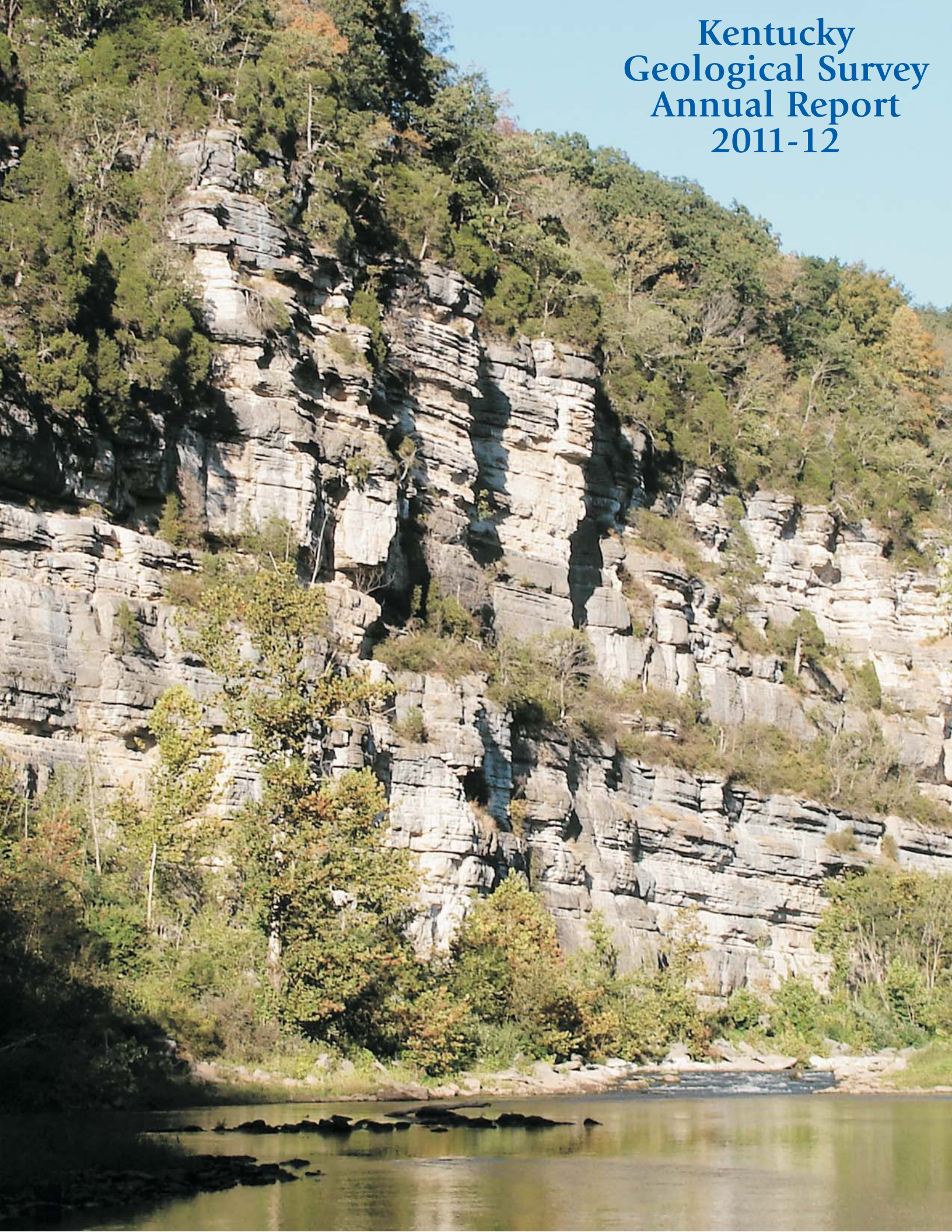
Kentucky Geological Survey Annual Report 2011-12



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

Dix River Palisades
by John K. Hiett of the UK Center for Applied Energy Research

A 240-foot-high cliff in the High Bridge Group,
Camp Nelson Limestone, looking upstream on the Dix River.
The location is in the Wilmore quadrangle of Garrard County
in the tailwater just below Herrington Lake dam.
This 3/4-mile stretch of water is the only remaining
naturally flowing section of the lower Dix River.

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Kentucky Geological Survey

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Contents

Director's Letter

The mission of the Kentucky Geological Survey is to investigate the commonwealth's geology, mineral resources, groundwater, and hazards, and report on them to the public. This report is prepared each fiscal year to inform the public about the Survey's activities in support of that mission. Investigations in 2011-12 were aided by 17 projects funded by $1.4 million in grants. Much of the resulting information was distributed via the KGS Web site, which continues to be a valuable tool used by many people in business, industry, and government, as well as private citizens and landowners. During the fiscal year, nearly 395,000 database searches were made online for oil and gas, coal, and water data, resulting in more than 8,000 downloads. These data were viewed on interactive Web maps, especially our signature interactive geologic map. An average of 450 users access our data at www.uky.edu/KGS each weekday. The KGS Web site is one of the University's most active information providers.

In addition, our western Kentucky office and Well Sample and Core Library provide information and samples to government agencies, researchers, professional geologists, faculty, and students. The Well Sample and Core Library acquired 105 new well samples and cores in 2011-12.

KGS celebrated a major achievement in geologic mapping this fiscal year when all 26 maps in the 30 X 60 minute geologic map series were completed and made available to the public. A formal unveiling ceremony of a new geologic map of Kentucky, 10 feet high by 23 feet wide, was held on December 1, 2011. UK President Eli Capilouto, Kentucky Energy and Environment Secretary Len Peters, and USGS Associate Director Suzette Kimball were present to help celebrate this achievement. A symposium, Celebrating Geologic Mapping for Science and Society, was held after the unveiling with participants from other state surveys, academia, the U.S. Geological Survey, and KGS. The contributions of the National Cooperative Geologic Mapping Program of the U.S. Geological Survey were significant for the completion of this series.

KGS has benefitted a great deal from international partnerships. In November 2011, KGS and the Earthquake Administration of Fujian Province, China, became partners in seismic research. This is in addition to existing partnerships with the Lanzhou Institute of Seismology and Beijing University. These partnerships have brought 18 visiting scholars and students to UK, and several joint investigations have been completed or are in progress.

KGS reaffirmed its mission to the Commonwealth of Kentucky by emphasizing four important areas: scientific investigations, publications, engagement with other UK departments, and database building.

- Scientific investigations are the foundation for all of our research and public service activities. They bring new information and interpretations to KGS and the commonwealth.
- Publications are the most obvious evidence of scientific achievement and are necessary for the dissemination of new information and building a lasting legacy.
- KGS has long partnered with the UK Colleges of Arts and Sciences, Agriculture, and Engineering. In this way, KGS is

increasing its engagement with both faculty and students.

• Building databases and preserving and disseminating data are vital functions of KGS. The capture and preservation of re search data in useful formats are ever-present challenges. The National Geologic and Geophysical Data Preservation Act was passed by Congress in 2008, and KGS is a participant. We also place a high priority on properly handling all research data generated by KGS.

KGS helps promote geology by assisting organizations that contribute to the science and application of geology. KGS hosted or cohosted meetings for several organizations in Kentucky: the 62nd annual Highway Geology Symposium, 45th annual Palynological Society meeting, ASBOG Board of Examiners meeting, and the 56th Midwest Groundwater Symposium. Nearly 1,000 people participated in these events.

On the national level, resource issues and geology have often been in the news during the year. Shale gas exploration and production were especially controversial in the eastern United States. The technology of hydrofracturing, or fracking, in order to produce gas has been in the news because of fears about groundwater contamination.

Also, the disposal of wastewater from gas wells brought the public's attention to the deeper subsurface. Disposal wells, often drilled in excess of 5,000 feet below the surface, have been reported to cause earthquakes in some states (this has not been reported in Kentucky). These earthquakes, although small in magnitude, have concerned the public and the media.

A number of scientific groups have studied these practices.

Energy, and the technologies and practices to produce fossil fuel in particular, are a political issue; therefore, the science surrounding them is very much in the public eye.

Because this is a presidential election year, the resulting complex political environment, together with unprecedented changes taking place in the energy sector as a result of regulatory, market, and technological conditions, will create challenges for KGS going forward. We will need to be prepared to respond to these research needs as they arise. The data that KGS collects, whether they are seismic data from our network or other hazards data, subsurface geologic data from research projects, or groundwater data from the Kentucky Groundwater Monitoring Network, are all relevant to the issues and concerns of society.

I hope this annual report informs you about the research and public engagement conducted by KGS during the year. Please let us know if you have any questions or comments.

The importance of energy resources is reflected in the activities and projects of the KGS Energy and Minerals Section, including coal, enhanced oil and gas recovery, and carbon storage research.

Kentucky House Bill 1 Carbon Storage Demonstrations

CO_2 Enhanced Oil Recovery and Sequestration

The final report for the pilot project on enhanced oil recovery and CO_2 storage at Sugar Creek was completed and submitted in March 2012 to the U.S. Department of Energy for review. The project in Hopkins County was part of the DOE Phase II regional partnership pilot program for the Midwest Geological Sequestration Consortium. The consortium is headed by the Illinois State Geological Survey and also includes the state surveys of Kentucky and Indiana.

The overarching goals of the project were to assess the potential for enhanced oil recovery and CO_2 storage through immiscible flooding in mature oil fields in the Illinois Basin. For approximately 1 year (May 13, 2009–May 26, 2010), 7,230 tons of CO_2 were nearly continuously injected (20 to 30 tons per day) into the Mississippian Jackson Sandstone oil reservoir at Sugar Creek Field. Following CO_2 injection, the field was returned to a waterflood. KGS researchers **Glenn Beck, Kathryn Takacs, Daniel Wedding,** and **Marty Parris** led the effort to monitor the chemistry of brine and wellhead gas coproduced with the oil in order to track the fate of CO_2 and to evaluate geochemical interactions in the reservoir. The chemistry of the shallow groundwater aquifer was also monitored to ensure that groundwater resources were not affected by the project (see Water Resources Section report).

Monitoring through September 2011 shows that an estimated 16 percent of the injected CO_2 was produced back to the surface, suggesting that 84 percent (6,073 tons) of the CO_2 still resided in the reservoir. Enhanced oil recovery was estimated at 2,700 to 3,200 barrels of oil. Based on these results, the Illinois Survey constructed a reservoir model for full-field injection of CO_2 for 20 years. The results suggest that approximately 5.5 percent (174,000 stock tank barrels) of the remaining oil in the Jackson Sandstone reservoir at Sugar Creek could be recovered. The amount of CO_2 needed to attain the additional oil would be 880 standard cubic feet of CO_2 per barrel of oil.

Devonian Shale Enhanced Gas Recovery Demonstration Using CO_2

A project headed by **Brandon Nuttall** is under way in Johnson County to test the hypothesis that Devonian black shales beneath about two-thirds of Kentucky may serve for long-term CO_2 storage and play a role in enhanced natural gas recovery. A transient pressure test, which measures flow rates and pressures under a variety of conditions to acquire reservoir data, was scheduled for September 2012. In addition to

The Johnson County site of the Devonian shale enhanced gas recovery project was prepared in June 2012.

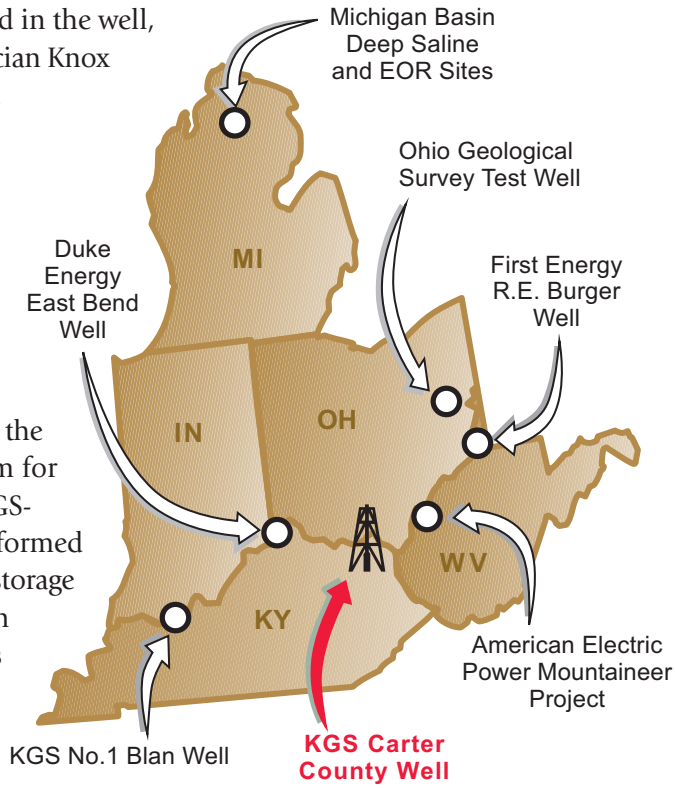
funding from House Bill 1(2007), support for this project has been secured from the U.S. Department of Energy through a contract with Advanced Resources International to provide engineering data analysis and simulation.

Eastern Kentucky Coal Field Deep Saline Injection Well

KGS chose a site to drill a 4,800–foot-deep stratigraphic research well in the Eastern Kentucky Coal Field. This project is part of the carbon dioxide storage research funded by Kentucky House Bill 1, which also funded part of the cost of a research well in Hancock County in 2009. KGS has partnered with Hanson Aggregates for access to property at their AA Limestone Quarry, in northern Carter County. Hanson Aggregates is a subsidiary of Lehigh Hanson Inc., which is part of the HeidelbergCement Group, one of the largest building materials manufacturers worldwide.

After a lengthy technical review by **Steve Greb, Rick Bowersox, Dave Harris,** and **Warren Anderson**, the site was chosen based on both its location and subsurface geology. The area has several geologic formations with suitable porosity at depths required for CO_2 storage. Because of budget constraints, CO_2 will not be injected in the Carter County well. It will provide important data on northeastern Kentucky and southeastern Ohio.

The well will be drilled as a research project, with no plans for commercial CO_2 storage, to gather data needed to evaluate CO_2 storage options along the Ohio River industrial corridor. KGS will obtain rock cores, geophysical well logs, and water samples, and test the reservoir and rock strength properties of several formations penetrated in the well, including the Ordovician Knox Group and Rose Run Sandstone and the Cambrian Mount Simon Sandstone. The depth of these zones ranges from 3,000 to 4,700 feet. Like the Hancock County project, this project is managed by the Kentucky Consortium for Carbon Storage, a KGS-industry partnership formed to carry out the CO_2-storage research mandated in House Bill 1. Progress and results of this research can be obtained by visiting the consortium Web site, www.kyccs.org.



The location of the Carter County deep storage test well will help fill in gaps in the data gathered so far on deep carbon storage in the eastern United States.

Evaluating Deep CO_2 Storage in the Illinois and Michigan Basins

Begun in 2010, this U.S. Department of Energy-funded 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 is characterizing the carbon-sequestration potential of the Cambrian-Ordovician Knox Group and Ordovician St. Peter Sandstone in the Midwest. KGS is characterizing the Knox Group in western Kentucky, a potentially important subsurface formation for storage of CO_2. Progress this year was:

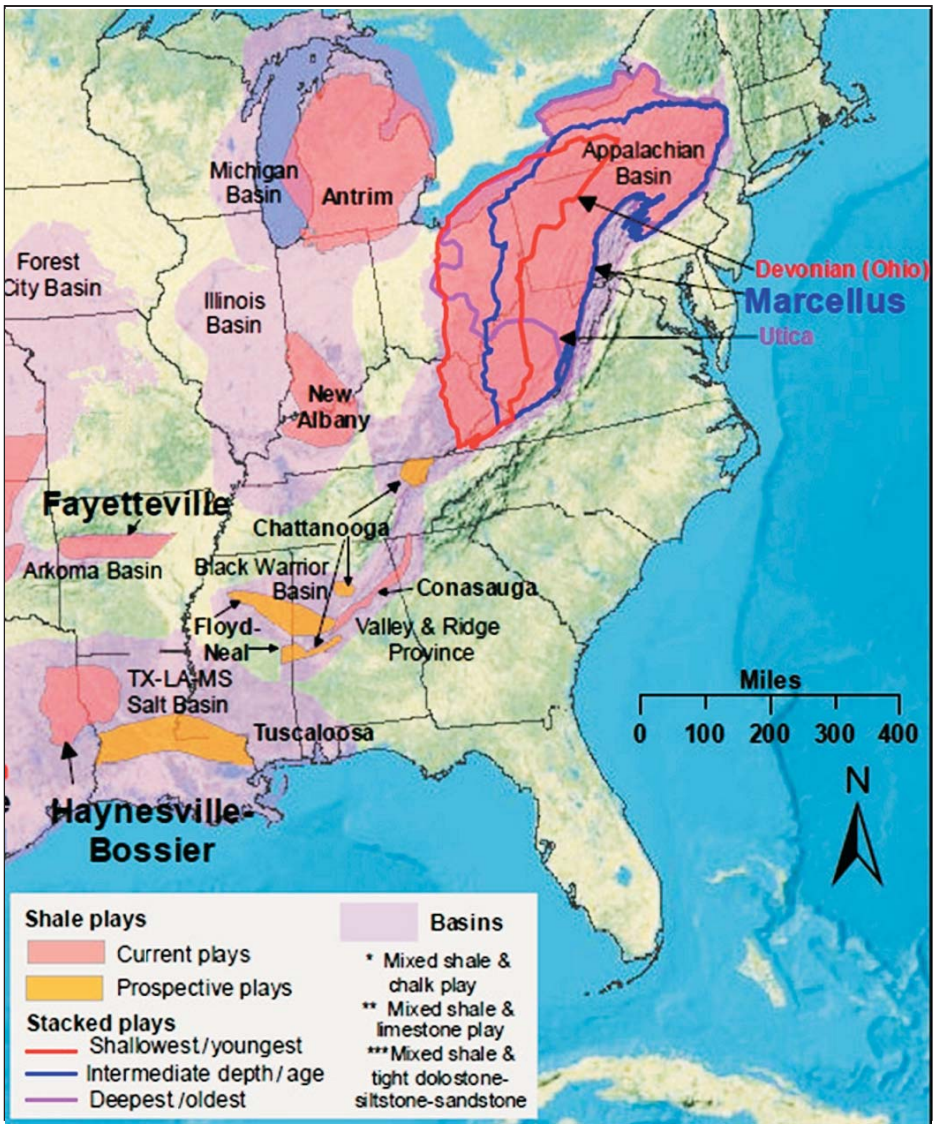
- Documentation of phase II CO_2 injection testing and 3D vertical seismic profile imaging at the KGS No. 1 Blan well (**Rick Bowersox** and **John Hickman**). Reports are in final draft and will be submitted to DOE later in 2012.
- Continuation of Knox core description and interpretation, with the addition of several new cores (**Dave Harris**). The Energy and Minerals Section presented a core workshop at the KGS annual seminar in May that showcased all of the cores obtained in the KGS Blan well. Thin-section petrography of Knox core samples to document porosity types and diagenetic processes is also ongoing.
- Development of geochemical models to predict interactions among supercritical carbon dioxide, brines, and the minerals making up the Knox carbonate reservoir and seal rocks (**Marty Parris** and **Junfeng Zhu**).

Geochemical modeling of the injected CO_2-brine-reservoir rock system was completed for the KGS Blan well by **Junfeng Zhu**, and a manuscript was written. Marty Parris continued work with Sienna Geodynamics Inc. on reactive transport modeling, with the goal of predicting reactions between CO_2-saturated brines and confining zones (shale or nonporous carbonates).

Evaluation of Heavy Oil and Tar Sand Resources, Western Kentucky

In response to the worldwide interest in developing heavy oil, **Rick Bowersox** initiated a project in mid-2011 to reevaluate western Kentucky tar sands resources. These tar sands are a belt of heavy oil- and bitumen-saturated sandstones of Late Mississippian and Early Pennsylvanian age, primarily in Logan, Butler, Webster, Edmonson, and Grayson Counties. Tar springs occurring along outcrops of these sandstones were exploited by settlers in the region as early as the mid-19th century, and these deposits have been mined for use as road asphalt since the early 20th century. Shallow wells (less than 600 feet deep) drilled into the tar sands have very low, noncommercial production of tarry oil.

Although estimates of in-place oil resources accessible by surface mining were reported in 1984 to exceed 3 billion barrels, large-scale commercial development of liquid oil has yet to be achieved. The last tests, in the early 1980's, of surface-mining processes and thermally enhanced oil recovery from wells had limited technical success and were halted by developers because of low oil prices and the difficulty in refining the low-quality



The extent of shale oil and gas source rocks in the eastern United States, including Utica shales, is outlined in this map, modified from the Energy Information Agency's map showing gas plays in the lower 48 states.

produced oil. Recent higher world oil prices have encouraged oil companies to reevaluate and develop commercial production from tar sands. Independent operators have been actively leasing properties in the western Kentucky tar sands belt, and projects are being planned to test new methods for extracting the heavy oil and bitumen. The KGS evaluation in progress will improve the estimate of heavy oil resources of western Kentucky by applying new models of deposition and distribution of sands in the region, evaluating modern heavy-oil recovery techniques, and considering the environmental impacts that may arise from commercial development.

Utica Shale Appalachian Basin Exploration Consortium

Over the last few years, oil and gas production from organic-rich shale units (Ohio, Marcellus, Bakken, Barnett, Haynesville, and others) has become a major component of onshore energy exploration in the United States. One such unit in the Appalachian Basin is the relatively

unexplored Upper Ordovician Utica Shale. Wells are currently producing from the Utica in eastern Ohio and western Pennsylvania, but Utica and equivalent shales extend into the subsurface from Kentucky northeastward through West Virginia, Ohio, Pennsylvania, New York, and into Quebec. Although recent well results outside Kentucky are promising, much can be done to reduce risk and improve our understanding of this complex reservoir interval.

To this end, KGS is participating in a five-state study of the geology, stratigraphy, and hydrocarbon potential of the Utica Shale. Research will be conducted by **John Hickman, Cortland Eble,** and **Dave Harris,** as well as researchers at the Pennsylvania, Ohio, and West Virginia geological surveys, Washington University, Smith Stratigraphic LLC, and DOE's National Energy Technology Laboratory. The Utica Shale study will be a coordinated effort with the new West Virginia University Shale Research, Education, Policy and Economic Development Center in Morgantown.

Regional Carbon Storage Partnerships

The Energy and Minerals Section continued research in phase III of the U.S. Department of Energy–funded Midwest Regional Carbon Sequestration Partnership (**Steve Greb**). Managed by the Battelle Memorial Institute, the project covers Indiana, Kentucky, Maryland, Michigan, New York, Ohio, Pennsylvania, and West Virginia. Phase III research includes continued regional characterization of reservoirs and confining intervals, and injection testing to help prepare for future commercialization of carbon storage. As part of the research, **Greb** and **Tom Sparks** collaborated with researchers from other states to construct a cross section depicting the surface to Precambrian basement from Michigan to Kentucky to Pennsylvania, in order to better illustrate the changing geology for CO_2 storage across the MRCSP region.

The section also participated in the multistate U.S. Department of Energy project, Simulation Framework for Regional Geologic CO_2 Storage Infrastructure Along the Arches Province of the Midwest United States (**Greb**). This effort, managed by the Battelle Memorial Institute, is modeling CO_2 sequestration into the Mount Simon Sandstone in Indiana, Kentucky, Ohio, and Michigan. The focus is on testing the feasibility of large-scale storage from multiple sources into a single reservoir, and to determine the CO_2 transport and infrastructure needed to implement large-scale CO_2 storage in the region. Work this year was on regional characterization of the confining interval above the sandstone for use in the modeling and testing of the regional model. **Ralph Bandy**, a graduate student from the Department of Earth and Environmental Sciences, is working on this project as part of his master's thesis.

For both projects this past year, **Tom Sparks** and **Kathryn Takacs** compiled large data sets of stratigraphic tops and petrophysical information from subsurface geophysical logs, cuttings, and cores, which will be combined into regional data sets for a better characterization of the region's sequestration potential.

Pennsylvanian Marine Shale Beds as a Potential Oil and Gas Resource

Shale beds of marine origin occur throughout Pennsylvanian strata in both the Eastern Kentucky Coal Field (central Appalachian Basin) and Western Kentucky Coal Field (Illinois Basin). Some of these shales are dark gray to black, thick (greater than 5 meters), laterally extensive, and occur below regional stream drainage across much of their geographic extent. Although these beds have been used extensively as marker beds for correlation, they are poorly understood as potential gas and oil resources. **Cortland Eble** and **Steve Greb** are working on a USGS-funded project to document the organic composition of these shale beds petrographically, palynologically, and geochemically, in an effort to better evaluate their potential as a future energy resource.

Eastern Kentucky Metallurgical Coal

Most of the coal produced from eastern Kentucky is used for electric power generation because of its low sulfur content. It is referred to as "compliance coal" because it can be burned without flue gas desulfurization to control sulfur dioxide emissions. In 2009, 74.7 million tons of coal was produced from the Eastern Kentucky Coal Field, most of which (89.4 percent) was consumed by electric utilities in 26 states. Although only a small amount (724,000 tons) of eastern Kentucky coal was used domestically for the production of metallurgical coke, a greater amount (1.2 million tons) was exported to other countries, primarily for use in the steel industry.

As the electric utility industry continues to expand its implementation of scrubbers, which allows the use of less-expensive, high-sulfur coal, the demand for low-sulfur coal in the electric utility market is likely to decline. Alternative markets such as metallurgical coal will be needed to

prevent a significant drop in production in eastern Kentucky.

The goal of this study, funded by the Kentucky Energy and Environment Cabinet, was to document the remaining eastern Kentucky coal resources with suitable characteristics for utilization by the domestic and international steel industry. To achieve this goal, **Cortland Eble, Jerry Weisenfluh,** and **Tom Sparks** developed maps showing remaining resources for beds that are known to be low in ash and sulfur, two important characteristics of metallurgical coal. Samples were also collected and analyzed by a variety of techniques specific to the metallurgical coal industry. Collectively, these data will be of use to further refine the eastern Kentucky metallurgical coal resource base.

Rare-Earth Element Research

Federal agencies consider rare earth elements to be strategic and critical minerals. These elements are used in a variety of applications from cellphones to guided missiles to magnets and lasers. The United States typically imports most of these metals from China, which recently announced restrictions on their export to the United States, citing China's own domestic need.

KGS has initiated a project led by **Warren Anderson** to examine ultramafic igneous rocks in the Western Kentucky Fluorspar District and has prepared numerous samples for analysis. **Jason Backus** has reviewed and developed in-house analytical capabilities for rare-earth elements, and analysis will begin in the next fiscal year. Once analysis is completed, the data will be interpreted to determine the potential for rare-earth resources in Kentucky's mineral districts.

Minerals Database

Warren Anderson, Tom Sparks, and **Richard Smath** worked to scan and organize the Kentucky minerals database. It consists of thousands of records including core logs, cross sections, mine maps, chemical analyses, and reserve reports and should be available online by the end of 2012. This will provide access to thousands of files with information about mines and mining in the state. With the possible opening of new fluorite mining operations in western Kentucky, this information should be very valuable to the mining community. Currently, KGS records are being organized into spatial and tabular documents that can be linked to images and documents for viewing in a geologic information system, to provide easy access to information by the public.

Cortland Eble and Steve Greb gather samples from an eastern Kentucky underground mine for the metallurgical coal project.

From groundwater-well contamination, to formation-water chemistry, to karst-hazard mapping, the issues addressed by the Water Resources Section staff are important to everyone in Kentucky.

Jim Currens sets up a sampling unit on Cane Run Creek at the Kentucky Horse Park. The device automatically pumps water samples from the creek at timed intervals for laboratory analysis as part of the Cane Run watershed project.

Cumberland Gap Tunnel Roadway Subsidence

KGS and the Kentucky Transportation Center at UK installed four test borings into the roadbed of the northbound Cumberland Gap tunnel as part of an effort to determine the cause of roadway subsidence. Limestone aggregate in 2-inch-diameter stainless steel baskets was suspended in these borings to determine how much they would dissolve as groundwater flowed through the baskets. The aggregate dissolved much more quickly than expected. Fortunately, funds became available to replace the roadway aggregate with more durable granite. The dissolution data will be analyzed further. A weir and water-level recorder in the tunnel monitor groundwater flow; **Steve Webb** is in charge of this monitoring.

Cane Run Watershed

High fecal bacteria, nitrate, and suspended sediment levels in groundwater in the Cane Run watershed resulted in research projects being funded to monitor the watershed. Water Resources Section staff and faculty in the University of Kentucky College of Agriculture and the Department of Earth and Environmental Sciences had successfully located and drilled into the Royal Spring aquifer conduit at the Kentucky Horse Park in 2010. The groundwater from springshed discharges at Royal Spring, the raw water supply for the city of Georgetown.

Three methods have been used to calculate the cross section of the conduit: downhole video, Doppler sonar, and quantitative groundwater tracing. The Doppler sonar was use-ful in determining passage size. To analyze the sonar data, **Jim Currens** performed vector analysis, which showed the direction of flow, the speed of the suspended material, and the coordinates of the location of the observation. The quantitative groundwater tracing has been the most effective tool for determining discharge because the data generated by it reflect the increasing width and depth of flow as the higher and normally air-filled conduits begin to discharge.

KGS began observing water quality in May 2011. The wells have been equipped with stage recorders, a velocity meter, a 12-volt pump to collect samples, and a water-quality testing device and data logger. Most of the current effort is to characterize the water quality and develop a more precise rating curve to calculate the discharge. These data will help characterize sources of contamination and develop a detailed knowledge of the hydrogeology of the Inner Bluegrass.

Karst Activities

In cooperation with the Kentucky Division of Water, **Jim Currens** completed and released the karst groundwater basin map for the Tell City 30 x 60 minute quadrangle. A major revision of the karst map of the Somerset 30 x 60 minute quadrangle has recently been completed and is now available.

Statistical analysis is being used to link geologic strata to the occurrence of past cover-collapse sinkholes and the probability of future cover collapse as part of a continuing effort to develop karst geohazard maps.

Geochemical Modeling of CO_2, Brine, and Reservoir Rock Interactions in the Knox Group, Western Kentucky

To understand the long-term fate of CO_2 injected into the Knox reservoirs, **Junfeng Zhu,** working with the Energy and Minerals Section, developed geochemical models to simulate reactions among CO_2, brine, and rock-forming minerals. The models used data from the deep-sequestration test at the KGS Blan well in Hancock County. The

models suggest the Knox dolomite has a small capacity to trap CO_2 and that most of the CO_2 will remain in aqueous or supercritical/gas phases for a long time.

Groundwater Contaminant Modeling at the Paducah Gaseous Diffusion Plant

Junfeng Zhu continued to develop a groundwater model to assist in remediation at the Paducah Gaseous Diffusion Plant, where a variety of hazardous and radioactive wastes were released in the past.

Private Well Initiative

Bart Davidson completed a second project with the Centers for Disease Control and Prevention in Atlanta. The CDC has initiated a nationwide project to identify and characterize private drinking-water sources, primarily wells and springs, not covered by the Safe Drinking Water Act. Funded through the Kentucky Division of Water, KGS targeted four data sets discovered during the previous year's project for entry into the Kentucky Groundwater Data Repository. Data for more than 4,000 wells, 70 springs, and 5,700 analyses were added to the repository as a result of the project.

Assessment of CO_2 Injection on Local Groundwater Quality

Glynn Beck, Kathryn Takacs, Daniel Wedding, and **Marty Parris** completed shallow groundwater monitoring for two pilot carbon storage and enhanced oil recovery projects overseen by the Energy and Minerals Section. Groundwater sampling and measurement of bulk and isotopic chemistry was conducted to characterize water chemistry before, during, and after CO_2 injection. At the Sugar Creek pilot site (Hopkins County), groundwater in Pennsylvanian sandstone aquifers was monitored for approximately 2½ years using four existing wells near the Sugar Creek oil field and three wells drilled specifically for groundwater monitoring within the field. Approximately 7,200 tons of CO_2 were injected into the Mississippian Jackson Sandstone oil reservoir from May 2009 to May 2010. Monitoring during injection and for a year afterward showed that CO_2 injection did not affect the shallow groundwater chemistry, suggesting successful containment of CO_2 in the Jackson Sandstone.

Glynn Beck makes a video of a well at an abandoned fluorspar mine as part of an effort to help locate an alternate water supply for the city of Marion in western Kentucky.

Analysis of Formation Water Chemistry in the Appalachian and Illinois Basins

Marty Parris, Glynn Beck, and **Kathryn Takacs** continued to evaluate water chemistry data from deep aquifers and reservoirs. The analysis is being conducted on historic and recent measurements. The recent measurements are primarily from CO_2 sequestration investigations and the historic measurements are mostly from oil and gas wells, mostly during the late 1960's and early 1970's. The total number of measurements is approximately 1,000 and includes data from 107 of the 120 counties in Kentucky.

Analysis of the historic water chemistry data in the Appalachian and Illinois Basins showed that formation waters in the Cambrian-Ordovician Knox Group reservoirs were less saline than would be predicted by salinity trends observed in shallower and younger Paleozoic strata. The measurements suggest that dilute Knox groundwater in the Jessamine Dome area is older than 1.5 million years, whereas groundwater in the Nashville Dome area has values approaching modern ones acquired before nuclear testing began in the mid-1940's.

The final two maps in the series of 30 x 60 minute maps of Kentucky were completed during the fiscal year. To commemorate this and other KGS mapping accomplishments, a celebration was held on December 1. State and university officials were invited to speak, current and previous KGS mappers held a reunion, and an afternoon mapping symposium was held. (See more information on pgs 14-15).

The KGS Geologic Mapping Section added two new mappers in 2011-12. Louisville native **Antonia Hansen** joined the section in July 2011 and began mapping surficial geology in the Lily 7.5-minute quadrangle near London.

Hall Hollow Arch is one of the locations Steve Martin has visited as he documents arches and fractures. This Wayne County arch, formed in the Bangor Limestone, is 85 feet high and spans 23 feet.

Max Hammond, of Carter County, Ky., also joined in July and spent much of his time examining soils and glacial deposits for surficial mapping in the Alexandria and Inde-pendence 7.5-minute quad-rangles in northern Kentucky. They filled vacancies created when **Mike Murphy** retired and **Matt Crawford** moved to the KGS Geologic Hazards Section.

Ron Counts mapped the Madisonville East 7.5-minute quadrangle,and **Scott Waninger** mapped the Madisonville West 7.5-minute quadrangle.

Steve Martin has continued to develop his inventories of fracture orientations and natural arch locations in Kentucky.

Bethany Overfield and **Dan Carey** completed an analysis of Kentucky highway maintenance costs, correlating them with surrounding geologic conditions. Seven years of Kentucky Transportation Cabinet maintenance costs were analyzed in the context of KGS digital geologic map data to determine the estimated costs associated with different geologic units.

This cut bank along Fowler Creek in Kenton County is an example of the surficial deposits mapped by Max Hammond in northern Kentucky.

Ron Counts, with a grant from the National Earthquake Hazards Reduction Program, has been completing research on a Quaternary fault found in Union County during earlier field mapping. He was awarded another NEHRP grant for the coming year to work with the Illinois State Geological Survey on a Quaternary fault in Illinois.

The subsurface data-collection capabilities of the section were improved when **Scott Waninger** refurbished a small truck-mounted Geoprobe drill rig at the Henderson office.

Geologic Mapping Section staff examine the soils of Kenton County during a field trip to check their mapping work.

Kentucky's earthquake and landslide hazards are the focus of research in the Geologic Hazards Section.

The Kentucky Seismic and Strong-Motion Network

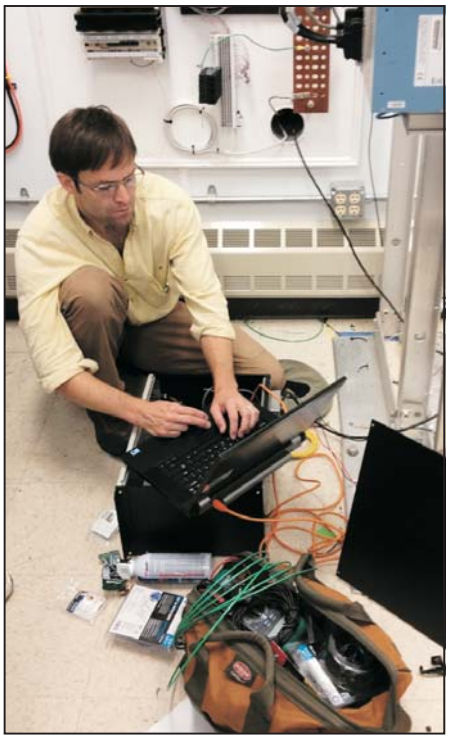
Operation and maintainence of the 26-station Kentucky Seismic and Strong-Motion Network is one of the Geologic Hazards Section's main tasks. This network monitors earthquakes, mine blasts, and other activities in Kentucky and the central United States. It also records the largest earthquakes around the world. Near-real-time recordings from 12 of the instruments can be monitored on the KGS Web site at www.uky.edu/KGS/geologichazards/equake3.htm.

Many of the real-time stations were upgraded from analog to digital to utilize the upgraded Kentucky Emergency Warning System. These stations have improved sensitivity to seismic signals while greatly diminishing the undesirable, nonseismic noise.

Seven earthquakes were recorded in the state during the fiscal year with magnitudes from 1.6 to 2.5. Six of the seven events occurred in the Mississippi Embayment (west of Hickman, Ky.) and one, the largest in the state during the year, occurred 15 kilometers west of Owensboro.

Seismic Hazard Assessment

The top priority for the Geologic Hazards Section continues to be seismic hazard assessment because economic development in western Kentucky has been affected by exaggerated ground-motion estimates from the U.S. Geological Survey. To communicate scientific findings on the true hazard in Kentucky, presentations were made to the Paducah Chamber of Commerce, the Central and Eastern U. S. Earthquake Sources Workshop for the USGS National Seismic Hazard Maps, and the American Society of Civil Engineers Symposium on Seismic Hazard Design Issues in the Central United States. The seismic design issue for the landfill that stores the wastes generated by the Paducah Gaseous Diffusion Plant was resolved when State government approved a design ground motion of 0.33g (33 percent of the acceleration of gravity) peak ground acceleration at the surface.



Seth Carpenter installs and tests a new seismic instrument at station SMKY in the Kentucky Emergency Warning building near Sacramento. He upgraded the analog station with digital equipment.

Landslide Hazard Characterization

By the end of the fiscal year, the KGS landslide inventory database contained 2,347 landslide locations in Kentucky, with 115 new slide locations added during the year. The database was integrated with other KGS databases so it has the same design and purpose as the other KGS data sets. Twenty landslides were investigated in the field, and two of those visits resulted in reports to assist the Kentucky Division of Emergency Management with its landslide hazard mitigation projects.

A field guide on landslide hazards in Kentucky, Ohio, and Indiana has been developed through a joint effort with **Paul Potter** and **Barry Maynard** of the University of Cincinnati. Landslide hazard research efforts and goals were presented at the International and North American Symposium on Landslides in Banff, Alberta, Canada, in June.

There were some significant changes in Section personnel during the fiscal year. **Matt Crawford** transferred from the Geologic Mapping Section as an engineering geologist to focus on landslide characterization. Seismologist **Seth Carpenter** was hired to oversee the operation and maintenance of the seismic network. He had previously worked at the Idaho National Laboratory in Idaho Falls.

Cooperative Research Across Campus

The Geologic Hazards Section continued cooperative work with the Department of Earth and Environmental Sciences, the

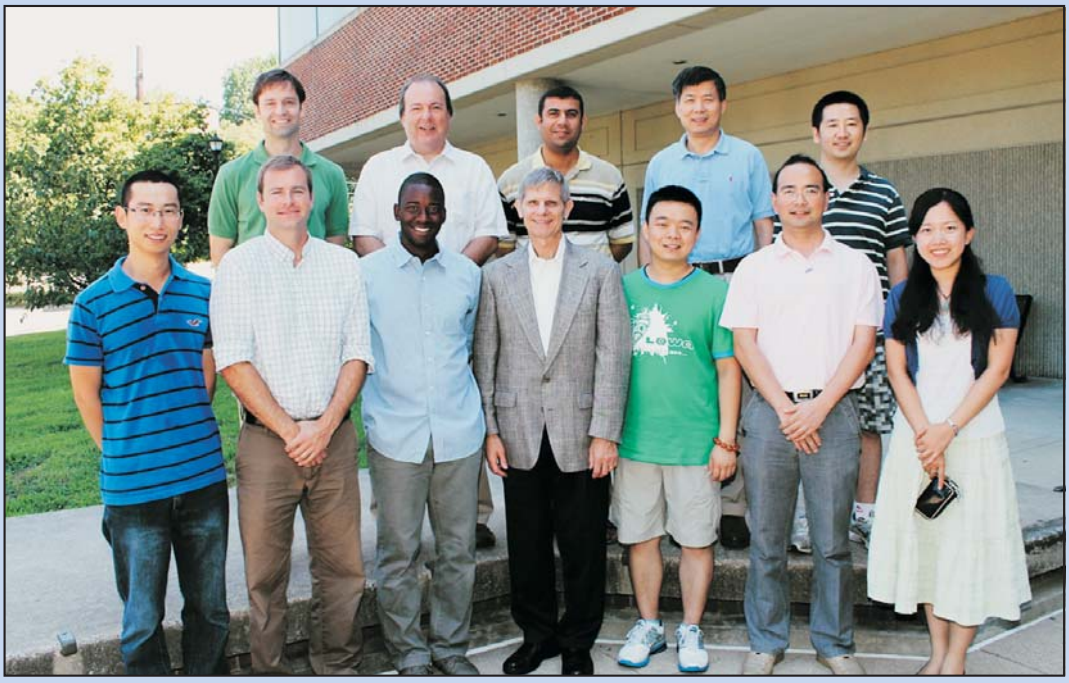
Kentucky Research Consortium for Energy and the Environment, and other academic units on the UK campus. Among the projects were a seismic experiment for underground conduit detection near the Kentucky Horse Park, site characterization at the Central U.S. Seismic Observatory, and operation and maintenance of the seismic network surrounding the Paducah Gaseous Diffusion Plant.

China Scholarly Exchange and Cooperative Research

The scholarly exchange and cooperative research between KGS and the Lanzhou Institute of Seismology and other institutes under the China Earthquake Administration entered its eighth year. KGS Director **Jim Cobb**, Geologic Hazards Section Head **Zhenming Wang**, and **Ed Woolery** of the UK Earth and Environmental Sciences Department visited Lanzhou from October 25 to 28 to develop and sign a new memorandum on academic exchange and cooperation between KGS and the Lanzhou Institute. The delegation also visited the Earthquake Administration of Fujian Province in Fuzhou, China, from November 2 to 4, where a memorandum on scientific and technological cooperation and personal exchange was signed. **Woolery** and **Wang** have been appointed adjunct research fellows at the Institute of Crustal Dynamics of the China Earthquake Administration. One postdoctoral and four visiting scholars from China came to UK to participate in research projects and exchanges. Six related papers were submitted to or published by scientific journals.

Matt Crawford is interviewed by a Cincinnati TV station while investigating landslide damage in northern Kentucky.

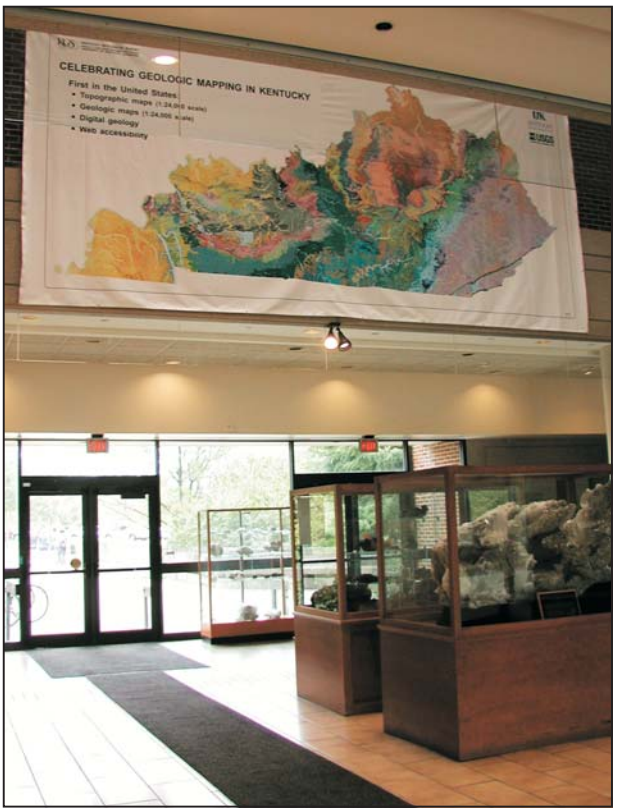
The cooperating geologic hazards researchers from KGS, the UK Department of Earth and Environmental Sciences, and the People's Republic of China gathered for a group portrait (see below). The researchers from China are participating in the ongoing exchange with the Lanzhou Institute of Seismology and the China Earthquake Administration.



FRONT ROW: Jiwei Feng, master's degree candidate from the Institute of Mechanical Engineering, China Earthquake Administration, in Harbin, China; Matt Crawford, KGS Geologic Hazards Section; Carrington Wright, Clarksville, Tenn., master's degree candidate, UK Department of Earth and Environmental Sciences; Jim Cobb, state geologist and KGS director; Jingyan Lan, visiting scholar from the Institute of Crustal Dynamics, China Earthquake Administration, in Beijing; Caibo Hu, post-doctoral scholar from Peking University, Beijing, China; Qian Li, visiting scholar from the Lanzhou Institute of Seismology.

BACK ROW: Seth Carpenter, KGS Geologic Hazards Section; Ed Woolery, KGS Geologic Hazards Section and UK Department of Earth and Environmental Sciences; Ali Al-Mayahi, Basra, Iraq, Ph.D. candidate, UK Department of Earth and Environmental Sciences; Zhenming Wang, section head, KGS Geologic Hazards Section; Lifang Zhang, visiting scholar from the Institute of Crustal Dynamics, China Earthquake Administration, in Beijing, China.

A Mapping Celebration

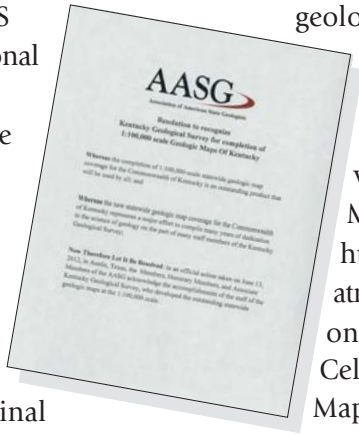


On December 1, 2011, KGS celebrated the state's leadership in geologic mapping and map technology as retired USGS mappers, KGS staff, officials of State agencies, the University of Kentucky, and the U.S. Geological Survey gathered at KGS.

KGS completed the final two maps in the 30 x 60 minute geologic map series (1:100,000 scale) for Kentucky in 2011 and made them available to the public for download or hardcopy purchase. This series of 25 detailed maps shows surface and subsurface rock types, formations, and structures such as faults. Information on the maps is valuable for resource production, protection of groundwater and the environment, stability of foundations and infrastructure, and avoidance of hazards. These maps are a result of KGS involvement in the National Cooperative Geologic Mapping Program of the U.S. Geological Survey. A previous geologic mapping partnership between the Kentucky Geological Survey and the USGS from 1960 to 1978 produced the original geologic maps that laid the framework for the 30 x 60 minute series. A KGS effort, largely funded by the USGS, converted those geologic maps to digital vector formats from 1996 to 2004.

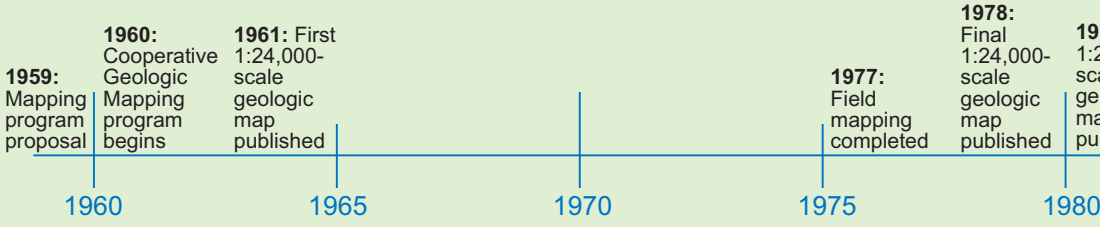
A 10-foot-high version of the Geologic Map of Kentucky was hung in the building atrium, and a symposium on geologic mapping, Celebrating Geologic Mapping for Science and

KGS Director Jim Cobb and UK President Eli Capilouto speak in front of news media at the opening of the celebration.



The Association of American State Geologists approved a resolution recognizing KGS for the completion of its geologic maps.

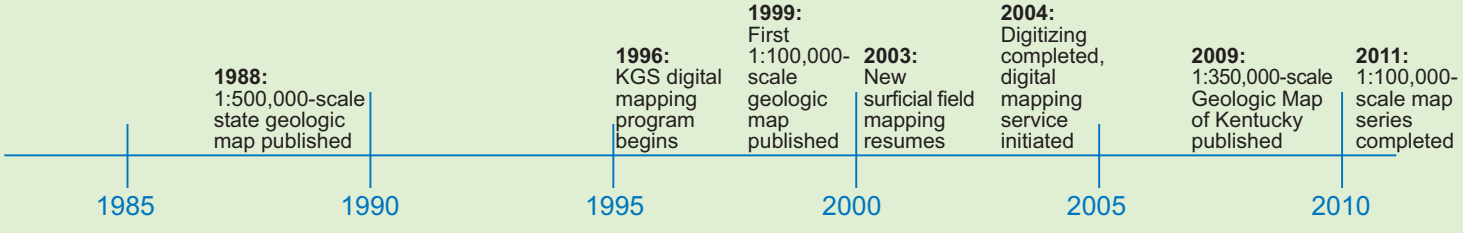
Timeline for the Kentucky geologic map series



The afternoon seminar celebrated the retired mappers whose efforts brought the project to completion.

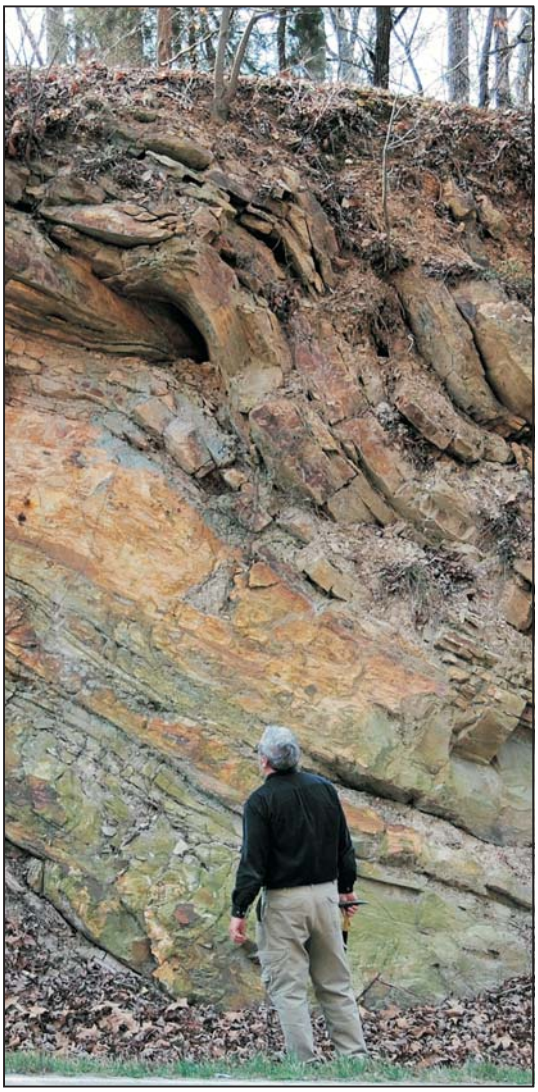
Society, was also held in the afternoon. A video on KGS mapping was produced by UK and posted at the University's YouTube site, and the new KGS mobile mapping app for smartphones and tablets was introduced as well.

Retired USGS mappers, KGS staff, and officials of State agencies, the University of Kentucky, and the U.S. Geological Survey gathered at KGS for the celebration.



Western Kentucky Office

The KGS office in western Kentucky provides public service and conducts research in western Kentucky. Staff activities there affect resource industries, agriculture, ground- and surface-water issues, public safety, and education in that part of the state. The staff regularly interacts with government agencies, private industry, and educational institutions. Henderson Office Manager **Dave Williams** has spoken to schools and community service organizations while also helping to conduct a hands-on geology camp for grade school children at Audubon State Park. He also responds to inquiries about the erosion of soils through natural subterranean channels; known as soil piping, it can lead to surface depressions or sinkholes. Williams's other projects include mapping paleochannels in the Western Kentucky Coal Field and adding information to the KGS database for petroleum tests in western Kentucky.



Henderson Office Manager Dave Williams looks at an exposure of the Rough Creek Fault along a ridge in Ohio County.

Carbon Storage Activities

Williams also closed out activities related to the reclamation the Hancock County deep carbon sequestration research project site, where KGS investigated the feasibility of injecting CO_2 into deep saline aquifers. The sequestration project was mandated by the 2007 Kentucky General Assembly and conducted by staff in the KGS Energy and Minerals Section.

Glynn Beck, a member of the Water Resources Section, monitored the shallow groundwater near the project site to characterize the local groundwater quality and assess any changes in quality that may be associated with CO_2 injection. The sampling is scheduled to continue through October 2013.

Emerging Contaminant Sampling

Beck also sampled 56 sites in six watersheds in Kentucky for 17-β estradiol (estrogen) and fluoroquinolones (antibiotics), which are both classified as emerging contaminants. Two of the watersheds are in the Jackson Purchase Region, two in central Kentucky, and one each in northern and eastern Kentucky. In addition to water-quality samples, field measurements (pH, specific conductance, dissolved oxygen, temperature, and total dissolved solids) were recorded and stream discharge was measured at some of the sites. Sampling and analysis were funded in part by the National Institute of Food and Agriculture–Southern Regional Water Program and the USGS State Water Resources Research Institute Program.

Glynn Beck collects water samples and other data for a project to detect hormones and antibiotics in streams.

Ron Counts and Scott Waninger drilled shallow tests to characterize seismic behavior of unconsolidated materials in western Kentucky and continued investigating paleoseismic features in the region. Counts continues collaboration with non-KGS research institutions on several projects relating to archeology and recent earthquake activity. Counts is working on his Ph.D. at the University of Cincinnati. More details and other work by Henderson office staff can be found in the Energy and Minerals Section (pg. 4) and the Water Resources Section (pg. 9).

Glynn Beck of the Water Resources Section took samples from wells and springs in the vicinity of the deep carbon storage research project in Hancock County to monitor for possible changes in groundwater chemistry from the injection of carbon dioxide into deep geologic formations.

Well Sample and Core Library

For over a century, rock materials and various scientific data have been collected by Survey geologists. Many of these materials are available at the KGS Well Sample and Core Library, which is among the largest facilities of its kind in the United States.

The library contains a State-mandated collection, which now includes more than 19,000 sets of well cuttings and 2,850 core samples obtained from exploratory and investigative drilling throughout Kentucky.

The collection includes a set of well cuttings drilled to a depth of 15,200 feet and a drill core that penetrated rocks over 1.9 billion years old. The cores and samples housed at the facility are available for viewing, and a catalog of the collection is also available on the KGS Web site at kgs.uky.edu/kgsweb/DataSearching/CSLib/CSLibSearch.asp.

This year, 150 industry, university, and survey geologists and both graduate and undergraduate students used the library for investigations related to oil and gas, coal, tar sands, oil shales, carbon sequestration, groundwater resources, environmental issues, stratigraphy, and minerals. Approximately 3,700 boxes of cores representing about 33,850 feet and 305 boxes of well cuttings exceeding 373,600 feet were pulled off the shelves and made available for examination.

Ryan Pinkston and Ray Daniel examine processed well cuttings.

Library staff accepted 105 new cores and well sample sets, exceeding 304,100 feet, to add to the collection.

Sampling is permitted under stringent controls and documented agreements, providing that adequate quantities of materials are available. The library provided 2,073 samples from 32 cores and well cuttings to 13 researchers from academia, geological surveys, industry, and students. The knowledge gained from examination and analysis of materials stored at the core library contributes to a better scientific understanding of Kentucky's geologic history, minerals, hydrocarbons, engineering issues, and environmental concerns.

A group of European geologists and engineers visiting the Core Library in April 2012 look at some of the cores housed in the facility.

Steve Mock prepares coal samples to test them for chlorine in the lab's X-ray diffraction instrument.

Laboratory Manager Jason Backus places samples in a sulfur and carbon analyzer that combusts the samples at 1,400 degrees Celsius.

Public Outreach

Each year, KGS makes an effort to provide information on geological sciences to a variety of audiences. We accomplish this through lectures and seminars intended for professional and academic audiences, educational events for the general public, and a Web site with earth science information, resource databases, and publications.

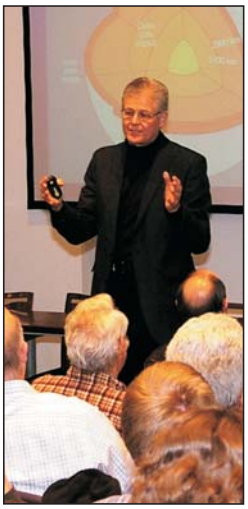
KGS Director Jim Cobb opened the annual seminar with a discussion of the geologic societies in Kentucky.

Annual Seminar

The 2012 annual seminar departed from the format of previous seminars, adding breakout sessions, poster presentations, and a field trip. The May 18 event attracted a crowd of 135 people to the Well Sample and Core Library. The seminar, KGS: The Nexus for Geologists in Kentucky, included a discussion on revitalizing the geologic, paleontologic, and other related societies in the state.

Participants chose from seven informational sessions led by KGS staff during three breakouts during the day. The topics were KGS online mapping, geologic hazards, the Association of State Boards of Geology exam, and a field trip to the Cane Run watershed. During the traditional barbecue lunch, changes in the State registration statutes enacted by the State legislature were discussed.

Lecture: Harvey Thorleifson



Minnesota Geological Survey Director **Harvey Thorleifson** spoke on February 2 about the history of diamond exploration and production to a packed lecture room at the William T. Young Library on the UK campus. Thorleifson was per-sonally involved in research on Canadian diamond mining for the Geological Survey of Canada and when he worked in the diamond exploration industry. He spoke earlier in the day to a UK geology class and two groups of KGS researchers.

Lecture: Eugenie Scott

KGS co-sponsored the annual Darwin Lecture in February, at which anthropologist **Eugenie Scott** spoke on "Darwin: Demon or Revolutionary?" Hundreds of people filled a lecture hall at the UK Singletary Center for the Arts to hear Scott, who is the executive director of the National Center for Science Education.

Well-Safety Web Site/Videos

A new Web site, developed jointly by KGS hydrogeologist **Glynn Beck** and the College of Agriculture at the University of Kentucky, offers help to well owners on construction and maintenance of wells and contamination prevention.

The Kentucky Well Education site (www.ca.uky.edu/enri/downwell) explains the requirements of State law relating to wells and provides videos on well issues and advice on well testing. According to the Web site, nearly 95 percent of the rural population in the country drinks groundwater. The site's organizers plan to add more video clips and develop pages on geology and groundwater on the site.

Stone-lined, hand-dug wells like this one in McLean County are very susceptible to contamination.

Game of Arches

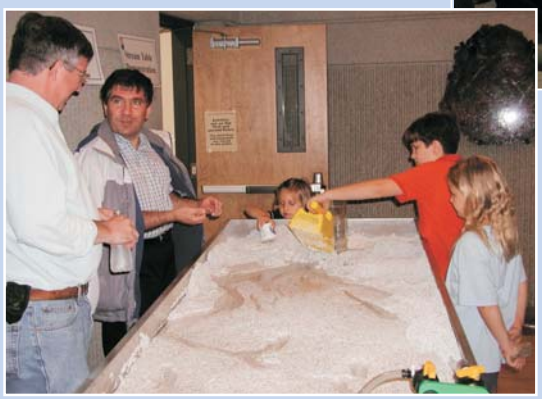
Kentucky Agate exhibit

Open House

More than 250 students, parents, and teachers visited KGS for the annual Earth Science Week open house on October 5. Eighteen displays and demonstrations covered earth science topics ranging from rocks and minerals to energy resources to snakes, iguanas, and dinosaurs. A number of students arrived with questions prepared by their teachers to get extra class credit for finding the answers.

Meteorite lesson

Amber exhibit



Water flow

Fossil dig

Well Sample and Core Library

KGS makes its Well Sample and Core Library available to the geologic community and others for meetings, workshops, courses, tours, and presentations. Nineteen meetings on a variety of topics were held at the library during the fiscal year, and 759 visitors, including academicians, research and industry geologists, and the general public, used the facility.

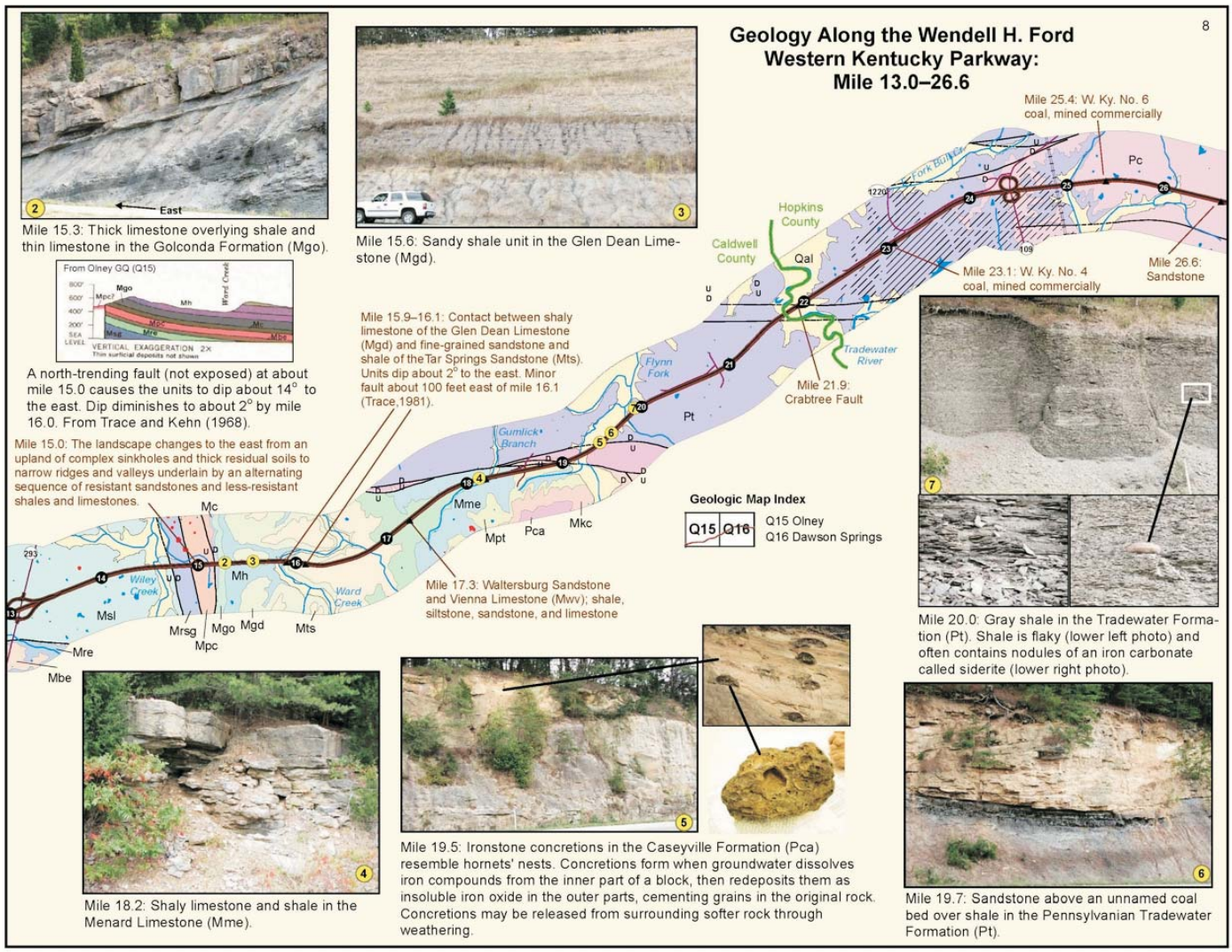
Publications and Web Services


The KGS GeoMobile app

KGS staff produced nine new publications during the fiscal year, including the final two maps in the 30 x 60 minute quadrangle series. Three more special publications on the geology along Kentucky's major highways and parkways were completed, along with a report on the use of light detection and ranging (LiDAR) to map landslides in Kenton and Campbell Counties of northern Kentucky.

The KGS Web site continues to serve a diverse audience, receiving a large number of visits during the fiscal year. Nearly 395,000 database searches were conducted by 116,000 users. KGS online map services were accessed nearly 100,000 times, with more than 8,000 tabular data downloads. The total number of files downloaded exceeded 2 million. Users most frequently downloaded oil and gas records, online publications, coordinate conversion services, and data from the online geologic map server.

A page from the publication Geology Along the Wendell H. Ford Western Kentucky Parkway.



A committee of KGS staff worked for several months to revamp the KGS home page, updating it with a new design, different graphics, and photos gleaned from the KGS archives.

A new KGS mobile mapping application was developed for smartphones and tablets with GPS and data access. The application, kgs.uky.edu/kgsmap/mobile/kgsgeoserver, allows users access to KGS mapping and other information on their location in Kentucky. The KGS GeoMobile service provides information on geologic formations, oil and gas fields and wells, mapped sinkhole outlines, and other geologic information.

Our New Home Page

KGS Staff 2011-12

State Geologist's Office

Cobb, Jim
State Geologist/Director
Weisenfluh, Jerry
Associate Director
Haney, Don
State Geologist Emeritus
Hower, Judy
Temporary Technician

Administrative Section

Silvers, Jackie
Administrative Staff Officer II
Ellis, Kati
Administrative Staff Officer II, Jan. 2012
Long, Mandy
Administrative Support Associate I
Phillips, Gwen
Staff Support Associate II

Energy and Minerals Section

Harris, Dave
Section Head
Anderson, Warren
Geologist V
Bandy, Ralph
Student Worker
Bowersox, Rick
Geologist IV
Eble, Cortland
Geologist V
Greb, Steve
Geologist V
Hickman, John
Geologist IV
Nuttall, Brandon
Geologist V
Parris, Marty
Geologist V
Sparks, Tom
Geologist III
Takacs, Kathryn
Geologist I

Geologic Hazards Section

Wang, Zhenming
Section Head
Altobellis, Eric
Student Worker
Burton, Cate
Student Worker
Carpenter, Seth
Geologist IV
Crawford, Matt
Geologist III
Hu, Caibo
Temporary Technician
Li, Qian
Temporary Technician
Woolery, Ed
Geophysics Faculty Associate

Geoscience Information Management Section

Cordiviola Steve
Section Head
Curl, Doug
Section Head, June 2012
Adams, Elizabeth
Senior Geologic Technician
Conover, Suzzanne
Student Worker
Ellis, Mike
IS Technical Support Specialist III
Livingood, Steve
Student Worker
Noakes, Chase
Student Worker
Pulliam, Carrie
Geologist II
Sergeant, Rick
Geologist IV
Smath, Richard
Geologist III
Spaulding, Dan
Student Worker
Thompson, Mark
Information Technology Manager I
Ulanday, Joe
Temporary Technician
Wang, Rebecca
Information Support Specialist
Watson, Anna
Temporary Professional
Wolfe, Phillip
Student Worker

Communications and Outreach

Weisenfluh, Jerry
Section Head/Associate Director
Banks, Roger
Stores Supervisor
Fedorchuk, Nick
Temporary Technician
Hounshell, Terry
Chief Cartographic Illustrator
Lynch, Mike
Technology Transfer Officer
Rulo, Collie
Senior Graphic Design Technician
Rufft, Kelsey
Temporary Technician
Smath, Meg
Geologic Editor

Geologic Mapping Section

Andrews, William
Section Head
Carey, Dan
Geologist V
Hammond, Max
Geologist I
Hansen, Antonia
Geologist I
Holcomb, Andrew
Student Worker
Martin, Steve
Geologist III
Overfield, Bethany
Geologist II
Rivers, Monte
Geologist I

Laboratory Services

Backus, Jason
Scientist II/Laboratory Manager
Conner, Andrea
Scientist I
Francis, Henry
Temporary Technician
Mock, Steve
Scientist I

Water Resources Section

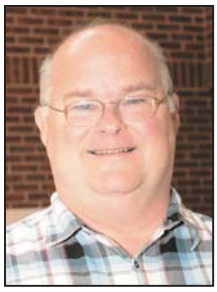
Dinger, Jim
Section Head
Davidson, Bart
Geologist IV and Acting Section Head, April 2012
Currens, Jim
Geologist V
Farwell, Mike
Student Worker
Fogle, Alex
Geologist III
Webb, Steve
Geologist II
Zhu, Junfeng
Geologist V

Well Sample and Core Library

Gooding, Patrick
Geologist IV/Manager
Daniel, Ray
Principal Research Analyst
Pack, Christian
Student Worker
Pinkston, Ryan
Research Analyst

Western Kentucky Office at Henderson

Williams, Dave
Section Head
Beck, Glynn
Geologist IV (Water Resources Section)
Bleichroth, Amy
Temporary Technician
Counts, Ron
Geologist III (Geologic Mapping Section)
DeJaco, Robert
Student Worker
Waninger, Scott
Geologist I (Geologic Mapping Section)
Wedding, Dan
Temporary Technician
Yoegerl, Ryan
Temporary Technician



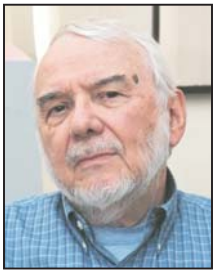
Water Resources Section Acting Head **Bart Davidson** was appointed by Gov. Steve Beshear to the Kentucky Water Well Drillers' Certification Board. He is serving out the term of retired Section Head Jim Dinger, which expires in August 2013.

Associate Director **Jerry Weisenfluh** is the chair of the Associate Members Group and Liaison to the Executive Committee of the Association of American State Geologists.

KGS publications editor **Meg Smath** is past-president of the Association of Earth Science Editors.

KGS laboratory scientist **Steve Mock** serves on the Staff Trustee Advisory Committee to the UK Board of Trustees while also serving in the University's Staff Senate.

Cortland Eble of the Energy and Minerals Section received the Gordon H. Wood Jr. Memorial Award from the Eastern Section of the American Association of Petroleum Geologists. The award recognizes outstanding contributions to the study of coal and other energy minerals and the goals of the section's Energy Minerals Division.



Retired KGS Laboratory Manager **Henry Francis** was presented the 2012 Bob Lauderdale Award for Water Quality by the Kentucky Water Resources Research Institute this spring. The award recognized Francis's long service to the Kentucky water resources community.

Matt Crawford of the Geologic Hazards Section is a committee member of the Appalachian Coalition for Geologic Hazards in Transportation.

Well Sample and Core Library Manager **Patrick Gooding** served as secretary-treasurer of the Kentucky Society of Professional Geologists and a delegate for the society to the House of Delegates of the American Association of Petroleum Geologists. He is also a member of AAPG's Preservation of Geoscience Data and Field Safety Committees.

Rebecca Wang and **Steve Greb** serve as co-webmasters for the Coal Division of the Geological Society of America.

Steve Greb is a member-at-large for the Geological Society of America Committee on Professional Development.

Fiscal Year 2011-12

Communications Outreach

Communications Specialist Liaison for the Kentucky Board of Registration for Professional Geologists.
FY $7,700. End date 6/30/2012
Funding source: Kentucky Board of Registration for Professional Geologists

Energy

Carbon Management

An Evaluation of the Carbon Sequestration Potential of Cambrian-Ordovician Knox Strata
FY $465,631. End date 12/7/2012
Funding source: U.S. Department of Energy through Illinois State Geological Survey

Assessment of Geological Carbon Sequestration Options in the Illinois Basin Sugar Creek Monitoring
End date 1/31/2012. Funding source: U.S. Department of Energy through Illinois State Geological Survey

Assessment of Geological Carbon Sequestration Options in the Illinois Basin Phase II MGSC Regional Partnership Research.
End date 1/31/12. Funding source: U.S. Department of Energy through Illinois State Geological Survey

Midwest Regional Carbon Sequestration Partnership (Appalachian Basin)
FY $26,201. End date 5/15/2012
Funding source: U.S. Department of Energy through Battelle Memorial Institute

Stimulation Framework for Regional Carbon Sequestration Storage Infrastructure Along the Arches Province of the Midwest United States
FY $50,000. End date 9/30/2012
Funding source: U.S. Department of Energy through Battelle Memorial Institute

CO_2 Sequestration and Enhanced Oil and Gas Recovery Using CO_2
End date 6/30/2013. Funding source: Governor's Office of Energy Policy

Coal Resources

Metallurgical Coal Resources in Eastern Kentucky.
FY $52,770. End date 6/30/2012
Funding source: Kentucky Department for Energy Development and Independence

Geologic Information

Coal Information

Computerized Coal Resources Data for the National Coal Resources Data System
FY $15,000. End date 6/30/2015
Funding source: U.S. Geological Survey

Data Dissemination

National Geologic and Geophysical Data Preservation Program
FY $45,592. End date 8/31/2012
Funding source: U.S. Geological Survey

National Geothermal Data System Program.
FY $211,038. End date 8/29/2013.
Funding source: U.S. Department of Energy through Arizona Geological Survey

Geotechnical Information

Analysis of the Geologic Context of Transportation Maintenance Costs
FY $50,000. End date 6/30/2012
Funding source: Kentucky Transportation Cabinet

Geology

Geologic Mapping

Determining the Deformation History of a Newly Discovered Holocene Fault in Wabash Valley
FY $57,623. End date 4/30/2012
Funding source: U.S. Geological Survey

Paleoseismic Investigation of the Meadow Bank Lineament in the Wabash Valley Seismic Zone.
FY $69,965. End date 2/28/2013
Funding source: U.S. Geological Survey

Quaternary and Surficial Geologic Mapping for Multiple Applications in Kentucky.
FY $216,363. End date 6/30/2012
Funding source: U.S. Geological Survey

Rock Geochemistry

Petrographic and Geochemical Examination of Pennsylvanian Marine Shale Beds.
FY $26,730. End date 6/30/2012
Funding source: U.S. Geological Survey

Hazards

Seismic Monitoring

Installation of Seismic Equipment at Station BLKY
FY $10,000. End date 6/30/2012
Funding source: Kentucky Energy and Environment Cabinet

Installation of the Central U.S. Seismic Observatory.
FY $30,298. End date 9/30/2012.
Funding source: U.S. Department of Energy through Center for Applied Energy Research

Implementation and Operation of Transportable Seismic Array Elements for EarthScope.
End date 9/30/2011
Funding source: Incorporated Research Institutions for Seismology

Water Resources

Groundwater Information

Feasibility Study for Compiling a National Groundwater Quality Database
FY $71,155. End date 6/30/2012
Funding source: Centers for Disease Control through Kentucky Energy and Environment Cabinet

Determining Groundwater Flow Velocities and Discharge Rate at the Kentucky Horse Park Royal Spring Conduit Monitoring Station
FY $5,000. End date 2/28/13
Funding source: U.S. Geological Survey through Kentucky Water Resources Research Institute

Groundwater Monitoring

Groundwater Modeling at the Paducah Gaseous Diffusion Plant.
FY $34,560. End date 9/30/2012.
Funding source: U.S. Department of Energy through Center for Applied Energy Research

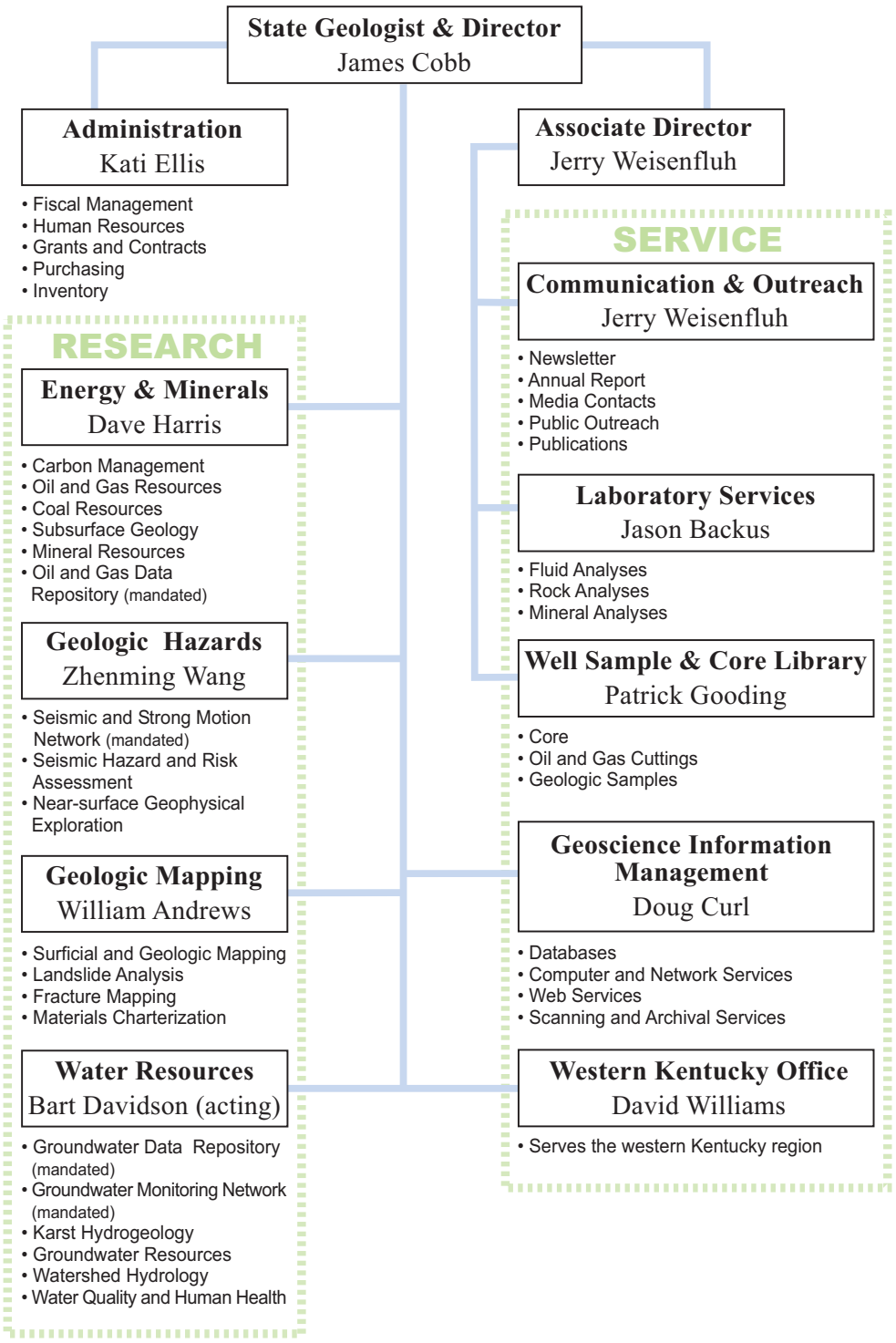
Monitoring Groundwater Containment Loading at Lisle Road and the Kentucky Horse Park.
FY $22,349. End date 6/30/2012.
Funding source: University of Kentucky College of Agriculture

Hydrogeochemistry of Tunnel Roadbed Subsidence at Cumberland Gap Tunnel
FY $8,475. End date 6/30/2014
Funding source: Kentucky Transportation Cabinet

Water Quality and Human Health

Sampling for Pharmaceuticals in Kentucky Surface Waters
FY $5,000. End date 2/28/13
Funding source: U.S. Geological Survey through Kentucky Water Resources Research Institute

Kentucky Geological Survey



What they're saying about us...

Customer of Publication Sales:

Thanks for sending the Geology Along Interstate 64 Report papers last week. I will be sharing it with the History Museum here in Winchester for possible future monthly meetings.

Online user:

Thanks for maintaining such a comprehensive and user friendly Web site. It is vital in obtaining information on the KY Gas and Oil Industry.

Customer of Publications Sales:

I just want to let you know about the outstanding job one of your employees did for me. I needed maps and he was so helpful in assisting me in the proper way to combine info to best achieve this. What an asset to your department to have employees on the front line to assist inexperienced people like me. Not only did he provide assistance to me but I received my material the next day (what a pleasant surprise). In this day of computers on the other end, what a refreshing change to hear a live, helpful voice. Thank you.

School science coordinator:

Honestly, there are some invitations I never send out or endorse because they aren't valuable. Earth Science Open House is so well done and engaging that I always want to make sure folks are excited about it!

Elementary school teacher:

I just wanted to drop you a quick note to let you know that your page **http://www.uky.edu/KGS/coal/mininglinks.htm** has great info on it!
The kids in my science class completely agree!

Editor: Mike Lynch
Copy Editor: Meg Smath
Design and Layout: Collie Rulo