OKLAHOMA GEOLOGICAL SURVEY

Annual Report 2023

TAKING CARE OF OUR GARDEN WHILE PLANTING NEW TREES

OKLAHOMA GEOLOGICAL SURVEY
OGS
1908

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ABOUT THE OGS

MISSION

The Oklahoma Geological Survey is a state agency for research and public service located on the Norman Campus of The University of Oklahoma, within the Mewbourne College of Earth and Energy. The Survey is charged with investigating the state's land, water, mineral, and energy resources, and disseminating the results of those investigations to promote the wise use of Oklahoma's natural resources consistent with sound environmental practices.

CORE VALUES

(i) Proud stewardship of public data, (ii) Rigor in science activities, (iii) Available service for all Oklahomans, (iv) Devoted support to the State and University as a top-tier Energy Geoscience community.

LOCATIONS

The Oklahoma Geological Survey main office is located in the Sarkeys Energy Center on The University of Oklahoma campus in Norman, Oklahoma at 100 E. Boyd Street.

OPIC, the Oklahoma Petroleum Information Center, is also located in Norman, Oklahoma at 2020 Industrial Blvd.

DIRECTOR'S LETTER

**DR. NICK HAYMAN, OGS DIRECTOR**

I write this letter in April of 2024, three years since our last annual report! What happened? Well, we have an entirely new organizational structure with many new faces helping along. We raised a lot of external funds from the federal agency alphabet soup, and started a string of new programs. We are now poised for growth!

But how is anybody supposed to know of these successes without an annual report? And how is anybody supposed to join our mission if they don't have a one-stop shop to see all the great things we're doing? Good questions, and so this year we return to our annual reporting. In 2024 we will also start to fill in other important process points, including plans for an OGS external advisory board and a strategic plan to guide and communicate our vision.

Meanwhile, what are the big changes? There are too many to go over in a single letter, so the annual report that follows gives voice to as much as we can get our arms around in a single document. The thread through it all though is: "taking care of our garden while planting new trees" (I write this in spring!). We have worked hard to ensure our staff are treated with respect and equity, while bringing new faces in. We've invested in our core repository and seismic network - and continued to seek new ways of supporting each - to help our state's energy industry. And we've launched new education-and-outreach programs and research into environmental topics statewide. All of this alongside new programs in energy geosciences. I'm proud of the work we've done, and excited for the coming years, and hope you are too!

Staff Directory
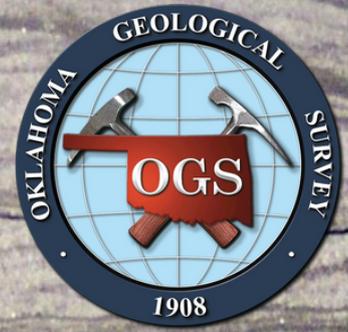
ADMINISTRATIVE

- Dr. Nicholas W. Hayman, Director & State Geologist
- Ms. Joyce Stiehler, Assistant to Director & Office Manager
- Ms. Cari Pryor, Finance & Operations Manager
- Ms. Chrishelle Drew, Administrative Technician

SCIENCE STAFF

- Dr. Benmadi Milad, Geostorage Specialist
- Dr. Paul Ogwari, Geophysicist
- Dr. Junwen Peng, Sedimentary Geologist
- Dr. Netra Regmi, Hazards Geologist
- Dr. Tom Stanley, Field Geologist
- Dr. Fnu "Ming" Suriamin, Petroleum Geologist & Petrophysicist
- Dr. Jake Walter, State Seismologist & Geophysicist

RESEARCH ASSOCIATES

- Dr. Benjamin Allen, Physics, Energy & Environment
- Dr. Carrie Miller-DeBoer, Education & Outreach
- Dr. Dessy Sapardina, Energy Geosciences
- Dr. Hongyu Xiao, Energy Geophysics
- Mr. Kevin Blackwood, Environmental Geosciences
- Ms. Cordelia (Cori) Smith, Energy Geosciences

TECHNICAL SUPPORT & OUTREACH

- Dr. Lindsey Hunt, Electron Microprobe Operator & Program Manager
- Dr. Molly Yunker, Education & Outreach Coordinator
- Mr. Nicholas Gregg, Seismic Analyst
- Mr. Carter Lewis, Research Associate
- Mr. Brandon Mace, Seismic Technician
- Ms. Cesalea Ray, GIS Analyst
- Mr. Russell Standridge, GIS Analyst
- Mr. Andrew Thiel, Seismic Analyst

OKLAHOMA PETROLEUM INFORMATION CENTER

- Mr. Richard Traver, OPIC Manager
- Mr. Scott Bryant, Warehouse Coordinator
- Mr. Jeffrey Dillon, Core & Cutting Customer Liaison
- Ms. Emma Morgan, Archivist
- Mr. Ryan Rosol, Warehouse Coordinator
- Mr. Mason Cullen, Machine Shop Technician
- Mr. Daniel Teran Castellon, Research Associate

AFFILIATE STAFF

- Dr. Carla Eichler, Field Geologist
- Dr. Emilio Torres, Energy Geosciences
- Dr. Brian Cardott, Energy Geosciences

OGS Org Chart

Admin Support	Regional Geology	OPIC	Education & Outreach
Joyce Stiehler	**Dr. Lindsey Hunt**	**Richie Tarver**	**Dr. Molly Yunker**
Cari Pryor	Dr. Tom Stanley	Scott Bryant	Dr. Carrie Miller-Deboer*
Chrishelle Drew	Russell Standridge	Jeff Dillon	

Energy Geoscience — Carter Lewis*, Dr. Carla Eichler** — Ryan Rosol — **Environmental Geoscience**

Energy Geoscience		OPIC cont.	Environmental Geoscience
Dr. Benmadi Milad		Ryan Rosol	**Dr. Netra Regmi**
Dr. Ming Suriamin	**Seismic Network**	Mason Cullen	Cesalea Ray
Dr. Junwen Peng	**Dr. Jacob Walter**	Daniel Terran	Kevin Blackwood
Dr. Ben Allen*	Dr. Paul Ogwari	Emma Morgan	
Cordelia Smith*	Andrew Thiel		
Dr. Dessy Sapardina*	Brandon Mace		
Dr. Emilio Torres**	Nicholas Gregg		
Brian Cardott**	Dr. Hongyu Xiao*		

* Research Associate
** OGS Affiliate
Bold = direct report to Director Hayman

Before 2020 OGS had an organization structure that was no longer serving our new projects and staff roles. Since then, we've been operating as essentially a single organizational group. In early 2024 we adopted a new organizational structure to better streamline communications, and more efficiently and effectively distribute efforts. From now on, if you reach out to the OGS, one of our team leads very well may get back to you and field your request or question. The names in bold are current leads, though this evolves over time. There are many cross-linking activities preventing siloing!

OGS Committees

Publications Committee	IT	Facilities
Dr. Paul Ogwari	**Richie Tarver**	**Cesalea Ray**
Dr. Lindsey Hunt	Dr. Ming Suriamin	Dr. Lindsey Hunt
Dr. Netra Regmi	Dr. Molly Yunker	Dr. Ming Suriamin
Mason Cullen	Nicholas Gregg	Scott Bryant
Carter Lewis	Russell Standridge	Brandon Mace
	Joyce Stiehler	Joyce Stiehler

Student Coordination	Awards
Dr. Jake Walter	**Dr. Lindsey Hunt**
Dr. Netra Regmi	Dr. Netra Regmi
Dr. Ming Suriamin	Daniel Terran
Dr. Molly Yunker	
Richie Tarver	

OGS now has five standing committees to ensure that we can (i) continue our greater-than-century long tradition of publishing important geological research, (ii) take advantage of the always changing landscape of computation and internet technology, (iii) access the needed tools for geological research, (iv) help our staff gain the well-deserved recognition from both OGS, the College & University, and science societies at large, and (v) provide support for staff and students in making OGS a home for undergrad and graduate research. Committees & Leads may evolve over time, but this structure ensures the key strengths of OGS are maintained and leveraged!

NEW STAFF

Since 2020 we've welcomed many new staff members!

CHRISHELLE DREW, ADMINISTRATIVE TECHNICIAN

Chrishelle is a familiar face to those at OPIC, the OGS core and data repository. Following a leave of absence Chrishelle has returned to OGS and is serving a larger role keeping our Sarkey's Energy Center office connected to OPIC on the northeast corner of Norman.

DR. LINDSEY HUNT, ELECTRON MICROPROBE OPERATOR & PROGRAM MANAGER

Lindsey did her Ph.D. at Texas A&M and was running the School of Geosciences Electron Microprobe, an important facility for doing microscopy and co-located mineral chemistry. OGS, as a user of the facility, brought Lindsey into the fold in 2021. Since then, Lindsey's ability to manage complex programs has found her leading several USGS projects on mineral resources as well.

NICHOLAS GREGG, SEISMIC ANALYST

Nicholas was an exploration geophysicist for fifteen years working on projects and plays throughout Oklahoma and the continental United States. Nicholas received his Masters of Science in Geophysics from OU, and is happy about his return to the Norman campus where he can help OGS and the seismology team tackle issue related to our States' seismicity.

PATRICK CARTER LEWIS, FIELD GEOLOGIST RESEARCH ASSOCIATE

Carter did a M.Sc. at Texas Christian (TCU) before coming up north to join our USGS project team. Carter continues the long tradition of OGS field geology.

BRANDON MACE, SEISMIC FIELD TECHNICIAN

Brandon began working as the seismic team's field technician in January, 2024. He helps to maintain and troubleshoot the seismic stations across the state. Brandon has spent most of his career working for the U.S. Forest Service as a biological science technician and wildland firefighter. He looks forward to helping the OGS with their continued research.

DR. BENMADI MILAD, GEOSTORAGE SPECIALIST

Benmadi did his Ph.D. in the OU School of Geosciences and has since had an accomplished postdoctoral career with the Petroleum Engineering School. We're excited to have Benmadi on board where he has already done great things!

DR. CARRIE MILLER-DEBOER EDUCATION & OUTREACH RESEARCH ASSOCIATE

Carrie joins our education and outreach program, working on funded projects in the energy transition. She brings 25 years of education experience, including 8 years teaching STEM in Oklahoma's middle schools, degrees in Biological Oceanography (B.S., University at Millersville, PA), Wildlife & Fisheries Science (M.Sc., Texas A&M), and Leadership & Academic Curriculumn (Ph.D., University of Oklahoma).

.... AND MORE NEW STAFF

EMMA MORGAN, OPIC CURATOR AND ARCHIVIST

Emma joined OGS in Spring of 2024 and is getting familiar with our impressive collections.

DR. JUNWEN ("AUSTIN") PENG, SEDIMENTARY GEOLOGIST

Austin began came up from UT Austin in 2023, where he did his Ph.D. in the Bureau of Economic Geology and the mudrock consortium. Austin will lead the "Organic Petrology Laboratory", of now retired Brian Cardott, into the future as the "Oklahoma Petrology Laboratory" to encompass our growing role in a wide range of geological resources.

CARI PRYOR, FINANCE & OPERATIONS MANAGER

Cari began with the OGS in 2021, taking the reins of OGS's finance and human-resources structure. Cari came to OGS from the OU College of Arts & Sciences and serves as an important conduit between OGS, the Mewbourne College, and the University. Cari also functions as our program manager, helping us manage the many external grants and contracts we are receiving.

CESELEA RAY, GIS ANALYST

Cesalea did her M.Sc. at Western Kentucky University and then joined the Kansas Geological Survey as an Arc-GIS specialist with their STATEMAP (USGS Project) team. Feeling the call of her home in Oklahoma, Ceselea came to the OGS in 2022 and hasn't looked back. Along with her work with STATEMAP, Cesalea has been helping with all things GIS across OGS, and starting a new drone-based environmental research program.

CORDELIA (CORI) SMITH, GEOSTORAGE RESEARCH ASSOCIATE

Cordelia did a Masters degree at University of Oklahoma and then spent several years working in the energy industry. She comes back to OU and OGS to help with our externally funded projects on hydrogen fuel and carbon dioxide geostorage.

DR. HONGYU XIAO, GEOPHYSICS RESEARCH ASSOCIATE

Hongyu did his Ph.D. at University of Illinois Urbana-Champaign and joins OGS as a research associate focused on induced seismicity hazards associated with future geostorage efforts.

DR. DESSY SAPARDINA, ENERGY GEOSCIENCES RESEARCH ASSOCIATE

Dessy joins us after several years in the oil industry and a Ph.D. from Colorado School of Mines. We look forward to having Dessy work on energy projects!

THANK YOU TO OUTGOING OGS STAFF

Several OGS staff departed, and some even came and went, since 2020. We thank them for their service to OGS efforts over the last several years.

- Leah Jackson (2021-2022)
- Linus Calauz (2020-2022)
- Carl Symcox (2021)
- Fernando Ferrar (2015-2023)
- Isaac Woelfel (2015-2023)
- Abbas Seyedolali (2018-2022)
- Brian Cardott (1981-2021)
- Kyle Murray (2011-2022)
- Vy Jordan (2008-2023)

Brian Cardott's Retirment

Fernando

Vy

Linus

As of this writing Dr. Carla Eichler is moving to a faculty position at Texas A&M, Amarillo. We anticipate Carla continuing with us as an affiliate and wish her well on her new endeavors!

IN MEMORIAM

Doug Bellis was a longstanding friend of OGS and passed away on April 20, 2024. He is well remembered by the Oklahoma Geological Community.

Please reach out if you know of others we can honor.

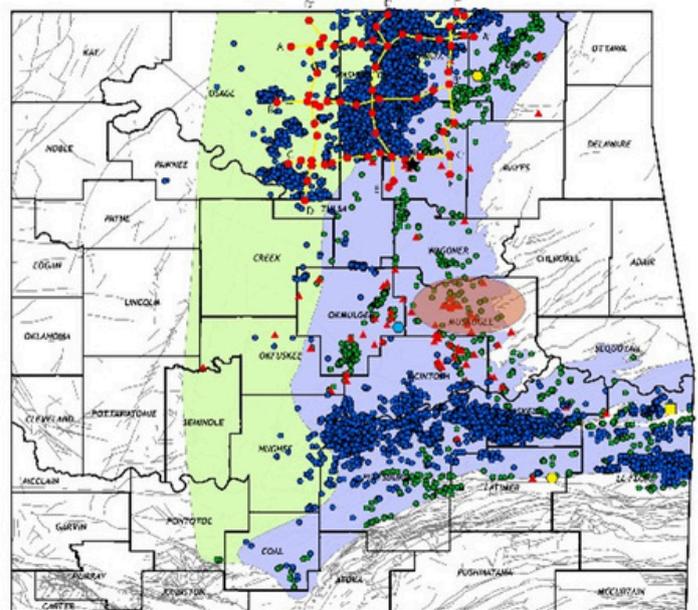# ENERGY GEOSCIENCES

Oil and Gas

OGS researcher Dr. Fnu "Ming" Suriamin, contributed to a significant publication in the journal *Fuel* (Ogbonnaya et al., 2024). The paper reports on a groundbreaking method for enhanced oil recovery (EOR) in low-permeability, liquid-rich shale reservoir, such as Oklahoma's Woodford Shale. Injecting a combination of urea and surfactant into the rock increased recovery of the original oil in place by 18% after just 14 days (see figure). This breakthrough not only enhances the efficiency of in-situ CO_2 generation for EOR but also expands its application to more complex shale formations, thereby promising improved resource recovery in areas that were previously considered less accessible.
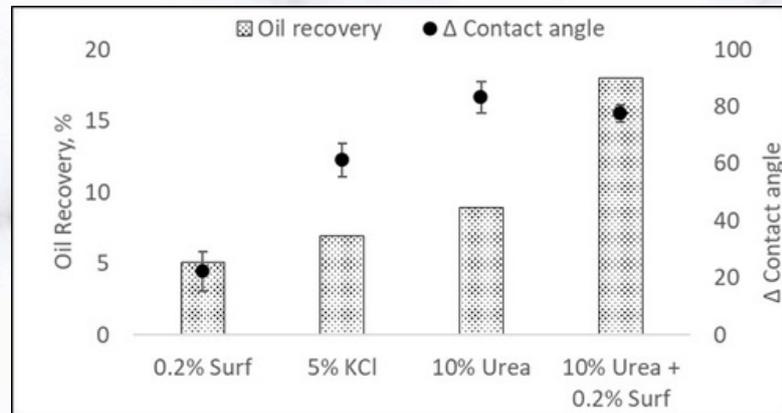
From Ogbonnaya et al., 2024, in *Fuel*, illustrating the improved recovery from a laboratory-tested injection process.

Critical Minerals (CoreCM)

The OGS teamed up with the Kansas Geological Survey to explore the potential of Rare Earth Elements (REE) and other critical minerals within coal and coal-bearing strata in the Cherokee-Forest City Basin. The OGS is providing support by supplying existing data (well logs, core, and rock samples) for further analysis. Utilizing techniques such as X-Ray Fluorescence (XRF) and other geochemical analysis, we are diligently working to ascertain the elemental composition of coal and underclay beds. These analyses are essential for determining the concentration and distribution of REE and critical minerals, which are vital for various high-tech and green energy applications. This investigation not only enhances our understanding of the region's geology but also contributes significantly to national efforts in securing a domestic supply of these indispensable resources. Funded by the US Department of Energy, the CoreCM project stands as a critical step towards realizing the untapped mineral wealth of Oklahoma and strengthening the state's position in the critical minerals industry.

The Cherokee-Forest-City Basin encompasses the coal belt of Oklahoma, and provides a potential stream of Rare Earth Elements for the domestic supply chain.

ENERGY GEOSCIENCES

Geothermal

OGS played a supporting role in a few efforts in geothermal energy. A non-profit group, *Project InnerSpace*, called upon OGS to assist with their national and global studies intended to deploy geothermal energy across the globe. This prompted OGS to revisit compilations of bottom hole temperatures and we anticipate more projects and compilations in the future, including OGS reports providing these data to the public.

Another effort, that cross-links the Energy and Seismology Orgs, is assisting the Mewbourne College Petroleum Geoscience Engineering school (MPGE), in a Department of Energy program to demonstrate reuse of boreholes as a heat source. OGS has deployed seismometers and studied the formation flow that will enable the group to heat a local elementary school off passive, semi-closed loop geothermal heat.

Bottom-Hole Temperature Compilation is a legacy product that OGS is reinvestigating for future geothermal potential.
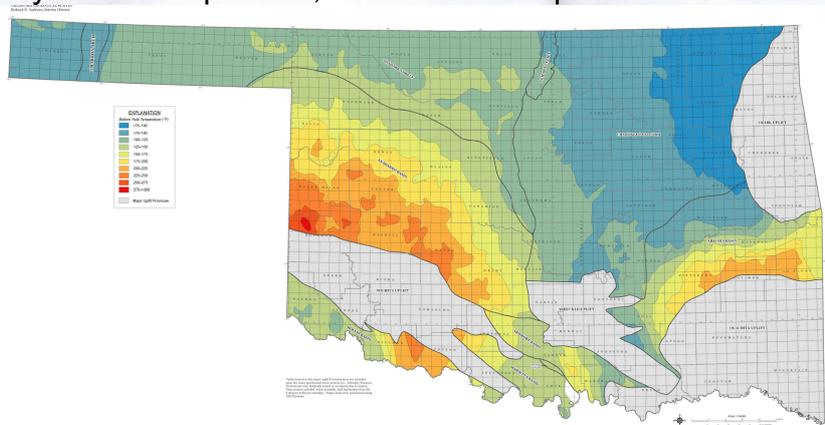

Carbon Management

Carbon Management is the broadest term for reducing greenhouse gas emissions through direct geological applications such as carbon capture and storage (CCS). OGS received a Department of Energy award to explore the carbon storage capacities of the Arbuckle Group and other geological formations within Oklahoma (see figure above). The project crosslinks many OGS Orgs and includes Prof. Brian Burkhart at OU and Camelia Knapp at OSU. The project also takes on communications with the public and policy-makers, tribal groups, and industry leaders.
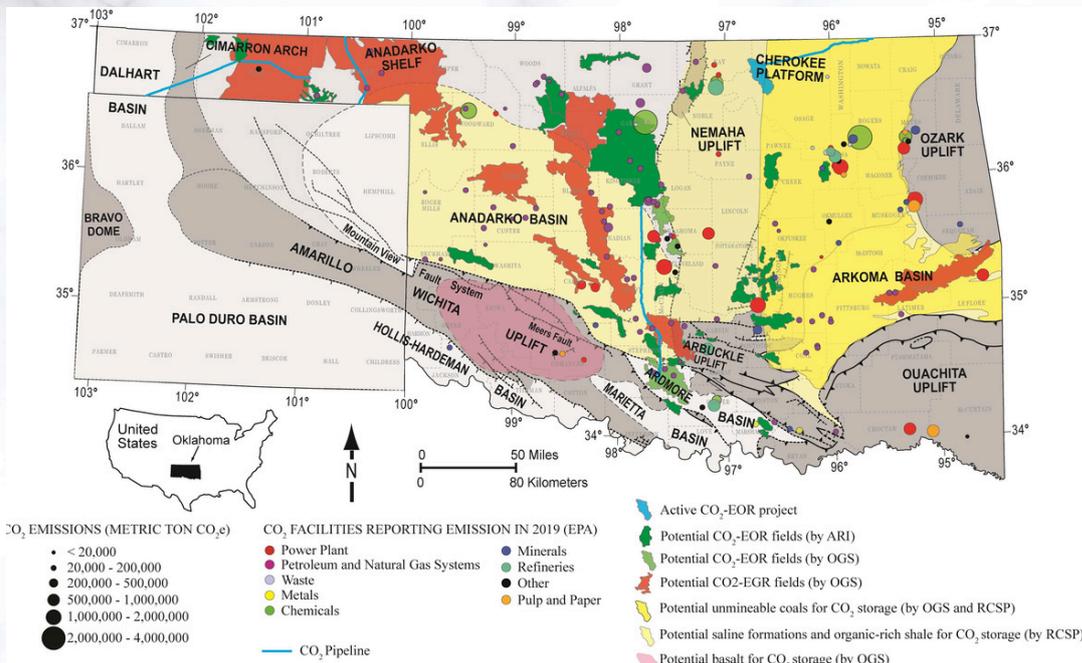
Carbon Management map for Oklahoma, from the 2021 OGS Fact Sheet
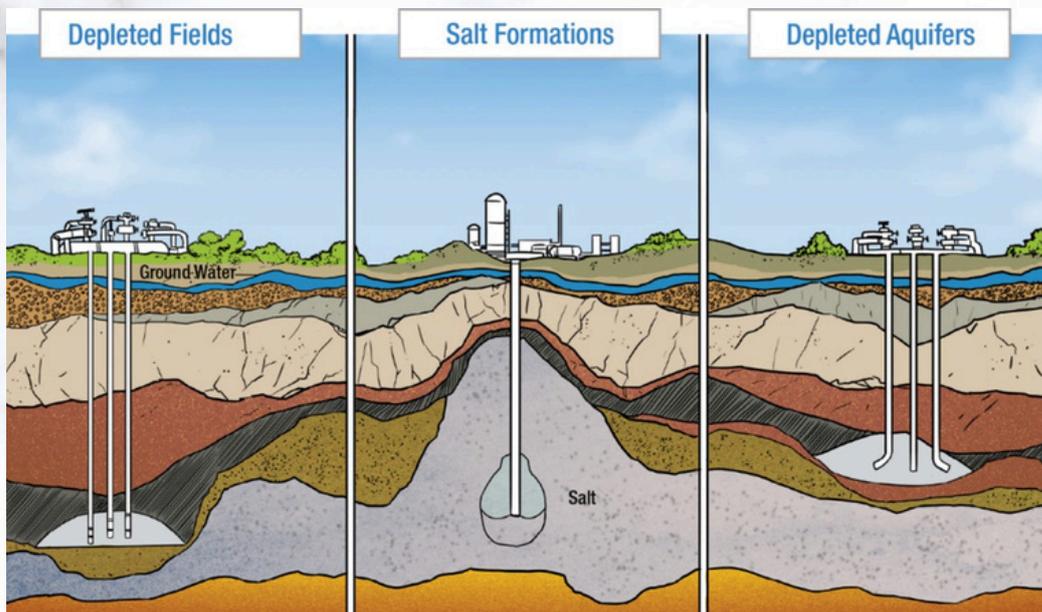
ENERGY GEOSCIENCES

OGS also participates in activities with the DOE regional initiative, CUSP West, run out of New Mexico Tech. Dr. Benmadi Milad led a CUSP-West focused project on the Osage Nation and Kay County, as published in a Fuel Journal co-authored by Director Hayman and Prof. Rouzbeh Moghanloo (MPGE). Also with CUSP West, Dr. Hayman working with Dr. Son Dang in MPGE and OGS affiliate Dr. Emilio Torres, supported the Utah State Geological Survey on planning a carbon sequestration project in southern Utah. Dr. Milad, Suriamin, and Hayman continue to help CUSP West with their regional CCS efforts.
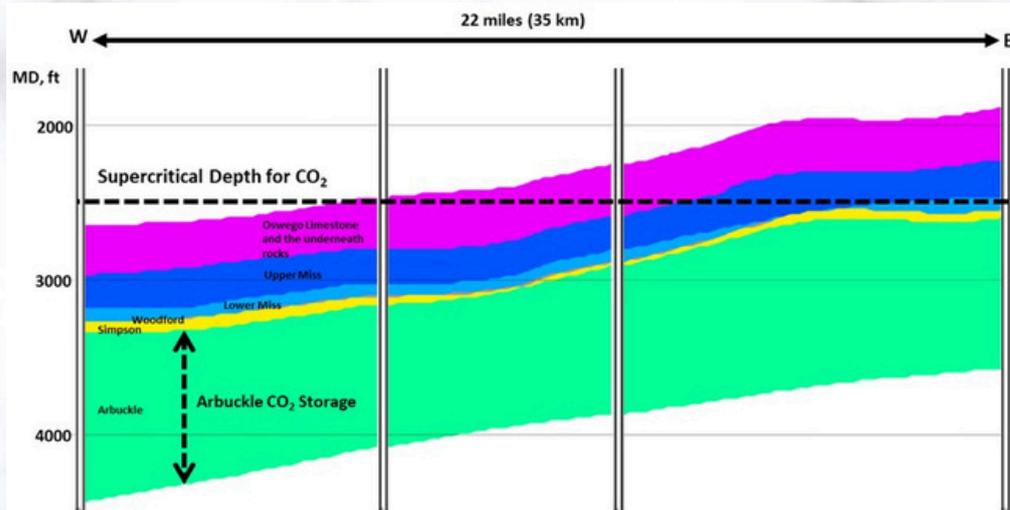
E-W cross-section over 22 miles within Osage Nation highlighting the Arbuckle targeted CO2 storage reservoir and overlaying caprocks.

Hydrogen Subsurface Storage

Hydrogen is part of the hydrocarbon energy for the world, but with the potential for production in a way that has lower climate-change impacts than traditional oil and gas sectors, as well as traditional ways of producing hydrogen itself. The OGS – led by Dr. Nicholas Hayman and Dr. Benmadi Milad - is working on a DOE-funded project with GTI Energy and Pacific Northwest National Laboratory, DISSPATCH H2. The project's primary focus is to develop and investigate the subsurface storage potential and technical challenges for hydrogen in the Anadarko Basin.


The GTI-led DOE-funded project, DISSPATCH H2 considers if depleted natural gas fields can store H2 for use.

ENERGY GEOSCIENCES

Another project on H2 is RANGE (tRANsition to Green Energy in gas-producing regions) , a project funded by National Science Foundation and led by Prof. Papavasiliou from Chemical Engineering, and involving Dr. Hayman and Dr. Allen from the OGS. The concept of RANGE, which started with the OU VPRP "Big Idea Challenge" as CHEPS (Carbon-free H2 Production and Storage) is to converge the social, natural, and engineering sciences to find a path toward a greener hydrogen economy.

The conceptual framework for RANGE, a project aiming for convergence of social, economic, engineering, and geo sciences
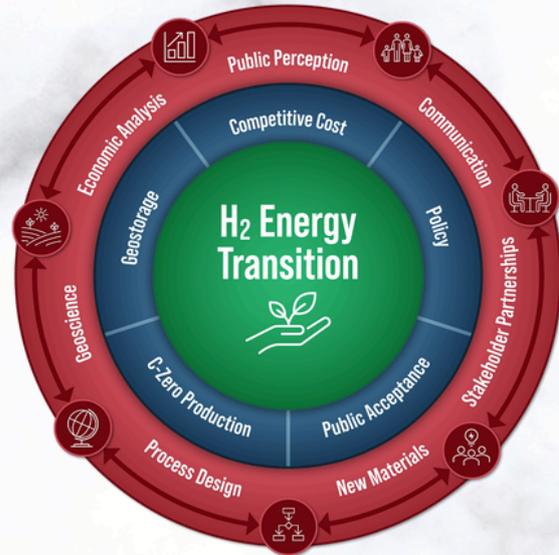
Methane Mitigation

Dr. Fnu "Ming' Suriamin works on a DOE-funded project to enhance methane mitigation strategies. This project, involving collaborators from the School of Geosciences, Electrical and Computer Sciences, the Data Institute for Societal Challenges (DISC), and the Meteorology team, focuses on improving the detection, quantification, and mitigation of methane emissions to boost environmental sustainability.Together, the group refines methane control measures, supporting global sustainability efforts and helping to reduce methane emissions significantly.

Transforming Methane Measurement, Monitoring and Mitigation

ENERGY GEOSCIENCES

Oklahoma Petrology Laboratory (OPL)

The OPL, led by Dr. Junwen Peng, is currently dedicated to building a state-wide database of petrographic characteristics of fine-grained sedimentary successions in Oklahoma. The lab continues the legacy of Brian Cardott and the study of organic shales. The OPL is equipped with one conventional optical microscope (Leica, Germany) and one fluorescence microscope (Carl Zeiss, Germany) (Figs 1-3). The objectives of OPL are to conduct traditional optical microscopy and organic petrographic microscopy characterization of sedimentary rocks, such as characteristics of mineral compositions, grain assemblages, diagenesis features, organic matter types, and vitrinite reflectance measurements. The OPL also collaborates with other labs at OGS or OU to characterize micron- to nanometer-scale pore systems in fine-grained sedimentary rocks.


The Oklahoma Petrology Laboratory (OPL) at the OGS equipped with one conventional optical microscope (Leica, Germany; left) and one fluorescence microscope (Carl Zeiss, Germany; right).

ENVIRONMENTAL GEOSCIENCES

The Environmental Geoscience group examines a wide range of Earth's surface and sub-surface processes, environmental issues involving the interaction of ground and surface waters with local geology, and explores how human activities impact the environment. Some key areas of interest include: 1) assessing the interactions among hillslope, rainfall, surface hydrology to characterize landslides, erosion and land subsidence, 2) application of drone- and satellite-based remote sensing to map these geo-hazards and quantify their trends over time, and 3) strategies for reduction or mitigation of geohazards.

Landslides: With support from FEMA and NASA, the environmental geoscience group has been studying landslides in eastern Oklahoma. The primary focus of these studies is to understand temporal and spatial characteristics of landslides, including their frequency and size distribution, the rate of hillslope deformation, the relationships between landslides and triggering forces such as rainfall and seismicity, and the preparation of high-resolution landslide susceptibility map. OGS has had NASA and FEMA support to conduct this work, made several public presentations, and worked on peer-reviewed scientific publications.
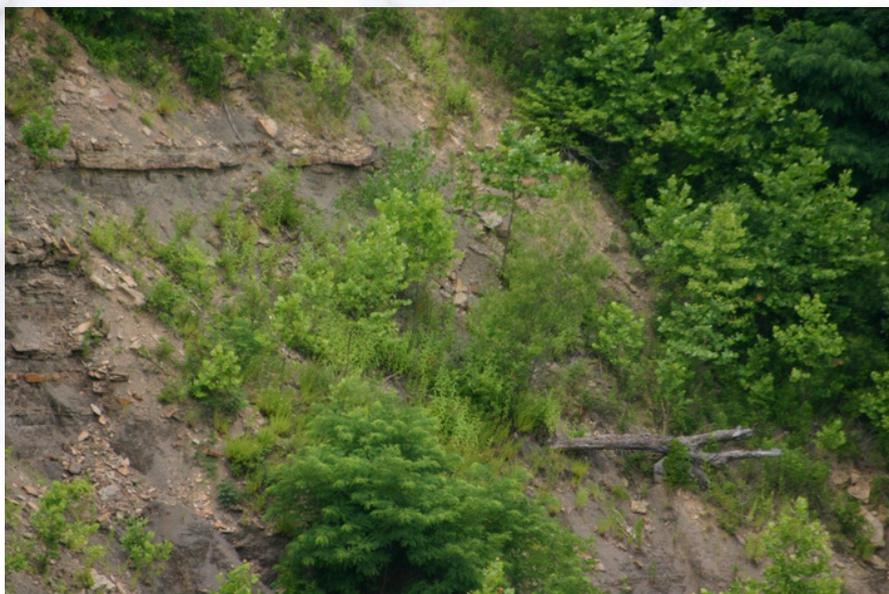
Landslides in Oklahoma are both a hazard, and under-investigated geomorphic phenomena

REGIONAL GEOLOGY

OGS has a long history of research projects centered around the regional geology of the area. The USGS program, STATEMAP, has been the cornerstone of the regional geology research since 1993. STATEMAP emphasizes the need for detailed geologic mapping on a sufficient scale and with modern techniques for the state's environmental and economic prosperity. These maps are constructed with the latest digital mapping methods, providing the user with scientific clarity and aesthetic appeal. STATEMAP projects organize older geologic information while developing new geologic data to resolve further problems encountered through urbanization, agriculture, and water use. STATEMAP focuses on 1) detailed mapping at 1:24,000 scale in areas with concentrated urban areas and their expanding suburbs or having potentially important geological outcomes. 2) complete, and make available to the public, geologic maps in areas requiring modern, digital maps at 1:100,000 scale. These larger-scale geologic maps will also be used in the ongoing compilation of Oklahoma's new 1:500,000 scale geologic map.

Recently, we have started a few new projects focused on critical minerals via the USGS Earth-Mineral Resources Initiative (EMRI) program. This program is congressionally mandated to investigate the potential critical mineral resources in specific focus areas in the state and old mines, quarries, and waste piles. For example, the Wichita Mountains project is a combination of a field-based mapping and geochemical reconnaissance. The 8 quadrangles surrounding the Wichita Mountains are being mapped and updated with new field data, sample info, XRF and imaging. Samples are also being collected and will be sent to USGS for analysis. The grant facilitated the purchase of the new handheld XRF, which has been a wonderful new addition for the field team. Another EarthMRI project is a Mine Waste Inventory of Oklahoma. This comprehensive ArcGIS database allows us to identify future sites of importance in Oklahoma, including the Tar Creek Superfund Site, which is an area of interest for future work.

OGS has been working in the Wichitas to understand how critical minerals are concentrated in such systems.

SEISMOLOGY

The seismic team worked to continue delivering timely earthquake information often providing that information within tens of second of an earthquake occurring. The team continues to extend the life of the instrumentation well beyond the shelf-life of much of the instrumentation that is currently deployed across the state. We continue to leverage partnerships with federal (US Geological Survey and Earthscope Consortium for instrumenation) and state (Oklahoma Corporation Commission and Oklahoma Department of Emergency Management) for coordination on earthquake preparedness and response.

OGS utilizes 3-component nodes for rapid deployment in response to large earthquakes to record aftershocks. The nodes have been used for short-term (1-2 months) earthquake monitoring at hydraulic fracturing and enhanced oil recovery fields.

We continued development of machine-learning approaches to augmenting earthquake identification and contribute to open-source software to achieve those goals. This enables us to detect many additional earthquakes with existing resources. This work was supported through OGS funding and a small grant from USGS.

Dr. Paul Ogwari presented work related to a cluster of earthquakes located in eastern Oklahoma at the Seismological Society of America Annual Meeting in April 2023. Dr. Jake Walter presented research related to hydraulic-fracture triggered seismicity at the AGU Annual Meeting in December 2023.

We continue to serve various outreach roles and visited schools throughout the year to deliver Oklahoma earthquake-focused presentations. In some of these schools, we also installed Raspberry Shake seismographs, which are capable of detecting small earthquakes and their data is accessible to teachers for use in classroom discussions or lesson materials.

Raymond Ng graduated in Spring 2023, his doctoral committee was supervised by Dr. Jake Walter. A publication related to magnitude calibration for microseismic networks was submitted to Geophysical Journal International in late 2023 and was accepted in early 2024.


OGS has deployed temporary seismic stations to monitor earthquakes at targeted sites where real-time stream of data is required to manage seismicity.

CORE & DATA STEWARDSHIP & SCIENCE

The Oklahoma Geological Survey (OGS) has amassed an enormous trove of geological and geophysical data during its more than one hundred years of existence. Examples include well logs, completion reports, aerial photos, production reports, scout tickets, and geologic maps, as well as several warehouses full of rock cores and cuttings. The collections are housed within a 192,000 square foot warehouse facility known as the Oklahoma Petroleum Information Center (OPIC). Processing, cataloging, and archiving these data to make them accessible, and consequently useful, is a principal activity at the OGS-OPIC Facility.

The primary users are members of the oil and gas industry, which is one of Oklahoma's primary revenue-producing industries. Statistics gathered from 2022 OPIC user data show that over 70 people per month come to the facility to examine "well data," which includes well logs, aerial photographs, core photos, mud logs, 1002A completion forms, and completion cards (see attached figure 1.). The data collections are listed in order of greatest to least usage.
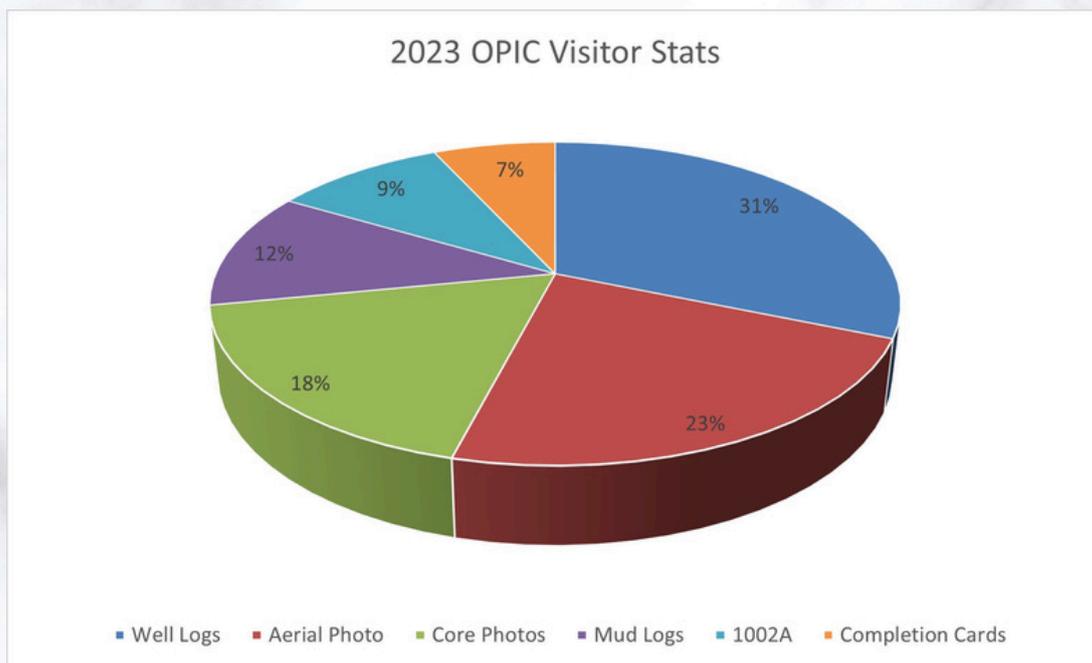
OPIC has hosted many activities as well. The Science Olympiads, a NASA consortium, the OU Law Oil & Gas Group, and Oklahoma Central University Energy law group have all used our facility. Additionally, the University Lutheran Church Styrofoam Recycling Group uses our warehouse to store their compressed styrofoam prior to shipping out for recycling. We're proud to help our community!

CORE & DATA STEWARDSHIP & SCIENCE CONTINUES....

Data Preservation

During FY 2007 OGS inventoried its well data collections and identified 26 types of data that were entered into the United States Geological Survey's (USGS) National Geological and Geophysical Data Preservation Program's (NGGDPP) digital archive. Since then, OGS has benefitted from being awarded several NGGDPP funded projects. While these past collection specific projects have been helpful laying the groundwork for digital infrastructure and cataloging efforts, OGS continues to receive funding from various data preservation efforts sponsored by the USGS and Department of the Interior. These projects have laid the foundation for virtualizing our collections to make them widely accessible to the general public. In FY 23, OPIC manager and data preservation lead principal investigator, Richie Tarver completed a project to virtualize well data assets including well logs and core photography.

Well Viewer Application

The Oklahoma Geological Survey (OGS) has recently initiated an effort to develop a comprehensive database of Oklahoma's geoscience and natural resource data that will be free and accessible to the public via a GIS spatially driven map-based web portal, OGS Well Viewer. Contents of the database will include digitally preserved images of OGS geoscience data holdings, publications, and research that will be synthesized with a master records dataset of Oklahoma oil and gas wells. As stakeholders of Oklahoma's natural resources, citizens and energy industry professionals alike will finally have a single online source to access a wealth of information relating to the state's natural resources, including: oil and gas production, well logs, completion reports, core and sample data, geology publications, aerial photography, and other data pertaining to the state of Oklahoma's geology and energy resources. The societal benefits conferred by the scope of the project are profound in that the ongoing database project is one of the largest undertakings of public information dissemination of unique geoscience collections ever attempted by OGS.

Future development work of the OGS Well Viewer Application will be directed towards enhancing digital infrastructure of OGS-OPIC collections by inventorying, generating metadata, and digitally preserving analog mediums so they may be incorporated into this comprehensive database and OGS Well Viewer web application. A pilot version of the application is available at the following URL: http//uat-wellviewer.dig.ou.edu/

EDUCATION & OUTREACH

Geologist Office Hours held roughly monthly during 2023 with 5-20 visitors at each event. We've identified many fossils, rocks, and minerals and more importantly, opened our doors to the public to humanize our work and engage with the public.

With funding from FEMA and the Oklahoma Department of Emergency Management and Homeland Security, OGS directed and produced four short videos to promote earthquake preparedness in 2022. The videos are geared towards different populations: elementary, middle school, high school, and a PSA for the general public. The four videos have a combined total of over 33,700 views on YouTube to date.

EDUCATION & OUTREACH CONTINUED....

Introduced a new program called MinKIDS in 2023 to promote mineral education in Oklahoma. The program was funded by the Oklahoma Geological Foundation and our team has developed eight lessons for students in grades K-8. The program makes use of individual mineral kits for each student which are loaned to teachers in Oklahoma, free of cost.

Continued sharing the GeoKIDS program (Geology Explorers in Oklahoma: Kids Investigating and Doing Science) with teachers and students throughout Oklahoma. In 2023, we disseminated 891 kits of rocks, minerals, and fossils to students. We have distributed 3,439 kits to Oklahoma students, in coordination with outreach programs since the inception of the program in 2018.

OGS organized two full-day field trips to the Wichita Mountains, for the public, led by geoscience professors from regional universities. A great and educational time was had by all!

EDUCATION & OUTREACH CONTINUED....

OGS continues to provide outreach opportunities around the state, including classroom visits with a geologist, setting up classroom seismographs, programs at libraries, schools, and recreation centers, as well as opening our doors for visitors to the OGS headquarters for educational tours. We provide workshops for teachers, and share resources widely with our community stakeholder groups.

EDUCATION & OUTREACH – SPECIAL PROJECTS

One of the newer approaches we are taking to Education & Outreach is to connect with large research initiatives. For example, OGS's E&O team participated in a successful grant proposal from the Department of Energy, to explore carbon capture and storage (CCS) in this region. Specifically, the education and outreach component will examine current knowledge of CCS amongst community stakeholder groups, and will then develop engaging programs to share these scientific concepts to different communities.

Similarly, OGS helped the Geosciences School successfully obtain funding from NSF – FRES for the DEEPDUST project. Co-PI Molly Yunker will be leading the education/outreach components for this international project which will involve workshops for teachers, field site visits, and a host of activities focusing on Tribal Nations in Oklahoma.

FACILITIES COMMITTEE

The Oklahoma Geological Survey is home to many laboratories and scientific equipment, including petrographic and reflected light microscopes, polishing and sample preparation laboratories, and hydrogeology laboratories.

- 7-inch Rock Saw
- EcoMet 30 Semi-Automatic Grinder (Image 1)
- ThermoScientific Niton XL5 handheld X-ray Flourescence (XRF) (Image 2)
- Seismic Network with 93 seismic stations across the state
- Microscope Laboratory with an Leica DMLP trinocular reflected microscope
- Core Facility viewing room equipped with core gamma-ray scan and X-ray imaging.
- Electron Microprobe Lab- CAMECA SX100 (Image 3)

EcoMet 30 Semi-Automatic Grinder

XRF at Cold Springs Breccia outcrop
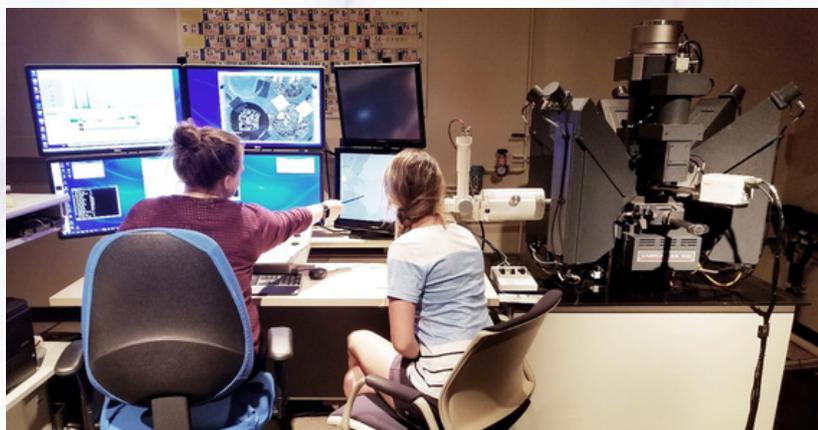
Lindsey Hunt assisting a student with the Electron Microprobe

AWARD COMMITTEE

Ken Johnson Award

The Ken Johnson Staff Award is given to a staff member who demonstrates stewardship for the Survey and community at large (including, but not limited to research, teaching, community outreach and public service).

1st Annual Ken Johnson Award
Joyce Stiehler

2023 Directors' Circle of Excellence
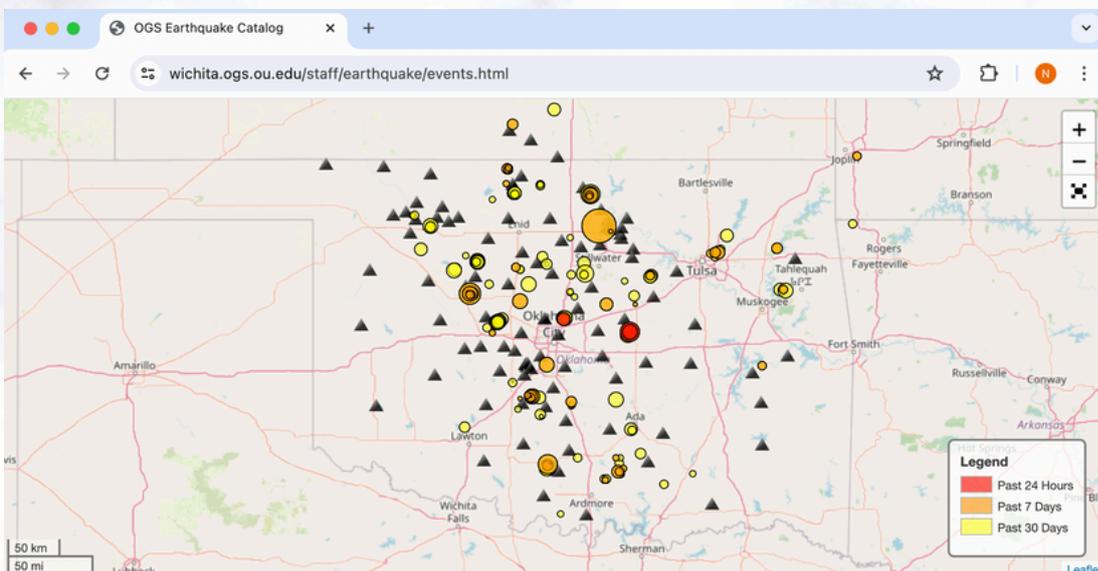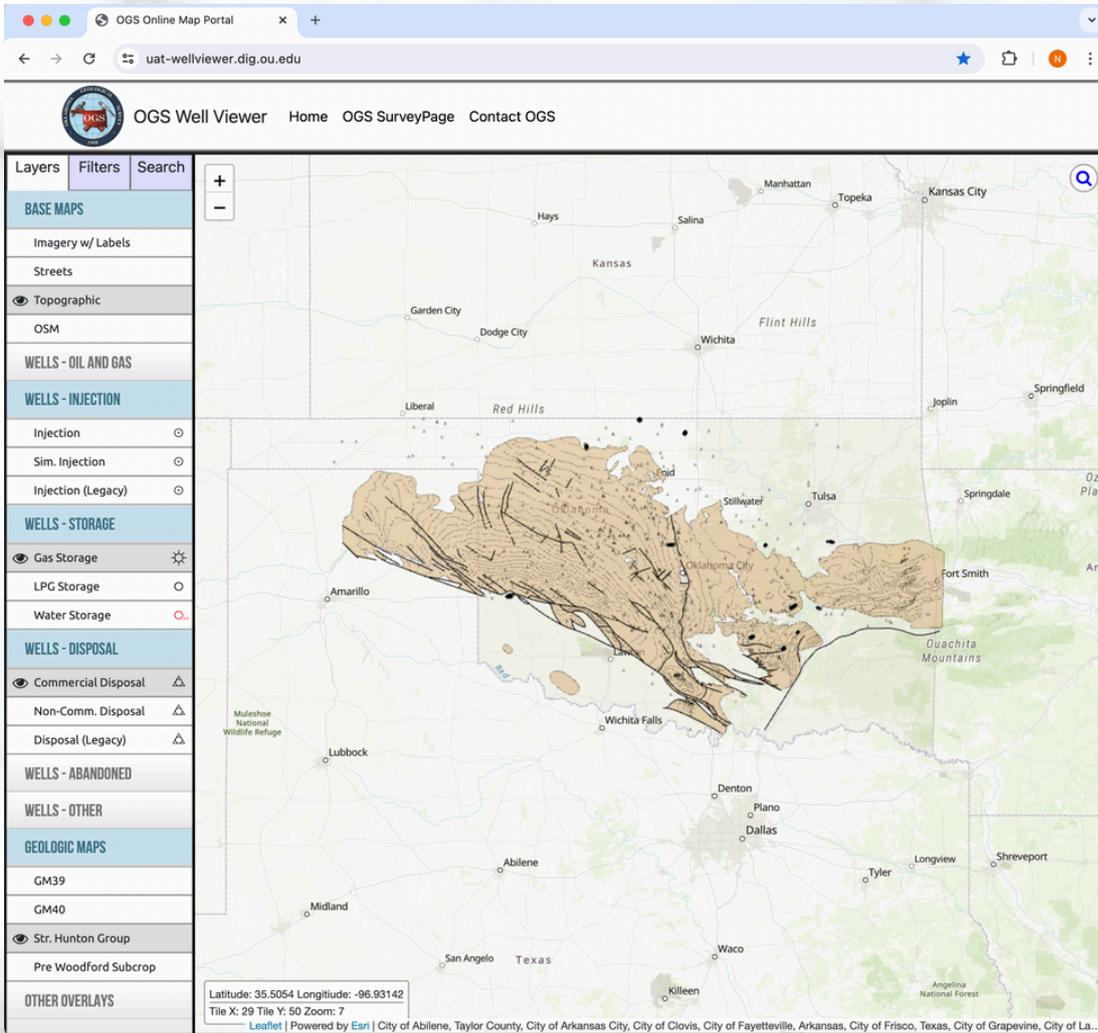

Russell Standridge

Scott Bryant

Vy Jordan

IT COMMITTEE

OGS's IT committee is working on our cyberinfrastructure. Upcoming years will see new web design and further integration of our on-line resources. Stay tuned!
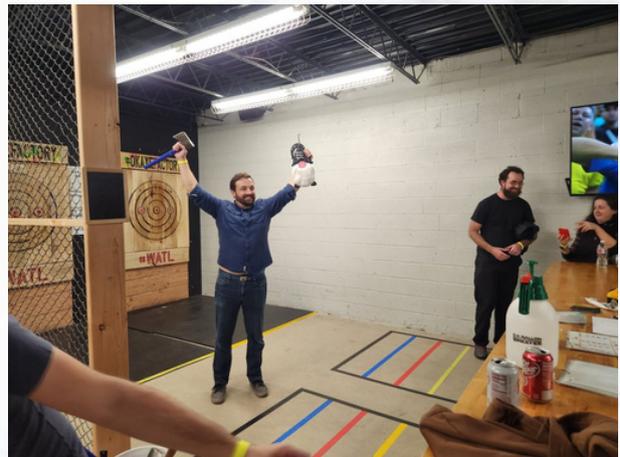
PLANTING ROOTS, CULTIVATING COMMUNITY

OGS Staff Activities

OGS Staff enjoying bowling and the first recipient of our OGS Gnome, Ben Allen

....

OGS Staff enjoying Axe Throwing and the 2nd recipient of our OGS Gnome, Jake Walter
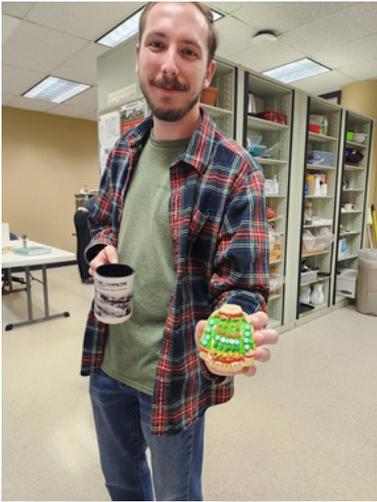

OGS Team Building Event

MORE OGS COMMUNITY

Team Building and strategizing for upcoming year

Carter, Chrishelle, & Ben showing off their skills during the OGS Staff Week cookie decorating day

Richie and Ming
testing new chair options

OGS INTERNAL PUBLICATIONS

Bulletins ISSN 0078-4389
- Bulletin 153: Salt Plains and Brines in Western Oklahoma Result from Dissolution of Permian Salt and Distinguishing those Brines from Oil-Field Brines, by Kenneth S. Johnson. 73 pages, 33 figures, 13 tables, 3 appendices. 2022.
- Bulletin 152: Woodford Shale (Upper Devonian to Lower Mississippian): From Hydrocarbon Source Rock to Reservoir, by Brian J. Cardott and John B. Comer. 108 pages, 36 figures, 2 tables, 3 plates, 2 appendices. 2021.

Circulars ISSN 0078-4397
- Circular 113: Evaporite Karst in the Greater Permian Evaporite Basin (GPEB) of Texas, New Mexico, Oklahoma, Kansas, and Colorado. Kenneth S. Johnson, Lewis Land, and David D. Decker, Editors. 350 pages. 2021.

Fact Sheet
- Fact Sheet No. 1: Geological Carbon Management in Oklahoma 2021.

Guidebook ISSN 2996-4652
- Guidebook 40: An Atlas of Woodford Shale Outcrops in Southern Oklahoma, by Andrew Cullen and David Hull. 196 pages. 2023.

Oklahoma Geologic Quadrangles (OGQ)
- OGQ-101: Geologic map of the Tulsa 30X60-minute quadrangle, Cherokee, Delaware, Mayes, Rogers, Tulsa, Wagoner, and Washington Counties, Oklahoma, by T.M. Stanley and C.M. Eichler, 2022. Scale 1:100,000.
- OGQ-100: Geologic map of the Oklahoma City South 30X60-minute quadrangle, Canadian, Cleveland, Grady, Lincoln, McClain, Oklahoma, and Pottawatomie Counties, Oklahoma, by T.M. Stanley, 2021. Scale 1:100,000.
- OGQ-99: Geologic map of the Oklahoma City North 30X60-minute quadrangle, Canadian, Kingfisher, Lincoln, Logan, Oklahoma, and Payne Counties, Oklahoma, by T.M. Stanley, 2021. Scale 1:100,000.
- OGQ-98: Geologic map of the Oklahoma portion of the Dalhart 2-degree sheet and Perryton 2-degree sheet, Beaver, Cimarron, Ellis, Harper, and Texas Counties, Oklahoma, by T.M. Stanley, 2021. Scale 1:250,000.
- OGQ-97: Geologic map of the Oklahoma portion of the Dalhart 2-degree sheet and Perryton 2-degree sheet, Beaver, Cimarron, Ellis, Harper, and Texas Counties, Oklahoma, by T.M. Stanley, 2021. Scale 1:250,000.

EXTERNAL PUBLICATIONS

- Buchanan, R.C., Young, M.H. and **Murray, K.E.** eds., 2023. Recent Seismicity in the Southern Midcontinent, USA: Scientific, Regulatory, and Industry Responses (Vol. 559). Geological Society of America.

- Heo, J., Lim, C., Lozano, J. and **Regmi, N.R.**, 2023. Hydrological Transport and Fate of Brackish and Inorganic Contaminants with Anthropogenic Influence. Sustainability, 15(21), p.15564.

- Horton, S.P., Scott M. Ausbrooks, **Paul O. Ogwari**, 2023. "Managing seismic hazard from induced earthquakes in central Arkansas through cooperation between scientific and regulatory agencies", Recent Seismicity in the Southern Midcontinent, USA: Scientific, Regulatory, and Industry Responses, Rex C. Buchanan, Michael H. Young, Kyle E. Murray

- Karson, J.A., Chutas, L.A., **Hayman, N.W.**, Hey, R.N., Horst, A.J., Hurst, S.D., Klein, E.M., Naar, D.F. and Varga, R.J., 2023. Upper Crustal Structure of Superfast-Spread Oceanic Crust Exposed at the Pito Deep Rift: Implications for Seafloor Spreading. Geochemistry, Geophysics, Geosystems, 24(3), p.e2022GC010527.

- **Milad, B.**, Moghanloo, R.G. and **Hayman, N.W.**, 2024. Assessing CO_2 geological storage in Arbuckle Group in northeast Oklahoma. Fuel, 356, p.129323.

- **Murray, K.E.**, Colin Brooks, Jacob I. Walter, Paul O. Ogwari, 2023. "Oklahoma's coordinated response to more than a decade of elevated seismicity", Recent Seismicity in the Southern Midcontinent, USA: Scientific, Regulatory, and Industry Responses, Rex C. Buchanan, Michael H. Young, Kyle E. Murray

- **Ogwari, P.**, **Walter, J.I.**, Chen, X., **Thiel, A.**, **Ferrer, F.** and **Woelfel, I.**, 2022. Distinguishing Unique Earthquakes with Overlapping Signals in Oklahoma. Seismological Society of America, 93(6), pp.3384-3395.

- **Symcox, C.** and Philp, R.P., 2023. Geochemical characteristics of oils from the Sooner Trend Anadarko Basin, Canadian, and Kingfisher Counties and South-Central Oklahoma Oil Province plays, Anadarko Basin, Oklahoma. AAPG Bulletin, 107(4), pp.593-627.

- **Peng, J.**, Hu, Z. and Feng, D., 2024. Influence of quartz types on rock fabrics and bulk physical properties in organic-rich mudstone: A review. Earth-Science Reviews, p.104670.

- Webb, N.D.S., **Regmi, N.R.**, Soreghan, G.S., Elwood Madden, A.S., Sylvester, J., Cartagena Colon, F., Demirel-Floyd, C. and Elwood Madden, M.E., 2022. Effects of mass wasting on the physiochemical properties of fluvial sediments in Puerto Rico following Hurricane Maria. Journal of Geophysical Research: Earth Surface, 127(6), p.e2021JF006509.

PRESENTATIONS

- **Allen, B.** 2022, In situ pressure monitoring of storage and disposal reservoirs in North-Central Oklahoma Arbuckle Group, *AGU Fall Meeting*

- **Allen, B.** 2022, Patterns of fluid intrusion in a Hele-Shaw cell of visco-elasto-plastic media, *American Physics Society Fall Meeting*

- **Allen, B.** 2022, Fluid Fracturing and Fingering in Visco-elasto plastic media, *Ada Rock Group*

- **Hayman, N.W.** 2022, The Science-Service Mission Re-evaluated, *GSA Annual Meeting*

- **Hayman, N.W.** 2022, Revisiting classic mesoscale field structures in the context of experimental rheology, GSA Annual Meeting

- **Hayman, N.W.** 2023, Geological resource & storage models, *GSA Annual Meeting*

- **Hayman, N. W.** 2023, Mid-continent US carbon management: the Oklahoma Perspective. *AGU Fall Meeting*

- **Hayman, N.W.** 2023, In-situ pressure and seismic monitoring of storage and disposal reservoirs in North-Central Oklahoma, *AAPG Image*

- **Hunt, L.** 2022, Geologic controls on mid-continent resources for the energy transition: the Oklahoma perspective, GSA Annual Meeting

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- **Milad, B.**, 2023, Outcrop to Subsurface Reservoir Characterization of the Mississippian Sycamore/Meramec Play in the SCOOP Area, Oklahoma, USA, *Fall Luncheon Seminar Chickasaw Lake Club Ardmore*, *Ardmore Geological Society*

-
- **Milad, B.** 2024, Simulation of CO2 Plume in the Arbuckle Group Utilizing Pressure Monitoring Wells and Historical Production/Injection Records, *SPE-AAPG-SEG CCUS Conference.*

- **Regmi, N.R.**, 2022, Application of LiDAR Topographic Data in Mapping Earth Surface Processes and Hazards, *USGS LiDAR Group.*

- **Regmi, N.R.**, 2022, Understanding Landslide Hazards, UTPB Colloquium on The Permian Basin: a Natural Resource Marvel, *University of Texas Permian Basin.*

- **Regmi, N.R.** 2021, Mapping Shallow Landslides in Eastern Oklahoma and Western Arkansas, *OU Geosciences Colloquium Series.*

- **Regmi, N.R.** 2021, Characteristics of Shallow Landslides in Eastern Oklahoma and Western Arkansas, *USGS Landslide Hazard Seminar Series*

- **Tarver, R.** 2023, *AAPG Orphan Wells Workshop, Oklahoma City*

- **Tarver, R.** 2023 Orphan, Idle, and Leaking Wells: Best Practices, Data Access, Funding Sources, and Business Opportunities , *AAPG Oprhan Well Conference, Austin, TX.*

- **Walter, J. I.** 2023, Seismic hazard of hydraulic-fracture triggered earthquakes in Oklahoma. *AGU Fall Meeting*

EXTERNALLY FUNDED PROJECTS

UNITED STATES GEOLOGICAL SURVEY (USGS)

- STATEMAP $747,103 (2020-2023), Carla Eichler
- EARTH-MRI $350,633 (2023), Lindsey Hunt
- DATA-PRESERVATION $42,526.000 (2022-2023), Richard Tarver

DEPARTMENT OF ENERGY (DOE)

- Oklahoma Geological Survey coordination of mi-continent carbon management, $999,999 (2024-2026), Hayman
- Fundamental Research to … Hydrogen Storage, $214,004 (2023-2025), Hayman (GTI lead)
- CORE-CM $197,166 (2020-2024) Cherokee-Forest City Basin encompassing Kansas, Iowa, Missouri, Nebraska, Oklahoma and the Osage Nation, Hayman (Kansas Geological Survey Lead)
- CUSP ~$200,000 (2020-2024) Focus projects in Utah & Kansas & Regional Initiative Support, Hayman (New Mexico Tech Lead)
- Refining Principal Stress...Induced seismicity, $495,423 (2018-2023), Walter (Electric Power Research Institute Lead)
- Field Evaluation of Caney Shale (2019-2022), Hayman (Oklahoma State University Lead)

NATIONAL SCIENCE FOUNDATION (NSF)

- NSFPLR-NERC: TIME (Thwaites Interdisciplinary Margin Evolution), $512,170 (2018 - 2022) Walter (UCSC Lead)
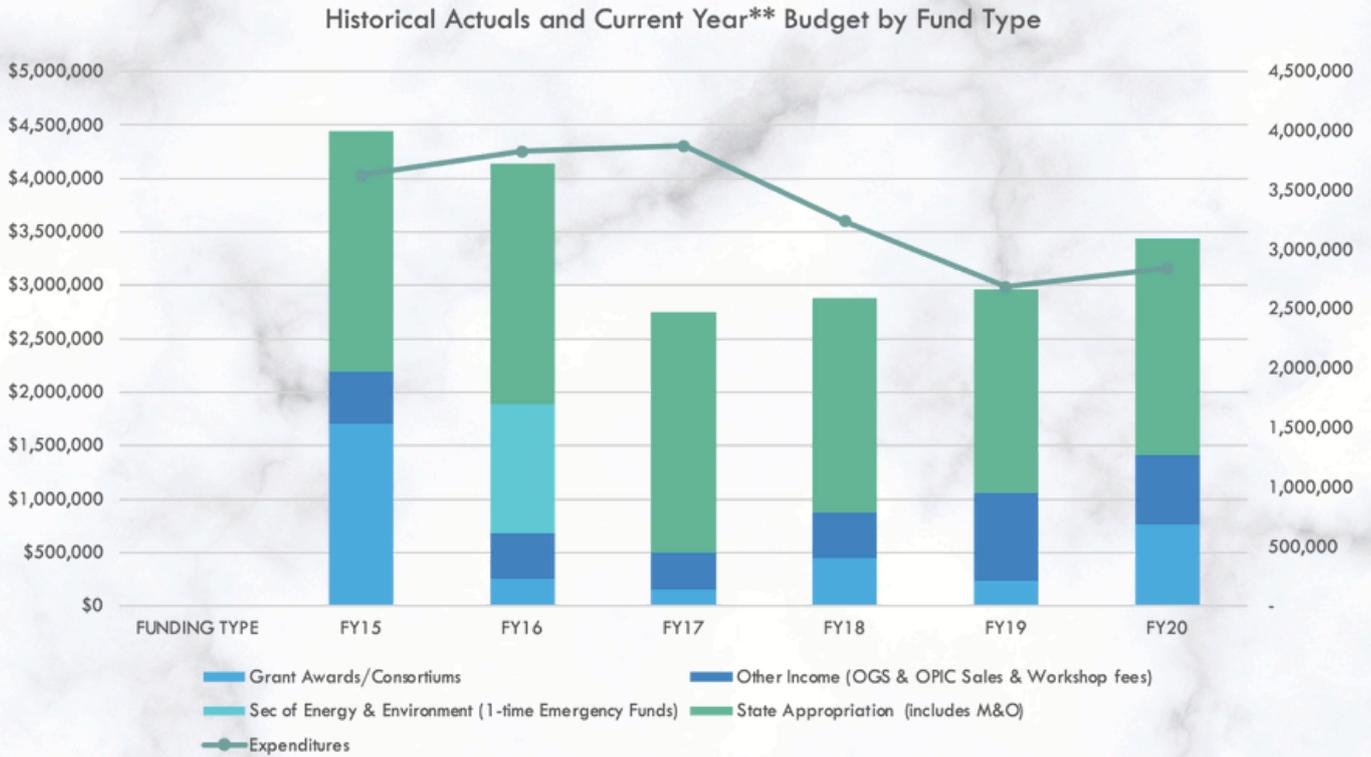- Growing Convergence Research: Transition to green energy, $3,599,999 Hayman (OU Engineering Lead)

NASA

- Earth Surface and Interior: Monitoring Hillslope Dynamics Using SAR Time Series and Machine Learning, $279,991 (2022-2025) Regmi

## FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

- Through Oklahoma Department of Emergency Management, Mapping Characteristics of Eastern Oklahoma Landslides, $86,000, 2019 - 2023, Regmi

FINANCIAL HISTORY OF OGS

Historical Actuals and Current Year** Budget by Fund Type

Legend:
- Grant Awards/Consortiums
- Other Income (OGS & OPIC Sales & Workshop fees)
- Sec of Energy & Environment (1-time Emergency Funds)
- State Appropriation (includes M&O)
- Expenditures

Base OGS funding comes from the State's General Education budget, and is nearly entirely used to support the OGS staff. Under special circumstances, OGS receives 1-time emergency funding from the State as well. All other funding stems from external grants and contracts, and workshop fees and publication sales. Current funding levels are lower than 5 years ago, though this is largely due to the University and State-wide budget cuts between 2015 and 2017.

FINANCIALS FY 2021-2024 BUDGETS AND ACTUAL EXPENDITURES
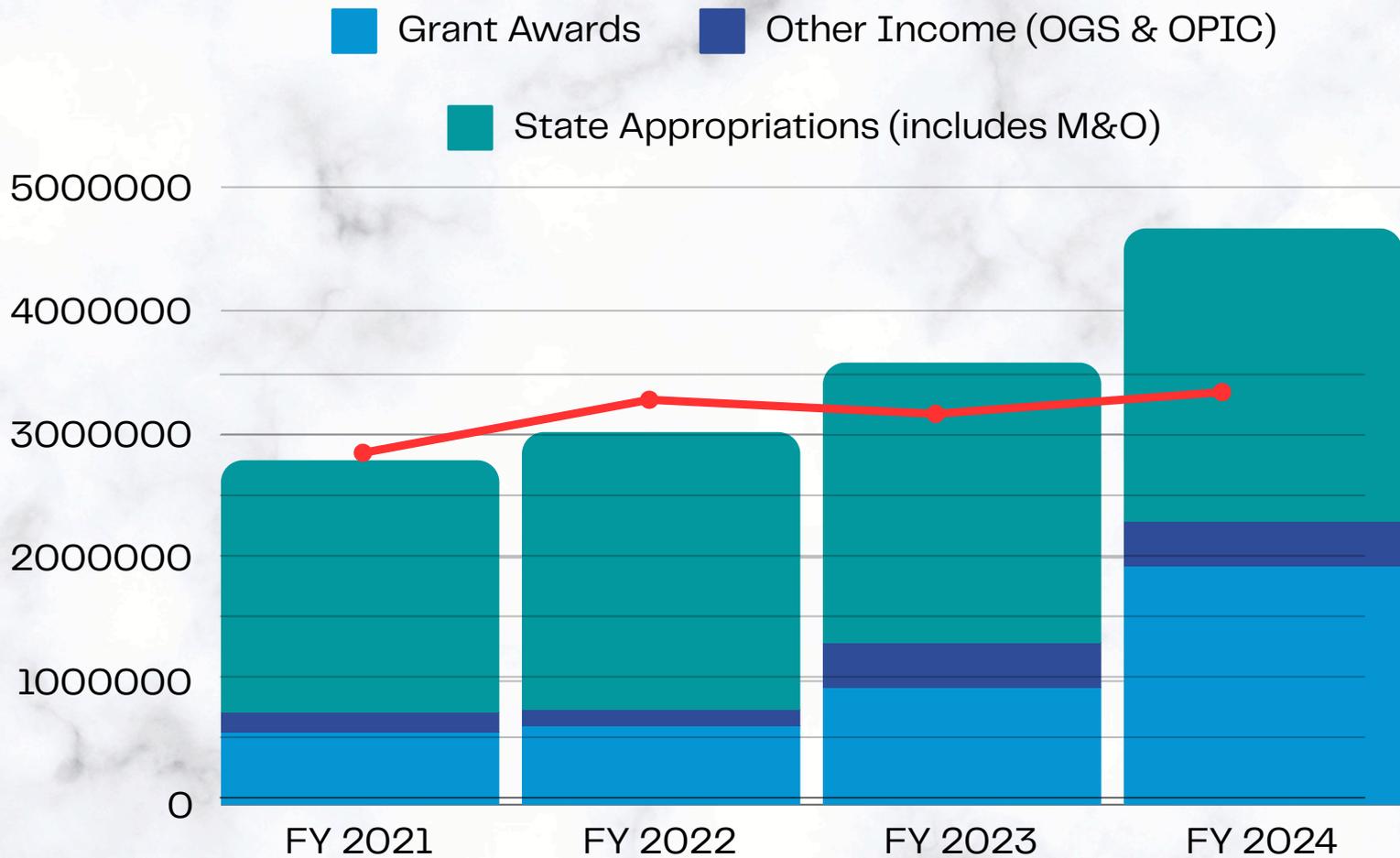
Legend:
- Grant Awards
- Other Income (OGS & OPIC)
- State Appropriations (includes M&O)

Base OGS Funding comes from the State's General Education budget, and is nearly entirely used to support the OGS staff. All other funding stems from External grants and contracts, and workshop fees and publication sales.
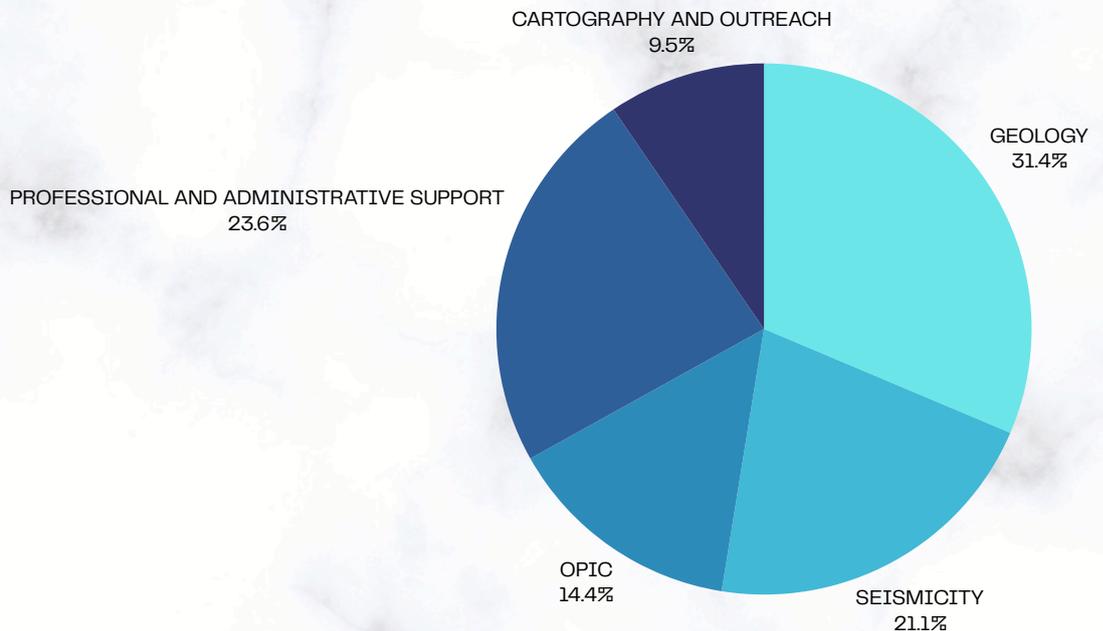
Yearly expenditures for FY21-23 are indicated with red line. Fiscal year 2024 is still in process. Expenditures approximate.
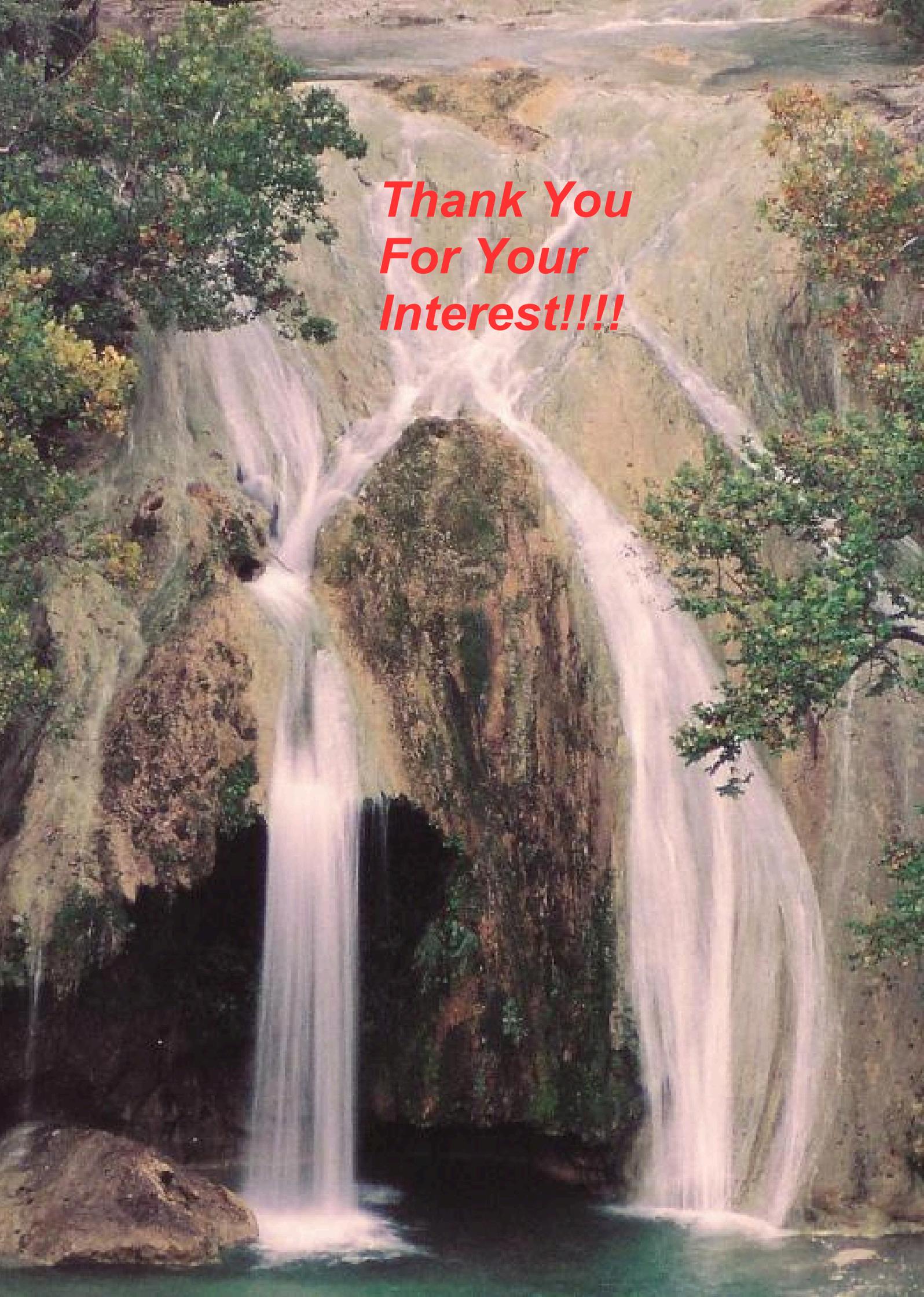
FINANCIALS FY 2023 EXPENSES BY AREA

Before 2020 OGS categorized financial expenditures by the following areas. We continue that here for 2023 to indicate the general breakdown of spending, including salaries.

PROGRAM CATEGORY	EXPENDITURES
GEOLOGY * HYDROGEOLOGY * OIL & GAS * GEO MAPPING * HAZARDS	$930,357.06
SEISMICITY	$626,072.92
OPIC	$425,541.17
PROFESSIONAL AND ADMINISTRATIVE SUPPORT	$699,221.45
CARTOGRAPHY AND OUTREACH	$281,646.53

CARTOGRAPHY AND OUTREACH 9.5%
GEOLOGY 31.4%
PROFESSIONAL AND ADMINISTRATIVE SUPPORT 23.6%
OPIC 14.4%
SEISMICITY 21.1%

Thank You
For Your
Interest!!!!