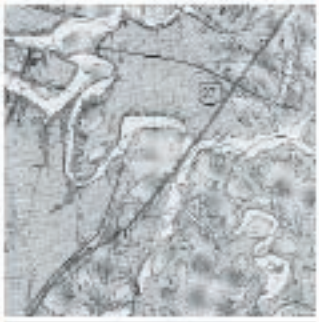
KGS

Kentucky Geological Survey Annual Report 2003–04



a full service Geological Survey

Director's Report

Ushering in the era of full-service geological surveys

Our goal here at KGS is to be a full-service geological survey. What makes us full service? First, our commitment to use our knowledge and skills to perform research to help the people of Kentucky. And second, our commitment to distribute our research results on the Web as broadly, easily, and inexpensively as possible.

We have a broad spectrum of research activities. Issues of importance to the people of Kentucky include seismic hazards, karst hydrology, groundwater supply and protection, geology for planning, coalbed methane, CO_2 sequestration, energy resources, geologic mapping, and mineral resources. We have active projects in all these research areas.

Our Web site provides free access to a vast amount of raw data and information, ranging from:

- Publications and maps
- Oil and gas records
- Water well and spring records
- Seismic records
- Data on coal quality and resources
- Descriptions of well cores and cuttings
- Digital geologic map data and other map resources
- Earth science educational materials
- General geologic information
- Paleontologic information

We have developed online tools to search for and retrieve publications, maps, and resource information for Kentucky. Copies of many of our publications are available free online as PDF files. In addition, our geologists travel throughout the state to assist people who have problems with sinkholes, landslides, and other geologic phenomena.

We're still engaged in traditional publishing and mapmaking. In the past 5 years, we have published nearly 100 titles, including five 1:100,000-scale, 30 x 60 minute geologic maps. We have developed an innovative series of maps with generalized geologic information for land-use planning. We have developed karst dye-trace maps in cooperation with the Kentucky Environmental and Public Protection Cabinet, coal resource maps in cooperation with the U.S. Geological Survey, and earthquake maps in cooperation with the Central United States Earthquake Consortium.

Each year our staff, on average, responds to 12,000 requests for information or assistance. We have excellent support facilities (such as the Well Sample and Core Library, analytical laboratory, and Western Kentucky Office). The Kentucky Seismic and Strong-Motion Network is the largest in the eastern United States; it has 25 seismic stations that provide real-time seismic records, which are posted on our Web site.

KGS is indeed a full-service geological survey!

James C. Cobb

State Geologist and Director

Digital Mapping

Milestone in digital geologic mapping

The Kentucky Geological Survey celebrated a milestone in the history of geologic mapping on April 30, 2004, when State Geologist and Director **Jim Cobb** announced the completion of geologic map coverage in digital format for the entire state. All 707 original printed geologic quadrangle maps (1:24,000-scale, 7.5-minute) for Kentucky were converted. This is an unprecedented accomplishment: no other state of large size has complete detailed geologic map coverage, and no other state of large size has detailed geologic map coverage in digital format.

The digital conversion of the original geologic quadrangle maps—called "GQ's"—began in 1996 with the establishment of the KGS Digital Geologic Mapping Program (www.uky.edu/kgs/mapping/mapping.html). The National Cooperative Geologic Mapping Act of 1992 and subsequent reauthorizations provided funding for the program; KGS supplied 50 percent of the costs. Oversight of the program by KGS and the USGS has ensured that the highest standards have been maintained in digitizing the data, that appropriate metadata are provided to assist the users, and that products are inexpensively and broadly distributed to the public.

Susan Bush, Commissioner of the Department for Natural Resources, Kentucky Environmental and Public Protection Cabinet, commented: "For the first time in our history, decision-makers across Kentucky will have instant access to critical information that will allow them to make well-informed decisons regarding future development and protection of our natural resources. Information that would have taken weeks of research and several thousand dollars to obtain on a project-by-project basis is now available at our fingertips. The valuable service the KGS has provided and continues to provide to Kentuckians is vital to wise and informed economic growth and the stewardship of our abundant natural resources."

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The conversion of the paper maps into digital format has numerous benefits. Many GQ's are out of print. The new digital data permanently preserve this valuable geologic information for use by future generations. Once the GQ's have been digitized, the newly created vector data are compiled and organized in databases and distributed to users on CD-ROM or through access on the World Wide Web. The digital format allows users to manipulate and analyze the data in a variety of computer applications and is particularly useful in geographic information systems.

Mapping surficial materials along the Ohio River in western Kentucky

Warren Anderson and **Drew Andrews** received a 1-year, $245,000 grant from the U.S. Geological Survey for the 2004 continuation of the STATEMAP Program. The funding will be used to convert geologic maps for Kentucky into digital format and to conduct new mapping of surficial materials along the Ohio River in western Kentucky.

This is the ninth consecutive year of funding from the USGS program. Since 1996, the Digital Geological Mapping Program (www.uky.edu/kgs/mapping/mapping.html) has generated total project awards of $1.6 million. Anderson has been the principal investigator throughout.

KGS is the top KYGEONET publisher

Kentucky's Geography Network (kygeonet.ky.gov) is a one-stop shopping site for geographic data resources for Kentucky. The site provides access to static map products and several Internet mapping services. In March 2004, of the 207 publication on KYGEONET, 82 were from KGS.

New GIS data available on KGS Web site

In fiscal year 2003–04, several new data sets were added to the geospatial data library on the KGS Web site (www.uky.edu/kgs/gis/intro.html).

- Wetlands maps, produced by the U.S. Fish and Wildlife Service, show categories of wetland areas on a 7.5-minute topographic base. landslide potential maps, produced by the U.S. Geological Survey, depict generalized slope-stability conditions at the time of field checking (1977–79). They are available for most of southeastern and south-central Kentucky. Mapped units depict the dominant stability conditions in delineated areas. These are preliminary maps and are suitable for general planning purposes only.

- Mapped sinkhole data, compiled by KGS and the Kentucky Speleological Survey Inc., were delineated from the outermost closed depression contour on USGS 1:24,000-scale digital topographic maps. These are vector data in ESRI shapefile format, in latitude and longitude coordinates (NAD83 datum.)

Expanded groundwater monitoring in eastern Kentucky

KGS hydrogeologists sampled groundwater at 30 sites in Kentucky basin management unit 5 (watersheds of the Big Sandy River, Little Sandy River, and Tygarts Creek) between fall 2002 and summer 2003 as part of the Groundwater Monitoring Program of the Kentucky Division of Water. Each site was sampled seasonally, and the analytical results were combined with existing data retrieved from the **Kentucky Groundwater Data Repository** maintained by KGS. A final report will assess the effects of nonpoint-source chemicals on groundwater quality in the region.

Groundwater quality in northeastern Kentucky

In cooperation with the Groundwater Branch of the Kentucky Division of Water, **Steve Fisher** is using analytical reports of groundwater quality stored in the **Kentucky Groundwater Data Repository** to evaluate natural and nonpoint sources of dissolved chemicals in groundwater in the Kentucky River, Salt River, Little Sandy River, and Tygarts Creek in the northeastern half of the state. The findings will be sent to the Division of Water, published as a KGS report, and made available on the KGS Web site.

Groundwater quality in the Jackson Purchase

Groundwater is used by more than 75 percent of the residents in the Jackson Purchase Region. Approximately 60 public utilities provide water from wells or well fields to residents, businesses, schools, and industry. During the past year, KGS hydrogeologists conducted research to better determine the role of 24-inch-diameter bored wells on shallow groundwater quality in the Jackson Purchase. These wells are constructed using jointed cement tiles, which allow groundwater to enter the well at varying depths below the land surface. Such wells are used because the shallow gravels and sands generally don't produce adequate quantities of groundwater from drilled, 4-inch-diameter wells. Because of their large diameter, bored wells also act as underground reservoirs. But because the joints between the tiles in the bored wells are not sealed, surface water can readily enter the well during or after a rainstorm, which may introduce contaminants to the drinking-water supply.

In cooperation with county extension service agents, county health departments, and personnel from the Natural Resources and Conservation Service, 131 large-diameter wells were sampled for nitrate and pesticides. Six percent of the wells sampled exceeded the maximum contaminant level (MCL) for nitrate and 20 percent exceeded half of the MCL. Sixty-two percent contained triazines, 29 percent contained metolachlor, and 15 percent contained alachlor.

KGS hydrogeologists will continue to sample bored and drilled wells through the Jackson Purchase to determine groundwater quality associated with different hydrogeologic settings. The results will be communicated to the public through State and local officials, as well as educational outreach programs. Funding for this research is provided by Kentucky Senate Bill 271, which is administered through the University of Kentucky College of Agriculture. The project is a cooperative effort between KGS and the UK Department of Agronomy.

Water supplies for rural communities in eastern Kentucky

The Kentucky Infrastructure Authority has provided funding for several years to help local communities find and develop raw water supplies. KGS hydrogeologists have worked in many eastern Kentucky counties to evaluate abandoned underground coal mines as potential supplies, and they have developed techniques to identify areas where high-yield wells might be drilled to obtain groundwater. The results were published in KGS Report of Investigations 10, "Using Remote Sensing and Inclined Drilling to Locate High-Yield Wells in the Eastern Kentucky Coal Field," by Robert Andrews, David Wunsch, Jim Dinger, and Glenn Dunno. The report may be accessed from the KGS online list of publications (kgsweb.uky.edu/main.asp).

Groundwater supply in eastern Kentucky

KGS hydrogeologists have evaluated the groundwater in the **Salyersville** area of **Magoffin County.** The yield and quality potential of the Corbin Sandstone are being studied. A well has been drilled, and several more locations have been selected for drilling in the summer of 2004. Well fields used by the petroleum industry for water supply 15 years ago are also being studied, and a pumping test for one such facility in northeastern Magoffin County is being designed.

Kentucky Groundwater Data Respository

The Kentucky Groundwater Data Repository was established in 1990 by KGS to archive and disseminate groundwater data collected by State agencies, other organizations, and independent researchers. Fiscal year 2003–04 was a banner year for the repository. The entire set of water-quality data was placed online in 2003, and a series of 30 x 60 minute quadrangle maps (1:100,000 scale) showing the location of water wells and springs across the state was completed. PDF versions of these maps may be accessed from the KGS online list of publications.

The Survey has also produced maps showing the concentration of nitrate, fluoride, pH, and arsenic in wells and springs throughout Kentucky; more maps are being completed for almost 30 additional parameters. Many of these maps, published in the KGS Information Circular series, are also available from the KGS online list of publications.

Kentucky karst atlas: helping communities avoid geologic hazards

Cover-collapse sinkholes

Economic losses resulting from karst hazards are generally unaccounted for because the incidents are scattered across the state, and individual incidents are relatively minor, compared to tornado or flood damage. But the increased cost of repairing roads, additional foundation preparation for large buildings, and extension of water distribution lines to replace polluted groundwater, all of which can be necessary because of cover-collapse sinkholes, increase the cost of publicly funded projects. A gross estimate of economic loss can be based on the estimated frequency of cover-collapse incidents. If one cover-collapse sinkhole per year per square mile requires repair, at an estimated average cost of $2,000, and there is 10,098 square miles of intensively karstified terrain, the upper limit on annual cost is $20 million a year.

In an effort to help communities understand the risks associated with karst hazards, **Jim Currens** and **Randy Paylor** are leading a pilot study to determine the frequency of cover-collapse sinkholes. Field work was completed in April 2004. Currens and Paylor identified potential cover-collapse features from aerial photography taken in 1971 of an area in **Christian County.** A second set of images taken in 1991 was obtained for the same area. Geologists from KGS visited each suspected site and confirmed or rejected that it was a cover-collapse sinkhole. The resulting calculation of the frequency of cover-collapse incidents is a minimum value; sinkholes that collapsed after 1971, but were filled or otherwise covered before 1991, could not be accounted for.

If a funding source is found, areas the size of 7.5-minute quadrangles will be chosen at random from the karst areas.

The frequency of occurrence of sinkholes will be determined for each major soil group, and for each stratigraphic unit in the quadrangles. The frequency values will then be interpolated across the karst areas of the state to construct maps showing the frequency by soil type or bedrock unit, as seems most advantageous.

Protecting water quality in karst springs

Many communities in Kentucky depend on karst springs for their water supply. For instance, **Georgetown** depends on **Royal Spring.** The groundwater basin of Royal Spring receives drainage from southern **Scott County** and northern **Fayette County,** both largely urbanized areas.

Hydrogeologists at KGS are nearing the completion of a set of maps that depict the time it takes a pollutant to reach Royal Spring. Multiple groundwater dye traces were required. Field work for the project is complete, and the maps and final report are under review.

Mapping karst groundwater basins in the Inner Bluegrass
Jim Currens and **Randy Paylor** completed an October 1999–June 2004 project to map karst groundwater basins in the Inner Bluegrass. More than 170 groundwater dye traces were conducted in the area of the Lexington and Harrodsburg 30 x 60 minute quadrangles. The resulting data were used to substantially rrevise previously published maps of the groundwater basins in the quadrangles. The revised maps are available from the KGS online list of publications.

Carbon sequestration: a strategy to reduce atmospheric emissions of carbon dioxide

Researchers at KGS completed a 3-year study on carbon sequestration in December 2003. This is a process in which CO_2 emitted in the atmosphere is captured and securely stored in subsurface reservoirs. With funding of $476,000 from the U.S. Department of Energy, **Jim Drahovzal** and **Brandon Nuttall,** together with colleagues at four other state geological surveys, have built an integrated database of information, called the Midcontinent Interactive Digital Carbon Atlas and Relational Database (MIDCARB). The Web-based atlas (www.midcarb.org) has information about the sources of CO_2 emissions and the location of possible geologic sinks in Kentucky, Illinois, Indiana, Ohio, and Kansas. Major sources of CO_2 include power plants, and the database includes their emissions records. Geologic sinks such as saline reservoirs, coal beds, oil and gas fields, Devonian shale, and deep-basin reservoirs in the Precambrian sedimentary units are identified. The database can be used to estimate the amount of CO_2 emitted by a source (for example, an electric power plant) and evaluate how close this source is to reservoirs in the five states that can provide safe and secure, long-term storage.

The carbon dioxide storage capacity of geologic sinks in Kentucky is estimated to be capable of sequestering up to 370 years of carbon dioxide.

A half-million dollar study, also funded by DOE, is investigating a strategy for sequestration in which CO_2 is injected into organic-rich shales. Nuttall and Drahovzal are studying samples of Ohio Shale to see if they adsorb CO_2. Results to date indicate that the most CO_2-adsorbent part of the Ohio Shale is the organic-rich Lower Huron Member. Preliminary estimates indicate that these Devonian black shales in Kentucky, deeper than 1,000 feet and thicker than 100 feet, could be used to store up to 27.7 billion tons of CO_2, or more than 300 years worth of carbon dioxide from power plants in the state at current emission rates.

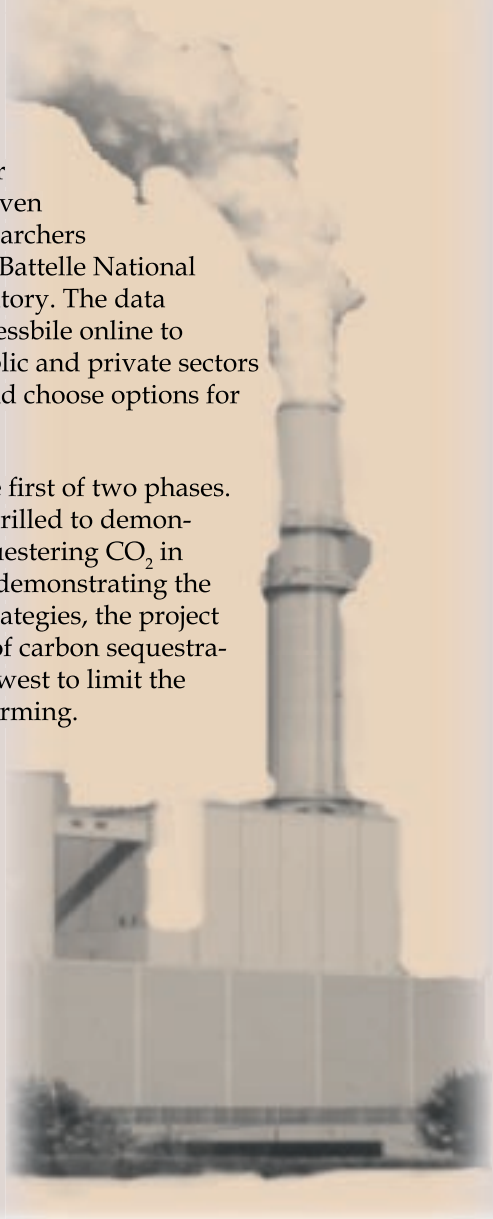
The black shale underlies approximately two-thirds of Kentucky and is the largest source of natural gas production in the state. If such shales prove to be a viable sink for CO_2, their extensive occurrence would make them an attractive option for carbon sequestration. There would also be potential for enhanced natural gas production. More information is available at www.uky.edu/kgs/emsweb/devsh/devshseq.html.

Carbon sequestration in the Midwest

Carbon dioxide is a greenhouse gas considered to be a major contributor to global warming. In two projects funded by the U.S. Department of Energy, KGS geologists are compiling and updating data on the major CO_2 sources and geologic sinks (storage sites) in the Midwest. GIS data will be included in the MIDCARB database for a variety of infrastructure components, such as oil and gas pipelines. The geologic frramework of the region will be investigated so that options for safe and secure long-term storage of CO_2 will be better understood.

DOE is providing $251,000 to fund the 2-year project through September 2005. **Jim Drahovzal** and **Brandon Nuttall** are collaborating with coleagues at five other state geological surveys, seven industry partners, and researchers from four universities and Battelle National Energy Technology Laboratory. The data being compiled will be accessbile online to decision-makers in the public and private sectors who want to investigate and choose options for long-term storage of CO_2.

The data compilation is the first of two phases. Ultimately, a well will be drilled to demonstrate the feasibility of sequestering CO_2 in various geologic sinks. By demonstrating the success of sequestration strategies, the project should encourage the use of carbon sequestration technology in the Midwest to limit the effects of CO_2 on global warming.



By demonstrating the success of carbon sequestration strategies, a multidisciplinary, interagency study should encourage the use of carbon sequestration technology in the Midwest to limit the effects of CO_2 on global warming.

Carbon sequestration regional partnerships

Jim Drahovzal, Brandon Nuttall, and colleagues from the Illinois, Indiana, Kansas, and Ohio geological surveys and the National Energy Technology Laboratory are cooperating to develop and link databases containing information on carbon sequestration.

The resulting integrated database structure, NATCARB, will allow each partner to retain ownership and control its own data, while allowing visitorrs to view data across partner boundaries.

KGS is an original partner in this $100,000 project funded by the U.S. Department of Energy. It is an extension of the MIDCARB project. KGS is responsible for assisting in the development of NATCARB for two of seven regional partnerships. A beta Web site is available at www.natcarb.org.

Aiding natural gas exploration in the Appalachian Basin

In a recently completed project, funded with $144,000 from the New York State Energy Research and Development Authority and Triana Energy of Charleston, W.Va., **Dave Harris, Jim Drahovzal,** and UK graduate student **Clay Wilcox** studied the geology and geochemistry of Ordovician tectonic dolomite outcrops and new cores in central Kentucky.

In a related project, Harris, Drahovzal, and UK graduate student **Bill Reid** used high-resolution seismic acquisition to conduct a geophysical study of shallow subsurface tectonic dolomite. This $25,000 study was funded by the U.S. Department of Energy.

Both studies contribute to an improved understanding of the origin and distribution

of fault-related dolomites in central Kentucky, which in turn will aid in the exploration of oil and natural gas reserves in the region. More information on both projects is available at www.uky.edu/kgs/emsweb/trenton/trnt.html.

Research by KGS geologists is contributing to an improved understanding of how natural gas reservoirs form in the eastern United States. This will aid in the exploration for natural gas reservoirs.

Geologic play book for oil and gas exploration in the Trenton–Black River of the Appalachian Basin

Jim Drahovzal and **John Hickman** are collaborating in a multidisciplinary project with colleagues at the geological surveys of Ohio, West Virginia, and Pennsylvania and the New York State Museum to study a multitude of factors that may influence the location of oil and natural gas reserves and optimal production from fractured Trenton–Black River oil and gas fields in the Appalachian Basin. This 2-year project is funded with $307,000 from the U.S. Department of Energy and a consortium of 18 oil and gas companies.

Numerous recent oil and gas discoveries in West Virginia (Cottontree Field), New York (Gloades Corners and Muck Farm Fields), Ohio (Lima-Indiana and others), and southwestern Ontario (Dover Fields and others) produce from similar features found in the same geologic units as those that lie beneath the surface in Kentucky. Researching the possibilities of similar oil and gas reservoirs in Kentucky could lead to increased oil and gas production, resulting in economic benefits to the commonwealth.

Coalbed methane in western Kentucky

Although the coals of Kentucky contain methane, this resource has not been developed because its economic potential is not well understood. Energy companies interested in developing the resource need information about the methane content of coal resources.

In a 1-year, $500,000 project, **Cortland Eble** and **Jim Drahovzal** are studying methane content, permeability, and well-completion data for selected Illinois Basin coals. Eble and Drahovzal are collaborating with colleagues from the geological surveys of Illinois and Indiana. The research is funded by the U.S. Department of Energy, Illinois Department of Commerce and Community Affairs/Department of Economic Opportunity, Kentucky Consortium for Energy and Environment, Charlois Coal, Royal Drilling and Production, and Black Beauty Coal.

Assessing Kentucky's coal resources

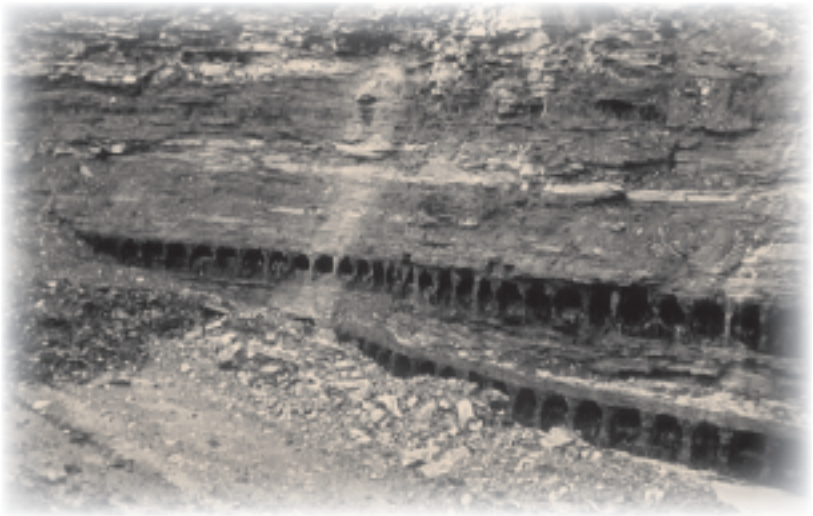
The Availability of Coal Resources for the Development of Coal is a U.S. Geological Survey program to characterize and quantify coal resources in specific parts of the country. Coal geologists **Jerry Weisenfluh, Drew Andrews,** and **Bethany Overfield** have studied coal resources in the Eastern and Western Kentucky Coal fields for several years as part of this program and another USGS program, National Coal Assessment.

From August 2003 to July 2004, Weisenfluh, Andrews, and Overfield characterized the Davis (W. Ky. No. 6) and Dekoven (W. Ky. No. 7) coals in western Kentucky. Potential stratigraphic problems were identified with the Dekoven coal, so it was necessary to update previous assessments of remaining resources conducted in the 1970s. After stratigraphic issues were clarified, original resources were calculated for both beds, using substantially larger data sets than had been used previously. Mined-out areas were substracted from the original total to calculate remaining resources. Technological and land-use restrictions to mining were determined and substracted from the remaining resources to calculate the resources available for production. This is the first accurate assessment of the Dekoven bed. The results of this study are available as KGS Open-File Report OF-04-01; a PDF file of the report is available from the KGS online list of publications. Assessments of the Fire Clay, Lower Elkhorn, Upper Elkhorn No. 3, and Amburgy coals in eastern Kentucky are in progress.

Enhancing coal quality data

Data on coal quality help electric utility staff locate and delineate areas of Kentucky that have mineable coal with specific quality parameters (low ash and low sulfur). The utilities want to use coal with low ash and sulfur content in order to comply with environmental regulations governing atmospheric emissions from the burning of coal. In addition, areas identified as having low-grade coal (high ash and sulfur content) may be targets for facilities using clean coal technologies (for example, fluidized bed combustion and coal gasification).

The National Coal Resources Data System (energy.er.usgs.gov/products/databases/CoalQual) includes a database of national coal quality data that have been compiled since the 1970s. In a 1-year study funded by KGS and the USGS, **Steve Greb** and **Cortland Eble** are augmenting the NCRDS database with newly acquired coal quality information. Many of the coal quality records from the KGS borehole records database were analyzed and assembled by Greb and Eble into a report on coal-quality variability on a mine scale.



Understanding the stratigraphy of rock units in the area of the Paducah Gaseous Diffusion Plant

Regional groundwater flow and transportation of contaminants in the area of the U.S. Department of Energy's Paducah Gaseous Diffusion Plant have been the subjects of research for several years. In order to accurately model the groundwater flow and transportation of contaminants, the spatial distribution of hydraulic conductivity, which in turn depends upon the uniformity of subsurface flow units, must be understood.

Steve Greb of KGS and **Alan Fryar** of the UK Department of Geological Sciences are using lithologic logs, outcrop mapping, and shallow high-resolution seismic surveys to develop a conceptual stratigraphic framework for the plant area. The framework will be used to develop more realistic groundwater flow models for the plant area. It will also be useful for assessing the potential for amplification of earthquake ground motions in near-surface sediments. The study will be completed by September 2005.

Mitigation of Natural Hazards

Kentucky Seismic and Strong-Motion Network

The Kentucky Seismic and Strong-Motion Network, jointly operated by KGS and the UK Department of Geological Sciences, was expanded in fiscal year 2003–04 with funding from two grants from the U.S. Department of Energy and the U.S. Geological Survey. One new seismic station is under construction in **Lovelaceville.** A new vertical strong-motion array, consisting of two three-component accelerometers located at a depth of 105 meters and one three-component short-period sensor at a depth of 46 meters, is under construction near the Paducah Gaseous Diffusion Plant in the Western Kentucky Wildlife Management Area. A new seismic station is also under construction at the Paducah airport.

Zhenming Wang and **Ed Woolery** are conducting research to improve our understanding of seismic risk in western Kentucky, the area surrounding the Paducah Gaseous Diffusion Plant in particular. Of critical importance is the true location and nature of the northern terminus of the New Madrid Seismic Zone and its relation to the Wabash Valley Seismic Zone to the north.

The new vertical strong-motion array, replacing the old vertical strong-motion array near the diffusion plant that was decommissioned several years ago, will provide critical information on ground motion and seismicity near the plant. This research is important for seismologists, engineers, building-code officials, emergency managers, and federal, state, and local government agencies assessing seismic risk in western Kentucky, especially **Paducah.**

The seismic network recorded several earthquakes in the Jackson PUrchase Region, including the June 6, 2003, Bardwell earthquake (magnitude 4.0), and provided valuable information, summarized in KGS Special Publication 6, "Observed Seismicity (Earthquake Activity) in the Jackson Purchase Region of Western Kentucky: January through June 2003." A PDF version of this publication can be accessed from the KGS online list of publications.

Assessing mine-void hazards

Mine voidspose significant economic and safety threats for citizens residing in coal fields in Kentucky. With support from a $120,000 enhancement grant from the UK College of Arts and Sciences, researchers at the UK Department of Geological Sciences and KGS are expanding the use of engineering geophysics to seek innovative ways to mitigate the enormous losses associated with nonseismic geologic hazards.

The research group's initial effort, in cooperation with the UK Department of Mining Engineering and Carnegie Mellon University, involves pilot field studies to assess an integrated state-of-the-art geophysical and robotic exploration technique for identifying and delineating mine voids in eastern Kentucky.

Seismic hazard assessment of the Paducah Gaseous Diffusion Plant and its vicinity

The federal government uses seismic hazard maps produced by the U.S. Geological Survey for seismic safety regulation. The maps currently being used predict the ground motion with 2 percent probability of being exceeded (PE) in 50 years, or 10 percent PE in 250 years. Under current U.S. Nuclear Regulatory Commission regulation (10 CFR 36.2), the Paducah Gaseous Diffusion Plant and its vicinity are subject to extremely high peak ground acceleration (PGA). Such a high PGA assessment could make it cost-prohibitive to design and build any facility, such as new landfills, at or in the vicinity of the plant site.

A sensitivity analysis showed that the seismic hazard in western Kentucky is dominated by earthquakes from the New Madrid Seismic Zone. there is also much uncertainty inherent in the ground motion hazard for western Kentucky, particularly concerning the northern boundary of the New Madrid Seismic Zone and ground motion attenuation near seismic sources.

The best way to define the New Madrid boundary is to monitor earthquake activity in the area. The new and existing seismic stations in western Kentucky will provide better information on earthquake activity in the region and help reduce the uncertainty about the boundary. The strong-motion data recorded during the last 2 years have provided valuable information about near-source ground-motion attenuation.

Assessing seismic issues in western Kentucky also requires intensive communication with relevant government and non-government agencies. **Zhenming Wang** and **Ed Woolery** have actively communicated with personnel from federal agencies, including the USGS and the Nuclear Regulatory Commission, and other national experts on seismic-hazard assessment in the central United States, and western Kentucky in particular.

Wang attended the Building Seismic Safety Council annual meeting March 10–11, 2004, and gave a presentation at the Seismological Society of America annual meeting April 13–16, 2004. A paper, "Communication with Uncertainty: A Critical Issue with Probabilistic Seismic Hazard Analysis," was published in *EOS,* the professional journal of the American Geophysical Union in November 2003.

Disaster preparedness for the Greater Evansville area

KGS's Western Kentucky Office and the Disaster Prepared Communities Corporation of Southwestern Indiana hosted a tri-state conference on Quaternary mapping in **Evansville, Ind.,** November 18–19, 2003. The conference reviewed the current understanding of the Quarternary for the Greater Evansville area and laid the groundwork for organizing a cooperative effort to geologically map these sediments. The participants discussed the mapping requirements necessary to support the detailed assessment of earthquake hazards of a seven-state region.

Seismic hazard maps for western Kentucky

The Tri-State Mapping and Hazards Assessment Group is a cooperative effort among geologists from the U.S. Geological Survey, state surveys, the Central United States Earthquake Consortium State Geologists, educational institutions, and local government. The group, established in September 2003, is participating in a 5-year program to map the Ohio Valley sediments in the **Evansville, Henderson,** and **Owensboro** area and develop seismic hazard maps for this region. They want to develop a better understanding of the geology and seismic risks that are particular to the region. Researchers are hoping to secure funding for drilling, seismic investigations, modeling of depositional environments, collecting geotechnical data, and performing remote sensing and educational outreach.

With funding from the STATEMAP program, KGS geologists are mapping unconsolidated materials along the Ohio River in Kentucky. They are also assisting USGS geologists who are mapping areas in Indiana to expand previous mapping completed by the Indiana Geological Survey.

Geologists at KGS are developing subsurface information from boreholes, water wells, and petroleum tests. By mapping the surface and developing subsurface information and gathering geotechnical information such as shear-wave values, the KGS and other research programs will develop maps that will illustrate the risks to people and property from earthquakes in the New Madrid and Wabash Valley Seismic Zones.

High-resolution geophysical and geologic investigation of Late Quaternary deformation in the Lower Wabash Valley Fault System

Considerable uncertainty remains about the locations of faults responsible for large paleoearthquakes in the central United States. **Zhenming Wang** and **Ed Woolery** are conducting a geophysical and geological investigation to more rigorously define the spatial and temporal characteristics of recently discovered neotectonic deformation in the southernmost Wabash Valley Fault System. Field investigations will integrate high-resolution seismic-reflection/refraction profiling (shear wave), ground penetrating radar imaging (groundwater is about 6 to 10 meters below the surface), and correlative coring/carbon-14 dating across major faults of the lower Wabash Valley Fault System. Preliminary work has thus far been able to constrain fault movement between about 26,000 and 42,000 years before the present age. Deformation of this age, along with evidence of historical and contemporary seismicity, classifies the particular fault segment as "capable" (movement within the last 35,000 years), according to U.S. Army Corps of Engineers and Nuclear Regulatory Commission criteria. The results of this study could have significant design implications for high-hazard and critical facilities in the area; moreover, results will be an important step in the USGS's efforts in the central United States to locate and charracterize seismogenic faults, and better constrain seismic source zone boundaries.

Serving the Public

Revolutionizing public service—the KGSGeoPortal

A revolutionary new system for accessing geologic data, maps, and publications for Kentucky went online in April 2004. The new **KGS-GeoPortal (kgsweb.uky.edu/main.asp)** is a convenient clearinghouse for map-based data and online databases and publications about geology in Kentucky, as well as other geographic data in the state.

Enter the KGSGeoPortal
Gateway to Online Maps, Databases, and Publications for Kentucky

The Survey has numerous databases and thousands of maps and publications that are accessible online. Other State agencies also maintain online maps. In the past, numerous databases maintained by several different agencies had to be accessed in order to gather data. Before the KGSGeoPortal, KGS staff could assist customers only during normal business hours.

This has all changed! Accessing data is now greatly simplified and made much more efficient with the tools provided by the KGSGeoPortal. Customers and researchers can access data from multiple sources on a 24-7 basis any time, at their convenience, from any location with an Internet connection.

Frequently, information required for a specific geographic location (for example, oil and gas well locations in Pike County; water well locations in the vicinity of Somerset; coal information in proximity to a stream drainage; all publications with geologic information from the Paducah 7.5-minute quadrangle). A geographic area of interest can be specified, and KGSGeoPortal tools will quickly access links to KGS databases and other sites that have map-based data and online publications about that area. Numerous sites with information about Kentucky's geology, landscape, environment, energy and water resources, and infrastructure are a click away. Using the portal, several services can be linked using the same map extent.

The KGSGeoPortal will be useful to anyone who has Internet access and is interested in locating information about Kentucky's energy resources (oil, natural gas, and coal), coal mines (historical, active, and surface), water wells, wastewater projects, water projects, water management planning, general geology, and land-use planning.

Data and maps can simultaneously be examined in adjacent windows on the KGSGeoPortal in order to identify relationships and patterns. This is the basic concept of a geographic information system. This service-to-service linking capability of the KGSGeoPortal is a particularly powerful too. In the future, additional links will be made to other relevant online databases and interactive maping services in order to enhance the serivce-to-service linking capability and increase the quality of public service made possible through the site.

"The Kentucky Geological Survey has been in the vanguard of bringing Kentucky into the digital age. Information that would have taken weeks of research and several thousand dollars to obtain on a project-by-project basis is now available at our fingertips."

—Susan Bush, Commissioner, Department for Natural Resources

Increasing public awareness of unique geology in Kentucky

In conjection with its 2004 fall field trip, the Kentucky Society of Professional Geologists designated the Middlesboro–Cumberland Gap area in **Bell County** as the third Distinguished Geologic Site in Kentucky. Middlesboro is the best-developed of three possible meteor impact craters in Kentucky. The broad crater basin has provided developable land for Middlesboro to grow to a sizeable city, and local coal and iron deposits have supported the area economy. The geology of nearby Cumberland Gap has also played a key role in the area's transportation history and the history of the Commonwealth as a whole.

Informing the public about groundwater quality

In April, KGS hydrogeologist **Steve Fisher** received a $450,000 grant from the U.S. Environmental Protection Agency for a 10-year project to make information on groundwater quality readily accessible to the public through the KGS Web site. The Web site will help Kentucky's citizens understand the importance of groundwater, including its quality throughout the commonwealth, potential threats to the resource, and ways to protect and preserve it.

Fisher and colleagues at KGS will develop Web-based interactive maps that will show sample sites and concentrations of various dissolved chemicals. The maps will link to statistical summaries for each chemical, and information will be provided to describe potential sources and health hazards associated with each chemical. Practices that can abate or prevent groundwater contamination will also be recommended. The final phase of the project will consist of a series of educational and training workshops where the products will be demonstrated; the workshops will also serve to inform the public about their availability. The project is administered through the Nonpoint Source Section of the Kentucky Division of Water.

New Western Kentucky Office in Henderson

The KGS office in Henderson moved to new facilities in August 2003. To reflect the permanent nature of the office, the name was changed to "Western Kentucky Office." The new larger facilities made it possible to bring together numerous data sets and make them available to the public. The University of Southern Indiana generously transferred to KGS its collection of petroleum data files. These files include pipeline production books for Indiana, Illinois, and western Kentucky for the years 1948 to 2000. Microfiche copies of petroleum well files for Indiana and Illinois were also transferred.

The new records, togethr with the extensive petroleum well files for western Kentucky that were already available, have made the Western Kentucky Office an invaluable asset to the petroleum industry throughout the tristate area. Public access for all these records make the Western Kentucky Office one of the most remarkable regional resources available to the petroleum industry. KGS will continue to improve the quality and accessiblity of the petroleum records by updating and scanning new materials, and posting them online to ensure that the most complete record set is available for public access.

The Western Kentucky Office serves as a base for research efforts by KGS staff and others working in the region. The KGS Henderson staff are involved in groundwater research, mapping of unconsolidated sediments in th Ohio River Basin, water-well construction, seismic hazard assessment, and research on coal mining and petroleum exploration. A new garage will be built to house equipment for collecting seismic profiles, obtaining downhole shear-wave values, and a shope for repairing field equipment. A laboratory for analyzing core and auger samples will also be part of the new garage. The drop location for oil well samples will also be relocated to the new facility.

The expanded facilities and the focus on research, field work, and public service in western Kentucky will continue to be an asset to the citizens of that region.

Helping people understand groundwater/surface water interaction in karst regions

Steve Fisher taught a module, "Groundwater/Surface Water Interactions in Karst Regions," as part of a short course at the 2004 Conference of the National Water Quality Monitoring Council, May 17–20, 2004. **Jim Currens** coauthored the short course materials. The National Water Quality Monitoring Council helps the international monitoring communicty develop methods and tools for monitoring and reporting water quality. Fisher also presented a poster and paper describing the methods used to summarize groundwater quality in Kentucky in work conducted by KGS for the **Kentucky Groundwater Monitoring Network.** The paper and poster were coauthored with **Peter Goodmann** and **James Webb** of the Kentucky Division of Water.

National attention for KGS online oil and gas well records

The Web-accessible KGS database for oil and gas well records was featured in an article in the August 2003 issue of *Government Technology* (www.govtech.net).

KGS annual seminar

The 44th annual KGS seminar, held at the Well Sample and Core Library in **Lexington** on April 30, 2004, featured five workshops to demonstrate the use of online maps and data available at KGS and discuss new techology used in current research projects. The workshops covered online groundwater data; online geologic data, maps, and reports' online data for carbon sequestration options and planning decisions; and seismic tools for geophysical field work and research.

Awards and Appointments

Paul Howell, a geologist with the U.S. Natural Resources and Conservation Service, received the 2004 KGS Distinguished Service Award on April 30. In recognizing his achievements, **State Geologist Jim Cobb** commended Howell for his lifelong dedication to promoting a better understanding of geology and its impact on the lives of Kentuckians.

In June 1967, Howell became the U.S. Department of Agriculture–Soil Conservation Service state geologist for Kentucky. His early work focused on the design of multipurpose watershed structures. During the past 20 years he has traveled across the state teaching people about the rocks they live on, and how to build their homes, ponds, reservoirs, and other facilities to avoid geologic hazards. during his 37 years of service, his geologic expertise has been widely respected.

C. Blaine Cecil, a research geologist with the U.S. Geological Survey in Reston, Va., gave the Second Donald C. Haney Distinguished Lecture in Lexington on February 26, 2004. In his talk, "Travels in Indonesia: A Potpourri of Geology and People," he explained how areas in tropical Indonesia and Australia are an analog for tectonic, eustatic, and climate controls on the origin of coal and coal-bearing strata. He explained why the study of peat in Indonesia contributes to an improved understanding of the origin of coal in Kentucky.

Carol Ruthven, Manager of Communications and Technology Transfer, was elected president of the Association of Earth Science Editors for 2003–04. **Meg Smath,** KGS editor, was elected to a 3-year term on the AESE Board of Directors in November 2003. She is also serving on AESE's Web Committee.

Richard Smath, the Earth Science Information Center Coordinator, was elected president of the Kentucky Society of Professional Geologists.

Jim Drahovzal, head of the Energy and Mineral Section at KGS, was elected treasurer of the Eastern Section of the American Association of Petroleum Geologists in September 2003. **Jim Currens,** a hydrogeologist in the Water Resources Section, was given an award for meritorious contributions in environmental geoscience by the Eastern Section of AAPG.

Matt Crawford, a geologist in the Energy and Minerals Section, was elected to the Friends of McConnell Springs Board of Directors for 2004. McConnell Springs is a nature preserve and historical site owned by the Lexington-Fayette Urban County Government and operated by the Division of Parks and Recreation (www.lfucg.com/ParksRec/McConnell-Springs.asp).

Paul Howell (left) and State Geologist Jim Cobb.

Blaine Cecil.

Carol Ruthven.

Fiscal year 2003–04 highlights

Number of active projects:	26
Amount of external funding:	$2,037,952
Number of publications:	57
Responses to technical inquiries or requests for information:	18,034*
Number of professional presentations by KGS staff:	170

*telephone, fax, e-mail, Web site, and office visits

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Web Site
www.uky.edu/KGS

Earth Science Education Network
www.uky.edu/KGS/education/education.html

KGS Online List of Publications
kgsweb.uky.edu/main.asp

Mission statement

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

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