cut and fill designs.

KGS is helping the state Transportation Cabinet to assess the geologic context of costs related to rockfalls and landslides such as this one in Breathitt County.



Recording of the September 27, 2009, 2.5-magnitude earthquake on an instrument of the Kentucky Seismic and Strong-Motion Network located in Powell County.

and records larger earthquakes around the world, as well as mine blasts and other activities. It includes 19 shortperiod (weak-motion) seismometers and 10 strong-motion accelerometers, including two vertical strong-motion arrays. Continuous near-real time recordings from 12 of

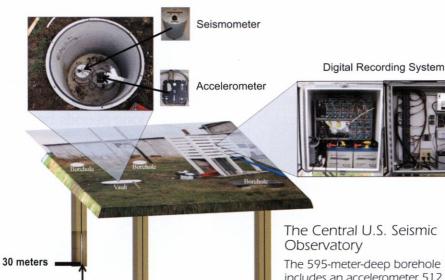
the instruments can be viewed on the KGS Web site at www.uky.edu/KGS/geologichazards/equake3.htm.

For the fiscal year, 23 earthquakes were recorded by strong-motion instrumentation of the network. One earthquake epicenter was located in Kentucky, but this 2.5-magnitude earthquake on September 27, 2009, near Jackson was not powerful enough to be recorded by the strong-motion network. Several hundred earthquakes from around the world were recorded by the more sensitive seismometers of the network.

The Central U.S. Seismic Observatory

Seismic instruments were installed at the Central U.S. Seismic Observatory in Fulton County in late October

> 2009. The observatory consists of three cased boreholes and a surface vault. The deepest borehole was drilled to 1,950 feet through the sediment overburden and into bedrock. A variety of broadband and strong-motion instruments has been placed in the boreholes and at the ground surface. A wireless Internet connection has also been set up.



260 meters

512

595

neters

Accelerometer

The 595-meter-deep borehole includes an accelerometer 512 meters deep and an additional accelerometer and seismometer at the bottom of the hole. Each of the 30- and 260-meter boreholes has an accelerometer at the bottom of the hole, and the surface vault includes a seismometer and accelerometer. A digital recording system for the observatory is housed on the surface at the site as well.



Geologic Hazards Section Head Zhenming Wang works with VLF Designs of Jackson, Mo., to install instruments at CUSSO.

Accelerometer

Seismometer

8. 03 Kypo

he 6-year exchange between KGS and China's Lanzhou Institute of Seismology continued with two visits to the Lanzhou region and exchanges of more scholars. KGS Director **Jim Cobb** led a group from KGS and the University of Kentucky's Department of Earth and Environmental Sciences on a trip to Tianshui in southeastern Gansu Province. Tianshui was a center of early Chinese civilization and has been affected by numerous large earthquakes in the past several thousand years, including the 2008 Wenchuan 8.0-magnitude quake. Geologic Hazards Section Head **Zhenming Wang** and Edward Woolery, associate professor in the Department of Earth and Environmental Sciences. conducted seismic hazard mapping with their Lanzhou counterparts. They also gave talks on

earthquake science and mitigation policy at the Lanzhou Institute and the Institute of Crustal Dynamics in Beijing during the trip.

of Baton Rouge, La., went on one of the trips to do seismic profiles of the Tianshui area for his thesis and to work with Lanzhou researchers and students.

A third scholar from China to visit KGS since the start of the exchange program, **Zhongxia Yuan**, came to KGS for 6 months. Yuan works in the Department of Loess Earthquake Engineering at Lanzhou and has focused his research on soil mechanics and dynamics relating to loess, a porous silt deposited over long periods by wind action.

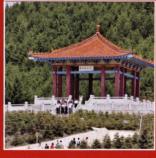
Zhenming Wang, Ed Woolery, and graduate student David Butler work with Chinese researchers during a visit to the Lanzhou region.



















KGS Director Jim Cobb adds comments to the guest book at a seismic office in Ping Liang, Gansu Province.

Director Li of the Longnan seismic office introduces Dr. Cobb to villagers as new homes and schools are built in the earthquake-damaged area. The man shaking Dr. Cobb's hand told him he could not remember any foreign visitors to the area in his more than 80 years.

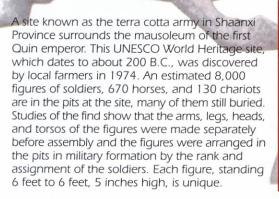




Dr. Cobb toured southern Gansu Province, an area undergoing reconstruction after serious damage in the 2008 Wenchuan earthquake. The improved foundation and structural support columns will help reduce damage in future earthquakes.



Lanmin Wang, director of the Lanzhou Institute of Seismology, poses with KGS Director Jim Cobb, Ed Woolery, and Zhenming Wang, who were recognized by the institute for their contributions to earthquake science and their work to help with recovery in the earthquake-affected areas of Gansu Province.

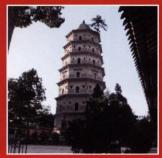














Applying New Technologies in

Kentucky Geoscience was the topic of the 50th KGS annual seminar, held on May 14. An audience of about 120 people heard presentations on a range of technologies, from horizontal drilling of natural gas wells in eastern Kentucky to new seismic instruments in the Central U.S. Seismic Observatory in western Kentucky and the use of light detection and ranging (LiDAR) technology for surficial geologic mapping and landslide research.

The state Board of Registration for Professional

Geologists held an official meeting during the seminar to listen to comments about proposed changes to Kentucky's registration law, including continuing education requirements and an end to registration exemptions for State and local government geologists.

In the afternoon, Junfeng Zhu demonstrated how the Water Resources Section uses electrical-resistivity equipment to detect underground water conduits. The equipment has been used to search for conduits of the Cane Run watershed as it flows from Lexington to Royal Springs, which is Georgetown's main water

supply.

Using videoconference technology, Doug Curl, of the Geoscience Information Management Section, demonstrated recent updates to the KGS Web service from his home office in Washington, D.C.





Displays of rocks and fossils, collections of agate and amber, and demonstrations of carbon dioxide and water issues again drew students from Lexington-area schools, their families, and friends to the annual KGS open house on the evening of October 7. KGS, the Kentucky Paleontological Society, the UK Department of Earth and Environmental Sciences, and others

set up the displays on the first and second floors of the Mining and Mineral Resources

Building. The open house is scheduled each October in conjunction with the national Earth Science Week, which is sponsored by a number of science agencies and professional groups, including the American Geological Institute.









CAER Energy Fair

Steve Greb of the Energy and Minerals Section (above) tells Lexingtonarea students about carbon dioxide during an energy fair sponsored by the Center for Applied Energy Research.

State Fair Rock Collection Judging

Bart Davidson, Steve Greb, and Richard Smath judged rock, mineral, and fossil collections submitted to the 2009 Kentucky State Fair in Louisville. The collections come from elementaryand middle-school-age members of 4-H clubs around the state. KGS staff members have been involved in judging the State Fair rock, mineral, and fossil collections for over 15 years.

Preschool Visitors

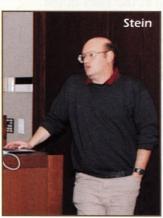
Seen from the second floor of the Mining and Mineral Resources Building,



Geologic Mapping Section Head **William Andrews** introduces a group of Lexington preschoolers to geology and KGS in the building's atrium.

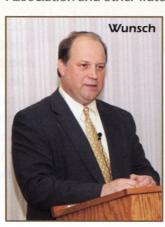
Lectures

On November 4. Seth Stein of Northwestern University spoke to a packed auditorium at the William T. Young Library on "Giant Earthquakes in the Midwest: Hazards, Hype, and Hard Choices." Stein talked about how the perceptions of the risk posed by the New Madrid Seismic Zone have changed in the past few decades. KGS and the University of Kentucky's Department of Earth and **Environmental Sciences**



jointly sponsored the free public presentation.

New Hampshire State Geologist and former KGS researcher **David Wunsch** gave the 2010 Donald C. Haney Distinguished Lecture on the evening of April 7. Wunsch worked for 15 years in the KGS Water Resources Section. His topic for the Haney Distinguished Lecture was the need for a national groundwater monitoring network. He is active with the National Ground Water Association and other water-



related organizations involved in water resources and policies. Wunsch also spoke the following afternoon at a brown-bag lunch seminar on the 2003 collapse of New Hampshire's iconic "Old Man of the Mountain" granite formation.

KGS worked with professional geological societies in the state and other universities to sponsor two speakers in the AAPG Distinguished Lecture series.

Tony Simo, a research

associate with ExxonMobil Upstream Research in Houston, spoke in February about his work on isolated carbonate platforms and mounds, in an effort to build better models for petroleum exploration and development. Martin Perlmutter, who works for Chevron, spoke in March about understanding ancient long-term climate variability and its effect on expectations for future climate changes.





ENDERSON

The KGS office in

Henderson provides geologic research in that region of the state and offers companies, government agencies, and private citizens a source of geologic information.

Staff in the Henderson office provided descriptions for cores supplied by coal companies and visited geologic exposures to collect information. They were contacted regularly to answer questions about minerals, coal and oil, meteorites, and fossils.

Office Manager **Dave Williams** served as co-principal investigator on the Hancock County carbonstorage test project and coordinated with the owner of the project site and the contractors who provided project services.

Henderson staff also document-

ed numerous rockfalls along Kentucky parkways in the western part of the state during the fiscal year. **Scott Waninger** and **Ron Counts** spent time in the field examining exposures in streams and rivers, for both mapping and paleoseismic research. They also mapped the Sturgis and Bordley quadrangles in Union County as part of the ongoing KGS mapping project funded by the USGS STATEMAP program.

Counts collaborated with other agencies and universities on several projects, including investigating an Ohio River archeological site, studying the Eastern Tennessee Seismic Zone, and researching soil-landscape relationships.

Glynn Beck continued working on water studies with the University of Kentucky College of Public Health in western Kentucky to research possible links between contaminants in well water and the health of people who drink the water. About 39 percent of 551 households responded to a survey mailed early in 2009. Survey data are currently being compiled, and interpreta-tions should be completed by the end of 2010. Beck also contributed



Henderson Office Manager Dave Williams investigates a large rockfall along the Western Kentucky Parkway in Hopkins County.

to a Web site on Kentucky well education hosted by the UK College of Agriculture. The Web site contains information on types and construction of wells and advice on resolving problems with them. It can be found at www.ca.uky.edu/downwell.

Beck also worked with **Kathy Takacs** of the Energy and Minerals
Section on shallow groundwater
monitoring at the sites of the
Hancock County carbon storage
research project and the enhanced
oil recovery project at Sugar Creek
in Hopkins County. The water
samples they collected will help
characterize the local water quality
and assess any changes in quality
that may be associated with CO₂
injection.



Glynn Beck (foreground) and Kathy Takacs prepare to take water samples at an enhanced oil recovery research site in Hopkins County.

LBRAR

The KGS Well Sample and

Core Library was built in 1996, and has 48,000 square feet of space to house its holdings, which KGS is required to collect and make available to researchers, industries, and the general public. The core sample racks in the warehouse are

Ryan Pinkston processes samples at the Well addition, 1,750 Sample and Core Library.

completely filled with 71,940 boxes of core obtained from 1,552 locations throughout Kentucky. There are also 18,349 well cuttings stored in 32,545 boxes on pallet racking. In addition, 1,750 cores stored in

wooden crates and cardboard boxes are stacked on 494 pallets.

Geoscience data are extremely valuable to

industry, research, and in education and training at all levels. Preservation of these data affects the economy through new discoveries, redevelopment of mature areas. sustained economic growth, and increased tax revenues. It allows intelligent planning decisions, better management of natural resources. and solutions to scientific. economic, and environmental issues and better prediction of natural disasters.

In an effort to eliminate errors, the facility's staff has inventoried the entire

collection again and added information to the user-friendly online database. Preservation efforts, storage methods, cataloging, and retrieval of materials in the collection were reviewed and improvements were implemented, including better document management.

More than 165,000 feet of cores and well cuttings were examined by visitors to the Well Sample and Core Library during the fiscal year. Two hundred eighty well samples and cores were added to the library, for a total of more than 910,000 feet. Over 400 telephone and e-mail requests for information were answered. A cooperative arrangement was set up with the nearby Kentucky Horse Park for mutual assistance. The horse park has provided staff to help rearrange materials and create space, and the core library has allowed the horse park to temporarily store exhibit packaging. These proactive efforts achieved greater visibility for the library and its preservation efforts.

More than 100,000 boxes of cores, cuttings, and samples are stored at the Well Sample and Core Library.



AB

The KGS laboratory

provides analytical services to researchers at KGS and other departments of the University of Kentucky, as well as agencies of State government and the Lexington-Fayette Urban County Government.

During the fiscal year, the lab analyzed a total of 864 samples:

- 604 water samples
- 183 mineral and rock samples
- 77 coal samples

The laboratory continued to analyze water samples for the Hancock County deep carbon storage test well drilled in 2009, as well as water samples taken from the enhanced oil recovery project in Hopkins County (Sugar Creek) and the newer Henderson County (Euterpe) site. The Energy and Minerals Section oversees those projects.

Laboratory staff also analyzed samples from the Cumberland Gap Tunnel project for the Water Resources Section.

The Kentucky Water Watch program that monitors the quality of the state's streams, rivers, lakes, and wetlands continued to send samples to the KGS laboratory for analysis.

Metal analysis was done on samples taken for the McConnell Springs Storm Water Structure Effectiveness Monitoring Project, administered by the local government in Lexington.

Several instruments were added to the laboratory:

- A new automated titrator for analyzing water samples for both alkalinity and acidity.
- A total organic carbon combustion analyzer with a total nitrogen analyzer attachment. This new TOC analyzer was chosen to aid in the analysis of the high-salinity brine samples from the KGS carbon storage and enhanced oil recovery projects.

The laboratory also oversees the maintenance and scheduling



Steve Mock uses the laboratory's ion chromatography system, which analyzes water samples from a variety of projects, including the Water Watch program samples from around Kentucky.

of the X-ray diffraction instrument. University of Kentucky students from many disciplines use the instrument for a wide variety of projects in such disciplines as geology, agriculture, and materials and chemical engineering. Graduate students in the Department of Mechanical Engineering, for instance, work on high-temperature and magnetic shape memory alloys.



Andrea Conner works with one of the new instruments in the KGS laboratory, a total organic carbon combustion analyzer, used to analyze water samples from carbon storage and enhanced oil recovery projects by the Energy and Minerals Section.

PUBS

At the end of

calendar year 2009, the KGS online publications catalog contained over 7,000 reports and maps relating to Kentucky geology. Of these, 4,408 are available for free download from the KGS Web site. There were 11 new additions during the fiscal year, bringing the total number of publications for the 12th Geological Survey to 1,194.

A new geologic map of
Kentucky at the scale of 1:350,000
was produced using statewide
1:24,000-scale GIS data. This map
was the culmination of the Digital
Mapping Program that digitized all
the state's geologic quadrangle
maps. Staff members of the Energy
and Minerals Section compiled a
comprehensive report on the

status of carbon sequestration research in Kentucky. This 244-page report will benefit policymakers, industry stakeholders, and the general public.

Brandon Nuttall published the

findings of a research project to assess the value of oil and gas resources on State-owned lands. A research report about the effects of agricultural practices on groundwater quality was authored by **Glynn Beck** and colleagues.

Six new river basin maps were added to the series that was

initiated last year to provide topographic and hydrologic base information for Kentucky's stream

basins. New maps were also added to the karst groundwater basin series and the 1:100,000-scale geologic map series.

Web Services

In fiscal year 2009-10, more than 200,000 database searches were conducted by over 100,000 users. Map services were used

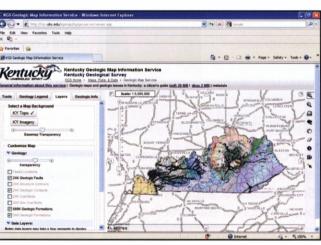
resulted in about 12,500 tabular data downloads during the year and close to 1.5 million file down-loads, such as files associated

with the large collection of oil and gas records available at the KGS Web site. The most frequently used services are for oil and gas information, online publications,

Carter coordinate conversion, and the online geologic map site.

KGS is recognized internationally for the quality and scope of its online geologic mapping and data dissemination. This year, new Web services were added that allow users to imbed the KGS data in other mapping software such as

ArcGIS Explorer, Google Earth, or other open-source mapping applications without having to



The new online Quick Map Viewer, which redraws the selected view and searches for areas of interest quickly, is versatile for browsing Kentucky's geology.

download any data. This provides unprecedented access to real-time geologic information. KGS also implemented new ESRI ArcGIS Server software for its signature geologic mapping service. The new service is called Quick Map Viewer because it has extremely fast redraw speeds and equally fast geographic search functions for finding areas of interest. These features make the new map service ideal for browsing the state's geology. The original geologic map service is still available, and continues to provide more features for customization and data inquiry than Quick Map.

Dan Carey received a Soil and Water Conservation Society Honor

Award for his presentation, "The Use of Geology and Geology-Related Land Use" at the GIS workshop in December 2009.



Jim Cobb was elected president of the Association of American State Geologists, the professional organization of state geologists. It

works to promote and advance the science and application of geology and related earth sciences.



Retired Energy and Minerals Section Head Jim Drahovzal was appointed special issues editor for

Environmental Geosciences Journal, published by the American Association of Petroleum Geologists.



Patrick Gooding was elected secretary/editor of the American Association of Petroleum Geologists House of Delegates for the 2010-11 term. He was also elected secretary/treasurer of the Kentucky Society of Professional

Geologists for 2010-13. He served on the Preservation of Geoscience Data Committee of the American Association of

Petroleum Geologists and the Credentials Committee of the AAPG House of Delegates.

Dave Harris served as the Eastern

Section representative on the American Association of Petroleum Geologists' Advisory Council.



Retired Assistant State Geologist John Kiefer was honored by the

Kentucky Society of Professional Geologists with its Distinguished Career Award. Kiefer retired in June 2009 after 30 years at KGS.



Jonathan McIntyre served as the treasurer/ secretary of the Ohio River Valley Section of the Association of



Environmental & Engineering Geologists and on the national AEG Governance Committee.

Steve Mock was elected treasurer of the University of Kentucky Staff Senate and chaired the Staff Issues Committee. He was also appointed

university's committee on employee benefits and its subcommittee on



retiree benefits.

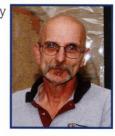
Meg Smath was elected vice president of the Association of Earth Science Editors for 2010. The duties of the position include serving as program chair for AESE's

annual meeting. The vice president automatically becomes president the following year.



Richard Smath was elected for a 1-year term as president of the

Kentucky Society of Professional Geologists in January 2010. KSPG has 203 members.



State Geologist's Office

Cobb, Jim

Geologist / State Director

Weisenfluh, Jerry

Associate Director

Haney, Don

State Geologist Emeritus

Hower, Judy

Temporary Technician

Administrative Section

Silvers, Jackie

Administrative Staff Officer II

Long, Mandy

Administrative Support Associate I

Phillips, Gwen

Staff Support Associate II

Graening, Kati

Student Worker

Energy and Minerals Section

Harris, Dave.

Section Head

Anderson, Warren

Geologist V

Bowersox, Rick

Geologist IV

Eble, Cortland

Geologist V

Greb, Steve

Geologist V

Hickman, John

Geologist IV

Nuttall, Brandon

Geologist V

Parris, Marty

Geologist V

Schumacher, Anne

Student Worker

Solis, Mike

Geologist I

Takacs, Kathy

Geologist I

Webb, Donna

Temporary Technician

Geologic Hazards Section

Wang, Zhenming **Section Head**

Ditty, Melissa

Student Worker

McIntyre, Jonathan

Geologist IV

Woolerv. Ed

Temporary Professional

Geoscience Information **Management Section**

Cordiviola, Steve **Section Head**

Adams, Elizabeth Student Worker Banks, Roger

Stores Supervisor

Briland, Sarah

Sr. Geological Technician

Curl, Doug

Geologist III

Ellis, Mike

Computer Support Specialist II

Farwell, Mike

Student Worker

Livingood, Steve

Student Worker

Pulliam, Carrie

Geologist II

Sergeant, Rick

Geologist IV

Smath, Richard

Geologist III

Sparks, Tom

Geologist III

Spaulding, Dan

Student Worker

Thompson, Mark

Information Technology Manager I

Ullande, Joe

Temporary Technician

Wang, Rebecca

IS Technology Support Spec. III

Watson, Anna

Geologist II

Communications and Outreach

Weisenfluh, Jerry

Section Head / Associate Director

Anness, Philip

Student Worker

Carey, Dan

Geologist V

Combs, Megan

Student Worker

Fedorchuk, Nick

Temporary Technician

Hounshell, Terry

Chief Cartographic Illustrator

Lynch, Mike

Technology Transfer Officer

Paschall, Tony

Student Worker

Rulo, Collie

Senior Graphic Design Technician

Smath, Meg

Geologist III

Geologic Mapping Section

Andrews, William **Section Head**

Crawford, Matt

Geologist III

Eastridge, Emily

Martin, Steve

Geologist III

Murphy, Mike

Geologist II

Overfield, Bethany

Geologist II

Rivers, Monte

Geologist I

Tripathi, Ganesh

Student Worker

Laboratory Services

Backus, Iason

Scientist II / Laboratory Manager

Conner, Andrea

Scientist I

Francis. Henry

Temporary Technician

Mock, Steve

Scientist I

Water Resources Section

Dinger, Jim

Section Head Currens, Iim

Geologist V

Davidson, Bart

Geologist IV Fogle, Alex

Geologist III

Paylor, Randy

Geologist II

Webb. Steve Geologist II

Zhu, Junfeng

Geologist V

Well Sample and Core Library

Gooding, Patrick

Geologist IV / Manager

Daniel, Ray Principal Research Analyst

Pinkston, Ryan

Research Analyst

Western Kentucky Office at Henderson

Williams, Dave

Section Head

Beck, Glynn

Geologist IV (Water Resources Section)

Berdine, Jane Staff Support Associate I

Counts, Ron

Geologist III (Geologic Mapping Section)

Fest, Kaitlin Student Worker

Waninger, Scott

Geologist I (Geologic Mapping Section)

Wedding, Dan

Temporary Technician

Student Worker

ROJECT

Fiscal Year 2009-10

Energy

Carbon Management

Assessment of Geological Carbon Sequestration Options in the Illinois Basin (Participation in Midwest Geological Sequestration Consortium)

Projects:

Phase II MGSC Regional Partnership Research (FY 2009-10) \$191,308 (TOTAL) \$689,713. Funding Source: U.S. Department of Energy through Illinois State Geological Survey Ending 9/30/2010

Phase III MGSC Regional Partnership Research (FY 2009-10) \$35,581 (TOTAL) \$106,741. Funding Source: U.S. Department of Energy Ending 2/28/2010

Sugar Creek Monitoring (FY 2009-10) \$56,703. (TOTAL) \$111,866.00. Funding Source: U.S. Department of Energy through Illinois State Geological Survey Ending 9/30/2010

CO₂ Sequestration and Enhanced Oil and Gas Recovery Using CO₂ (House Bill 1) Projects:

Carbon Storage Demonstration Projects (FY 2009-10) \$1,250,000 (TOTAL) \$5,000,000. Funding Source: Governor's Office of Energy Policy Ending 6/30/2011

Precambrian Core and Analysis, KGS No. 1 Blan Well, Hancock Co., Ky. (FY 2009-10) \$270,000 (TOTAL) \$298,452. Funding Source: U.S. Department of Energy Ending 9/30/2010

Southeast Regional Carbon Sequestration Partnership Phase 2

Total amount of grants and contracts awarded:

KGS: \$2,615,668

Federal: \$1,067,250

State: \$1,482,047

University: \$66,371

Projects:

Subsurface Correlations of Deep Coals in South-eastern Kentucky and Analysis of Virginia's Coal CO₂ Test (FY 2009-10) \$6,000 (TOTAL) \$66,000. Funding Source: U.S. Department of Energy through Virginia Tech; subcontract to KGS Ending 9/30/2009

Regional Analysis of Deep Devonian Shale and Deep Big Lime Oil Fields (FY 2009-10) \$25,000 (TOTAL) \$50,000 Funding Source: U.S. Department of Energy through Marshall Miller, subcontract to KGS. Ending 11/30/2010.

Mount Simon Simulation Framework Research Group

Simulation Framework for Regional Geologic CO₂ Infrastructure along the Arches Province of the Midwest (FY 2009-10) \$47,727 (TOTAL) \$150,000. Funding Source: U.S. Department of Energy through Battelle Memorial Institute, subcontract to KGS Ending 11/5/2010

Midwest Regional Carbon Sequestration Partnership Phase 2

Regional Characterization of Potential CO₂ Reservoirs and Seals in Eastern Kentucky (FY 2009-10) No-cost extension (TOTAL) \$283,232. Funding Source: U.S. Department of Energy through Battelle Memorial Institute, subcontract to KGS.

Geologic Information

Coal Information

Compilation of Coal Data for the National Coal Resources Data System

FY 05-10 (FY 2009-10) \$15,000 (TOTAL) \$75,000. Funding Source: U.S. Geological Survey Ending 6/30/2010

Creating a Web-Based Energy Infrastructure Map

Full Award (FY 2009-10) \$87,047 (TOTAL) \$87,047. Funding Source: Kentucky Office of Energy Policy Ending 6/30/2010

Data Dissemination

Cataloging Kentucky Geologic Data Sites for the National Geologic and Geophysical Data Preservation Program

Continuing Grant Program (FY 2009-10) \$15,195 (TOTAL) \$70,102. Funding Source: U.S. Geological Survey Ending 8/31/2011

Geotechnical Information

Analysis of the Geologic Context of Transportation Maintenance Costs

Three-year project (FY 2009-10) \$50,000 (TOTAL) \$150,000. Funding Source: Kentucky Transportation Cabinet Ending 6/30/2012

Geology

Geologic Mapping

Analysis of Subsurface Data to Characterize the Lithostratigraphy of the Paducah Gaseous Diffusion Plant Property

Borehole Compilation (FY 2009-10) \$9,865 (TOTAL) \$39,459. Funding Source: U.S. Department of Energy through Center for Applied Energy Research Ending 9/30/2010

Producing Quaternary and Surficial Geological Mapping for Multiple Applications in Kentucky

Multiple-Quadrangle mapping (FY 2009-10) \$208,267 (TOTAL) \$844,515. Funding Source: U.S. Geological Survey STATEMAP program. Ending 6/30/2010

Hazards

Seismic Monitoring

Installation of Subsurface Seismic Array for Measuring Earthquake Wave Attenuation in the Central U.S. (Central U.S. Seismic Observatory)

Phase II CUSSO Maintenance (FY 2009-10) \$67,609 (TOTAL) \$155,490. Funding Source: U.S. Department of Energy through Center for Applied Energy Research Ending 9/30/2010

Phase II CUSSO Installation (FY 2009-10) \$55,800 (TOTAL) \$55,800. Funding Source: U.S. Geological Survey Ending 1/31/2010

Gathering, Processing, and Dissemination of Seismic-Instrument Data to the Mid-American Integrated Seismic Network

Phase II (FY 2009-10) \$36,058 (TOTAL) \$108,175. Funding Source: U.S. Geological Survey Ending 1/31/2010

Water Resources

Groundwater Monitoring

Groundwater Modeling at the Paducah Gaseous Diffusion Plant

Review of Existing Model Results. (FY 2009-10) \$15,312 (TOTAL) \$61,247. Funding Source: U.S. Department of Energy through Center for Applied Energy Research Ending 12/31/2010

Kentucky Geological Survey Organizational Chart 2010

State Geologist and Director

James Cobb

Administration

Jackie Silvers

- Fiscal Management
- Human Resources
- · Grants and Contracts
- · Purchasing
- · Equipment Inventory

RESEARCH

Energy and Minerals

Dave Harris

- · Carbon Management
- · Oil and Gas Resources
- Coal Resources
- Subsurface Geology
- Mineral Resources
- · Oil and Gas Data Repository (mandated)

Geologic Hazards

Zhenming Wang

- · Seismic and Strong-Motion Network (mandated)
- Seismic Hazard and Risk Assessment
- · Near-Surface Geophysical Exploration

Geologic Mapping

William Andrews

- · Surficial and Geologic Mapping
- · Landslide Analysis
- · Fracture Mapping
- · Materials Characterization

Water Resources

James Dinger

- Groundwater Data Repository (mandated)
- · Groundwater Monitoring Network (mandated)
- Karst Hydrogeology
- Groundwater Resources
- · Watershed Hydrology
- · Water Quality and Human Health

Associate Director

Jerry Weisenfluh

SERVICE

Communication and Outreach

Jerry Weisenfluh

- Newsletter
- Annual Report
- Media Contacts
- Public Outreach
- Publications

Laboratory Services

Jason Backus

- · Fluid Analyses
- Rock Analyses
- Mineral Analyses

Well Sample and Core Library

Patrick Gooding

- Core
- · Oil and Gas Cuttings
- · Geologic Samples

Geoscience Information Management

Steve Cordiviola

- Databases
- · Computer and Network Services
- Web Services
- · Scanning and Archival Services

Western Kentucky Office

David Williams

· Serve the western Kentucky region