

Kentucky Cross Section

Earth Resources—Our Common Wealth

Winter 2016

Geological Survey collaborates in study of landslide hazards in Kentucky

A wooded slope in Pulaski County has become the most recent landslide research site for Matt Crawford of the Geologic Hazards Section. “It’s adjacent to a known landslide that has caused damage to several homes,” he says. “It’s accessible from the Forest Service road, and it’s not too steep. We can walk around the site and get work done.”

The monitoring site, on a slope above Lake Cumberland, is representative of the area’s terrain and shaly underlying bedrock geology, helping Crawford to better understand landslide mechanisms in the region.

He and a U.S. Geological Survey landslide researcher have collaborated to install instruments at the Pulaski County site to monitor conditions such as rainfall, soil water content, and the gradual movement of the slope.

Measurements of the electrical resistivity of the soil are also being used to detect excess moisture and clayey soil types, which are part of the conditions that lead to slope failure.

“Collaboration between the USGS and KGS also allows both agencies to stretch their limited research funds to conduct the monitoring,” says Crawford’s USGS research partner, Francis Ashland, of the USGS Landslide Hazards Program. “Both agencies



Landslide researcher Matt Crawford downloads data from the Pulaski County monitoring site.

—Continued on p. 6

Phase 2 of rare-earth elements in coal refuse study begins

As American dependence on foreign sources of rare-earth elements increases, a second phase of research is getting under way at UK on recovering these elements from domestic coals. KGS is one of the partners involved in the research with project leader Rick Honaker of the UK Mining Engineering Department. Rare-earth elements are essential to a wide variety of technology applications from consumer products to military weap-

ons systems. The majority of global production of rare-earth elements has shifted to China in recent decades; none is currently being produced in the United States.

Rare-earth-bearing minerals can be found in coal and have the potential of being concentrated during coal-preparation processes. They are also found in the ash byproduct from coal-fired power plants. Some Kentucky coal beds contain higher

—Continued on p. 4

Kentucky Geological Survey
228 Mining & Mineral Resources Bldg.
University of Kentucky
Lexington, KY
40506-0107
859.257.5500
fax 859.257.1147
www.uky.edu/KGS
Jerry Weisenfluh,
Interim Director
Mike Lynch, Editor,
Kentucky Cross Section, mike.lynch@uky.edu
Meg Smath, Copy Editor

Annual seminar with energy theme planned for May 13

KGS has scheduled its 56th annual seminar for Friday, May 13, with the timely theme of “Navigating the New Energy Landscape in Kentucky.” Presentations will begin at 8:30 a.m. at the Well Sample and Core Library on Research Park Drive in Lexington. The speaker list and workshop agenda is being developed, and meeting updates will be posted on our website and our calendar. ❖

Director's Desk

KGS was originally established as a State agency in 1854, and this is only the 69th year that we've been a member of the University of Kentucky community. There have been four state geologists during that time, beginning with A.C. McFarlan in 1948, followed by Wally Hagan, Don Haney, and Jim Cobb. That's an average of 17 years per director. That kind of continuity is one of the great benefits of being at UK. A few of the current 43 KGS staff members have served under three of those directors, and one active retiree served under all four! Staff continuity translates to 788 years of cumulative experience in conducting geoscience research and public service for the commonwealth—an invaluable resource. I believe we are fortunate to be located at UK and appreciate all the support we receive from the university. The next two budget years are surely going to be a challenge for us, but I'm confident we'll continue to provide the programs and services that we are known for.

Geologic mapping continues to be a priority for KGS. The economic value of the bedrock geologic quadrangle maps has undoubtedly been immense for Kentucky. One study conducted many years ago estimated a benefit as much as 39 times the original \$20 million cost for the program. And they keep on paying back year after year. The maps are used extensively for resource development, geotechnical engineering assessments, land-use planning, environmental remediation, and academic studies. We've recently completed another 66 geologic maps focused on surficial deposits, and these new data will be extremely important for improved land-use planning, water-resource development, and seismic-hazard assessments. We hope to produce these new surficial geologic maps in regional compilations and on our website, as contiguous areas are completed, as we did with our bedrock map series.

Our Water Resources Section has been busy conducting research to assess both surface and groundwater resources across the state. Intensive field sampling has been conducted to evaluate the water

quality of streams in parts of Muhlenberg County, and a large groundwater-quality



Jerry Weisenfluh

sampling project is just beginning in northeastern Kentucky. We've also been assessing groundwater availability in karst aquifers in Hardin County and groundwater quality in the Cane Run/Royal Spring basin in central Kentucky. The data and improved understanding of groundwater and surface-water systems provided by these projects, and by the new groundwater-level monitoring network, will be crucial in coming years to ensure sustainable use of the state's water resources.

These are just a few examples of the work that is being done at KGS to benefit the commonwealth. You'll find more in this issue of *Kentucky Cross Section*. I hope you enjoy the reading. ❖

Paul Potter honored with highest award conferred by AAPG

Information for this story came from the December 2015 edition of the *AAPG Explorer*.

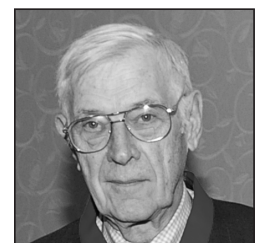
Geology professor, researcher, and author Paul Potter will receive the Sidney Powers Memorial Award, the highest honor given by the American Association of Petroleum Geologists, at the AAPG's June convention in Calgary, Canada. Potter, who has more than six decades of experience, is a professor emeritus in the Geology Department at the University of Cincinnati. He has also collaborated with KGS on a number of projects

and publications, earning him the unofficial title of Best Unpaid KGS Employee at the 2007 KGS annual seminar.

Potter "is widely celebrated as an expert on the Midwestern U.S. Paleozoic—he performed groundbreaking research on paleocurrent analysis and basin analysis—and is the author of 'Sedimentology of Shale' (1980), one of the first textbooks on the subject," according to a December news release from

AAPG. The Sidney Powers Award, named for a founding member and 14th president of AAPG, annually recognizes distinguished contributions to or achievements in petroleum geology, according to the release.

Potter is credited with authoring or co-authoring 130 articles and maps, along with seven books, including "Exploring the Geology of the Cincinnati/Northern Ken-



Paul Potter

—Continued on p. 5

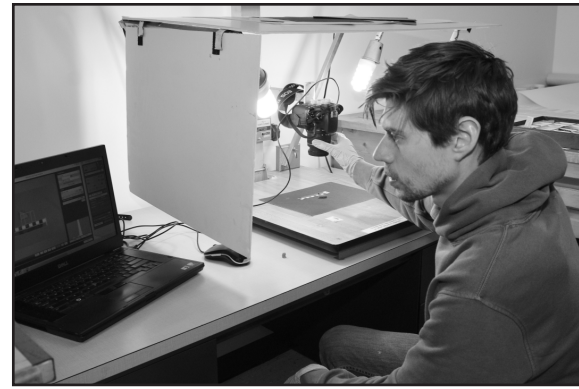
KGS meteorite collection photographed for new web page

Much of the KGS collection of more than 200 meteorites is on display in glass cases in the atrium of the Mining and Mineral Resources Building on the UK campus, where visitors can browse them. But curator Warren Anderson of the Energy and Minerals Section plans to make photos and information about the collection available to a much larger audience through the KGS website with the help of other KGS staff and a UK student. Ethan Davis, a Fort Thomas, Ky., geology student in the Department of Earth and Environmental Sciences, has begun the long process of photographing each of the meteorites.

The Survey's collection grew exponentially with the large 2014 donation by the late William Russell, a meteorite collector and ama-

teur astronomer from Goshen, Ky. His collection included specimens of major meteorites from around the world, as well as some that fell in Kentucky. KGS also has specimens donated earlier by William Ehman, a former UK chemistry professor and nationally recognized meteorite and moon-rock researcher.

"I'm planning to include a world map on the website, showing the location where each meteorite in our collection fell, along with specific information about them," Anderson says. "Close-up photos will show the interesting character of the specimens, such as Widmanstätten patterns, which are long nickel-iron crystals, found in certain types of meteorites."



UK student Ethan Davis adjusts the camera settings as he takes photos of a specimen in the KGS meteorite collection.

Richard Smath of the Geologic Information Management Section is editing the photos and adding identification labels to prepare the pictures for loading to the website. The process is expected to take several months. ❖

Final report issued for brine disposal framework for the northern Appalachian Basin

Increasing shale-gas production and the accompanying production of brine and flowback waters from wells have increased demands for disposal wells in the Appalachian Basin. In response, a multistate project began 3 years ago to develop a geologic and operational framework for safe and economical disposal of the produced fluids in the northern Appalachian Basin. The project was funded by the Research Partnership to Secure Energy for America; Battelle Memorial Institute was the principal investigator. State surveys in Ohio, Pennsylvania, West Virginia, and Kentucky were subcontractors on the project. Kentucky Geological Survey staff, Tom Sparks and Marty Parris, conducted the Kentucky portion of the work.

The project study area covered eastern Kentucky, Ohio, Pennsylvania, and West Virginia. Operational data for more than 200 Class II brine-disposal wells were collected from 2008 through 2012. The compilation showed brine has been injected into a variety of Cambrian through Pennsylvanian reservoirs, and injection in these reservoirs increased from 6 to 7 million barrels per year to about 18 million barrels per year by 2012. The more than twofold increase was driven largely by shale-gas development. In addition, the study compiled reservoir data, developed models for reservoir characteristics, and conducted advanced reservoir and geomechanical simulations.

KGS contributed three whole-core samples for rock mechanics testing (compressive, acoustic, and

tensile-strength testing) from the KGS No. 1 Hansen Aggregates stratigraphic test well in Carter County. Operational data (monthly volumes injected, average and maximum injection pressures) were provided for 30 active brine-injection wells in eastern Kentucky.

The project ended last October, and a final report is available at the Research Partnership website, www.rpsea.org/projects/11122-73. One of the major findings of the study was provided through a source-sink analysis, a geographic analysis of where produced fluids are generated and where they can be disposed of. The analysis concluded that "there may be ultimate demand for brine disposal related to unconventional production of approximately 700–2,300 million barrels, while the capacity for brine disposal in depleted

—Continued on p. 6

Brandon Nuttall in South Africa

Brandon Nuttall of the Energy and Minerals Section was invited to speak about the New Albany Shale in Pretoria, South Africa, in early February. He made his presentation, “Successes and Challenges in Developing Shale Resources,” at a conference of the Shale Research Group of the South African Council for Geosciences. The research group is planning to drill a deep test hole to acquire data to better characterize the shale and deep freshwater resources in South Africa. ❖



Rare-earth elements—continued from p. 1

levels of rare-earth elements compared to coals elsewhere in the United States. Cortland Eble of the Energy and Minerals Section leads the KGS portion of the project, and says KGS staff will locate refuse areas at coal-preparation plants and determine the amount of material in them. The KGS laboratory will analyze coal and coal-waste samples for their rare-earth-element concentration. Ultimately, it is hoped that these waste areas, considered by some to be unsightly and environmentally hazardous, will prove to be a valuable resource asset for rare-earth elements.

“We anticipate analyzing more than 1,000 individual samples during the project, which is 1 year in duration,” Eble says. “This phase 2

Lexington high-school student conducts earthquake project in Geologic Hazards Section

Paul Laurence Dunbar High School junior is analyzing earthquake information in the KGS Geologic Hazards Section through next fall as part of his participation in the Fayette County Schools Math, Science, and Technology Center. The MSTC offers a 4-year program designed to develop students with high competencies in STEM (science, technology, engineering, and math) disciplines. The student, Kyle Combs, spends 3 hours every other weekday in the Hazards office, and will work there at least 360 hours to complete the program.

“I was interested in geology and earthquakes. So I met with Dr. Dave Moecher [chair of the UK Earth and Environmental Sciences Department] and he introduced me to Dr. Wang [Geologic Hazards Section Head Zhenming]. I’m looking at data such as the arrival times of S-waves and P-waves, comparing them, and trying to see where the earthquake originated.” The seismic waves he has been examining originated from events as near as states surrounding Kentucky and as far as Colombia, in South America.



Paul Laurence Dunbar High School junior Kyle Combs at work in the Geologic Hazards Section.

Wang serves as Combs’s mentor, guiding him in learning how to use the earthquake data and verifying the time spent on his project. Besides the research, the demanding Fayette County Schools program requires a final research paper, a poster at a regional science fair, and a 25-minute presentation on the research at the high school. Although he has an interest in natural hazards, Combs says he plans to study engineering in college.

His project is also supported by the Kentucky Young Researchers Program, sponsored by UK’s Vice President for Research. It provides funding for high-school students doing such work on the campus. ❖

research is specifically aimed at producing an ‘ore-grade’ or ‘near-ore-grade’ product. An ore-grade deposit contains 2 percent of the material being sought.” Funding for the project comes from the U.S. Department of Energy, with contributions from private industry.

The first phase of the research, in 2014-15, was a preliminary assessment of rare-earth elements in coal. Results from phase 1 demonstrated that certain Kentucky

coals contain elevated quantities of rare-earth elements, and that certain levels of coal purity showed significant enrichment.

The project will also develop and test a pilot plant to extract rare-earth elements from the preparation refuse of central Appalachian bituminous coal. The extraction and recovery process will use both physical and chemical separation methods that are currently available for deployment at pilot scale. ❖

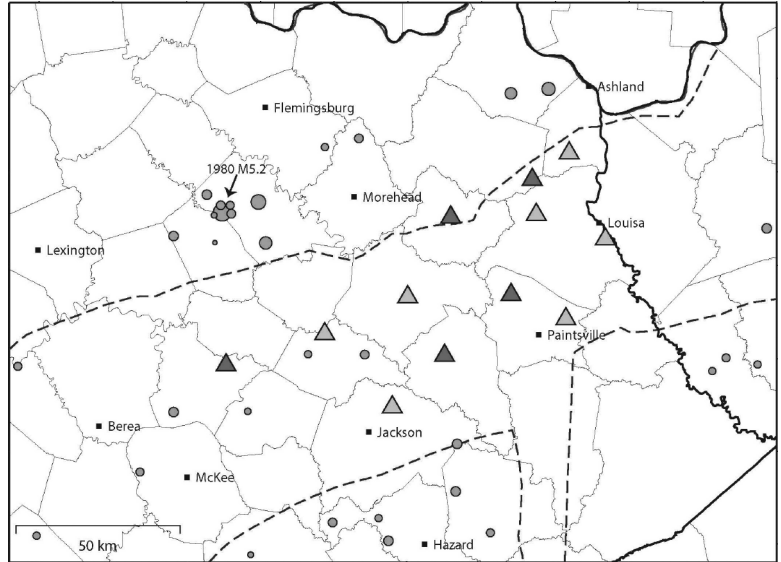
A dozen sensitive instruments now monitoring seismicity in eastern Kentucky

With the help of private partners providing equipment and landowners who have given access to their property, the new KGS seismic network that monitors earthquakes and other activity in eastern Kentucky now has 12 stations in operation. Each station operates autonomously, powered by solar-charged batteries and communicating wirelessly over cellular networks, and their recordings are available on the KGS website. “The network typically sees something like 20 coal-mine blasts each day and records earthquakes from around the world,” says Geologic Hazards Section seismologist Seth Carpenter, who has overseen the setup of the instruments. “Distant earthquakes as far away as Japan and as low as magnitude 4.5 have been detected, if they occur deep in the earth.”

Oil and gas exploration company Cimarex Energy has provided instruments for five of the stations, and Carpenter received permission from property owners to set up all of the instruments. He began installation last summer as concern increased about earthquakes being induced by human activities, particularly deep injection of wastewater from oil and gas drilling. Wastewa-

ter injection has been linked to a significant increase in earthquakes elsewhere in the country, particularly in Oklahoma and surrounding states. No seismic events are known to have been induced by injection in eastern Kentucky, but the prospect of possible increased injection as a result of oil and gas activities in the Rogersville Shale prompted the creation of the network.

The network has recorded 13 earthquakes in Kentucky and nearby states. “Primarily due to the sensitivity and number of instruments, ours is the only network that recorded six of those events,” Carpenter says. All of the recorded events were “natural” earthquakes, rather than human-induced events. But even without events caused by deep injection, the network is achieving



Locations of active instruments in the eastern Kentucky seismic network (triangles) and earthquakes in the region (circles).

its primary purpose of establishing the background seismicity in eastern Kentucky. The lack of human-induced activity in the region may be related to reduced drilling activity as a result of lower oil and gas prices.

Carpenter is planning a talk about the network at the Seismological Society of America’s annual meeting in April. He is also hoping to add as many as four new stations with additional equipment donated by Cimarex or purchased with KGS funds. ❖

Paul Potter—continued from p. 2

tucky Region,” first published by KGS in 1996; a second edition was published in 2007. He has received multiple previous recognitions, including the Outstanding Educator Award (2000) and John T. Galey Memorial Award (2007), both given by the Eastern Section of the AAPG.

His career began in 1952 at the Illinois State Geological Survey, after he had earned bachelor’s, master’s, and doctoral degrees from the University of Chicago. He taught at the University of Indiana from 1963 to 1971, followed by a long teaching stint at the University of Cincinnati, where he is still professor emeritus. He has also served as

visiting professor at universities in Brazil.

A search of the KGS publications database shows Potter has authored or contributed to at least 20 publications, and the Survey’s online photo collection includes 355 outcrop and scenic geology shots taken by Potter during field trips around Kentucky. ❖

Landslide hazards—continued from p. 1

shared the cost of the monitoring at the site, achieving together what may not have been possible on their own.”

With the help of State and local agencies, as well as reports from property owners, Crawford has collected information on more than 2,500 Kentucky landslides, as well as about 75,000 landslides indicated on old maps. Information on the costs of landslide repairs to Kentucky’s roads and highways indicates that the annual costs of landslides in the state is at least \$10 million. Crawford has set up two other monitoring stations at landslides in Kenton and Lewis Counties. As the population increases in landslide-prone areas, this research can benefit geologists, engineers,

local officials, and planners in communities interested in assessing landslide hazard and risk.

Crawford has also helped homeowners and communities apply for federal and State grant assistance in such cases by writing detailed reports on sites where homes have been damaged beyond repair by landslides. Homeowner’s insurance does not typically cover landslide losses.

Ashland says other research suggests climatic variability may be affecting natural hazards in the eastern United States. “Since 2010, a combination of severe storms and above-average wet seasons has caused widespread and numerous landslides in the region.” ❖

Brine disposal framework—continued from p. 3

oil and gas zones and deep saline rock formations may be nearly 500 billion barrels.”

The brine-disposal project’s final report references the KGS online map service that provides locations and detailed information on all disposal wells in Kentucky. Tom Sparks developed the map service, which can be found at <http://goo.gl/dLrmqE>. ❖