

Kentucky Cross Section

Earth Resources—Our Common Wealth

Spring 2015

Emerging Rogersville Shale oil and gas play, Appalachian Basin

A deep unconventional oil and gas play is in the early stage of exploratory drilling in eastern Kentucky and adjacent parts of West Virginia. The Cambrian Rogersville Shale is the oldest organic-rich shale in the Appalachian Basin, and occurs at depths of 8,000 to 14,000 feet in a sedimentary basin called the Rome Trough. Research at

the Kentucky Geological Survey in 2002 identified the hydrocarbon source potential of the Rogersville Shale, and successful resource recovery in shallower shale formations such as the Marcellus and Utica in Pennsylvania and Ohio prompted industry to test the potential of this formation in 2014.

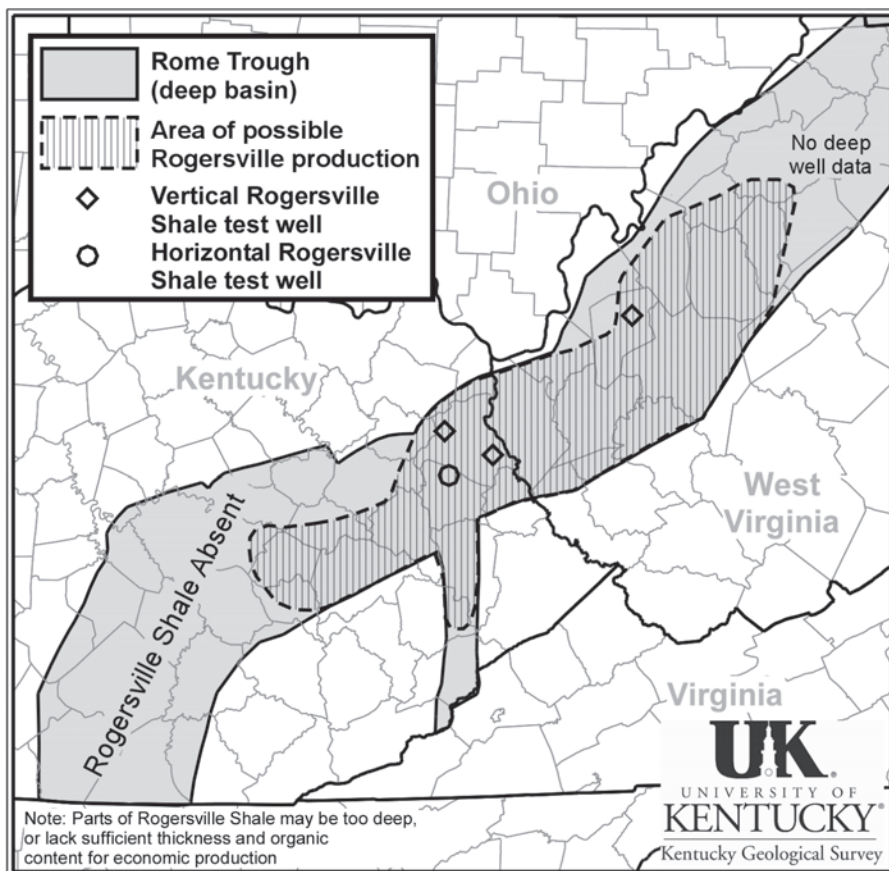
Eight wells have been permitted, and four have been drilled to date, but results remain confidential. Companies involved in the play include Bruin Exploration, Horizontal Energy Technology Co., and Cabot Oil and Gas. Unofficial reports indicate the Rogersville Shale has significant potential to produce oil and gas, resulting in a recent land-leasing boom in eastern

Kentucky. The Kentucky legislature just passed significant revisions to the Commonwealth's oil and gas regulations to better regulate and monitor deep horizontal wells and hydraulic fracturing (see page 3).

It's too early to accurately assess the potential of the Rogersville Shale play; however, based on limited existing well data, the productive area could be as large as 4 million

acres. Centered in eastern Kentucky and adjacent parts of West Virginia, the play has the potential to significantly increase oil and gas production in eastern Kentucky. KGS is responding to this activity with an expanded seismic network to monitor and assess natural and induced seismic events (see page 4) and a proposal for groundwater monitoring. ♦

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



Director's Desk

The release of the spring issue of the KGS newsletter coincides with the mass exodus of students from the UK campus—except for a few that we know about. Those seven are working at KGS over the summer to gain hands-on experience in the geoscience profession. They are involved in a variety of projects, including oil and gas well-log inventory, seismic-data analysis, sinkhole mapping, hydrostratigraphy, and subsurface brine analysis. Some will continue working part time next fall when the next semester begins, while others will move on to other endeavors.

We have given about 80 students similar opportunities since 2006 when we began keeping track. Most of the students were undergraduates in the UK Department of Earth and Environmental Sciences, but a few have come

from other departments at UK and other universities such as the University of Southern Indiana and the College of Wooster. I've supervised quite a few of these folks myself in the coal resource assessment program. They learn about data management and database creation, subsurface correlations, core logging, GIS, and mapping techniques. All of them learn skills that are not generally included in their academic coursework. Some of these skills are technical, such as software applications and well-log interpretation, but others are skills such as dependability and professional behavior. Our student program is one of the best ways we have to contribute to the future success of UK geoscience students.

A large percentage of the students we've employed go on for advanced degrees at UK or other institutions. The remainder generally find employment in the profession. Many of them contact



Jerry Weisenfluh

us after they have left to relate that the experience they received at KGS helped them get a job, advance, or excel in graduate school. I've heard this so often that I'm convinced of the importance of the program and committed to sustaining it.

A lot of other exciting things are going on at KGS. I hope you enjoy this issue of the newsletter containing some of the highlights.❖

Retired KGS mapper Martin Noger dies in March

Martin Charles Noger, who worked at KGS for 27 years, died on March 3 at the Thomson-Hood Veterans Center in Wilmore, Ky. Noger was born in Hazard, Ky., on November 30, 1923. He was a graduate of the University of Kentucky and also served in Europe during World War II.

Before he was hired by KGS, he spent 13 years as an exploration geologist at Shell Oil. Known as "M.C." at the Survey, he coordinated the geologic mapping of Kentucky with the U.S. Geological Survey, making Kentucky the first state to be completely mapped

at a detailed scale. Noger retired from the Survey in 1993 but continued to work part-time at KGS through 2005.

He authored or co-authored 40 KGS publications on a broad range of topics, including tar sands, subsurface stratigraphy, roadside geology, and geologic land-use maps. He compiled the "Geologic Map of Kentucky: Sesquicentennial Edition of the Kentucky Geological Survey" (1988).

Noger is survived by his wife of 64 years, Iona Moore Noger, and five children.❖



Martin Noger

Legislature approves Oil and Gas Modernization Act, regulating fracking

Kentucky's General Assembly unanimously approved legislation relating to high-volume hydraulic fracturing—also known as fracking—earlier this year. Gov. Steve Beshear signed Senate Bill 186 into law March 19. The Kentucky Oil and Gas Regulatory Modernization Act was the result of a working group set up by Energy and the Environment Cabinet Secretary Len Peters. It included industry representatives, government agencies, and environmental groups. Increasing interest in developing the state's natural gas resources and concerns about the effects of fracking to stimulate production prompted the effort to develop legislation.

New sections of Kentucky Revised Statute 353.510 define high-volume hydraulic fracturing as “the stimulated treatment of a horizontal well by the pressurized application of more than eighty thousand (80,000) gallons

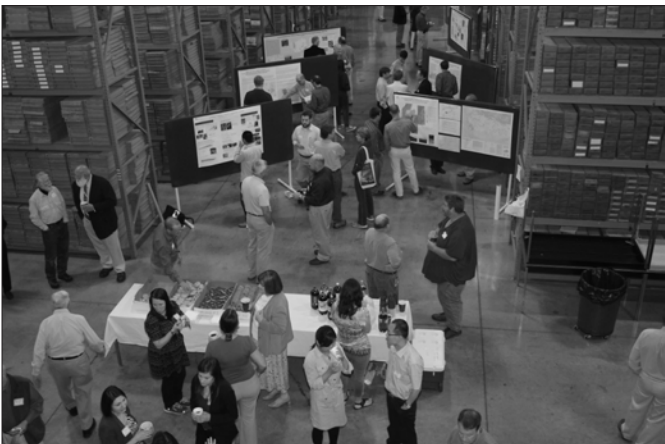
of water, chemical, and proppant (sand or synthetic material used to prop open the artificially created fracture once the treatment is completed), combined for any stage of the treatment or three hundred twenty thousand (320,000) gallons in the aggregate for the treatment.” It requires notice of at least 20 days for owners of property within 1,000 feet of the surface location of a well before the fracking operation can start. A reclamation plan is required for all wells, including deep horizontal wells, with a “deep” well being defined as one drilled below a depth of 6,000 feet or below the deepest member of the Devonian shale. A \$40,000 minimum plugging and reclamation bond is required for deep horizontal wells. Operators who use high-volume hydraulic fracture-stimulation in wells must disclose information about the chemicals used in their treatment at the FracFocus.org website

within 90 days of its use, though exceptions can be made for situations involving confidential business information. Rules concerning trade secret and confidential business information establish that such information must be available to health professionals upon application.

The legislation also requires water-quality testing of surface impoundments and groundwater sources within 1,000 feet of the surface location of the well, both before and after a fracture treatment. A new program for the reclamation of abandoned oil storage tank sites was also created in the legislation.

The new law takes effect June 24. The Kentucky Oil and Gas Association says 33 Kentucky counties had natural gas production in 2014, and 61 counties reported oil production, employing more than 3,200 people.❖

Annual seminar speakers discuss KGS research in the public interest



Participants in the annual seminar browse posters during a morning break.

The 55th KGS annual seminar focused on how research at the Survey serves the public interest of Kentucky and its communities. It drew more than 110 participants to the Well Sample and Core Library on May 15. The event is considered the largest annual gathering of geologists in the state. KGS research-

ers spoke during seven morning sessions about their work and its impact on the public.

The topics included the use of geologic maps to improve the understanding of radon potential, induced seismicity in Kentucky, hydraulic fracturing issues in Kentucky, and groundwater resources for the western part of the state. After the lunch break, KGS staff provided three concurrent sessions on sensitive seismic monitoring

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Eastern Kentucky microseismicity monitoring project starting up

A geologic hazards researcher at KGS has begun a project in eastern Kentucky to monitor for microseismicity, including possible seismic activity related to the use of hydraulic fracture stimulation, also known as fracking, and disposal of wastewater in deep injection wells in the heavily faulted Rome Trough. There has been growing interest in developing deep shale gas plays, such as the Rogersville Shale, in that region. Oil and gas development activities involving fracking and deep wastewater injection in several other central U.S. states have been linked to cases of induced seismicity. No such events are known to have occurred in Kentucky, but KGS seismologist Seth Carpenter is conducting the proactive, collaborative research project to install a temporary network of sensitive seismographs in eastern Kentucky to detect any such activity.

“The effects of injecting wastewater from developing oil and gas operations in eastern Kentucky into the Rome Trough are largely unknown,” Carpenter says. “This project is intended to determine background levels of natural earthquakes too small for current instruments in our seismic network to detect, and to determine if current oil and gas activities are

causing such microseismicity. We would also like to identify characteristics that differentiate natural and manmade seismic events.”

That region of Kentucky has experienced moderate natural earthquakes, such as the 1980 magnitude-5.2 Sharpsburg (Bath County) earthquake and the 2012 magnitude-4.2 event in Perry County.

The UK Department of Earth and Environmental Sciences is collaborating with KGS on the study, and instrument manufacturer Nanometrics has agreed to match the number of stations that KGS purchases, increasing the overall sensitivity of the temporary network. Nanometrics has extensive experience in seismic instrumentation and with monitoring around oil and gas operations. Carpenter says KGS is finalizing another industry partnership, which will add more instruments to the network.

Carpenter points out that induced seismic events occur regularly in Kentucky from mining activity in both the Eastern and Western Kentucky Coal Fields, but no seismic activity has been connected with oil and gas operations in the state. This is probably a result of the relatively low volumes of fluids used in either hydraulic- or nitrogen-based stimulations his-



UK student Andrew Holcomb and Seth Carpenter set up of one of the new seismic instruments next to the KGS building to test its operation. The instruments rely on solar cells to charge their batteries.

torically conducted in Kentucky and a lack of monitoring stations in the immediate vicinity of the injection activities.

Earthquakes induced by fracking and by wastewater injection have been identified in areas surrounding Kentucky, including Arkansas, Ohio, and West Virginia.

In mid-May, KGS received an initial shipment of seismic monitoring instruments, and Carpenter hopes to begin deploying the first of the stations during the summer months. Once it is completely set up, the network will operate for at least a year, with continuous real-time data streaming wirelessly from each station to KGS for processing and archiving.❖

Annual seminar—continued from p. 3

equipment being installed to detect microseismicity, the Cane Run watershed monitoring project, and a Pennsylvanian core workshop.

Two of the professional geological societies of Kentucky

presented their annual awards during the seminar. Several KGS staff received recognition from the societies. Ray Daniel, of the Well Sample and Core Library, was recognized for outstanding service

to the Geological Society of Kentucky, and retired Water Resources Section Head Jim Dinger received a Distinguished Service Award from GSK; Richard Smath, of the

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New digital tool helps speed the collection and storage of mapping data

The Geologic Mapping Section has a new tool to speed the process of data-gathering at mapping sites in the field and adding those data to KGS mapping databases. Section mappers can now carry with them to their field-mapping locations a tablet loaded with a free app created by digital mapping company ESRI. Information from the location can be entered into fields within the app, and, if a wireless data connection is available, the information is added to KGS mapping databases almost instantly.

Mapper Antonia Hansen and Mike Ellis, of the Geoscience Information Section, tested the app, called Collector for ArcGIS, on a rainy spring day in Bullitt County, where Hansen is working on USGS-funded surficial mapping. “This saves a lot of time,” Hansen said of the app. “It’s also more accurate. Instead of writing everything about a surficial geologic deposit down in a notepad and adding it to the database when I get back to the office—when my memory of the details may not

be perfect—it lets me enter the information immediately.” Hansen adds that if she is using a GPS device in conjunction with the app, an accurate location can be automatically included. Geotagged photos taken at the project site can also be uploaded. If a wireless data connection isn’t available at the project site, Hansen adds, the information can be synched with the databases when a connection becomes available.

“The Collector app itself allows mappers to access different maps for use in the field,” Hansen adds. “If we were to put all the information that we might need on a paper map, it would be cluttered at best and impossible to read at worst. The Collector app simplifies this for us. I can take my field map and yet also be able to see the other features of the land via Collector.”

Geoscience Information Section Head Doug Curl, who integrated the app with KGS databases, hopes it will become a standard KGS tool for mapping and other



Antonia Hansen and Mike Ellis test the Collector app in Bullitt County.

field tasks. “It’s very convenient and easy to set up. Other KGS staff have expressed an interest in using the app for field work such as sinkhole data collection. The app requires an ArcGIS Online organizational account, which we now have for KGS. We can use the account for enabling Collector maps and also for hosting Story Map data, allowing researchers to create their own Web maps very easily.”❖



Landslide researcher Matt Crawford, of the Geologic Hazards Section, documents the features of a large debris flow in Floyd County after heavy rains in April. These very mobile events can damage buildings, roads, and utilities. County Emergency Management Director Bobby Johnson took Crawford to several areas in the eastern Kentucky county affected by slides after the spring storms.

Annual seminar—continued from p. 4

Geoscience Information Section, was awarded a Presidential Certificate of Merit from the Kentucky Section of the American Institute of Professional Geologists; and Core Library Manager Patrick Gooding was recognized for service to the American Association of Petroleum Geologists House of Delegates.❖

Collection of rocks, fossils, and mineral specimens offered to KGS

Steve Greb, of the Energy and Minerals Section, went to the small city of Ekron, in Meade County, Kentucky, in March to look into a collection of natural and polished rocks, fossils, and mineral specimens offered to KGS. The collection was the lifelong accumulation of Cosby Keys, who had been the first president of the KYANA Geological Society. The society was founded in 1961 to promote interest in geology, minerals, fossils, and lapidary arts in Kentucky and Southern Indiana.

Keys died at the age of 88 in 2011, and his daughter, Carol Keys Cox, offered her father's collection to KGS. The large collection of specimens from Kentucky and elsewhere in the United States was neatly stored in dozens of wooden boxes Keys had handmade himself.



Cox told Greb her father ignited her own interest in collecting geologic specimens when he gave her jewelry he created from items in his collection. Greb took 30 boxes and received permission from Cox to use them for educational purposes and to make specimens available to teachers and others participating in events such as the annual KGS open house.❖

Steve Greb and Carol Cox look through the boxes of specimens collected by Cox's father, Cosby Keys.