



Kentucky Geological Survey

2023–2024 Annual Report

Letter from Acting Director

To the Commonwealth,

As I reflected on my year as the Acting Director of the Kentucky Geological Survey (KGS) during the 2023–2024 fiscal year, I have struggled to find a theme that captures the experience of this year for the KGS staff.

I finally realized: resilience.

With the departure of our 13th director, Bill Haneberg, at the end of June 2023, KGS staff were facing significant uncertainty in the



William "Drew" Andrews Jr., Acting Director, 2023–2024

leadership and future direction of KGS. The only thing we knew for certain was that KGS would change; the scope and magnitude of that change were unknown. Despite the uncertainties, KGS staff continued their outstanding research and service for the Commonwealth in areas such as methane emissions, critical minerals, karst, carbon management, landslides, earthquakes, flood modeling, geologic mapping, data preservation, geoscience information services, outreach, geoheritage, and education. Through this work, KGS extended the theme of resilience to the residents and economy of the Commonwealth by

increasing understanding of natural hazards, providing evaluations of water and mineral resources, and creating the potential for increased jobs and prosperity across Kentucky.

KGS researchers grew external funding for new research projects to nearly \$3 million, the largest amount in recent memory. KGS supported students, both through the endowed Paul Edwin Potter Internship Program and as adjunct faculty supporting graduate projects in the University of Kentucky (UK) Department of Earth & Environmental Sciences (EES) and elsewhere. KGS research collaborations continued to grow across campus, the state, the country, and the world. KGS staff were invited to contribute to multiple national and international projects and events. Staff answered frequent public requests for information. Our podcast and social media continued to inform and entertain a growing audience of people interested in geoscience.

In short, KGS continued to be ... KGS.

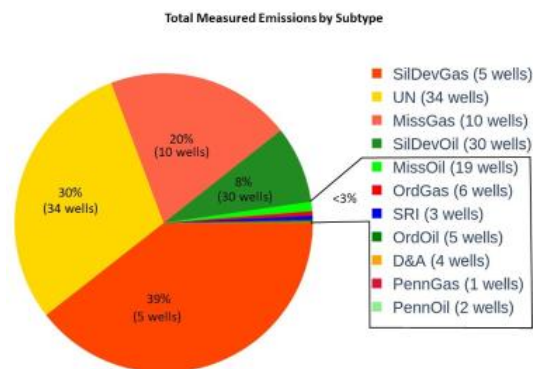
So, it is an honor and a pleasure to submit the following summary of the work of the Kentucky Geological Survey for the

2023–2024 fiscal year. I hope you find the content informative and interesting. Perhaps it will spur you to engage with KGS and help us guide our future research to support the beautiful Bluegrass State we call home.

William "Drew" Andrews Jr., PG, Ph.D., Section Head (Geologic Mapping), Acting Director, KGS, 2023–2024

Research

Measuring Methane Emissions from Orphaned Oil and Gas Wells



Methane is a powerful greenhouse gas with a global warming potential about 84 times greater than CO₂ over a 20-year period. Within the oil and gas sector, which emits about 29% of the 30 million tonnes of methane annually, orphaned wells account for 0.06 to 1.0 million tonnes. This large range reflects the

uncertainty in the number of orphaned wells and the range of their emissions.

Through 2023 and into 2024, researchers **Deron Zierer**, **Steve Webb** (now at Oregon Water Resources Department), and **Marty Parris** continued their partnership with the Kentucky Division of Oil and Gas (KDOG) to measure methane emissions from orphaned oil and gas wells in Kentucky (July 31, 2023 | Kentucky Edition (ket.org) minute 11:35). With funding from the Bipartisan Infrastructure Law through KDOG, KGS researchers have measured emissions from 125 oil and gas wells distributed among 27 counties in the Appalachian and Illinois basins and the southern Cincinnati arch. The results show that 11 gas wells

account for 91% of the 35.4 tonnes of methane emitted by the 125 wells. This total methane is equivalent to the average annual emissions from 646 cars. Leveraging the analysis for the most effective mitigation of methane, the analysis shows that, on average, gas wells are twice as likely as oil wells to emit significant amounts of methane (>1 g/hr).

Edge-of-Field Monitoring: Western Kentucky

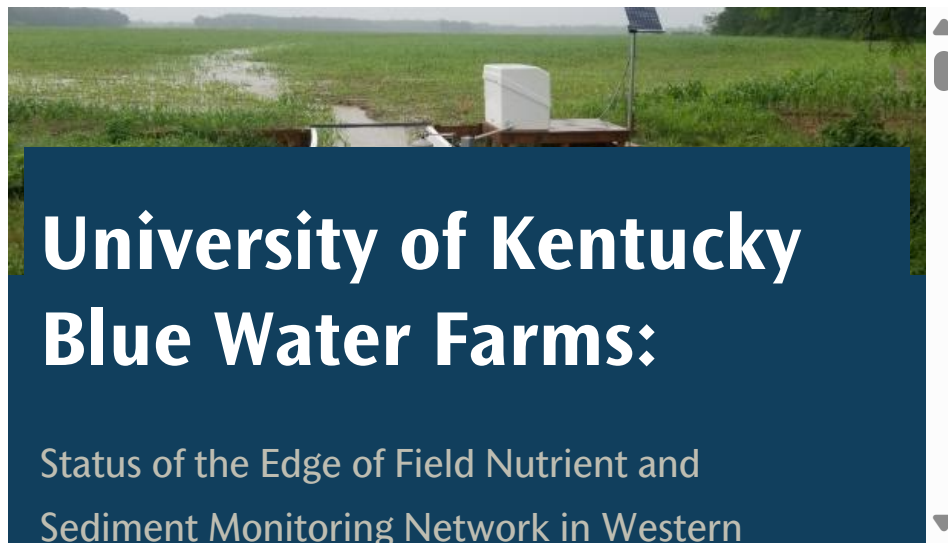
Nutrients (nitrogen and phosphorus) and sediment derived from urban construction and food production activities are leading contaminants resulting in stream and river impairment in Kentucky. While agricultural producers commonly employ best management practices (e.g., crop rotation, cover crops, no-till farming, etc.) to retain in-field nutrients by mitigating nutrient and sediment losses, studies evaluating the efficacy of best management practices in reducing nutrients and sediment in agricultural runoff are limited in western Kentucky. To further understand the relationships between agronomic practices and water quality, **Glynn Beck** is collaborating with researchers Brad Lee, Zach Creech, Sarah Longacre, Jason Unrine, Erin Haramoto, and John Grove from the UK Martin-Gatton College of Agriculture, Food and Environment (CAFE) to conduct edge-of-field water quality monitoring in the lower Green River and lower Cumberland River watersheds. This project is part of a national effort to evaluate the efficacy of best management practices and assist the agricultural community in making informed nutrient management decisions. Funding sources include the Natural Resources Conservation Service (NRCS), Kentucky Soybean Promotion Board, Kentucky Agriculture Development Board, and five western Kentucky agricultural producers.



Steve Webb, Marty Parris, and Deron

Zierer inspecting an orphaned well.

During the 2023–2024 fiscal year, year-round sampling of surface water runoff from seven no-till corn/soybean field watersheds (3–12 acres in size) in the lower Green River watershed continued. Also, year-round sampling of surface water runoff from eight no-till corn/soybean/wheat and four soybean/wheat row crop operations (3–11 acres in size) in the lower Cumberland River watershed continued. Monitoring of these row crop watersheds will improve our understanding of nitrogen, phosphorus, and sediment loads from active row crop fields in western Kentucky. For example, siltation (soil erosion) is consistently in the top three water quality impairments for all monitored Kentucky waterways. Edge-of-field monitoring in the lower Green River and lower Cumberland River watersheds is expected to continue through 2026 and 2028, respectively. A detailed summary and preliminary findings of this project are available in a jointly published KGS Interactive Tour and UK Cooperative Extension Service Bulletin ([Blue Water Farms StoryMap](#)).



Blue Water Farms: Edge of Field Nutrient and Sediment Monitoring Network StoryMap

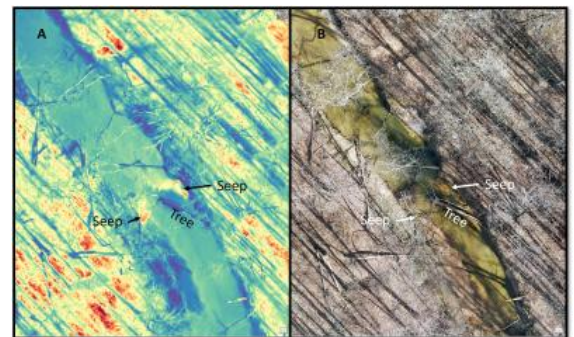
Edge-of-Field Monitoring: Northern Mississippi Embayment

Wetland conservation easements are promoted by the U.S. Department of Agriculture Natural Resource Conservation Service to return floodplains and other flood-prone row crop fields to

natural vegetation to filter nutrients and sediments in surface water runoff prior to reaching a stream or river. **Glynn Beck** is collaborating with researchers Brad Lee, Leighia Eggett, and Jason Unrine from the UK CAFE to conduct edge-of-field water quality monitoring for nitrogen, phosphorous, and sediment in six wetland watersheds in the northern Mississippi Embayment (Jackson Purchase region) and one watershed in the lower Green River watershed (Henderson County). Surface water runoff sampling of the seven watersheds began in 2019 and continued during the 2022–2023 fiscal year. A drone-mounted multispectral camera was used to collect images of each watershed to document leaf on and leaf off, which will be correlated with surface water quality. Surface water sampling for this phase of the project ended in December 2023. Funding to continue wetland sampling is currently being sought. Funding from 2019 to 2024 is provided by the NRCS's Agricultural Conservation Easement Program. A detailed summary and preliminary findings of this project are available in a jointly published KGS Interactive Tour and UK Cooperative Extension Service Bulletin ([Blue Water Farms StoryMap](#), see above).

Mapping Surface Water-Groundwater Interaction with Thermal Imaging

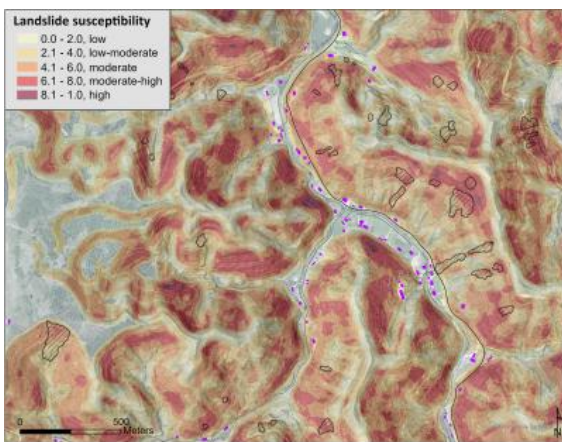
Surface water and groundwater interaction is being assessed along a 2.4-mi segment of Little Bayou Creek in northern McCracken County using a drone-based DJI Zenmuse H20T thermal camera. The goal of the project, sponsored by the Kentucky Research Consortium for Energy and Environment, is to identify small groundwater seeps discharging into Little Bayou Creek north of the Paducah Gaseous Diffusion Plant. Groundwater seep identification will assist efforts to monitor shallow groundwater and streams for trichloroethylene and technetium-99



Thermally identified groundwater seeps (A) along Little Bayou Creek. The seeps cannot be identified in the aerial photo (B).

contamination associated with the Paducah Gaseous Diffusion Plant. The first round of flights was conducted during full leaf-off conditions between February 29 and March 7, 2024. Thermal images taken during the first-round flights identified several known seeps and possibly several unknown seeps discharging into Little Bayou Creek. The second round of flights will be conducted during full leaf-on conditions in July and August 2024. Images will be taken from above the full leaf-on canopy to compare with the full leaf-off conditions. In addition, a Mavic 3 thermal drone will be flown below the canopy within the stream channel to verify previously identified seeps and potentially identify smaller undocumented seeps. The locations of all identified groundwater seeps will be recorded for future monitoring efforts. **Glynn Beck** is conducting this research.

Landslide Susceptibility and Risk Mapping



This map models the probability that a landslide exists or that the slope conditions are such that a landslide may occur in the future. Mapped landslides are represented by hatched polygons, buildings are represented as purple polygons, and roads are represented as black lines.

Building on previous landslide susceptibility projects, this project implements measures designed to evaluate landslide hazards and reduce risk to individuals and properties in the Kentucky River Area Development District. Landslides are a common occurrence in this mountainous region of eastern Kentucky, incurring millions of dollars in direct and indirect costs. The landslide impact is further underscored by 18 Federal Emergency Management Agency (FEMA) disaster declarations from 2010 to 2023, which include many

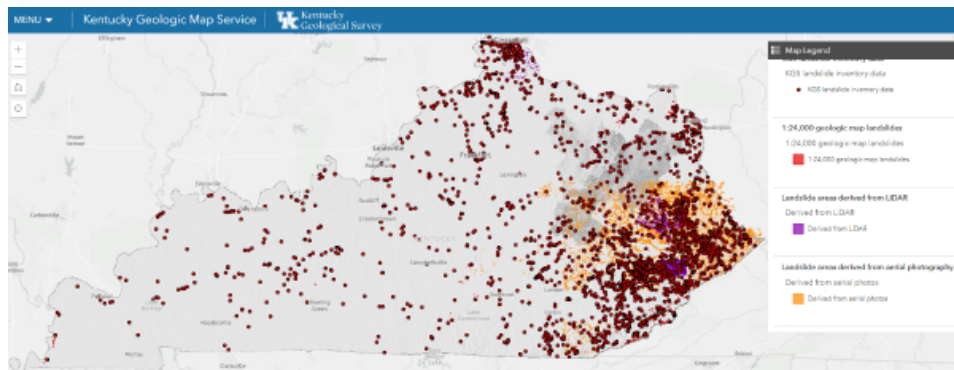
different types of landslides (translational slides, rockfalls, debris flows, slumps, and creep, for example). Direct costs of landslides are conservatively estimated between \$10–\$20 million annually, impacting residential homes, roads, utilities, and other infrastructure.

We used an established two-step machine learning approach that uses bagged decision trees (a supervised learning algorithm) to parse variables, followed by logistic regression to assess statistical significance and calculate susceptibility. This method includes testing geomorphic variables (topographic wetness, flow accumulation, flow direction, proximity to streams, and proximity to roads) not previously considered in models for this region, determining how the landslide inventory is used to acquire geomorphic variables, and compiling unbalanced binary dataset for both landslide and non-landslides. We also developed the risk assessment using a static, socioeconomic approach that includes landslide effects on population, roads, railroads, buildings, and land class. We incorporated hazard (susceptibility results), vulnerability, and consequences to produce each risk map. Modeling landslide susceptibility and risk will support mitigation efforts to reduce risk before a disaster, providing the community with the information needed to make risk-informed decisions. This project is funded by the FEMA Hazard Mitigation Grant Program.

Landslide Inventory Database

Landslide inventories are the mechanism for documenting the locations, types, and extents of landslides and have long provided the foundation for many approaches to hazard and risk assessment, including landslide susceptibility mapping. The KGS landslide inventory and associated inventory maps portray the locations of prior (existing) landslides, which provide critical insights needed to characterize hazards, predict the locations of future landslides, and differentiate high- and low-hazard areas. The inventory database's design is based on common attributes related to what is known about Kentucky's landslide activity. Most importantly, the landslide inventory data records the locations and, when known, the dates of occurrence and types of landslides that have left discernible traces in an area.

The FEMA Hazard Mitigation Grant Program has funded KGS to improve and build on these important aspects of landslide inventory. The purpose of this project is to enhance landslide data collection and dissemination of the Kentucky landslide inventory database. A primary goal is to improve the inventory database as a tool for increasing awareness and commitment to reducing risk and losses. The project will add new landslide data, correlate new and existing landslides with storm events, and update database maintenance techniques.



Landslide locations in Kentucky. Points, lines, and polygons represent the locations of known landslides and areas susceptible to landslides in a geologic and geomorphic context. The purpose of the map is to provide an overall view of landslide hazards across the state.

Federal and State Landslide Research Collaboration

The primary objective of this research opportunity is to continue collaboration with the U.S. Geological Survey (USGS) Landslides Hazards Program through the Intergovernmental Personnel Act Mobility Program guidance. This program, intended to facilitate cooperation between the federal government and non-federal entities, provides for the assignment of federal personnel to state and local governments and institutions of higher education. A critical area of overlapping expertise between the KGS and the USGS is landslide hazard research. This work revolves around both improving our understanding of the conditions influencing slope stability and suggesting mitigation strategies. KGS will develop research ideas, share data collection approaches, evaluate susceptibility and risk, and lend expertise related to landslide hazard assessment. One particular focus is the assessment of a

new nationwide landslide susceptibility map to evaluate how a continental-scale product compares to local- or regional-scale susceptibility.



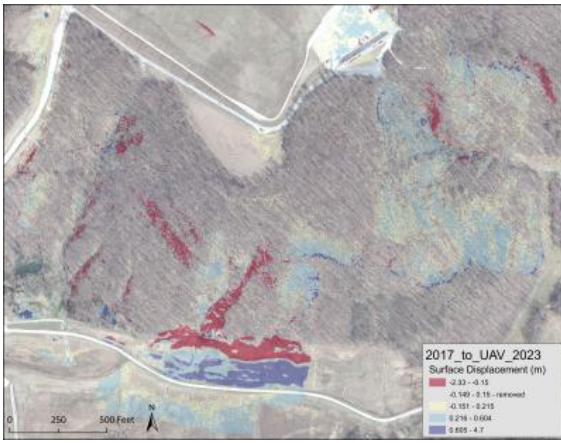
Large landslide mitigation project visit near Kandy, Sri Lanka. Left to right: Gina Belair (USGS), Corina Cerovski-Darriau (USGS), Laksiri Indrathilaka (NBRO), Matt Crawford (KGS), and Mahesh Somaratne (NBRO).

In addition, **Matt Crawford** is working with the USGS Landslide Disaster Assistance Team (LDAT), who assist foreign partners in developing technical building capacity for landslide hazards and support overall hazard mitigation in their respective countries. A partnership between KGS and LDAT facilitates the sharing of Kentucky-based landslide research for the public good and provides KGS geohazard researchers access to unique experiences, observations, and data in a larger landslide community.

This promotes excellence in public service, intellectual curiosity, and information sharing and builds cross-disciplinary bridges between researchers, engineers, and other practitioners in need. In October 2023, **Crawford** worked with LDAT and their partnership with the National Building Research Organization (NBRO) in Colombo, Sri Lanka, part of the national Ministry of Disaster Management. The team conducted a workshop discussing landslide hazard assessment and carrying out data collection related to landslide inventory mapping, susceptibility modeling, rainfall monitoring, landslide early warning, and landslide mitigation. They also spent time visiting landslide projects with geologists from NBRO.

Landslide Monitoring at Maxey Flats

The Maxey Flats facility, part of the Kentucky Division of Waste Management, has experienced several landslides along the south, west, and east borders. Larger rotational landslides exist mid-slope and extend towards the base of the slope, particularly along an old road on the property's southern border. The landslides show



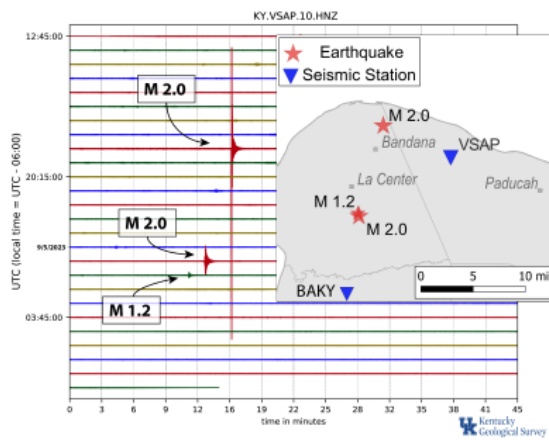
Elevation difference and interpreted surface displacement between 2017 lidar and 2023 UAV-acquired lidar. The cap of the Maxey Flats facility is the open, grassy area at the top of the photo.

multiple stages of movement, primarily due to precipitation and slope modification over the years. The purpose of this project is to evaluate landslide activity and determine areas of accelerated movement or non-movement. KGS is conducting four rounds of UAV flights (two per fiscal/project year) bracketing the beginning and end of leaf-on conditions.

KGS will generate digital elevation models (DEM) of the area of interest,

quantify the hillslope elevation change between flights by differencing the DEMs, and evaluate landslide activity, determining areas of accelerated movement or non-movement. The possibility of retrogressive displacement farther upslope, near the ridgetop, will also be evaluated. KGS is collaborating with Brad Lee and Leighia Eggett of the UK Cooperative Extension Service.

Kentucky Seismic and Strong Motion Network



Signals from three earthquakes that occurred beneath Ballard County on September 4, 2023, recorded by the 100 m deep borehole accelerometer at VSAP. The smallest of these events (magnitude 1.2) was only observed by KGS.

The Hazards Section of KGS operates the Kentucky Seismic and Strong Motion Network (KSSMN), which provides critical data and information on earthquakes in Kentucky and around the world. The network continues to evolve and improve; this year, KSSMN consisted of 24 stations, 19 of which sent data to KGS computers in near real-time. These data were used to locate and estimate the sizes of 19 earthquakes that occurred in Kentucky as well as additional events outside of the state. This year, a

communications upgrade at the strong-motion station operating at the Paducah Gaseous Diffusion Plant, VSAP, improved real-time

monitoring in western Kentucky. The high-quality recordings from VSAP's borehole sensor, which is located 100 m below the surface, allowed KGS seismologists to detect and precisely locate four nearby earthquakes in McCracken and Ballard Counties, which were not detected by other monitoring agencies, soon after they occurred.

Jon Schmidt and Seth Carpenter

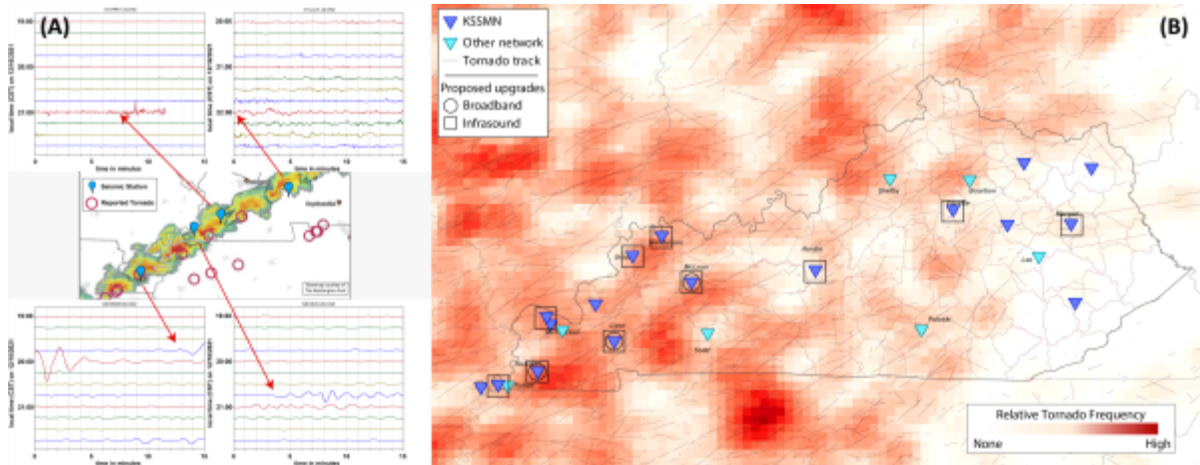
collected ambient noise data at western Kentucky stations CUSSO, FMKY, LLKY, and SMKY in Fulton, Hickman, Lyon, and McLean Counties, respectively. These data and several new instruments purchased this year will greatly improve the signal quality at these stations.

Kentucky has experienced several severe storm systems in the past decade, including the devastating December 10–11, 2021, system that produced multiple strong tornadoes. Although the National Weather Service issues tornado warnings, obtaining ground-truth verification of tornado touchdowns requires chance eyewitness accounts or post-event verification. During the December 2021 storms, changes in ground vibrations in Tennessee and Kentucky were detected in seismic data recorded by stations near verified tornado tracks. **Seth Carpenter** received funding from FEMA both to investigate vibratory signals produced by touched-down tornadoes as recorded by seismic and infrasonic (sound waves at frequencies lower than audible) sensors and to upgrade several KSSMN stations with new sensors. Three stations will receive new broadband seismometers of the sort that recorded the ground vibrations from the 2021 tornadoes, which can record a large range of ground shaking frequencies. Also, infrasound sensors will be installed at 10 stations. The project will also investigate the

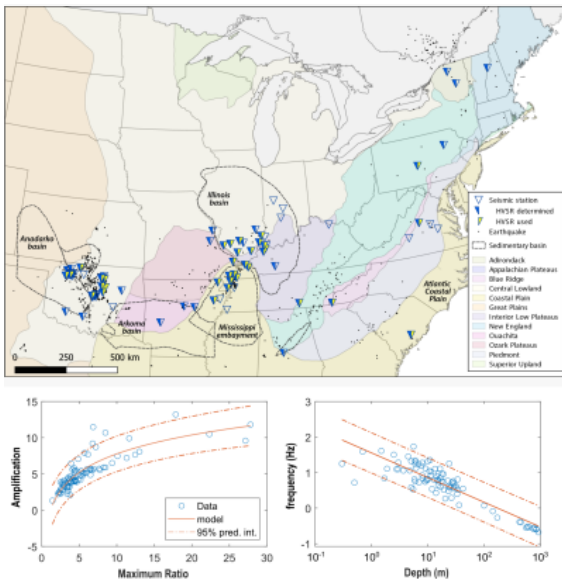


Jon Schmidt uses water to help sand settle around a broadband seismometer installed at the KSSMN station FMKY (Hickman County). Data from this and other temporary installations are helping KGS seismologists to improve KSSMN signal quality.

pathway to serve future touchdown warnings in near-real-time to assist emergency managers and local officials. New earthquake data will also be collected at the seismic stations in and around Kentucky to assist with earthquake mitigation planning as an ancillary project goal.



(A) Path of the supercell responsible for the largest tornado in the December 2021 outbreak (radar collage courtesy of Washington Post) and seismograms showing vibrations due to the passing storms. (B) Tornado paths in and around KY from 1950 through 2021, the frequencies with which tornado paths cross through parts of KY, the KSSMN, and other seismic stations operating in KY, and upgrades to be made as part of the FEMA-funded tornado-seismic project.



Top: Physiographic provinces in the central and eastern United States and seismic stations in the seismic-wave resonance study. Relationships between the max. ratio of seismic impedance and amplification (bottom left) and the depth to that ratio and resonance frequency (bottom right).

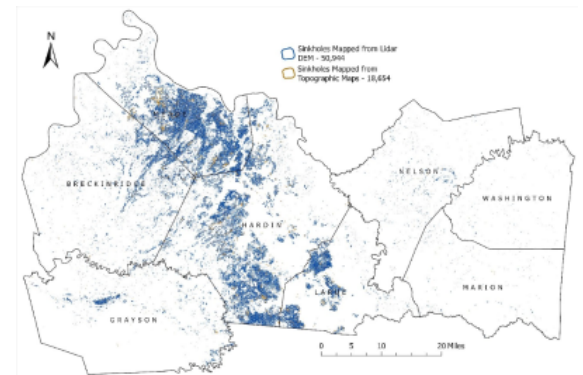
Seismic shear-wave resonances from near surface geological layers cause additional and sometimes profound amplifications of seismic waves. **Seth Carpenter, Zhenming Wang,** and Ed Woolery completed a study on ground-motion resonances at 89 seismic stations in Kentucky and elsewhere in the central and eastern United States. The team found that amplifications of weak seismic motions in Kentucky and across the study area vary by more than an order of magnitude and occur across frequencies that range by more than two orders of magnitude. One of the study's key findings was that the largest ratios of the

near-surface seismic impedances (i.e., wave speed times material density) are key predictors of the amounts of amplification, and that the depths to such ratios control the resonance frequencies. They also found that observations made by single seismometers can help to characterize the resonances empirically and affordably.

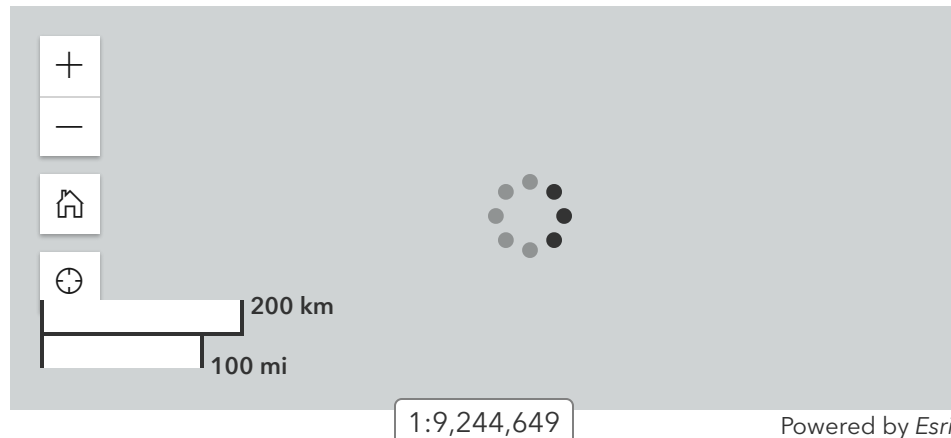
KSSMN data, especially the real-time online recordings, provide reliable information on earthquakes and other activities for stakeholders and media. This fiscal year, KGS seismologists received interviews with and inquiries from WKYT (3), WEKU (3), The Courier Journal (1), and WVLT Knoxville (1). Some KSSMN data streams are also served to earthquake researchers around the globe via real-time sharing with the University of Memphis and with the EarthScope Data Management Center.

Sinkhole Mapping

KGS has continued its efforts to improve karst sinkhole mapping for Kentucky using high-resolution lidar elevation data and advanced GIS and machine learning techniques. With funding support from the FEMA, **Junfeng Zhu** and **Hudson Koch** mapped karst sinkholes for the Lincoln Trail Area Development District, including communities in Breckinridge, Grayson, Hardin, Larue, Marion, Meade, Nelson, and Washington Counties. **Zhu** also worked with Olivine Painter, a 2023 Paul Potter intern, and mapped karst sinkholes for Carroll, Gallatin, Grant, Henry, and Spencer counties. These efforts resulted in the addition of 51,883 lidar-derived sinkhole records to KGS's online map server.



Karst sinkholes mapped for the Lincoln Trail Area Development District.

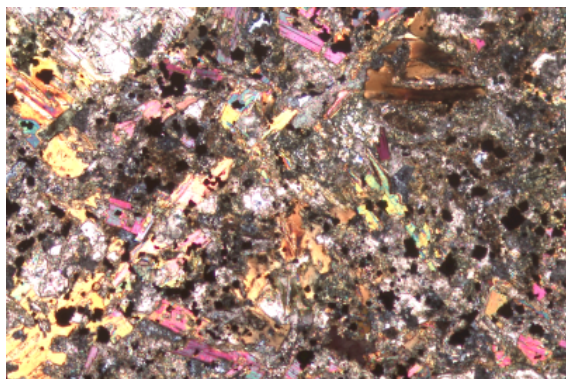


Earth MRI/Critical Mineral Lab

KGS involvement in the USGS Earth Mapping Resources Initiative (Earth MRI) program continued in the 2023–2024 fiscal year under lead PI **Gina Lukoczki**, with four active projects and one new project awarded. The newly awarded project will investigate the critical mineral potential of Mississippi Valley-type and phosphate deposits in central Kentucky. We are currently in the second year of a three-year grant with co-PI **John Hickman** investigating the overlapping critical mineral systems in south-central Kentucky and north-central Tennessee. Our investigations target the Mississippi Valley-type mineralization that is well-known in south-central Kentucky and north-central Tennessee (see preliminary findings in this [GSA abstract](#)) and the less-known Devonian black shale-hosted critical mineral occurrences in adjacent regions, which together we refer to as the Kentucky-Tennessee Mineral District (KTMD). The purpose of this project is to develop regional stratigraphic framework and mineral system conceptual models to support the critical mineral assessment of the area of the KTMD. Completion of this project will improve overall understanding of the geometry and architecture of mineralization and associated features in the KTMD and will provide essential data for evaluation of critical and strategic mineral resources.

Additional funding was received as a subaward from the Illinois State Geological Survey to perform an in-depth geochemical

survey (with contributions from **Alex Washburn**) of the Devonian black shales, which will extend the area of critical mineral research in Devonian black shales beyond the initial KTMD area to the entire state. This multi-state collaboration led by Illinois will result in a basin-scale understanding of the processes that control the distribution of critical minerals hosted in the Devonian black shales. Under **Cortland Eble**'s lead, we also continued our involvement in a multi-state collaboration led by the Kansas Geological Survey by contributing to a similar investigation targeting critical minerals hosted in Pennsylvanian black shales. These two regional projects are expected to significantly improve our understanding of the critical mineral resource potential of organic-rich black shales.



Photomicrograph of a rare earth element-bearing igneous dike from the WKFD under cross-polarized light; 500-times magnification.

KGS researchers continued their inventory of mine waste features related to historical mining in the Western Kentucky Fluorspar District (WKFD). Mine wastes have recently been considered as potential sources for critical minerals.

Paul Puckett continued to impress our USGS collaborators with his forensic investigation skills as he tracked down documentation pertaining to potential mine waste features that he identified

using lidar and a series of historical aerial photographs.

Meanwhile, **Puckett** also collaborated with the Geoscience Information Management Section of KGS to continue adding legacy mineral exploration documents to improve and enhance the [Kentucky Mineral Resources Information web service](#) supported by the USGS Data Preservation Program's Earth MRI-related priority area.

The rare earth element (REE) potential and the genesis of the igneous dikes of the Illinois-Kentucky Fluorspar District (IKFD) remain a hot topic. The three-dimensional geological map of the Fluorspar District, created during an earlier Earth MRI project, is

now available [online here](#). This map provides a powerful tool for future research in the district. The **Lukoczki** team also continued to work on deciphering the origin of the REE-bearing dikes and delivered conference presentations on this topic in [Pittsburgh](#), [San Francisco](#), and [Springfield](#). To allow for further in-depth investigations into the origin of these peculiar rocks, as well as to expand the analytical capabilities of KGS and the UK, funding was obtained to purchase new and upgrade existing Linkam microthermometry instrumentation. PI **Lukoczki**'s microscopy lab now includes state-of-the-art instrumentation to perform fluid and melt inclusion microthermometry on a variety of geological materials.

Midwest Regional Carbon Initiative



Energy & Minerals Section Head Steve

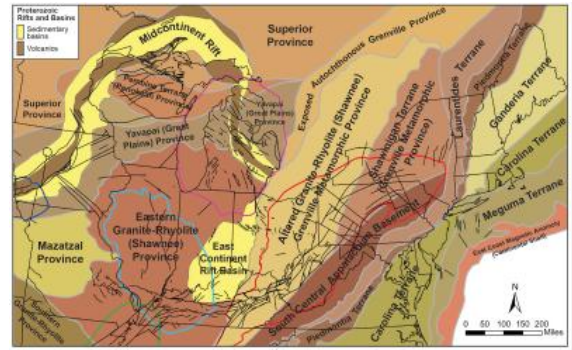
Greb working on regional cross sections.

The Midwest Regional Carbon Initiative (MRCI) is a multi-year regional carbon storage and utilization research project funded by the U.S. Department of Energy (DOE) and led by the Battelle Memorial Institute and the Illinois Geological Survey. The MRCI region includes 20 states in the Midwest, east-central, and northeastern United States, and parts of the offshore mid-Atlantic Ocean. MRCI's goal is to advance regional research on carbon capture, utilization, and storage (CCUS) by addressing key technical challenges, obtaining and sharing data to support CCUS, facilitating regional infrastructure planning, and performing regional technology transfer.

The MRCI project concluded at the end of September 2024. The final technical report contains accessible information about the geology, infrastructure, and social and regulatory issues related to carbon storage in the region. KGS researchers worked on several

chapters summarizing the subsurface geology of the MRCI region relative to carbon storage.

Chapters of particular relevance to Kentucky are those on the Appalachian Basin (including eastern Kentucky), Central Arches (including central Kentucky), Illinois Basin (including western Kentucky), and Upper Mississippi Embayment (including the Jackson Purchase region of Kentucky). These chapters were written by **Steve Greb** and geologists from other states. New regional maps on subsurface stratigraphic horizons by **Tom Sparks** and **John Hickman** are also included in the report. Large format, regional cross sections by **Greb, Sparks, Hickman**, and geologists from other states show subsurface geologic units color coded relative to carbon storage geology, with brief explanations of the geology for each. Regional stratigraphic correlation charts compiled by **Greb** and others are also color coded relative to carbon storage and provide a useful stratigraphic reference for the region.



Basement map of regional provinces and faults

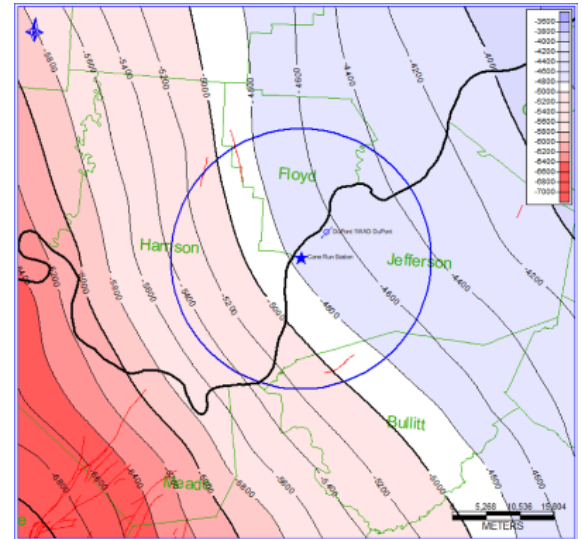
Other chapters, which were written by **Seth Carpenter, Jon Schmidt**, and geologists from Lettis Consultants International, discussed catalogs of seismicity and in situ stress data compiled as part of this project. These chapters also presented estimations of both the regional tectonic stress throughout the project area and the potential for faults that penetrate the Precambrian to slip in two candidate CCUS locations. Understanding the state and direction of tectonic stress in basement rocks is critical to safe and effective implementation of CCUS and the avoidance or limitation of induced seismicity in the future. These contributions provide a wealth of CCUS data for potential future projects and continued research efforts.

The final project report has been submitted to the DOE and will be available to the public on the MRCI, DOE, and KGS websites

following review. The [MRCI website](#) includes links to information, podcasts, short courses, and a [searchable, regional CCUS database](#).

Cane Run CO₂ Storage

As part of a larger DOE funded research project through the UK College of Engineering's Kunlei Liu (PI), in June 2024, **John Hickman** completed a preliminary assessment of the geologic CO₂ sequestration potential for an area surrounding the LG&E-KU Cane Run Generation Station in Jefferson County, Kentucky. Subsurface geophysical logs from petroleum-exploration and waste-disposal wells penetrating the Knox Group or deeper formations were used to compile data on potential reservoirs and seals below a depth of 2,600 ft (the minimum depth for CO₂ storage in the region). The Mount Simon Sandstone is a potential reservoir in the area, and shales in the overlying Eau Claire Formation are potential seals for the reservoir. No cores are available at the site, but core analyses (porosity and permeability) for the Mount Simon Sandstone (reservoir) and the overlying Eau Claire Formation (seal) from wells in the region were used for estimates.



Structure map of the top of the Cambrian Mount Simon Sandstone (in subsea ft). County boundary lines are indicated in green, and the In./Ky. border is drawn as a wide, black line.

Additionally, porosity estimates from downhole logs recorded in the nearby (approximately 3.5 mi NE) DuPont #1WAD DuPont Fee well were used to estimate porosity and permeability of the sandstone. These data and interpretations were then used as input data for the DOE National Energy Technology Laboratory's CO₂-SCREEN modeling software package for subsurface volumetric calculations. The results based on the available data indicate that Cane Run Generation Station has potential for geologic storage of CO₂ beneath the property. The Mount Simon Sandstone is likely the only formation beneath the surface in the study area with

suitable porosity and permeability at the depths required for supercritical-phase CO₂ sequestration. Excellent confinement for injected CO₂ would likely be provided by the Eau Claire Formation, which is more than 500 ft thick and contains thick shale intervals in available downhole logs in the region. However, local geologic data control for the reservoir is limited, with only one well (the DuPont #1WAD DuPont Fee well) penetrating the reservoir interval within a 20-km radius, so cores, additional well data, and likely geophysical data would need to be collected at any future proposed storage site to confirm the sequestration potential of both the reservoir and seal.

Center-Pivot Irrigation and Groundwater



A limestone conduit that is pumped dry during irrigation. The ceiling and floor of the conduit are 65 and 68 ft, respectively, below land surface.

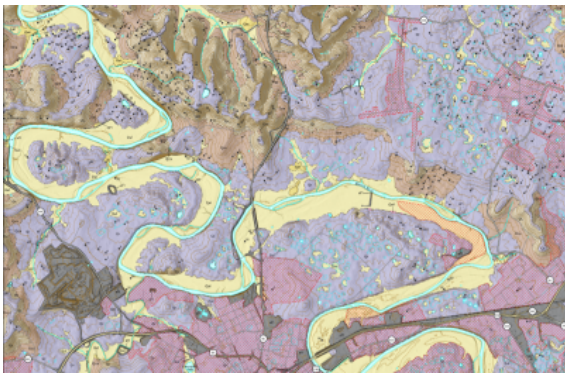
Locating adequate groundwater supply for center-pivot irrigation in fractured and/or karstic limestone bedrock in the Western Pennyroyal can be difficult. This difficulty was experienced by a corn/soybean farmer in southern Hopkins County who drilled more than 20 test boreholes but only installed six water wells, along with two ponds, that produce water for four center pivots. One of the production wells was completed in a conduit, which is pumped dry during

irrigation. Pressure transducers were installed in December 2023 in five unused water wells on the farm to collect year-round continuous groundwater elevation data. Data from this project will be used to evaluate the influence of center-pivot irrigation on a local limestone aquifer in the Western Pennyroyal and to educate the agricultural sector on the importance of understanding the local hydrogeology before investing in center-pivot irrigation. **Glynn Beck** is conducting this research, which is funded by KGS.

Mapping

STATEMAP-Funded Geologic Mapping Activities

During the 2023–2024 fiscal year, KGS worked on three subprojects funded by the STATEMAP component of the USGS's National Cooperative Geologic Mapping Program, coordinated by **William Andrews**.

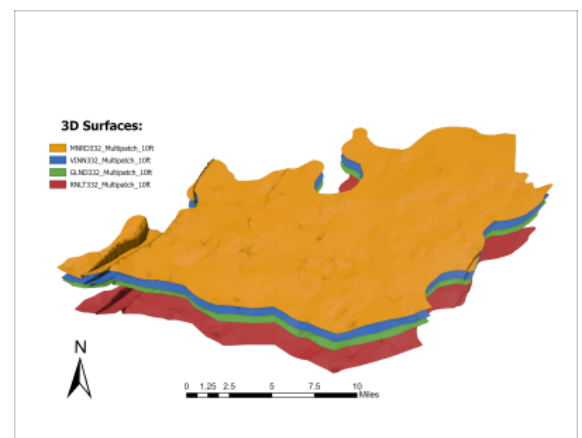


Portion of the surficial geologic map of the Bowling Green North 7.5-Minute Quadrangle, Warren County, Kentucky.

The first project included surficial geologic mapping in the Warren County area and saw the completion of Rockfield, Hadley, and Bowling Green North quadrangles (2022–2023) and the initiation of new mapping in the Bowling Green South, Bristow, and Smiths Grove quadrangles (2023–2024). Mapping was completed by a team of geologists, including **Meredith Swallom, Bailee**

Hodelka, Matt Massey, Hannah Hayes, Chaz Wells, and **Steve Martin**, and covered the urban center of Bowling Green, the Dripping Springs escarpment, and the sinkhole plain within the Barren River watershed. The resulting maps provide detailed coverage of the Warren County area and advance our stakeholder-directed goal of producing a comprehensive cartographic and GIS resource for the county.

In the second project, **John Hickman, Devan Robinson**, and **Dibya Koirala** interpreted new 3D stratigraphic surfaces in Union and Henderson counties north of the Rough Creek Graben. The software program Petra was used to generate digital structure contours of the Menard Limestone, Vienna Limestone, Glen Dean Limestone, and Renault Limestone based on new geophysical well log



3D surfaces created by Devan Robinson and John

Hickman for StateMap Project 2 in western Kentucky

interpretations and detailed stratigraphic correlation. These Chester series horizons were then imported into ArcGIS Pro and converted into 3D multipatch features using established KGS geoprocessing methods.

In the third project, **Devan Robinson** crafted an inventory of potential geoheritage sites selected from Kentucky state parks, national parks and historic sites, nature preserves, and several sites nominated by the KGS Geoheritage Working Group. This process resulted in 81 geoheritage site candidates for consideration by KGS. Extensive research was conducted to assess the scientific, cultural, economic, aesthetic, artistic, ecological, and recreational value of each site. Of the 81 sites, KGS designated 14 as prime candidates for receiving geoheritage status.



Exposure of jointed Borden Formation along the Bluegrass Parkway in Hardin County. The rose diagram shows joint orientations measured at the exposure, and the orange arrow shows the orientation of one of the joints.

County Joint Maps

Joint data collected in Hardin, Warren, and Scott Counties was combined with joint data collected during geologic mapping of the USGS quadrangles to produce county-scale (1:125,000) joint maps for hydrological and geotechnical applications. New joint measurements were collected along roadways, hiking trails, and streams, as well as at natural arch locations. These data can be viewed via the KGS [Geological Map Service](#). The resulting joint map of Hardin County was

published in the KGS Map and Chart series and is available for download from [UKnowledge](#). KGS is also sponsoring the development of joint maps of Warren and Scott counties, which are currently in progress.



Zoom in to view the orientation of the measurements. Black are measures by Steve Martin, and blue are measures digitized from the original 1:24,000-scale geologic maps.

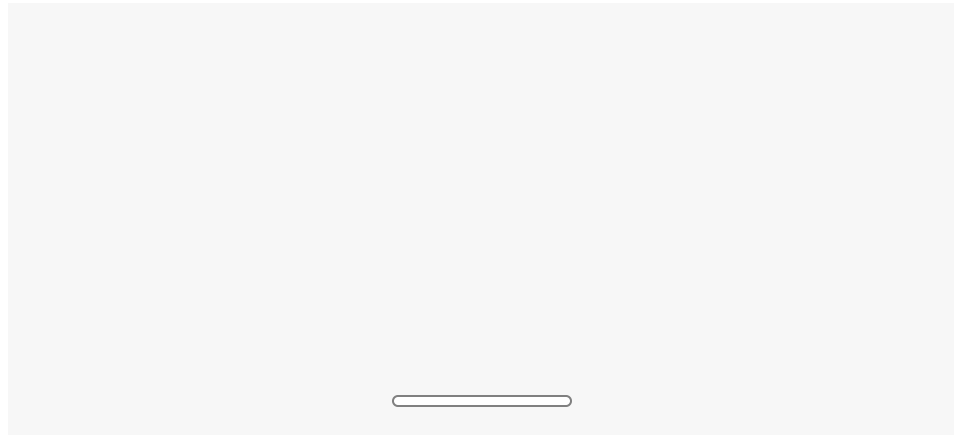
Equipment & Data

Earth Analysis Research Library (EARL)

The Earth Analysis Research Library (EARL), the premier geologic repository for geophysical samples and geologic documentation for the state of Kentucky, supported many research projects and added **Mallory Sailors** as a full-time warehouse technician in the 2023–2024 fiscal year. We were able to provide over 150 rock cores spanning 70,000 ft and contained in over 6,000 boxes for researchers from academia and industry. From those cores, 207 samples were taken for geochemical and other analytical testing. The studies involving these cores ranged from critical minerals research to oil and gas exploration. We hosted the Kentucky NRCS engineering meeting, providing attendees with a tour of the facility and an open session for questions about the facility and Kentucky geology. EARL also hosted a combined research trip for two Canadian industry groups to allow them to study several boxes of Rome Trough well cuttings, and we were able to provide them with 13 samples for analytical purposes.

Data Preservation

The USGS National Geological and Geophysical Data Preservation Program (NGGDPP) awarded KGS \$319,499 to increase data discoverability, ensure the long-term preservation of KGS collections, and provide better data to KGS patrons by addressing five main objectives. **Ben Tobin**, **Sarah Arpin**, and **Maaz Fareedi** focused on cataloging source data of the KGS dye trace database for karst groundwater basins with the goal of providing accurate and accessible data to the public. **Doug Curl** made this data available through the KGS website via the associated [KGS map service](#) or by referencing them as found.



KGS dye trace data can be viewed through our Kentucky Geologic Map Service and downloaded from UKnowledge: https://uknowledge.uky.edu/kgs_data/13/.

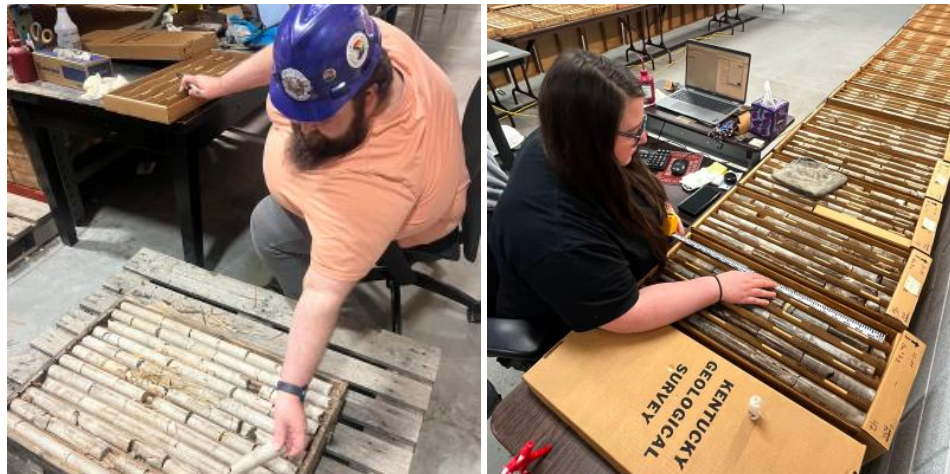
Gina Lukoczki, **Emily Morris**, and **Paul Puckett** worked to (1) georeference and vector digitize critical mineral prospect areas and drill hole field maps pertinent to the IKFD, (2) publish a mine map over the entire district, (3) develop a detailed plan for visual analytics and information extraction of geological content from digital mining documents, and (4) collect and submit 200 samples from our legacy sample collection for geochemical analysis by the USGS.

The other objectives addressing oil and gas well logs, KGS publications, research subsamples, and KGS collection metadata

are midway through their two-year timeline. To date, **Stephanie Holland** and **Olivia Teleky** have worked with **Monte Rivers** to identify, organize, scan, and disseminate nearly 100 ft³ of paper logs representing approximately 8,000 oil and gas wells drilled in south-central Kentucky. **Natalie Warren** and **Olivia Teleky** have worked with **Ray Daniel**, **Elizabeth Adams**, and **Cheyenne Hohman** to create a legacy of conservation stewardship and access through the creation of a resource library at EARL, providing centralized storage and standardized organization systems for our publications, maps, sample documents, and collection of returned subsamples, data, and publications related to research using our sample collections. These objectives aim to sustainably develop energy and natural resources information, modernize our collections' useability, and create a conservation stewardship legacy.

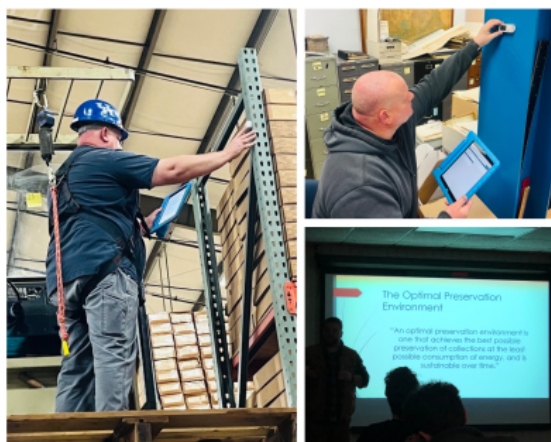
Saving America's Treasures

In the second fiscal year of the Saving America's Treasures project, nearly 35,000 ft of 52 cores were described, 45 were photographed and posted online, and 105 cores were rehoused from wooden crates to cardboard core boxes. The project team added three new employees this year, **Julia Carr-Trebelhorn**, **Zachary Morris**, and **David Whitaker**, working alongside geologist **Kurstin McKinney** and geologic photographer **Natalie Fields**. The two-year project involves 170 mineralized cores from the South-Central Kentucky Mineral District (SCKMD) and WKFD. The cores were drilled in multiple quarries in the 1960s and 70s and donated to KGS in the late 1980s. For this project, staff work diligently to identify, rehouse, describe, and photograph each core to increase digital access and improve the preservation of these mineral cores in our rock core collection. Several obstacles, including fragile core sections, mold, missing cores, and jumbled cores with unclear orientation are addressed by the project team's various workflows.



Archive tech Zachary Morris rehousing and geologist Kurstin McKinney identifying and describing south-central Kentucky mineral cores.

Archive Environmental Monitoring Program



Ryan Pinkston, EARL facility manager, installing environmental monitoring equipment at EARL; Jeremy Linden presenting a talk about archival preservation and environmental monitoring for the KGS staff.

KGS was awarded \$10,000 by the National Endowment for the Humanities (NEH) to work with preservation consultant Jeremy Linden for 18 months to establish an environmental monitoring program and develop a strategic plan for their archive spaces. In February 2024, Jeremy Linden worked with **Elizabeth Adams**, **Ryan Pinkston**, and **Doug Curl** to set up and install dataloggers in various archive spaces. The deployment locations were based on collections storage and past/known environmental risks (such as historic mold outbreaks, water leaks, and

microclimates for heat and/or moisture). Temperature and relative humidity data from the dataloggers will be used to track important preservation metrics and identify which environmental risks require mitigation measures. While at KGS, Jeremy Linden also hosted a half-day workshop about environmental degradation for KGS, UK Libraries, and other interested staff from various departments at UK. The data collected through the new monitoring program will help improve preservation practices and frame future grant proposals.

Paul Edwin Potter Internship Program

This year's program focused on creating a research team experience for six interns with six KGS staff mentors. Projects were designed based on each intern's interests and answered research questions about the karst features in the Red River Gorge area. During the 10-week program, interns participated in nearly 20 seminars, field trips, and equipment demonstrations focused on developing hard and soft skills. This included mock interviews with three members of the KGS Advisory Board and Association of International Professional Geologists (AIPG). The program concluded with the Interns' Showcase, where each intern was given the opportunity to show off their work with a lighting talk and poster presentation. At the close of the program, one intern stated, "I think my experience was great. I loved learning a lot of new information this summer and the hands-on work was super fun. The mentors were really great, and I am really proud of the work I've done."

2024 Paul Edwin Potter Interns



Top: Madison High, John T. Gribbins, III, and Sierra Ison
Bottom: Abbie Grzynkiewicz, Emelia Harris, and Darryl Woods, Jr.

Special thanks to: Alice Jones (KGS Advisory Board), Tim Crumbie (KGS Advisory Board/AIPG), Austin Dilla (AIPG), **Kati Ellis, Hudson Koch, Alex Washburn, Steve Greb, Emily Morris, Jason Dortch, Jason Backus, Junfeng Zhu, Ambre Armstrong, Mike Ellis, Ray Daniel, Rebekah Frazier, Devan Robinson,** Lauren E. Cagle (UK Writing, Rhetoric, and Digital Studies), Ed Woolery (UK EES), and Helene Gold (UK Libraries), who were instrumental to this year's program.

Missing Middle Data Management Workshop

KGS staff **Elizabeth Adams** and **Rachel Noble-Varney** and collaborators Saebyul Choe (Lamont-Doherty Earth Observatory) and Natalie Raia (University of Arizona) were awarded a \$5,000 pilot grant by Earth Science Information Partners (ESIP) to design

a workshop focused on introducing state-level earth science researchers to best practices in research data management, including training material on how to implement these practices and an emphasis on engaging with ESIP resources. To help with the workshop design, **Noble-Varney** and **Adams** gathered information from many KGS researchers about their relationships with research data and data management practices. Raia, Choe, **Adams**, and **Doug Curl** recruited Kyle Bachman-Johnson and Isaac Wink from UK Libraries to develop a one-day training workshop for interested KGS researchers.



Left: Elizabeth Adams, Saebyul Choe, Rachel Noble-Varney, and Natalie Raia with their winning poster at ESIP's 2023 FUNDing Friday. Right: The Missing Middle Workshop for KGS researchers at the Mining and Minerals Resources Building, UK.

KGS Analytical Lab

In the 2023–2024 fiscal year, the KGS analytical laboratory conducted chemical analysis research for scientists from KGS, the broader UK research community, and Kentucky's private sector and assisted graduate students with their analytical research endeavors. Natural gas samples were analyzed using gas chromatography in support of KGS's involvement in Kentucky's orphaned oil and gas well identification and plugging project. The



lab analyzed samples for coal quality and rare earth element concentrations for the KGS Illinois Basin Core Critical Minerals project and a similar project with New Mexico Tech. The lab's wXRF spectrometer was used to analyze limestone cores for a local investigator and to analyze soil samples for Chris Sheppard of the UK Department of Plant and Soil Sciences. Water quality monitoring samples were analyzed for KGS researchers investigating springs and caves, the Kentucky River Watershed Watch program, and UK Department of Civil Engineering monitoring projects at Cane Run and South Elkhorn Creek. Graduate students from the UK EES used the lab's analytical instruments to support their research projects, which included looking at carbon in lake sediments on the coulometer and LECO carbon analyzer. Funds for upgrading the electronics, software, and computer on the X-ray diffractometer were successfully obtained. The instrument is running well and continues to be used by graduate students from many UK departments.

Analytical lab manager Jason Backus analyzing natural gas samples using gas chromatography.

KGS Analytical Geochemistry Laboratory Ser...

The KGS analytical geochemistry lab specializes in chemical and physical analyses of water, coal, mineral...

<https://www.uky.edu/KGS/education/factsheet/Analytical%20Geochemistry%20Laboratory%20Services.pdf>



Kentucky Oil and Gas Archive

More than 200,000 oil and gas wells have been drilled in Kentucky since the first well was put into production in 1818. In 1960, the KGS became the official archive for oil and gas documents required by the state upon completing a well, though KGS records go back to the first well and are accessible through the KYGeode search engine [online](#). Users can search by a geographic area (county, quadrangle, [Carter](#)

Oil and Gas Records Search

County: None selected ▾
[use an INDEX MAP to make selection](#)

Quadrangle(s): None selected ▾
[use an INDEX MAP to make selection](#)

Coordinates and Radius: Not Selected ▾

Carter Coordinates: Not Selected ▾

☐ Only return wells with a known coordinate location (lat/lon and carter)

coordinate, KGS record number, KY permit number, API number, date of permitting or completion, stratigraphy, available data (production data, scanned documents, scanned elogs, etc.), or depth.

A new feature added in the last year is the ability to limit search results to only wells with a known location. Many older records lack a specific well location. This feature allows a user to query only results that are mappable. As the archive contains KGS's most used data, staff are constantly working to improve the service. Contact **Carrie Pulliam** with any suggestions or questions about the oil and gas wells archive.

Communications

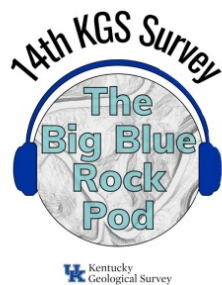
The Big Blue Rock Pod

This is year three of KGS's The Big Blue Rock Pod, a Kentucky-themed earth science podcast where hosts **Matt Crawford**, **Sarah Arpin**, and **Doug Curl** invite guests, typically geoscience researchers, to join in relaxed, unscripted conversations about geologic topics. Formatted around monthly themed episodes and expert guests, the aim of the podcast is to highlight how geology and earth processes impact daily life.



KGS's The Big Blue Rock Pod hosts Sarah Arpin, Matt Crawford, and Doug Curl

Twelve episodes were released between July 2023 and June 2024, with topics ranging from landslides to the philosophy of science to Kentucky's natural rock arches. The Big Blue Rock Pod is hosted on PodBean and available on multiple applications, including Apple Podcasts, Amazon Music, Spotify, and Google Podcasts, and it's available for download on the KGS homepage.



The Big Blue Rock Pod

Ep. 45: Building resilience...



▶ Ep. 45: Building resilience from the gro...	August 27, 2025	31:44	⌵
▶ Ep. 44: Out of Office Messages	July 31, 2025	46:29	⌵
▶ Ep. 43: Same Geologic Time, New Listen	June 27, 2025	53:05	⌵
▶ Ep. 42: Shale, yeah!	May 30, 2025	41:31	⌵
▶ Ep. 41: Someone to Organize Our Schist	April 30, 2025	55:42	⌵

The Big Blue Rock Pod player, hosted on [PodBean](#).

KGS Annual Seminar



At the annual seminar, KGS staff present posters at on a range of topics from digitizing physical geologic specimens to variations in trace element distributions.

KGS hosted its 63rd Annual Seminar on May 15th at the Jacobs Science Building on the UK campus. This year's theme was "KGS for the Commonwealth" and the seminar explored the breadth of KGS's impact on Kentucky and included presentations about KGS research and collaborations.

KGS Tabling

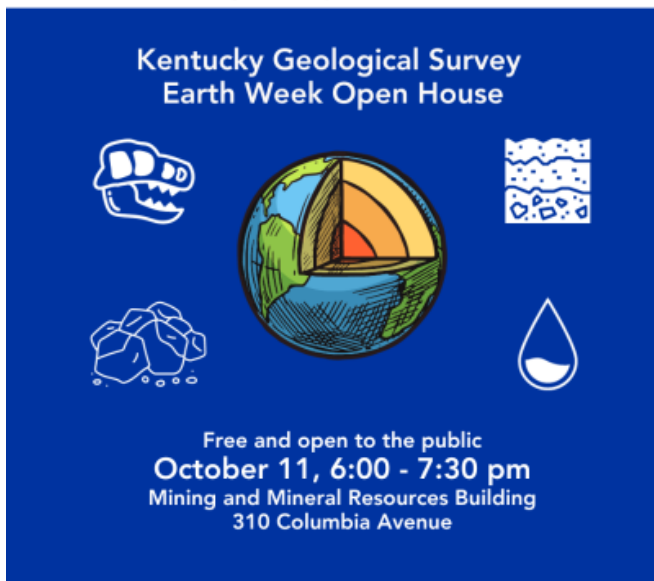
KGS participates in both regional and national conferences and meetings. This year, KGS had exhibit tables at Geological Society of America's Annual Meeting, Kentucky Academy of Science's Annual Meeting, several elementary school and public libraries STEM nights, Mammoth Cave National Park's National Fossil Day, UK College of Engineering's E-Day, and Kentucky Oil and Gas Association's Annual Meeting.



KGS tables at Mammoth Cave National Park's National Fossil Day, Wellington Elementary's STEM Night, and UK Engineering's E-Day.

Social Media

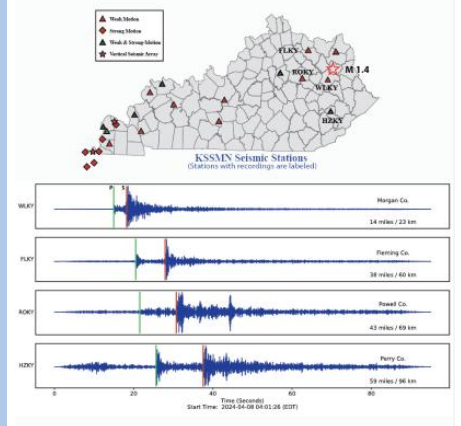
KGS operates five social media channels ([LinkedIn](#), [Facebook](#), [Instagram](#), [Threads](#), and [X](#) (formerly Twitter)). As a communications tool, social media is vital for the mission of KGS. It serves as an effective platform for sharing key news and messages, while also building a sense of community and opening new channels for interaction. KGS actively works to increase its social media engagement and audience size by sharing both general and research-specific content. Additionally, KGS's media presence provides job seekers insight into KGS's culture, helping to attract potential candidates. All these efforts increase KGS's status and reputation in the geology and geoscience communities.



2024 Paul Edwin Potter Interns



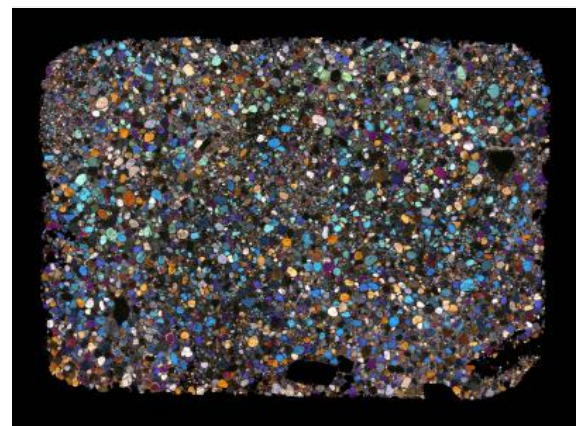
Top: Madison High, John T. Gribbins, III, and Sierra Isen
Bottom: Abbie Grzynekowicz, Emelia Harris, and Darryl Woods, Jr.



Samples of KGS social media posts.

Kentucky as Art

William Andrews received a small grant to compile a set of aesthetically pleasing geospatial images for the Kentucky as Art project. Haluk Cetin of Murray State University (MSU) subcontracted with KGS as part of a larger project funded by America View. KGS staff were invited to nominate images funded by the USGS, and candidate graphics included Landsat images, geologic maps from the USGS Geologic Quadrangle series and the KGS map service, STATEMAP-funded geologic



One of the rock core thin slice photographs by geologic photographer Natalie Fields submitted for the Kentucky as Art project.

maps, and thin-section photomicrographs generated for the USGS Earth MRI program. **Natalie Fields, Emily Morris, Cheyenne Hohman, Doug Curl,** and **Rebekah Frazier** made particular contributions to the project. The pool of nominated images was reviewed by attendees of the KGS Annual Meeting in May 2024 and by KGS staff. The final images will be available for future public education programs at KGS and MSU.

Funded Research Projects

PI	Sponsor	Project
Elizabeth Adams	National Endowment for the Humanities	Kentucky Geological Survey Environmental Monitoring Program Development
	U.S. Geological Survey	Kentucky Geological Survey FY2024 Geologic Data Preservation Project; Kentucky Geological Survey FY2023 Geologic Data Preservation Project
	Institute of Museum and Library Services	Preserving Collections from the Western Kentucky Fluorspar and South-Central Kentucky Mineral Districts
William Andrews	U.S. Geological Survey	New Surficial Geologic Mapping, Stratigraphic Geoframework, and Geoheritage Inventory Projects in Kentucky

PI	Sponsor	Project
	Murray State University	Kentucky As Art - Pilot Project: StateView Program Development and Operations for the State of Kentucky
E. Glynn Beck	Kentucky Soybean Board	Blue Water Farms: Edge of Field water monitoring in Kentucky soils
	U.S. Department of Agriculture	Nutrient and sediment runoff assessment in the Upper Mississippi River embayment
J. Rick Bowersox	Virginia Polytechnic Institute and State University	Clean Hydrogen Production, Storage, Transport, and Utilization to Enable a Net-Zero Carbon Economy: Fundamental Research to Enable High Volume, Long-Term Subsurface Hydrogen Storage

PI	Sponsor	Project
	East Kentucky Power Cooperative Incorporated	Preliminary Evaluation for CO2 Storage, Trapp Gas Field Area, Clark County, Kentucky
N. Seth Carpenter	Federal Emergency Management Agency	Real-time Tornado Touchdown Monitoring from the Kentucky Seismic and Strong Motion Network

PI	Sponsor	Project
Matthew Crawford	Federal Emergency Management Agency	Enriching Kentucky's Landslide Inventory Database
	KY Energy and Environment Cabinet	Landslide monitoring project at Maxey Flats Disposal Site
	Federal Emergency Management Agency	Multi-Jurisdictional Hazard Mitigation Planning-Related Activity for Landslides for the Kentucky River Area Development District
	U.S. Geological Survey	Building on Federal and State Landslide Research Collaboration
	KY Department of Military Affairs	UKRF and KGS Geo Risk Assess, BRIC
Doug Curl	WWKY Data Portal Overhaul FY23-24	Watershed Watch in Kentucky Incorporated

PI	Sponsor	Project
Cortland Eble	University of Kansas	Critical Minerals in Pennsylvanian Black Shales of the US Midcontinent
	Department of Energy	Kentucky part of the Carbon Ore, Rare Earth and Critical Minerals (CORE-CM) Resource Assessment of the Appalachian Basin (MAPP-CORE)
John Hickman	Department of Energy	LG&E Cane Run Station CO2 Storage site assessment
Charles Taylor	Federal Emergency Management Agency	Identifying Areas of Higher Potential Vulnerability to Sinkhole or Karst-Related Flooding in the Inner Bluegrass Region Lower Kentucky River Basin

PI	Sponsor	Project
Steve Greb	University of Illinois	Illinois Basin (IB) Carbon Ore, Rare Earth, and Critical Minerals (CORE-CM) Initiative
	University of Illinois	Midcontinent Stratigraphy of the Gulf Coastal Plain: Northern Embayment - Illinois, Kentucky, and Missouri, a Two-Year Project
	Battelle Memorial Institute	Regional Initiative to Accelerate CCUS Development
Georgina Lukoczki	University of Illinois	Earth Mapping Resources Initiative: Critical Minerals in Devonian Metalliferous Black Shales of the Illinois Basin
	U.S. Geological Survey	Earth Mapping Resources Initiative: Kentucky Non-Coal Mine Waste Inventory

PI	Sponsor	Project
	U.S. Geological Survey	Integrated Studies of Overlapping Critical Mineral Systems in South Central Kentucky and North Central Tennessee
T. Marty Parris	KY Energy and Environment Cabinet	Methane Emission Measuring on Orphaned Oil and Gas Wells: Pilot
	KY Energy and Environment Cabinet	Methane Emission Measuring on Orphaned Oil and Gas Wells: Phase 1
Junfeng Zhu	Federal Emergency Management Agency	Develop a Karst/Sinkhole Hazard Mitigation Plan-Related Activity (PRA) for the Barren River Area Development District (BRADD)
	National Science Foundation	Collaborative Research: Data Fusion for Characterizing and

PI	Sponsor	Project
		Understanding Water Flow

Publications

KGS Series Publications

Bowersox, J.R., and Hickman, J.B., 2023, Assessing compressed air energy storage (CAES) potential in Kentucky to augment energy production from renewable resources: Kentucky Geological Survey, ser. 13, Report of Investigations 14, 17 p., <https://doi.org/10.13023/kgs13.ri14.2023>.

Buchanan, W., Swallom, M., Bottoms, A., Massey, M., Hodelka, B.N., and Morris, E., 2023, Surficial geologic map of the Rockfield 7.5-minute quadrangle, Warren, Logan, and Simpson Counties, Kentucky: Kentucky Geological Survey, ser. 13, Contract Report 57, scale 1:24,000, <https://doi.org/10.13023/kgs13ct57.2023>.

Haneberg, W.C., 2023, Recurrence interval estimates for the July 2022 eastern Kentucky floods, North Fork of the Kentucky River: Kentucky Geological Survey, ser. 13, Open-File Report 1, 26 p., <https://doi.org/10.13023/kgs13of1.2023>.

Martin, S.L., and Morris, E.R., 2024, Joint map of Hardin County, Kentucky: Kentucky Geological Survey, ser. 13, Map and Chart 6, scale 1:125,000, <https://doi.org/10.13023/kgs13mc6.2024>.

Massey, M., Swallom, M., Bottoms, A., Buchanan, W., Hodelka, B.N., and Morris, E., 2023, Surficial geologic map of the Hadley 7.5-minute quadrangle, Warren County, Kentucky:

Kentucky Geological Survey, ser. 13, Contract Report 56, scale 1:24,000, <https://doi.org/10.13023/kgs13cr562023>.

Storrs, G.W., McDonald, H.G., Scott, E., Genheimer, R.A., Hedeem, S.E., and Schwalbach, C.E., 2023, Field guide to Big Bone Lick, Kentucky: Birthplace of American vertebrate paleontology: Kentucky Geological Survey, ser. 13, Special Publication 2, 54 p., <https://doi.org/10.13023/KGS13SP22023>.

Swallom, M., Massey, M., Buchanan, W., Hodelka, B.N., Hayes, H., Wells, C., III, and Morris, E., 2023, Surficial geologic map of the Bowling Green North 7.5-minute quadrangle, Warren County, Kentucky: Kentucky Geological Survey, ser. 13, Contract Report 55, scale 1:24,000, <https://doi.org/10.13023/kgs13cr552023>.

KGS Data Products

Arpin, S.M., Tobin, B.W., Fareedi, M., Link, A., and Currens, J.C., 2023, Kentucky karst dye trace database: Kentucky Geological Survey, ser. 13, research data, <https://doi.org/10.13023/kgs.data.11.09.2023>.

Martin, S.L., 2023, DVGQ joint data: Kentucky Geological Survey, ser. 13, research data, <https://doi.org/10.13023/kgs.data.8.9.2023>.

Martin, S.L., 2023, KGS joint data: Kentucky Geological Survey, ser. 13, research data, <https://doi.org/10.13023/kgs.data.11.01.2023>.

Tobin, B., Miller, B.V., Niemiller, M., and Erhardt, A., 2023, Hydrology data for Fern Cave, Alabama (2020–2022): Kentucky Geological Survey, ser. 13, research data, <https://doi.org/10.13023/kgs.data.07202023>.

KGS-Affiliated External Publications

Carpenter, N.S., Wang, Z., and Woolery, E.W., 2023, Linear site-response characteristics at central and eastern U.S. seismic

stations: *Frontiers in Earth Science*, v. 11, article 1216467,
<https://doi.org/10.3389/feart.2023.1216467>.

Clary, R.M., Pyle, E.J., and **Andrews, W.**, 2024, Encompassing geoheritage's multiple voices, multiple venues and multi-disciplinarity, in Clary, R.M., Pyle, E.J., and **Andrews, W.**, eds., *Geology's significant sites and their contributions to geoheritage*: London, The Geological Society, p. 1–7,
<https://doi.org/10.1144/SP543-2024-34>.

Decker, L., Sawyer, A.H., Welch, S.A., **Zhu, J.**, Binley, A., Field, H.R., Hanrahan, B.R., and King, K.W., 2024, Wide-ranging timescales of subsurface phosphorus transport from field to stream in a tile drained landscape: *Journal of Hydrology*, v. 635, article 131185,
<https://doi.org/10.1016/j.jhydrol.2024.131185>.

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<https://doi.org/10.1144/SP535-2022-228>.

DiMichele, W.A., Lucas, S.G., **Eble, C.F.**, Kerp, H., Reynolds, S.J., May, P., and Pigg, K.B., 2024, A detailed stratigraphic and taphonomic reassessment of the late Paleozoic fossil flora from Promontory Butte, Arizona: Review of Palaeobotany and Palynology, v. 320, article 105004,
<https://doi.org/10.1016/j.revpalbo.2023.105004>.

Ettensohn, F.R., Seckinger, D.C., Moecher, D.P., and **Eble, C.F.**, 2023, Paleoenvironmental and tectonic implications of an Upper Devonian glaciogenic succession from east-central West Virginia, USA, in McLaurin, B.T., ed., *Field excursions to the Appalachian Plateaus and the Valley and Ridge for GSA Connects 2023*: Boulder,

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EQIP EoF grant, semi-annual data report to the U.S. Department of
Agriculture, Natural Resources Conservation Service.

2023–2024 Staff

State Geologist's Office

- Andrews, William. Acting Director and State Geologist

Administrative

- Ellis, Kati. Administrative Business Officer
- Armstrong, Ambre. Administrative Support Associate I
- Hohman, Cheyenne. Publication Resources Curator Manager
- Phillips, Gwen. Staff Support Associate II

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- Frazier, Rebekah. Communications Officer
- Fulton, Shelby. Geologic Publication Editor

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- Dortch, Jason. Geologist V
- Saha, Sourav. Post-Doctoral Scholar

Energy and Minerals

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- Eble, Cortland. Geologist V
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- Hickman, John. Geologist IV
- Kiraly, Edit. Geologist II
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- Parris, Marty. Geologist V
- Puckett, Paul. Geology Database Support

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- Ellis, Mike. IS Technical Support Specialist IV
- o'Flaherty, Fin. Web and Database Specialist
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- Wells, Charles. Geologic Field Technician

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Earth Analysis Research Library

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- Carr-Trebelhorn, Julia. Geologic Archive Technician
- Daniel, Ray. Principal Research Analyst
- Eastridge, Emily. Geologist I
- Fields, Natalie. Geologic Photographer
- Hall, Charlie. Archive Technician
- McKinney, Kurstin. Geologist I
- Sailors, Mallory. Research Warehouse Technician
- Teleky, Olivia. Archive Technician
- Warren, Natalie. Geologic Records Curator

Western Kentucky Office

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- Ruckdeschel, Lucas. Student Geologist
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KGS Paul Edwin Potter Internship Summer 2024

- Adams, Elizabeth. Internship Coordinator
- Gribbins, JT. Potter Intern
- Grzynkiewicz, Abbie. Potter Intern
- Harris, Emelia. Potter Intern
- High, Madison. Potter Intern
- Ison, Sierra. Potter Intern
- Woods, Darryl, Jr. Potter Intern