UNIVERSITY OF OKLAHOMA
SCHOOL OF GEOSCIENCES

EARTH SCIENTIST

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ABOUT THIS ISSUE

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Did You Know... The Earth Scientist has showcased departmental news since 1982. Its earlier incarnation was known as the Sooner Geologist, which debuted in 1967. Thus, accounting for the rare exceptions of years unpublished, we are now on volume 45 of the alumni magazine. And, prior to that, we have records of our alumni newsletters dating to 1959.

The Earth Scientist welcomes short letters from readers, and will print them as space allows. Letters should address some item from a previous issue. Please include your name, city and state, as well as an email address for purposes of correspondence. We may edit your letter for space, style and civility, without distorting the substance or spirit of your piece. We reserve the right to decide whether a letter is acceptable for publication.

For accommodations, please call the School of Geosciences at (405) 325-3253.

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Letter From the Director

We continue to navigate through times of enormous change in several ways: the lingering effects of the pandemic, the ongoing demographic turnover in our faculty, the lackluster trends in geoscience enrollments and hiring, the energy transition, etc. Nevertheless, we've had an eventful and productive 2021-22 school year. Thankfully, we began exiting the difficulties imposed by the pandemic. We dusted off our social skills, returned to in-person instruction and cautiously conducted some of our classic field trips, including summer field camp. It turns out that education in the actual classroom and the actual field, where we can engage in real-time and animated discussions, remains far superior to virtual options.

By now it's no surprise that geology programs are facing trying times. Enrollments have dropped nationally and internationally. And yet, the two greatest challenges facing humanity in the 21st century deal directly with the geosciences: How do we maintain a livable environment for the (entire) biosphere as well as supply the world with energy? The geosciences have never been more relevant. We need a diverse and diversely educated geoscience workforce in order to forge a livable future on planet Earth. As we shape OU Geosciences, we must rise to this challenge.

We continue to rebuild our program in the wake of a wave of retirements, and our junior- and incoming faculty are truly outstanding, and well-poised to contribute to areas of research highlighted in the college and campus strategic plans. This year, we conducted three faculty searches, in the areas of structure/tectonics, invertebrate paleontology, and vertebrate paleontology. I'm thrilled to report that we succeeded in attracting our top candidates in all of these searches. Indeed, we benefitted tremendously from partner accommodations that enabled us to attract additional outstanding faculty in critical areas of need. Thus, for the 2022-23 academic year, we are welcoming the following faculty to the school: Gilby Jepson in structure/tectonics, Sarah George in sedimentation and tectonics, Jaqueline Lungmus in vertebrate paleontology, Selina Cole in invertebrate paleontology, and Davey Wright, who brings expertise in both invertebrate paleontology and quantitative analyses. Professors Lungmus, Cole, and Wright will split their time and responsibilities between the School of Geosciences and the Sam Noble Oklahoma Museum of Natural History. Sadly, we have lost our star seismologist, Xiaowei Chen, who elected to move closer to a major metropolitan area for personal reasons. We are in discussions with the upper administration to attempt to fill this very essential position in geophysics.

Our efforts to rebuild our program are showing in key metrics: 2021 saw increases in refereed publications, proposals submitted, funding secured, and numbers of majors (a 34% increase in majors over 2019). For fall semester 2022 we are welcoming our largest freshman class in several years, together with a healthy graduate-student cohort. We continue to teach a number of general education courses and are in the midst of expanding these offerings. Our faculty and students gave numerous presentations at national and international conferences, and both students and faculty won a number of awards and recognitions at both local and national levels. We look forward to continued positive trends as our newest faculty arrivals ramp up their programs.

Letter From the Dean

The University of Oklahoma and the Mewbourne College of Earth and Energy are proud of the many accomplishments of the School of Geosciences throughout the past year. The school has been, and continues to be, a leader in several key areas. In addition to its reputation in research and education, the school is a campus role model for service, delivering a high-quality general education in geology and geophysics and actively engaging in all aspects of university governance. At the university level, President Harroz and the administration are busy implementing our "Lead On, University" Strategic Plan. Specific efforts include the consolidation of our hospital entities on the Health Sciences Center campus in Oklahoma City and launching a new Polytechnic Institute in Tulsa. Closer to home, the School of Geosciences continues to make progress toward our commitment to increase our ranking to a Top 25 School of Geosciences.

RESEARCH

Our new vice president for research and partnerships, Tomás Díaz de la Rubia has led several important efforts, including carbon capture, hydrogen, and fusion energy. Tim Filley joined his team as the director of the Institute of Resilient Environmental and Energy Systems. His efforts have been particularly noteworthy across disciplines as we compete for grants in carbon capture and sequestration.

ADVANCEMENT

Amy Noah, vice president for university advancement, is making great strides at the OU Foundation. Stephanie Buettner has once again exceeded expectations with a record fundraising year with $9.63 million in donations for 2022. Moreover, Tyler Junell led our Giving Day campaign to another record year with more than $686,000 in annual gifts.

GRADUATE EDUCATION

Our focus over the past two decades has been the undergraduate experience. These efforts have paid huge dividends to our undergraduate programs and have differentiated us from our peers. However, our graduate programs are the key to improved rankings and the generation of new ideas, resulting in enhanced research, which will lead to growth. President Harroz has expressed his intent to focus on expanding and enhancing our graduate programs by increasing stipends, a focused recruiting effort and a larger graduate student body.

FACULTY SUPPORT

In July 2021, OU welcomed its new provost for the Norman campus, André-Denis Wright, who has quickly engaged to support our faculty recruiting and retention efforts. One particularly noteworthy initiative has been the addition of a partner assistance program designed to attract and retain targeted faculty to the university. It has been our experience that spouses/partners who are offered meaningful employment improves retention of one of our most valuable assets, our faculty. Moreover, the provost is leading the charge to pay competitive salaries coupled with a performance-based bonus structure, improving our ability to attract and retain the highest-quality faculty. All of these initiatives will strengthen the university, the college, and the school. I personally want to express my full support for President Harroz, Provost Wright, and School of Geosciences Director Lynn Soreghan as we aggressively pursue our goals. We have a lot to be proud of at the University of Oklahoma and I would like to thank you for your support and confidence in the Mewbourne College of Earth and Energy.

- J. Mike Stice, Mewbourne College of Earth and Energy Dean

Letter From the AAC Vice Chair

Dear Alumni, Students, and Faculty,

It's hard to believe that we are back to school again. After the wild ride the past couple of years, we are finally getting back to normal in many aspects. Of course, the pandemic forced many people and companies to up their digital game. In doing so, I hope that we gained some improvements in our day-to-day lives. For instance, we now have been holding our AAC meetings in person and digitally, with the hope that we can still have the face-to-face interaction, but without leaving out those who no longer live nearby. Our last couple meetings have seen attendance drop lower than the fully digital zoom meetings during 2020 and early 2021, but some of that was to be expected as things open back up and people try to catch up on everything. Hopefully, we will see a continued rise in alumni joining our group and our meetings. Although it is a pain on those that have to do the set-up, I think we should continue to do the meetings both in person and online to allow the most participation possible. Thank you, faculty and staff, for all of your efforts to help us out. We truly appreciate you!

The quarantining mode of the last couple years has left many dreading to get back out and into the busy life, and hopefully we can continue some of the slower pace in many areas of our life, but there is something truly valuable about face-to-face interactions. The AAC will be sponsoring a student social in the upcoming semesters to facilitate these face-to-face networking events where students and alumni can interact. I cannot over-express how valuable my connections are as I continue my career, so I really encourage everyone to join us. I am really looking forward to it.

Many of our alumni continue to bring value to our world and our school. Brent Wilson, now CEO of Galvanic Energy, is challenging the lithium market and creating opportunity for the U.S. Molly Turko and Steve Ladner are helping to set up the AAPG Mid-Continent meeting for Fall 2023. Andrew Cullen, along with David Hull, is guiding a Woodford Field Trip on October 15, 2022, through OCGS, to name a few.

I hope everyone keeps getting out there to look at the rocks and have fun with colleagues and friends.

Cheers,

Tiffany Stephens

AAC Vice Chair

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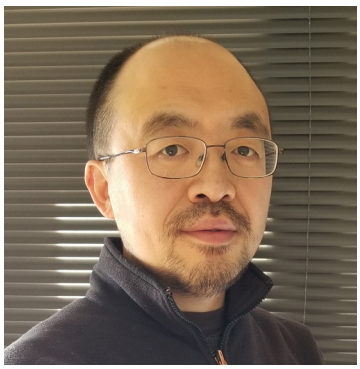

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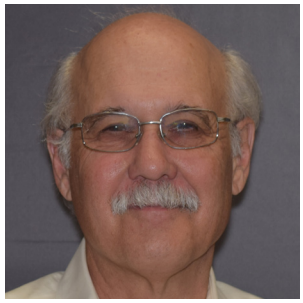

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Meet the

Sarah George, Assistant Professor

Sarah George uses the sedimentary record to address tectonic and climatic questions. She specializes in basin analysis, sedimentary geology, tectonics, and geochronology. Her work typically focuses on basins in mountainous regions, as they are the loci of weathering, erosion and climate-tectonic feedbacks. She is interested in answering questions like: How do changes in deep-earth processes impact earth's surface? How do climatic shifts impact weathering and erosion?

Her work typically starts in the field, with construction of stratigraphic columns, detailed facies analysis, and mapping. In the lab, she combines traditional U-Pb dating with trace and rare element geochemistry (petrochronology). She is currently focused on taking petrochronologic techniques designed for bedrock studies and applying them to detrital systems. With proper chronology, sedimentary basins in orogenic systems provide temporally calibrated archives of tectonics and climate. She has active projects in Chile, Argentina, Peru, Ecuador, Colombia, British Columbia, Turkey, and Nepal.

George attended Wellesley College, where she completed a bachelor's degree in geosciences. She received her doctorate from the University of Texas at Austin on the tectonic evolution of the Peruvian and Ecuadorian Andes. Since 2019, George has been a postdoctoral scholar at the University of Arizona, where she has worked in the Arizona LaserChron Center. Her work in the lab is focused on integrating trace element and isotope geochemistry with radiometric dates on a variety of mineral phases (monazite, apatite, and zircon), and helping hundreds of visitors annually produce high-quality geochronologic data.

George believes that equitable access to resources and support is critical to a more representative demography in geosciences. To broaden access, George helps co-run futureROCKdoc.com, a website designed to provide resources to graduate students in geosciences.

Over the years, George has been heavily involved in field education. She has taught field camp with Indiana University and University of Texas at Austin, and served as the lead instructor for GeoFORCE, a program designed to take lower socio-economic students to the field during high school. She is enthusiastic to continue field (and classroom) education efforts at OU!

New Faculty

Picture of Gilby (left) and a prickly field assistant (right) in the South American Cordillera.

Gilby Jepson, Assistant Professor

An ever-present feature of the Earth's surface, orogenic systems or mountain belts provide a record of the dynamic processes which have shaped the planet over the last 4.5 billion years. Understanding orogenic systems provides insights into the feedbacks among the relative contributions of plate-tectonic, rheology, and climatic processes that have shaped the Earth through geological time. To address this relationship, Gilby Jepson investigates how and, crucially, when major structures bring rocks to the surface and form mountain belts. Jepson applies thermochronology, which records the time at which a rock cools through a specific temperature window corresponding to a certain depth in the Earth's crust. Rock cooling is facilitated by the removal of overlying material via structural or erosional processes.

Jepson's active research interrogates what controls the distribution of modern topography. Specifically, do plate-tectonic interactions (i.e., rifting and collision) or changes to atmospheric circulation and the hydroclimate exert a first order control on the life-cycle of orogenic systems? Currently, Jepson's focus is on the major contractional orogens of Central Asia (Himalaya, Pamir-Tibet, and Tianshan) and North America (the North American Cordillera), with aspirations of applying this research to the South American Cordillera. In addition, Gilby looks to improve our tectonic/thermochronological toolbox by developing new methods, expanding on traditional ones, and seeking out novel applications.

Jepson undertook his undergraduate, honours, and Ph.D. work at the University of Adelaide. The honours project involved interrogating the small-scale structures of subsurface geomechanics in the Carnarvon Basin, Western Australia. From there, Jepson transitioned to large-scale tectonics during his Ph.D., looking into the Mesozoic-Cenozoic reactivation of the Tianshan in Kazakhstan, Kyrgyzstan, Uzbekistan, and Tajikistan. In 2019, Jepson moved to the United States as a postdoctoral researcher at the University of Arizona, where he fell in love with the North American Cordillera and metamorphic core complexes – a love of which he has attempted to covey to the local community through outreach with local hiking groups and high school students. Outside of academic life, Gilby is a football (soccer) tragic and will happily complain about the latest game he lost and why it wasn't his fault.

Meet the

Selina Cole, Assistant Professor Assistant Curator of Invertebrate Paleontology

Selina "Lena" Cole is an evolutionary paleoecologist who uses fossil marine invertebrates to investigate evolutionary patterns and their driving processes through deep time. In particular, Cole's research emphasizes the role of ecology in generating and maintaining evolutionary patterns within both lineages and paleocommunities. Much of her work focuses on extinction, including ecological factors that elevate extinction risk, selectivity during background versus mass extinctions, and post-extinction recovery, all of which are key for better understanding modern biodiversity losses. Another key area of Cole's research centers on deep-time community paleoecology, including the assembly and phylogenetic structure of communities and how they are restructured through time and in response to extinction events. Methodologically, Cole relies heavily on fossil specimen data integrated with fieldwork, quantitative analysis, phylogeny reconstruction and phylogenetic comparative methods to investigate these topics.

Although Cole has worked on many groups of marine invertebrates, she specializes in fossil crinoids, especially those from the Ordovician. Her work resolving the crinoid tree of life through phylogenetic inference has helped make crinoids a model group for tree-based investigations of evolution and ecology in deep time. She has also described more than 20 new crinoid species, including the second most diverse crinoid assemblage from the Ordovician and the most species-rich fauna known from the Ordovician of Gondwana. Much of Lena's recent and ongoing work has focused on the community structure and feeding ecology of these Ordovician crinoid assemblages, including an incredibly diverse fauna from the Bromide Formation of southern Oklahoma. In addition, Cole works extensively on the Ordovician mass extinction, the first of the "big five" mass extinction events, through both museum-based studies and fieldwork on Anticosti Island in Quebec, Canada.

Cole completed an associate of art degree at Danville Community College, a bachelor of science degree in geology with a biology minor at James Madison University, and doctorate in geology at The Ohio State University. Cole then held postdoctoral positions at the Smithsonian Institution's National Museum of Natural History and the American Museum of Natural History, where she developed a framework for quantifying ecological diversity in extinct crinoid communities and investigated relationships between mass extinctions and functional ecology. Most recently, Cole was a research geologist and curator of fossil crinoids at the Smithsonian NMNH where she continued her research on fossil crinoids, assisted in numerous collections improvement projects, and increased collections accessibility for research and educational purposes.

Cole is also passionate about providing hands-on opportunities for student learning. Most notably, while at the AMNH, Lena was an instructor for the museum's M.A. in Teaching degree that prepares residents to teach Earth science in underserved schools in New York City. In this program, Cole worked with pre-service teachers on intensive summer research projects and led field trips to provide them with hands-on research and field experiences. To date, Cole has mentored 18 students on specimen-based research projects in museum settings, many of which have focused on size-selective extinction of marine invertebrates during the Ordovician mass extinction.

When she isn't in the lab or field, Cole enjoys gaming, ink and watercolor artwork, cooking, and perfecting the art of baking bread. Having grown up in rural Alaska, she also loves the outdoors and all aspects of natural history and is a particularly avid birder.

New Faculty

David F. Wright, Assistant Professor Assistant Curator of Invertebrate Paleontology

David F. "Davey" Wright is an evolutionary paleobiologist who combines data from the fossil record with phylogenetic biology to better understand the origin, maintenance and modification of biological diversity throughout the history of life. Wright is particularly interested in research questions revolving around the influence of geological processes on major features of biological evolution, including the origin of higher taxonomic lineages, their adaptations and the interplay between ecology and environmental change during major evolutionary radiations.

Fundamental to Wright's macroevolutionary research is the reconstruction and downstream analysis of evolutionary trees (i.e., phylogenies). Wright specializes in Bayesian statistical methods to infer phylogenies containing fossil species, as well as the application of mathematical and computational approaches to investigating diversification dynamics and morphologic evolution in the fossil record. Wright has wide-ranging expertise in the systematics of fossil invertebrates, ranging from brachiopods to Paleozoic arthropods, but most of his work focuses on Phylum Echinodermata (starfish, sea urchins and kin). His specimen-based research has described dozens of Paleozoic echinoderm taxa, including a major taxonomic revision of the Class Crinoidea and the description of 19 new species.

Wright received a bachelor of science degree in geology from the University of Kansas (minor from physics and astronomy), a master of science degree in geological sciences from Ohio University and a doctoral degree from the School of Earth Sciences at The Ohio State University.

Before arriving in Oklahoma, Wright held several postdoctoral positions, including fellowships at the National Museum of National History (Smithsonian Institution) and the American Museum of Natural History. During his postdoctoral research, Davey worked on a variety of empirical and theoretical questions, including a simulation-based evaluation of best practices for modeling stratigraphic age data in fossil phylogenies, quantifying support for alternative models of speciation in the fossil record, and conducting geologic fieldwork on Anticosti Island (Canada) to document patterns of biodiversity change across the Ordovician—Silurian transition. In 2019, Wright was a recipient of the Norman Newell Early Career Award from the Paleontological Society.

Wright believes science is a social activity and a public good. He strongly advocates science be conducted within a culture of inclusivity and accessibility, and has been engaged in diversity, equity and inclusion efforts in his (former) departments, academic societies, and community. At the University of Oklahoma and Sam Noble Museum, Wright is especially looking forward to building a diverse and interdisciplinary lab-group to study the exceptionally rich geologic history of Oklahoma's Paleozoic fossil record. Aside from research, Wright enjoys birdwatching, sports, playing Nintendo and punk rock music.

Meet the New Faculty

Jacqueline Lungmus, Assistant Professor Assistant Curator of Vertebrate Paleontology

Jacqueline Lungmus is paleobiologist focusing on the link between shape and functional morphology. Through a combination of linear and multivariate geometric morphometric analyses on the appendicular skeleton, primarily on the limbs and girdles, Lungmus is testing the geologic and phylogenetic timing of the massive diversity that many tetrapod groups are known for.

Her work focuses on the morphological and ecological diversity of fossil synapsids, a group with an evolutionary history spanning over 300 million years and to which all modern mammals belong. Given this deep evolutionary history, it is difficult to truly appreciate the uniqueness of mammals without understanding the long evolutionary context that gave way to mammals. Lungmus's research helps to pinpoint when the astounding breadth of form and functionality originated within the synapsid lineage. Through comprehensive shape quantification methods, she has uncovered previously hidden diversity patterns in some of the earliest synapsids and she has published these results in journals such as *Proceedings of the National Academy of Sciences*, *Proceedings of the Royal Society* and *Science*.

Lungmus completed her doctorate in integrative biology from the University of Chicago in August 2020. Further, Jacqueline has a long history in museum-based research and considers advocating for and protecting natural history institutions a critical part of her professional mission. Starting as an undergraduate docent at the Washington State Burke Museum of Natural History and Culture, she then conducted her doctoral research at the Field Museum of Natural History in Chicago, and has just finished a two-year postdoctoral appointment at the Smithsonian National Museum of Natural History in Washington, D.C.

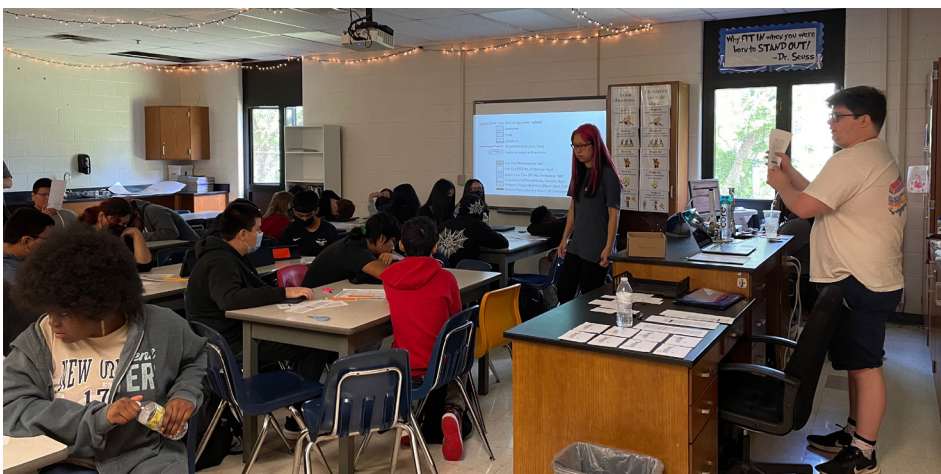
Using her methodological background, Lungmus focused the efforts of her postdoctoral work on quantifying the shape of a specific group of fossil synapsids – sphenacodontid pelycosaurs. This group includes some of the most iconic ancient animals of the American West and of ancient Oklahoma, such as the sail-backed Dimetrodon, and her work will help to update our understanding of the group's diversity through time and space. Further, clarification surrounding species identification in this group will advance the use of sphenacodontid collections across the country, heretofore an underutilized paleontological resource.

Undergraduate Recruitment Update

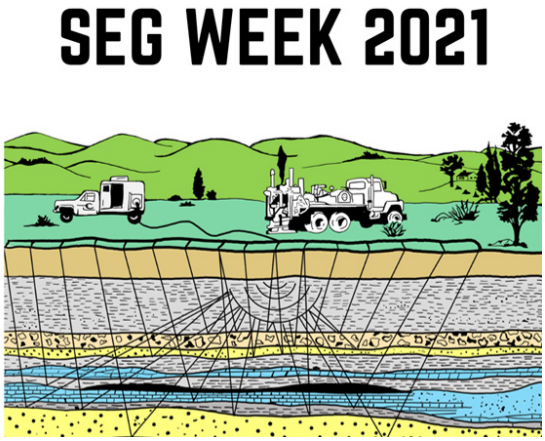
Gail Holloway, Undergraduate Recruiter

With the relaxation of COVID-19 restrictions, we were very happy to return to more in-person events this year! For the 2020-2021 school year, we were only able to hold Sooner Saturday in person, with everything else held either on Zoom or through video uploads. This school year, in-person were the norm with only a handful of events held remotely.

From tabling events to career fairs, from student visits to presentations, this year saw a mix of everything! All together, we met with close to 3,000 students, counselors, principals and teachers.





SEG Student Chapter

Abidin Caf, President

As we finally started to leave the COVID-19 lock-downs behind us, we were excited to return to campus and get together with our geoscience family. In the 2021-2022 academic year, we hosted numerous technical and social activities for our community and invited our friends from other student chapters both locally and internationally.

Among these, the most significant one was our traditional "SEG Week" event, during which we hosted various geophysical technical talks from distinguished geoscientists and fun activities such as "Who Wants to Be a Millionaire" trivia and "Geo Happy Hour" events. Additionally, we also offered our members professional development workshops to hone their non-technical skills needed for their future careers. We believe that improving interviewing, communication and self-branding skills are equally essential to the scientific skills that we need to be successful.

The perception of exploration geophysics, in general, has been long associated with oil and gas exploration, which narrows down our profession and the answer to "what geophysicists do?" In fact, the science of geophysics is crucial to solving some of the most significant problems facing humanity, such as energy, climate, and water. Today, our world is facing a dual challenge. While we still need to provide affordable and safe energy to feed the growing energy demand, we still need to combat climate change and achieve "net-zero" emissions. In this context, geophysics is (and will be) the key science to provide more efficient and less carbon-intensive hydrocarbon production and help reduce the carbon intensity with emerging technologies. This year we provided our community with a variety of technical talks related to carbon capture utilization and storage, geothermal energy, and near-surface geophysics, to help increase the awareness of the energy transition and the role of geoscience in this effort.

As the SEG OU Student Chapter, we believe that diversity is essential to forming an excellent academic experience and impactful science. Our goal was to promote and celebrate the importance of diverse views and skillsets to widen and enrich the educational and intellectual environment. With this focus, we participated in outreach and social events where we provided information about the science of geophysics to people with diverse backgrounds and underrepresented communities to hopefully spark inspiration for geoscience in their minds. We also co-hosted the "international student, professor, and staff meet and greet" event with the SPE student chapter to build a relationship between international students and faculty while celebrating our culture and diversity.

Overall, we are delighted to get back together with our "geoscience family" and have a year filled with lots of fun and learning. We are also thankful to our student members, faculty, and staff for their continuous support throughout the year.

AAPG Student Chapter

Brittany Stroud, President

The OU AAPG Student Chapter strives to provide networking opportunities, leadership experiences, and collaboration among OU geoscience students. This past year, we held several technical talks from industry professionals such as Mark Shuster on the topic of hydrogen storage, and Bill Fairhurst's interactive presentation on building a career roadmap. We also collaborated with OU SEG for many events as well, and hope to work with more student organizations in the future.

This year, we instated the first "OU AAPG Energy Week," dedicated to energy-related research. The 2022 Energy Week speakers consisted of BP industry professionals Jacek Jaminski and Bunmi Elebiju and professional researchers Mathieu Perton and Sergio Chavez-Perez. They provided great talks the on energy transition, seismic resolution, and DAS technology. During this time, our "Energy Bar" was opened and allowed busy college students and faculty to enjoy free coffee, hot chocolate, and desserts.

Another very important focus of our chapter is student outreach. This past year we reached out to local Norman and Oklahoma primary and secondary schools with geoscience education activities. Provided outreach activities included "Geo-Dig-Kits," which consisted of a miniature rose-rock dig exercise, popping rock candy, handmade coloring sheets, a fun geology presentation and, on one occasion, a surprise visit from professional geologist Mike Barber. These school visits were conducted both in-person and virtually.

Overall, the OU AAPG Student Chapter had an amazing year filled with education and fun. We are so thankful for the students and faculty who supported all of our events and outreach, and we look forward to the future of our chapter.

Pick & Hammer Club

John Smith, President

With COVID-19 in our rearview mirror, Pick & Hammer was able to get a lot done during the 2021-2022 academic year. President John Smith, Vice President Chris Bodzioch, Treasurer Sam Sundberg, Secretary Emma Steiner, Archivist Bren Cable, and Lead Outreach Coordinator Conner Whitley were elected to our positions in the spring of 2021. Officers took the summer off and got to work immediately once the fall semester began. In a matter of weeks, the office was morphed by our VP into an organized and open space more conducive to our needs. Within the first two weeks of the fall semester, Pick & Hammer had already reached hundreds of underclassmen through events such as Camp Crimson and Shell Fall Fest.

In the past, Pick & Hammer events had included eat & meets, movie Nights, general meetings, Sarkeys Energy Center tours, and school visits. All of these were disrupted by the arrival of COVID-19 and we are proud to say we were able to carry out all of these events, in person, once again in the 2021-2022 academic year! The school visits put on by Pick & Hammer this year were the first school visits we had been able to provide in over a year and a half! We were also able to host multiple events for the club that had not taken place in many years, such as a field trip to the Crater of Diamonds State Park in Murfreesboro, Arkansas and multiple Pick & Hammer game nights. While many of the effects of COVID-19 were less than ideal for the club, there were some good things that resulted from the pandemic, such as Pick & Hammer's videocast, "Antiformal," which is posted to our YouTube channel. This year, we were able to add seven new educational episodes and interviews to the videocast archives.

Pick & Hammer volunteers, under the guidance of Bobby Melton from Putnam City area/UCO, participated in the Science Olympiad. This year, we were once again able to proctor tests in person, as well as create online versions of our exam.

Through the various events in our K-12 Outreach Program, we were able to reach approximately 1,000 children across the United States, and even started the process of sending our genius boxes to South Africa! We were also able to reinstate our in-person mineral auctions in Sarkeys Energy Center, as well as host our first alumni auction in almost three years – the most successful in P&H history, according to our records.

Toward the end of this academic year, Pick & Hammer participated in person at Sooner Saturday on the North Oval and Earth Day on the South Oval. These events were treated as recruitment for both the club and the college, so we broke out our best samples and activities to bring people in. At one point, the Pick & Hammer table had the biggest crowd on the South Oval for the Earth Day event! We got to meet the new students and give away fun stickers, as well as allow prospective members to crack their own geode for a more hands-on experience.

The 2021-2022 Pick & Hammer officers were able to improvise, adapt, and overcome many of the obstacles thrown at them. In April 2022, a new group of officers was elected to continue our mission. The officers for the 2022-2023 school year are: President Logan Crawford, Vice President Sam Sundberg, Treasurer Braeden Moreland, Secretary Amy Huynh, Archivist Alison Johns, and Outreach Officers Xander Margheim and Ash Simpson. We have high expectations for this new crew and are excited to see all of their accomplishments!

This isn't all we've been working on, either... Keep an eye out on the second floor of Sarkeys in the near future for the last mark on this university by the 2021-2022 P&H officers.

Student Research Symposium

The annual Student Research Symposium sponsored by ConocoPhillips was held April 1 in Sarkeys Energy Center. Members of the Oklahoma Geological Survey served as judges for the event, allowing students an opportunity to network with researchers. Below are the winners for the Ph.D., Master's, and undergraduate categories:

Ph.D.	Master's	Undergraduate
David Lubo Robles	David Sanger	Brock Dumont
Karelia La Marca	Laura Ortiz Sanguino	Emma Steiner
Cansu Floyd	Diana Salazar Flores	Justin Bonner
	Branson Harris	

Spring Awards

The School of Geosciences celebrated the end of the semester with succulent planting and pot decorating during the annual spring picnic held at Andrews Park. Additionally, we recognized the following students for their achievements:

Outstanding Freshman
Bryson Fetters
Alison Johns
Braeden Moreland

Outstanding Sophomore
Sultan Al Balushi
Will McCraine

Outstanding Junior
Dawoud Al Hasheimi
Turki Al Mamari

Staff Rock
Steve Adams

Teague Dickson

Charles Gould Award for Outstanding Senior in Geology

Emma Steiner

David Stearns Award for Outstanding Achievement

John McKnight

Alan Witten Award for Outstanding Senior in Geophysics

Elizabeth Beall

Estwing Hammer Award for Excellence

The annual spring Student and Alumni award banquet hosted by the Mewbourne College was not held this year. These undergraduate and graduate students were, instead, recognized for their achievements at the Geosciences spring picnic.

Laura Ortiz

Ben Hare Excellence in Research Award (M.S.)

Abidin Caf

Ben Hare Excellence in Research Award (Ph.D.)

Rachel Neher

Stan Cunningham Excellence in Teaching Award

Alicia Bonar

Frank A. Melton Memorial Research Award


FIRST GENER
Live On, University


SCHIST JUST GOT REAL
BOOMER SOONER
THANKS MOM, DAD


Live On, University

Congratulations to our 2021-2022 graduates!

B.S. GEOLOGY
Hussain Al Balushi
Wijdan Al Jabri
Thuwaiba Al Wahaibi
Cynthia Andrade-Lerma
Preston Batchler
Elizabeth Beall
Justin Bonner
Bren Cable
Jacob Clements
Spencer Cross
Logan Dickson
Brock Dumont
Hunter Hughes
Anthony Lewis
Ian McMurphy
Leah Medina
Cassidy Nickell
Townsend Noakes
Autumn Roche
Nicholas Rylko
Emma Steiner
Jeremy Strech
Berri Tamfu
Joshua Wester
Zachary Williams
Nicholas Wood

B.S. GEOPHYSICS
John McKnight
Duc Tran

M.S. GEOLOGY
Bailey Abney
Kurt Crandall
Zachary Tomlinson
Ryan Totten

M.S. GEOPHYSICS
Ahmet Alyaz
Kaycee Sims

PH.D. GEOLOGY
David Duarte Coronado
Matt Hamilton
Carl Symcox

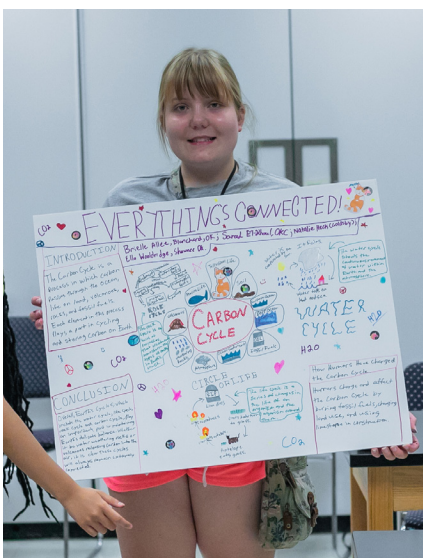
PH.D. GEOPHYSICS
Dustin Dewett
David Lubo Robles
Pranshu Ratre
Saurabh Sinha

Earth Cycles Camp

Mike Soreghan, Ph.D.

The School of Geosciences hosted 30 rising 6th to 8th graders from across Oklahoma in a one-week summer science camp focused on "Earth Cycles." The theme encompassed the natural cycles of rock, water, and carbon and involved a number of activities and experiments, including sampling soils with Caitlin Hodges at the nearby OU Duck Pond. Students learned about interactions of the Earth System and particularly how the carbon cycle is impacted by human activities such as changes to soils, deforestation, and burning fossil fuels.

The program was funded through a grant from the Oklahoma Department of Education through the College of Professional and Continuing Education. The academic component of the camp was organized by myself and M.S. student Elise Callahan assisted throughout the week. Students also participated in a STEM lunch in which small groups of students met with a group of Geosciences faculty, staff and students. On the last afternoon, students exhibited their new-found knowledge to their family and friends in the form of a "research symposium" in which student groups created and presented posters they had worked on throughout the week that explained the importance of the natural carbon cycle and how it fits in the "Earth Cycles."



Inaugural Geosciences Day

Gail Holloway, Undergraduate Recruiter

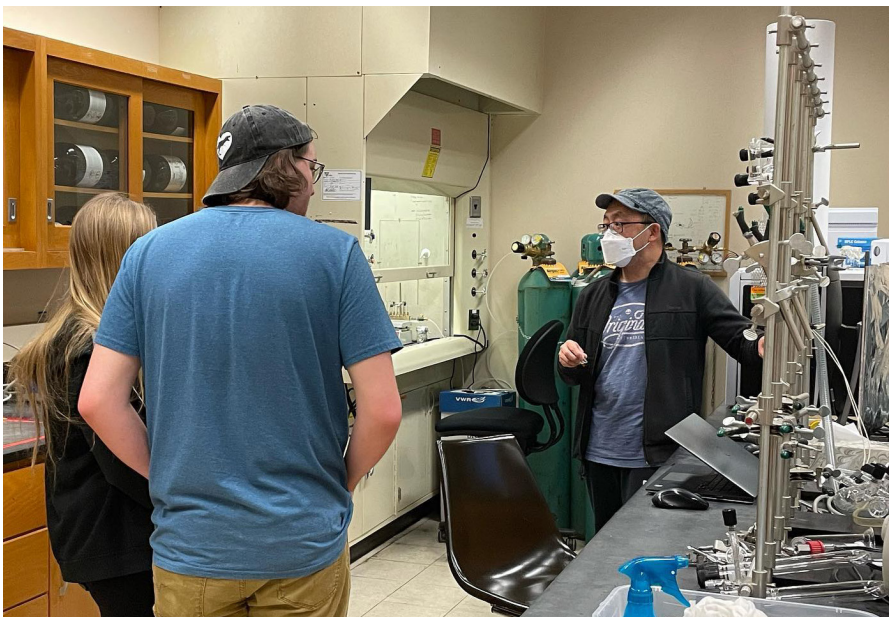
On March 4, 2022, the school held its first Geosciences Day. High school and community college students from Oklahoma and surrounding states were invited to visit the School to learn more about our program and OU. Sixteen students and guests attended, representing a variety of majors and grade levels.

We started the day with an OU information session and campus tour. Courtnay Thomas from the Office of Admissions and Recruiting presented about Financial Aid, University College, and admission timelines. Afterwards, students received the full OU tour covering academic, social, and residential highlights.

Back in Sarkeys, faculty and students joined the attendees for an informal lunch. This gave attendees a chance to ask questions, learn about our classes and programs, and to get a feel for the school. Following lunch, students heard from director Lynn Soreghan, and a panel of current undergraduate and graduate students. The culmination of the day were lab tours led by professors and graduate students, including such research programs as geophysics, sedimentology, structure, and geochemistry.

We had great feedback from the attendees. The chance to talk directly to students and faculty was the highlight of the day. This included both the student panel and the informal lunch. I think this helped by not only answering questions and addressing concerns, but also by allowing attendees to "see" themselves here as students.

We hope to make this an ongoing event and are already planning for next year. In the future, we plan to add a Sarkeys tour, expand the lab tours, and potentially add a class visit. We also plan to increase the time for attendees to interact with current students and faculty as this was a favorite activity.



Electron Microprobe Lab Moves to Oklahoma Geological Survey

Lindsey E. Hunt, Ph.D.

It has been a busy year for the electron microprobe lab, which is now officially part of the Oklahoma Geological Survey (OGS). The electron microprobe lab at OU originally opened in 1988 under the leadership of David London. In 2015, the original CAMECA SX50 instrument was replaced with a newer CAMECA SX100 microprobe, which continues to be operational today. The instrument is equipped with five wavelength-dispersive X-ray spectrometers, integrated Thermo Ultra-Dry SDD energy-dispersive X-ray analyzer, Gatan PanaCL/F cathodoluminescence detector, and standard SEM imaging capabilities including secondary and backscattered electron signals. The wavelength dispersive spectrometers are outfitted with standard and synthetic crystals, which permit quantitative analysis of elements from boron to uranium. The instrument is commonly used for compositional data, image analysis and X-ray elemental mapping of a variety of different materials. The facility has not only been used by OU and OGS researchers. It is also commonly used by many external academic users, as well as commercial and private clients ranging from DOE National Laboratory researchers to mining companies and mineral dealers. The lab is also equipped with a sample preparation facility that is attached to the lab and can be used to prep samples for both SEM and microprobe work. Additional information about the lab can be found via the probe lab website at www.ou.edu/empl or by email (lehunt@ou.edu).

I have been the lab manager and primary operator of the microprobe lab since my arrival at OU in May 2018. I've often said, I'm not a normal geologist. I didn't collect rocks or fossils as a kid, but I had a love (some might call it an obsession) for natural disaster movies. I was always drawn to the lab-oriented characters, so maybe it's not all that surprising that I became one after I was bitten by the SEM-probe bug as an undergraduate at the University of West Georgia, and through my Ph.D. in geology at Texas A&M (2017).

Immediately following graduation, I took a temporary assistant professor of geology position at Austin Peay State University in Tennessee. While I absolutely loved teaching, I knew my heart was meant for the lab. Now that the lab is part of OGS, I am looking forward to not only continuing to work with the existing users, but also the opportunity to work with fellow OGS members on samples from right here in Oklahoma.

My own research interests tend to fall in hard rock (specifically, amphibolite, peridotites, and xenoliths). Some of my favorite samples to come on the probe have admittedly been dominated by olivine, amphibole, and pyroxenes. However, since working for the probe lab here at OU and now OGS, I have also had the opportunity to look at many different types of rocks and minerals, and a surprising number of other materials masquerading as possible meteorites, along with plenty of concrete. I have learned to appreciate every sample that comes through the lab, because even the most normal samples can become extraordinary under an electron beam.

Depositional Systems and Stratigraphy Field Trip

Steve Adams, Ph.D. candidate

This fall the Depositional Systems and Stratigraphy (GEOL 4113) class resumed our annual trip to the Sacramento and Guadalupe Mountains of New Mexico and Texas, after pre-trip testing and various other protocols. Lynn Soreghan led the four-day field trip that exposes students to many different rocks and environments of this part of paleo-equatorial Pangaea from the Mississippian through the Permian. After enduring so many pandemic cancellations, students were enthusiastic to be in the field studying rocks and learning about the ancient environments of the region. Some highlights of the trip were visiting White Sands National Monument, measuring a stratigraphic section in La Luz Canyon, seeing giant marine algal-microbial mud mounds, hiking the Permian Reef trail, and visiting Carlsbad Caverns. This is an important trip that exposes students to rocks deposited through a dynamic interval of Earth history. They discover how changes in tectonics, sea level, and climate influenced environments and the biosphere through time.

Last year we built an online version of the trip because we were not able to travel. This year that online material was used by students who were not able to attend the trip. This material, which includes several online modules along with hand samples from field trip stops, provides an alternative to students who might otherwise miss out on the trip.

Hodges Research Group Update

Caitlin Hodges, Ph.D.

This summer, undergraduate researchers Dodger Stankewitz and Riley Woodrow are working with me to characterize the effect of European colonization on soils in Central Oklahoma. Improper land management practices employed by Europeans increased erosion rates, which resulted in eroded hillslopes and floodplains filled with sediment.

Every other week the students and I sample this sediment and the buried floodplain soils near Washington, Oklahoma to quantify the volume of sediment produced from European settlement in Central Oklahoma. The students then take the soils back to the lab to conduct particle size analysis, characterize soil mineralogy, and measure microbe-mineral interactions in the sediment and buried soils. This work will contribute toward quantifying the lasting impact of anthropogenic soil erosion in Oklahoma, and results from this project can be applied to sites across the Southern Plains of the United States.

AASPI Research Group Update

Heather Bedle, Ph.D.

The Attribute Assisted Seismic Processing and Integration Research group has been extremely prolific over the last year. In the 2021-2022 academic year, we have graduated one Ph.D. (David Lubo-Robles), one M.S. student (Ahmet Alyaz Murat), and an undergraduate researcher (Zach Williams), and welcomed two new Ph.D. students (Marcus Maas and Emily Jackson) and one new M.S. student (Daiana Salazar Florez). In 2022, we were additionally joined by visiting scholar, Daiane Cardosa from Brazil. David Lubo Robles has chosen to stay with AASPI as a post-doc, joining Thang Ha. Kurt Marfurt is enjoying his "retirement", continuing his research and algorithm development for AASPI. Coming from different academic and cultural backgrounds, our students and researchers make AASPI a robust group for creating new ideas and workflows.

Using a mixture of seismic reflection attributes in combination with a variety of machine learning methods to illuminate the geology hidden beneath our feet, AASPI has published 15 peer-reviewed manuscripts already in 2022 in a variety of scientific journals, as well as several newsletters articles with AAPG, all available on the AASPI website. Taking advantage of the virtual capabilities, we continue to record our student presentations, as well as tutorials for AASPI workflows, and these, and our publications are available on the AASPI website (mcee.ou.edu/aaspi/). Presentations in other languages such as Spanish are available as well, to make AASPI more accessible and inclusive to all.

While Marfurt remains an integral member of the AASPI consortium, Bedle has taken over as PI of AASPI as of the fall 2021. As we look toward the future of seismic reflection research, our efforts are pivoting to use and test our unique and successful imaging and analysis methods, previously developed by AASPI for frontier energy applications, including carbon capture and underground storage, geothermal reservoirs, and hydrogen storage. Bedle has received grants from the National Science Foundation, Department of Energy, and American Chemical Society, and is collaborating with international scientists in research for future energies. We continue to look toward our alumni and industry colleagues for guidance, ideas, data, and support. Also, if any alumni would like a three-month evaluation license to explore and see what AASPI is up to, just contact me!

Upper row: Abidin Caf, Anna Turnini, Brittany Stroud, Grace Barber
Lower row: Hannah Morgan, David Duarte, David Lubo and Professor Pranter (advisor)

Reservoir Characterization and Modeling Laboratory

Matthew Pranter, Ph.D.

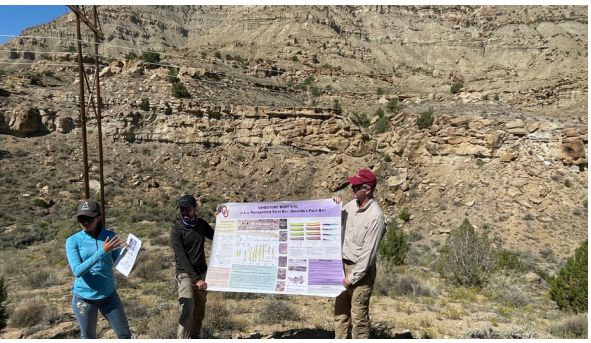
This year I was honored to be elected to the American Association of Petroleum Geologists (AAPG) Executive Committee to serve as Editor (three-year term). As AAPG Editor, I manage the editorial board and the peer-review process for the AAPG Bulletin (AAPG's flagship technical journal) and AAPG special publications. I also appoint senior associate editors and associate editors on the editorial board. I am excited to work with the AAPG Executive Committee, editorial board and staff, and the AAPG membership.

For spring 2022, I was on sabbatical at OU in Norman. The sabbatical allowed me to expand the scope of my research and teaching into additional topics related to energy resources, especially CO_2 utilization and storage as well as hydrogen and geothermal. In addition, I had the opportunity to work on several manuscripts for publications.

I have expanded my teaching plans by offering and proposing additional and timely general education courses. I am working on course materials to instruct Earth, Energy, Environment (GEOL 1033), and will instruct it in fall and spring semesters (beginning Fall 2022). This energy-related course is very timely; especially given the global energy-related issues we face and the long-term demand that will require a balanced approach and all forms of energy resources. The course will include topics on coal, oil, natural gas, biomass/biofuels, nuclear, hydrogen, hydropower, geothermal, wind, solar, as well as CO_2 storage and critical energy minerals.

I am excited to propose a new general education course: Geology of National Parks (GEOL 1023). I hope to begin instructing it in fall 2023. I believe this new course will be of interest to many students, one in which students of various backgrounds can relate, and it could potentially attract new students to geosciences. The course will address introductory geology concepts to explore the amazing landscapes and geological features of selected U.S. National Parks. The National Parks are important for illustrating and describing concepts related to Earth processes and geologic time.

Students in the Reservoir Characterization and Petroleum Geology courses had a very educational time on the fall 2021 field trip to northwestern Colorado – and it was great to be back in the field following the pandemic. I led students to numerous localities in the Piceance Basin area to analyze world-class fluvial and shallow-marine outcrops. We were joined in the field by Javier Tellez and Rex Cole, professors at Colorado Mesa University.



Students in the Reservoir Characterization and Modeling Laboratory (RCML) and I continue our research in reservoir geosciences and explored a range of questions related to the controls that structure, stratigraphy, and sedimentology play regarding subsurface reservoir architecture, lithological and petrophysical-property heterogeneity, and storage capacity and flow characteristics. We have expanded the scope of our research and teaching into additional energy resource topics, especially CO_2 utilization and storage, hydrogen, and geothermal

In his doctoral research, Abidin Caf (Ph.D. Geophysics student) is using quantitative seismic interpretation and supervised machine learning methods for reservoir characterization and modeling workflows. His work ranges from seismic-constrained mapping of subsurface formation properties to the assessment of injectivity and storage potential for CO_2 using both static and dynamic modeling methods (Zulfiqar Reza from petroleum engineering collaborates on this research). Caf recently presented his research on the injectivity and storage potential assessment of the Arbuckle Group for CO_2 sequestration at Wellington Field, Kansas, at two research meetings. Caf discussed his results at the Boone Pickens School of Geology TechFest at Oklahoma State University in February 2022 (for which he was awarded 2nd place) and at the AAPG Carbon Capture, Utilization, and Storage Conference in Houston in March 2022. He presented at the OU Geosciences Research Symposium in April and will also present at the 2022 IMAGE Conference in Houston. For his achievements, Caf was awarded the Ben Hare Excellence in Research Award by the School of Geosciences.

Anna Turnini (Ph.D. Geology student) is focusing on a statewide assessment of CO_2 storage capacity, injectivity, transport, and reactivity potential of the Arbuckle Group in Oklahoma. We have been compiling an extensive digital well database for Oklahoma using appropriate software to conduct statewide regional mapping and modeling of the Arbuckle Group structure, stratigraphy, petrophysical properties, and storage capacity. This research is of great interest to those focused on the Arbuckle Group of Oklahoma for CO_2 storage.

Brittany Stroud (M.S. Geology student) is conducting a regional study of the Caney Shale that explores the variability of elemental composition, mineralogy, and petrophysical properties within the Ardmore Basin, Oklahoma. For her achievements, Brittany received the Oklahoma Energy Resources Board (OERB) Geosciences Fellowship Award and the Oklahoma Geological Foundation Suzanne Takken Memorial Fellowship Award. Brittany will present her research results at the 2022 IMAGE Conference in Houston.

Grace Barber (M.S. Geology student) is focusing on the reservoir-scale stratigraphy and lithology and petrophysical property variability of the Cretaceous Williams Fork Formation at Mamm Creek Field in the Piceance Basin, Colorado, using machine learning, seismic-attribute analysis, and 3-D reservoir modeling.

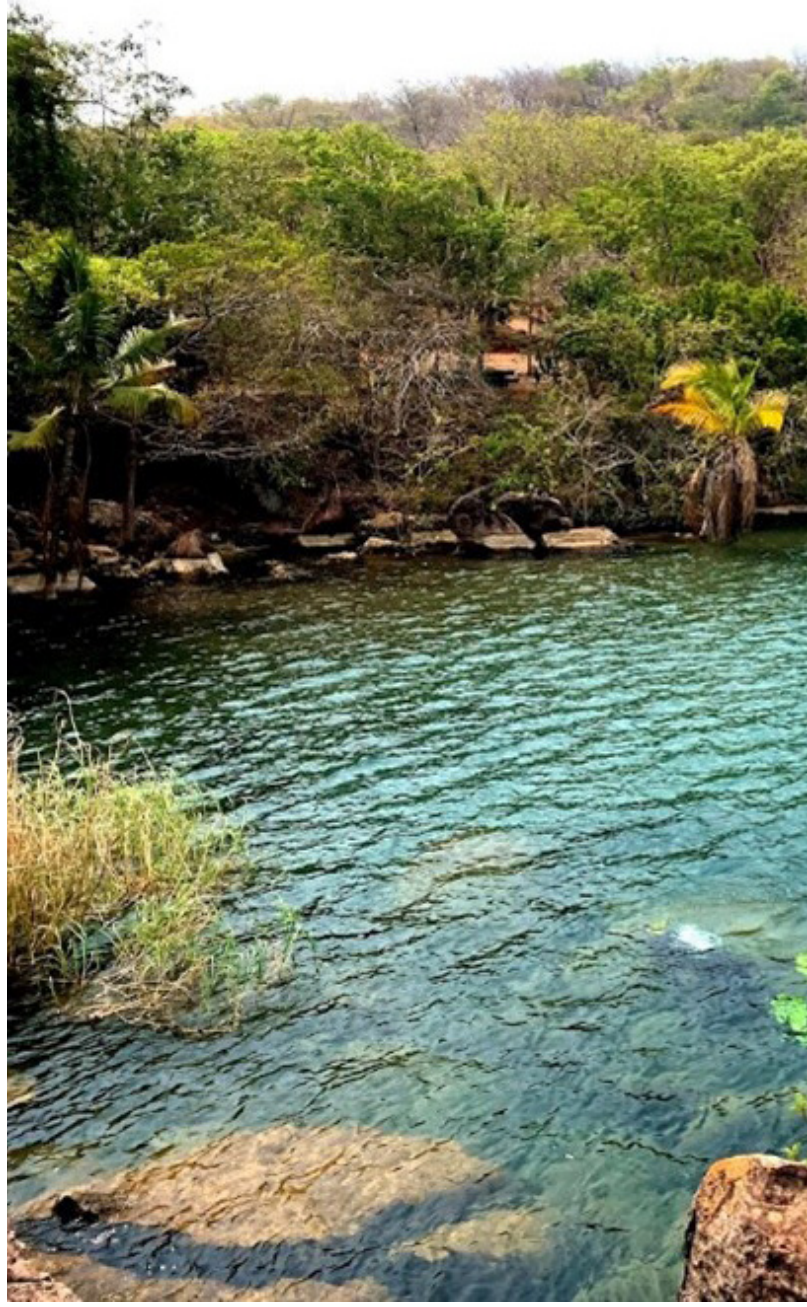
Hannah Morgan (M.S. Geology, 2021) recently graduated, and David Duarte (Ph.D. Geology, 2021) and David Lubo (Ph.D. Geophysics, 2022) were hooded during the December 2021 and May 2022 graduation ceremonies, respectively. Hannah is a petroleum geologist with Devon Energy in Oklahoma City, David Duarte is a petroleum geologist with Ovintiv in Houston, and David Lubo is a post-doctoral research associate at OU.

Exploring Sedimentology, Hydrology, and Paleoclimate in Western Tanzania

Alicia Bonar, Ph.D. candidate

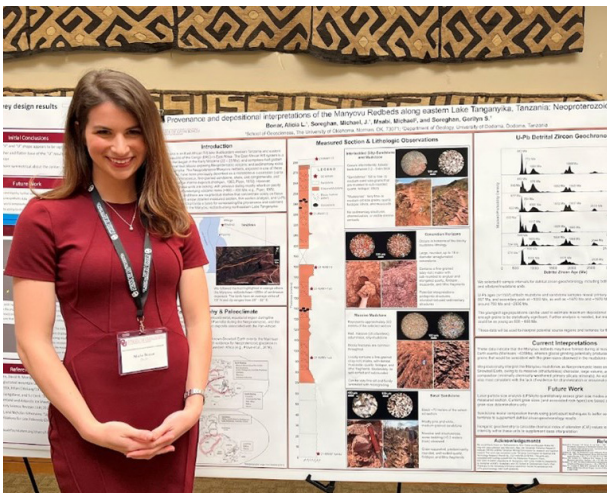
At the end of the summer 2021 field season, we finally made it back to Tanzania after two years of canceled field work due to the COVID-19 pandemic. The trip was led by Michael Soreghan, who has been doing research along Lake Tanganyika in western Tanzania for three decades. The lake is within the East African Rift system and is an important locality for understanding paleoclimate, biodiversity, as well as modern and ancient continental rift systems. Being the largest tropical lake on Earth today, Lake Tanganyika is also home to many people who depend on the fish and fresh water; therefore, environmental sustainability of the lake, fish, and river systems are critical to local populations.

This year, Mike Soreghan, Bren Cable (B.S. 2022), and I traveled to Kigoma, Tanzania to study multiple projects related to both the sedimentology and hydrology of the lake and surrounding areas. Mike continued data collection for his research studying the snail shell beds in the modern, shallow shelves of the lake, which required multiple scuba-dives by both him and Bren as well as local Tanzanian Fisheries researchers. Bren collected preliminary data and water samples from feeder river systems to Lake Tanganyika to identify changes in dissolved organic carbon (DOC) and other geochemical signals related to vegetation, agriculture, and farming practices by local communities. She has been working with Kato Dee (hydrogeologist at OU) to better constrain the potential roles for the lake in current climate change and the carbon cycle. I have been studying the paleoclimate and depositional environments of the Neoproterozoic (over 600 million years ago) redbeds that are exposed along eastern Lake Tanganyika. Bren, Mike and I logged over 250 meters of measured section to better constrain the age of these rocks and the sediment transport system(s) that deposited these silty, massive, red units. These research projects continue to add to the growing knowledge about important topics related to both anthropogenic impacts to earth systems and modern and deep-time climate change.



During our travels, we also were able to have many unforgettable cultural and local experiences. We took a trip to Gombe National Park where we saw two chimp families and Jane Goodall's Tanzanian home. We went on a Katavi safari while waiting for export permitting documents in order to bring home rock samples; and we were even able to make our own chapatis at the local fish market in Dar es Salaam. A very successful field season!

Both Bren and I presented our findings at the School of Geosciences Research Symposium in spring 2022. Bren is graduating in summer 2022 and will begin her master's degree at the University of Vermont in fall 2022. I am continuing to work on the Neoproterozoic redbeds as part of her dissertation with Mike and Lynn Soreghan and collaborator Michael Msabi from the University of Dodoma. I also plan to present additional data and interpretations at the annual GSA conference in Denver this year.


Provenance and depositional interpretations of the Manyovu Redbeds along eastern Lake Tanganyika, Tanzania: Neoproterozoic
Introduction
Measured Section & Lithologic Observations
Future Work

Semester in the West Coast – University of Oklahoma to Caltech as Visiting Student Researchers

Raymond Ng, Ph.D. Student

Part I: All work and no play - Understanding the subsurface in Northern Oklahoma using telecommunications fiber optic cables.

Oklahoma is no stranger to earthquakes created from fluid injection. However, this does create concern of more destructive earthquakes such as the 5.8 Mw Pawnee earthquake in 2016. Traditionally, earthquake monitoring is performed with a sparse network of cumbersome equipment that yields an equally sparse understanding of the happenings of the subsurface. To improve on this, high-density deployments have been the recent trend in observation seismology with innovated technology. However, a higher density of equipment means exponentially larger amounts of data to process and requires use of improved techniques. Recent innovations in earthquake monitoring techniques and technological advancements have allowed researchers to record and analyze large datasets more efficiently. For example, Distributed Acoustic Sensing (DAS), is a calibrated pulsing laser and can connect to existing fiber optic cables from telecommunication networks to monitor ground vibrations. In spring and summer 2021, Xiaowei Chen (OU) connected a DAS interrogator (Silixa iDAS unit) to the fiber system operated by Oklahoma OneNet for telecommunication in Enid, Oklahoma. The DAS unit converted 40 km of dark fibers (fibers not actively used for communication) into densely space seismic channels at 2 m spacing, and collected ground vibration for about 40 days (20 days east of Enid – between Enid and I-35, 20 days west of Enid – between Enid and Oklahoma) (Figure 1). Concurrently, OU Ph.D. candidates Deepankar Dangwal, Pranshu Ratre (now a postdoc), Zhuobo Wang and I deployed, three component self-contained seismic nodes along the installed fiber optic line location to compare the two datasets.

Recently, significant progress was made in processing and analyzing the data. Chen, Deepankar and I spent the first half of 2022 at Caltech collaborating with Zhongwen Zhan, who has done significant work with a few permanent DAS networks to monitor the Mono lakes region and Ridgecrest, California. With Zhan's and Chen's assistance, Deepankar and I made significant progress with the dataset. Our goal is to build a high-resolution understanding of the subsurface. Deepankar focused on ambient noise correlation and development of a subsurface velocity model and I focused on site characterization at a high spatial resolution of the fundamental frequency of the sediment column. The site response is the ambient noise Horizontal-to-Vertical-Spectral-Ratio (mHVSR), commonly used in ground-motion modeling to predict ground motion amplification. The sediment velocity can be used to calculate theoretical responses. In Figure 2, the preliminary results show correlation between the site response I obtained and the subsurface velocity model Deepankar obtained. Moreover, the shallow velocity model shows agreement with surface geology, validating the preliminary results. Our findings will further the understanding of the subsurface and be used for earthquake hazard mitigation.

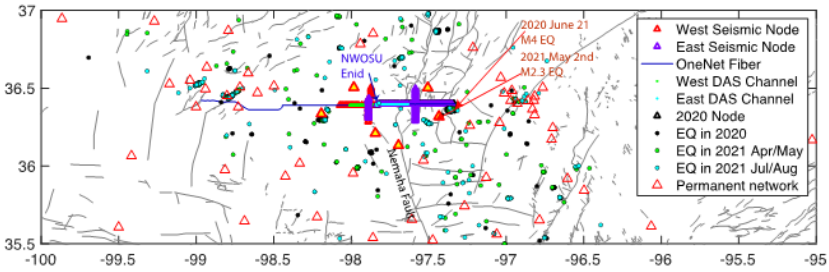


Figure 1. Map view of the array, faults from OGS database, and earthquakes within 200 km of Enid during array deployment periods in 2020 and 2021 that will be used for site response analysis. The triangles denote the node locations. Note that the 2021 East overlaid the 2020 Node locations. The East array crosses the Nemaha fault zone. The two earthquakes mentioned in the proposal are denoted on the map. The yellow triangles with red outlines are stations within 40 km of the interrogator location at NWOSU, which will be used for relocation and waveform modeling of the local earthquakes. The dark blue box outlines the area of focus for detailed earthquake relocation. Node 4001 is used for examples.

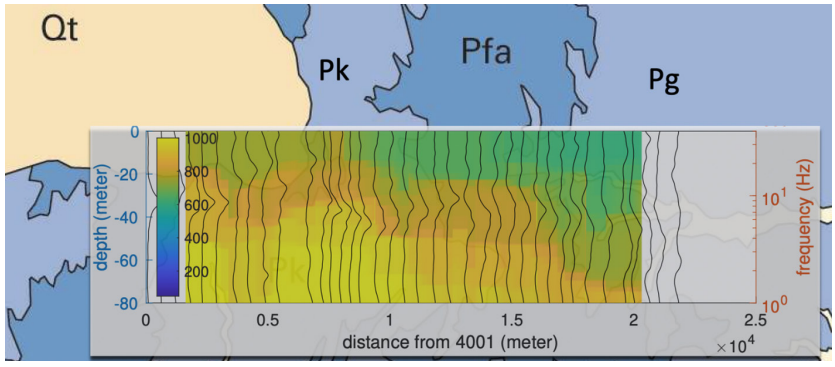


Figure 2. mHVSR versus velocity model. Left-axis: Velocity image of the top 80 meter from ambient noise processing. Right-axis: variations of mHVSR versus distance from node 4001. Background is digital geology map from USGS data center. Pk: Kingman Siltstone, Qt: Terrace Deposits, Pfa: Fairmont Shale, Pg: Garber Sandstone

Part II: Relaxation and fun – Venturing into the West, Santa Cruz Island

Within the hallowed halls and ivory towers of Caltech, Deepankar, Chen and I worked. However, we also explored California's rich food culture while Deepankar and I ventured into lush geologic history, ecology, and natural beauty of California. We made several hikes in places such as Santa Cruz Island, an island in the Channel Islands National Park, once inhabited by Chumash. The Channel Islands were created approximately 20 million years ago as a result of the rotation of a large structural block that is also responsible for the rapid growth of the transverse ranges. We successfully backpacked and traversed the island from Prisoner's Harbor to Scorpion Anchorage following the Del Norte Trail, which entailed hundreds of meters of elevation gain and descent to sea level across more than 16 miles of gorgeous scenery in two days. The island basement comprises metamorphosed sediments and volcanic casting cathedral-like shadows across the landscape and breaking the sea horizon with large rocky peaks and rolling hills. Along the way, we visited other historical locations such as Chinese Harbor, once a location for one of the many Chinese abalone fishing camps that existed in Southern California in the mid 1800's that, with warming oceans, contributed to the rapid decline in abalone population. We chose this hike was chosen for the scenery and challenge. The only fresh potable water on the island is at Scorpion Anchorage which meant all fresh water used for drinking, cooking, and cleaning during the island trek must be carried from the ferry at Prisoner's Harbor.

Packed up and geared up, we made our way across the island admiring the landscape and fauna. Fields of grass filled the scenery with their red to golden seed pods swaying in the ocean breeze. Originally introduced to cultivate grazing pastures for sheep in the 1800's, grass is all that remains from Santa Cruz Island's ranching history where all sheep were eventually removed by 1980 for conservation purposes.

We observed abundant wildlife ranging from bottle nose dolphins, California sea lions, and orcas on the ferry ride to island. On the island, we saw scrub jays (endemic to Santa Cruz island), Island foxes (recently removed from the endangered list in 2016), and much more. We spent an extra day at Scorpion Anchorage to explore the coast, even sighting the endangered black abalone, and Santa Cruz Island visitor center prior to a short ferry ride back to the mainland.

Dust, Dust, Everywhere!

Lily Pfeifer, Ph.D.

Drs. Lynn and Mike Soreghan together with Ph.D. student Alicia Bonar and I executed another successful field research season in May 2022. We initiated new collaborations with Spanish colleagues Josep Fortuny and Chabier de Jaime, collected field data to expand on previous work in the Permian of south-central France, and mentored three new undergraduate students to perform field-based sedimentology and paleoclimate research. This concludes the final year of Lynn and Mike Soreghan's NSF-funded International Research Experiences for Students (IRES) program, which has afforded 16 undergraduate students in geology (most from historically marginalized groups) the opportunity to conduct international field-based geological research in collaboration with OU students/faculty and French colleagues Jean Van Den Driessche and Stephane Pochat. This project has also been fundamental for my doctoral and postdoctoral research, which has origins in my OU M.S. degree that I started with Lynn several years ago. Publications in *Geology, Geological Society of America Bulletin, Basin Research, Frontiers in Earth Science*, and *Journal of Geoscience Education* have resulted from the team's work here, and more remains to be done, particularly to explore the role of volcanism on climate near the peak of the Late Paleozoic ice age. Since joining the international research team in 2021, Alicia Bonar has also completed several objectives for her own doctoral research; this summer, her work included retrieving dust traps from the Pyrenees to help assess dust inputs to soils of the Mediterranean. Undergraduate student participants Savannah Rivera (University of Science and Arts of Oklahoma) and Brianna Farreny (Rowan University) will continue to pursue undergraduate research projects with data from this program.


TENIM CARN FRESCA

In Search of Lost Time*

** With apologies to Marcel Proust*

John Pigott, Ph.D., Chenxi Xu, and Rachel Neher

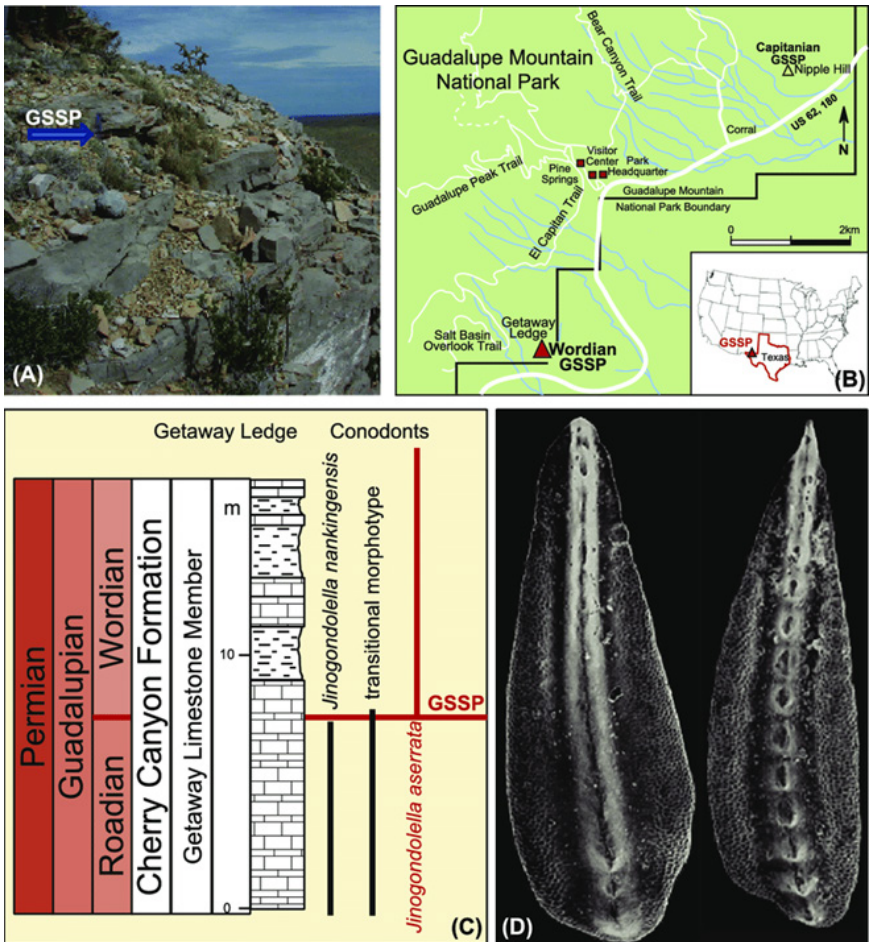


Figure 1. Location of investigated GSSP base of Wordian section. (A) outcrop view. (B) Location (C) Stratigraphic position (D) Holotype of Holotype of Jinogondolella aserrata. From Henderson et al., 2012

Figure 5. Dr. P. and Dr. Hearst on site.

One of the problems of time is the question of the meaning of time outside of the human experience. Among all the scientific disciplines, only Geoscience attacks the chronology of times past both relatively and absolutely without the stigma or bias of trying to place the geologic record into an anthropological domain. The modus operandi is termed "Stratigraphy," where sedimentology and paleontology are the major relative players. But herein lies an inescapable problem. Sedimentation is not everywhere continuous, eventually there occurs at the end of the sentence of deposition a punctuation mark, an unconformity indicating the existence of a lacuna. Similarly, speciation can end with an abrupt extinction event. Whether the physical and biologic stratigraphic signals always coincide is open to question, but what is true is that within the fossil record species are only recognized within a time context (Norris and Hull, 2011).

As the Permian Delaware Basin of New Mexico-West Texas was open to the Panthalassa Ocean through the Hovey Channel (as described in the research of many theses of the OU Permian Basin Research Group), it is reasonable to assume that global changes affecting depth and microclimates in the world ocean would also impact sea depth and microclimates of marine species within the Delaware Sea, e.g., conodont fauna. Indeed, conodont fauna are presently being used to confirm the stratigraphic position of the Permian Wordian base of the GSSP section (Global Boundary Stratotype Sections and Points) within the Getaway Ledge section proximal to the Guadalupe Mountains National Park, West Texas, USA (Figure 1).

Unfortunately, while the early conodont data at Getaway Ledge were informative, upon reexamination, the data appear inconclusive. Consequently, a new conodont analysis is presently being conducted by a collaboration of American and Chinese scientists. In the meanwhile, something interesting has happened. Through the invitation of Jonena Hearst (of the National Park Service Guadalupe Mts), she along with Chenxi Xu, Rachel Neher and Pigott made an incredible sedimentologic observation at this site this past December.

Though for the most past invisible to the naked eye, through a high-resolution LiDAR (Light Detection and Ranging) survey taken from half a km away at a resolution of 2mm at 1 km (Figure 2), they imaged by laser reflectance bedding geometries analogous to examples which can be interpreted in the subsurface via classic seismic stratigraphy (Figures 3 and 4). The LiDAR reveals a subaqueous storm wavebase controlled toplap boundary in a relatively shallow offlapping carbonate shoal. This observed bed geometry is indicative of a Lowstand Systems Tract (LST) when sea level was at a low stillstand. As sea level rose, this LST is capped by a Transgressive Systems Tract (TST). Conclusion: Just by chance the conodont paleontologists are searching for the GSSP just below this almost invisible parasequence set boundary! What does this mean in plain language? It means that the conodont paleontologists may be looking in exactly the right place for a conodont species change. The Delaware Sea at this time indicated that the global Permian Ocean was having only a small little hiccup in sea level, minutely small compared to the dramatic changes which would soon occur that would have devastating effects upon the life at that time, one of the largest global extinctions the Earth had ever witnessed!

"I longed for nothing more than to behold a stormy sea, less as a mighty spectacle than as a momentary revelation of the true life of nature;" -Marcel Proust, "À la recherche du temps perdu."

Henderson, Charles & Davydov, Vladimir & Wardlaw, Bruce. (2012). Chapter 24, The Permian Period. The Geologic Time Scale 2012: Amsterdam, Netherlands, Elsevier. 653-680.

Norris, R. D., & Hull, P. M. (2012). The temporal dimension of marine speciation. Evolutionary Ecology, 26(2), 393-415. doi: 10.1007/s10682-011-9488-4

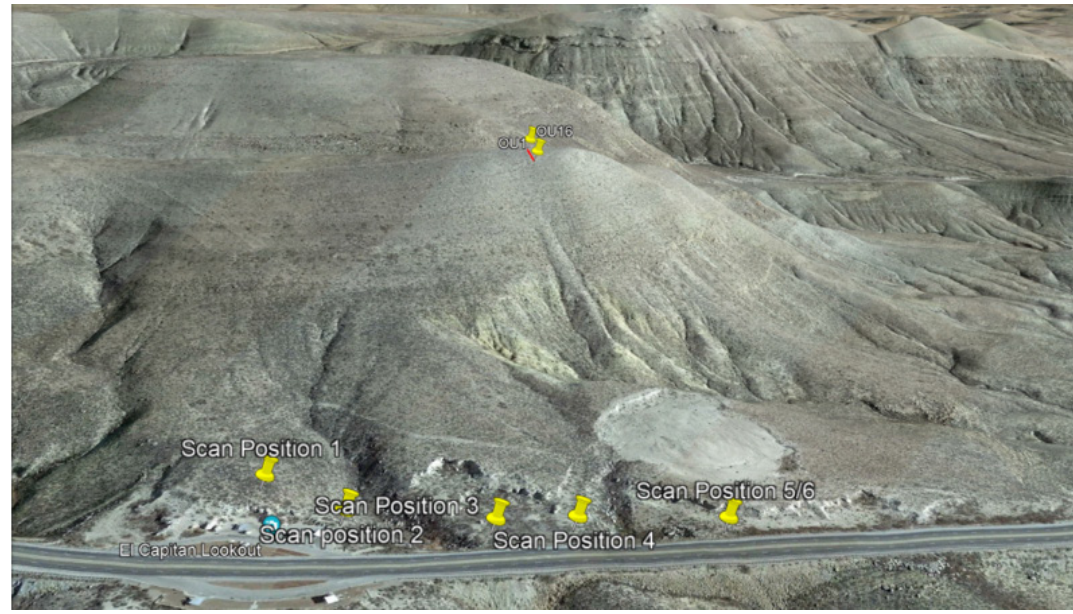


Figure 2. Getaway Ledge view via Google®. Red arrow indicates Getaway Ledge. The bottom yellow pushpins indicate the six scan positions. The top two yellow pushpins (OU1 and OU16) indicate the 15m transect for paleontological and geochemical sampling. The following figures reveal LiDAR scans of the upper transect.

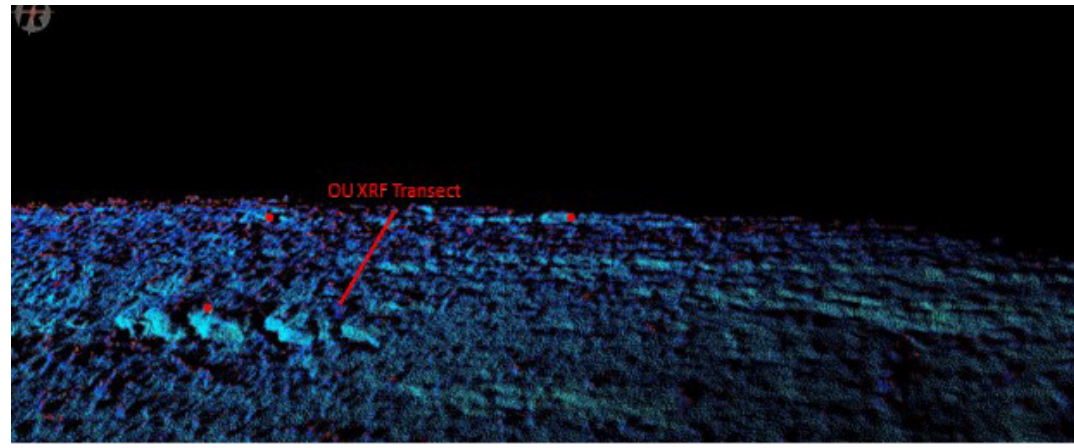


Figure 3. Uninterpreted LiDAR reflectance scan 0.5 km from observation. Length of red line is 15m.

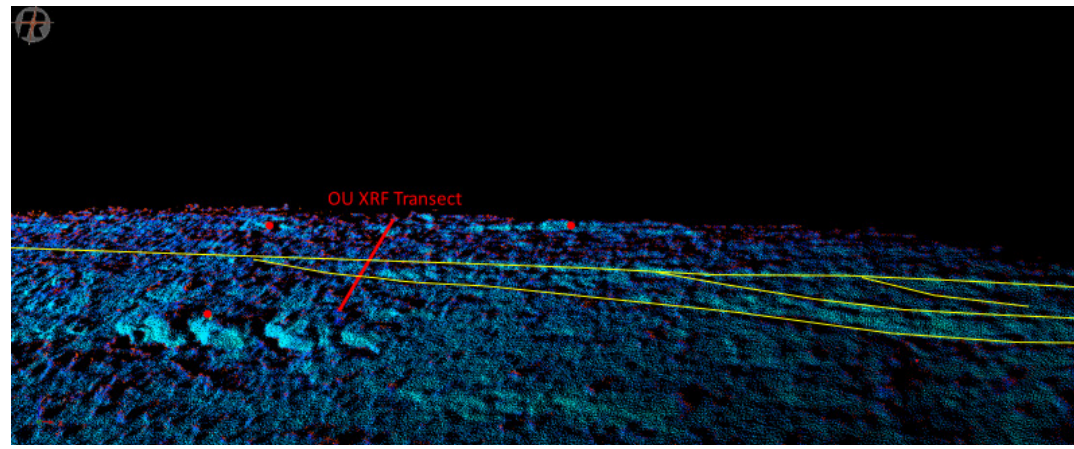


Figure 4. Interpreted LiDAR reflectance scan 0.5 km from the scanning positions. Length of red line is 15m. The yellow lines indicate basinward offlapping with clinoforms tangential to an upper flat yellow line indicating toplap of a stillstand parasequence set of a lowstand. Above are onlapping green lines of a transgressive systems tract.

A Core Engine of Geomaterials Research and Education at OU: the Samuel Roberts Noble Microscopy Laboratory

Andy Elwood Madden, Ph.D.

"New research directions are launched much more often by new tools than new concepts." - Jim Kurose, National Science Foundation Assistant Director

For many decades, microscopy and materials science sat as foundational aspects of the geosciences at OU – just ask any student having worked through mineralogy and petrology courses. Advanced microscopy and analysis with electron beams also have a long history in geosciences research at OU, including scanning electron microscopy (SEM) and the electron microprobe laboratory (EMPL). My students and I became heavy users of the Samuel Roberts Noble Microscopy Laboratory (SRNML), shared-use university core facility, when I arrived on campus over 15 years ago. In graduate school, the materials user facility was one of my favorite spots, a place where I could meet core facility scientists and researchers from around campus, learn about their projects and methods, and get new ideas and tips that benefited my work.

In fall of 2019, I had the opportunity to step into the role of SRNML director, helping to manage day-to-day operations and shape the future of this shared-use university core facility at OU. I work closely with the three Ph.D. researchers on the SRNML team, the Office of the Vice President for Research and Partnerships, a steering committee of faculty and researchers from across OU and the Oklahoma Medical Research Foundation, and many faculty and researchers from around OU and the region. Geosciences faculty have a long history of collaboration with the SRNML, serving on the original steering committee that was established at the founding of the current SRNML facility.

Despite the setbacks, shutdowns, and challenges associated with the COVID-19 pandemic, we've been able to work with 445 users 2019-present, spanning 12 academic units on the OU Norman campus in addition to many users from OUHSC, across Oklahoma, and beyond. SRNML teaches three courses: Advanced Light Microscopy, Scanning Electron Microscopy, and Transmission Electron Microscopy, which many Geosciences students have taken past and present. These courses are at the heart of our Graduate Certificate in Microscopic Imaging & Technology, giving students fundamentals and hands-on skills they can bring to a wide range of careers after graduation.

We're heavily involved in outreach, including the award-winning Oklahoma "Ugly Bug" competition for elementary schools, where kids submit their bugs for SEM imaging and voting. Our microscopy team, with many wonderful volunteers and participants (including from Geosciences), brought the excitement of science and technology to more than 175 K-12 students and their families in April 2022 alone through three events: the Oklahoma Microscopy Society "Kids with Microscopes" event at the Norman Public Library led by Tingting Gu (approximately 200 people in total attended from the community), our first "K-12 experience" co-organized with the Office of Admissions and Recruitment for kids from Eisenhower Elementary, and the BE4NANO group from CKTC led by Professor Wilhelm from biomedical engineering.

This year, the undergraduate mineralogy course also came to SRNML for a lab and used our new Quattro S field-emission environmental SEM for their course projects, with high-resolution imaging and live-time EDXA compositional mapping capability. Students brought rock samples from their own collections and used a range of tools (optical petrography, SEM/EDXA, and XRD) to identify the minerals in their samples. The Quattro instrument can capture a backscattered montage image of a thin section at submicron resolution in an hour, or approximately 600 nm resolution in a few hours (the file sizes get very large!). Since commissioning in early 2021 it has been used for a wide range of geoscience research projects, including bioweathering of Antarctic glacial drift, dynamic wetting/drying experiments studying the role of cation exchange in sulfate precipitation on Mars, fluid alteration of uranium-bearing Permian clastics, electron backscatter diffraction (EBSD) of Fe-dolomites, among many other projects.

Geosciences students are also actively using the SRNML transmission electron microscopes (TEMs) for studies ranging from pyrite weathering and clay transformation in brines, studies of nanodiamonds from Oklahoma sediments, identification of the chemistry and mineralogy of individual clay grains, investigations of the role of sulfidic solutions on the chemistry of smectites, and a range of other projects.

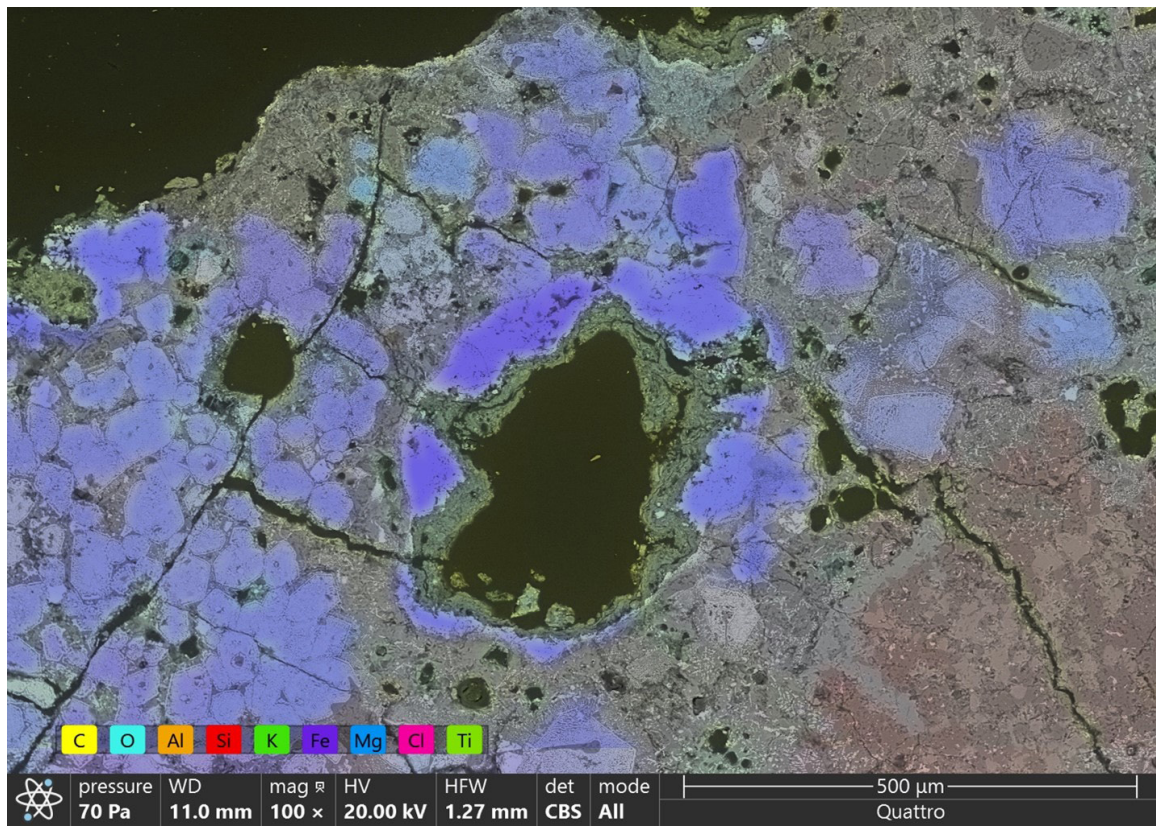
OU's "Lead On, University" strategic plan and Research Strategic Plan express the key roles of shared research infrastructure that enable OU researchers and their regional academic/ industrial partners to compete at a world-class level. In the SRNML we work closely with partners across the university and beyond to make this a reality. In just the last year and a half, with support from the vice president for research and partnerships (VPRP) and many around campus, we acquired the new environmental SEM and Keyence ultramicroscope. Multidisciplinary teams of faculty also submitted grants

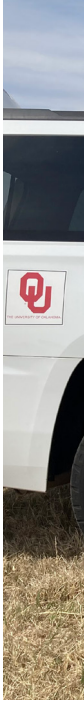
to acquire over $6 million of cutting-edge microscopy equipment, including aberration-corrected analytical TEM, multi-ion plasma FIB-SEM, and inverted white-light confocal laser scanning microscopy with light-sheet capability.

Today's advanced materials research requires demanding and specialized technical equipment, human, and facility resources. Shared research infrastructure for advanced materials research at OU will promote research, education, and connection to regional partners with big impact. For example, our TEM proposal submitted to the National Science Foundation included 54 faculty / Principal Investigator participants involved in 264 funded projects over the last 5 years with more than $166 million of impact, involved in training 142 MS and 211 Ph.D. students, with 39 current postdoctoral researchers. Open and collaborative shared-use core facilities help promote connections between individuals where ideas, methods, and technologies can be shared in unexpected ways at the interfaces of disciplinary research. This summer (2022) we're part of a team to help shape a bold new future of collaboration and innovation in materials research and education, led by the Office of the VPRP and the Center for Quantum Research and Technology. Exciting times ahead for geomaterials research at OU, from the atomic to planetary systems scale!

Above: Preston Larson from SRNML working with a physics student on the dual-beam FIB-SEM

Below: "ColorSEM' X-ray map and backscattered electron image collected by students from 2224 on their unknown sample brought from home.





Imaging a Mysterious Feature in the Subsurface of the Buried Wichita Uplift

Heather Bedle, Ph.D. and Lynn Soreghan, Ph.D.

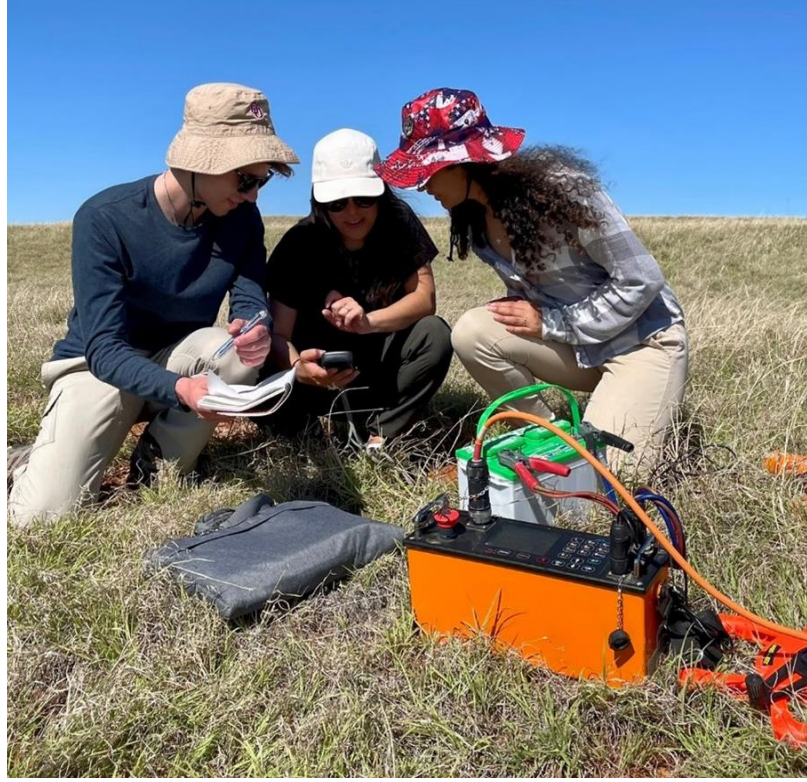
In late summer 2022, Lynn Soreghan and I acquired two 2D seismic lines in S.W. Oklahoma, as part of a National Science Foundation(NSF) funded project to perform a site survey of a potential drilling location for an International Continental Drilling Program (ICDP) project dubbed “Deep Dust.” The Deep Dust project aims to recover core of the continental Permian primarily in the keel of the Anadarko Basin — the paleo-lowland; but the preservation of part of the Wichita Mountains in the subsurface offers the amazing opportunity to access a yoked upland-lowland system.

The Wichita Mountains are an extraordinarily rare example of a truly ancient landscape: the mountains you see today are merely the peaks of a larger upland now buried beneath Permian strata. A series of dry holes drilled during the early wildcat days of the Oklahoma oil industry outlined the extent of the uplift, and once its location was known, the drilling — as well as geophysical probing — moved elsewhere. A recent data-room seismic share with SEI revealed an enigmatic feature near the edge of the buried uplift that could be a paleovalley, an impact crater, or perhaps something else entirely. Further defining and — ultimately — coring the sedimentary fill of this feature would provide unique insight to the paleoclimate of this Permian upland. Is this feature an incised river valley that formed during a glacioeustatic low stand of the late Paleozoic icehouse (LPIA), or a valley carved by ice during a particularly intense phase of the LPIA? The latter constitutes a truly outrageous hypothesis (cf. Davis, 1926) that would fundamentally shift our view of the late Paleozoic icehouse, given the paleo-equatorial location. And of course, impact craters — another possible option — are always fun and revealing.

This seismic acquisition is designed to image the shape of the feature - and determine if it is fluvial, glacial, or something else entirely. Borrowing seismic nodes from PASSCAL, and using a source truck provided by UT El Paso, all students from OU Geosciences had the opportunity to participate in this seismic acquisition, and students in my GPHY 4874 (Seismic Exploration) class will have the opportunity to analyze and use the data for years to come. Ph.D. students Bobby Buist and Alex Vera Arroyo are helping lead the field work, with Alex leading the seismic deployment and Bobby taking the lead on the seismic processing, analysis, and interpretation.

Groundwater Investigation Using Electrical Resistivity in Sentinel, Oklahoma

Sina Saneiyan, Ph.D., and John McKnight, M.S. student



The near-surface geophysics group at OU is aiming to understand the physicochemical characteristics of the subsurface within 100m of the Earth's surface with novel and minimally disruptive geophysical methods. This year, the team (PI: Sina Saneiyan; students: John McKnight (M.S.), Vanessa Rios Perez (M.S.) and Diana Salazar Cortez (M.S.)) was contacted by a farmer in Sentinel, Oklahoma to locate groundwater for drinking and agricultural purposes in an area of 100 by 100 m. The near-surface geophysics team suggested using the electrical resistivity geophysical method for this purpose before any well drilling.

Electrical resistivity is an intuitive and reliable method for locating groundwater due to its relatively low cost, discrete deployment, and sensitivity to earth material's electrical properties. Each material in the subsurface has a specific resistivity value which can be determined by sending an electric current into the ground. The resistivity is calculated from measured voltage drop (which depends on injected current) across potential electrodes on the surface. Typically, freshwater aquifers have higher resistivity than their surrounding rocks and sediments; therefore, identifying groundwater zones is relatively straightforward by looking at a resistivity map.

Previous data from well logs in the nearby area show that the shallowest layers in the near-surface were mostly red sand with pockets of clayey soil. Clayey aquifers are not desirable for groundwater production and usually have a very low yield. Therefore, drilling in the clayey pockets should be avoided. Clay is characterized by its low resistivity due to its high cation exchange capacity in the resistivity maps. To locate the clay deposits in the area, the near-surface team set four East/West 93 m in length arrays of 32 electrodes each (electrode spacing: 3 m) and two North/South 93 m arrays with the same electrode spacing as the previous four arrays. The E/W arrays were separated by 10 m each and the N/S array had a separation of 30 m.

After data acquisition with the ARES II geophysical instrument, the near-surface team analyzed the data and plotted a 3D resistivity map of the subsurface resistivity distribution. Based on the results, some shallow clay pockets in the study area were spotted a possible location for drilling in the westward most portions of the study area, where it is most likely to have a high yield well (least likely to be within a clay pocket), was identified. It is important to note that the groundwater here is more resistive than the surrounding material (sand and clay) as it is freshwater (not brackish).

John McKnight (the near-surface team member) has future plans for the Sentinel, Oklahoma, data which include measuring the resistivity of the sand layers in the study area in the laboratory from collected soil samples. The near-surface team is looking forward to future studies in the area.

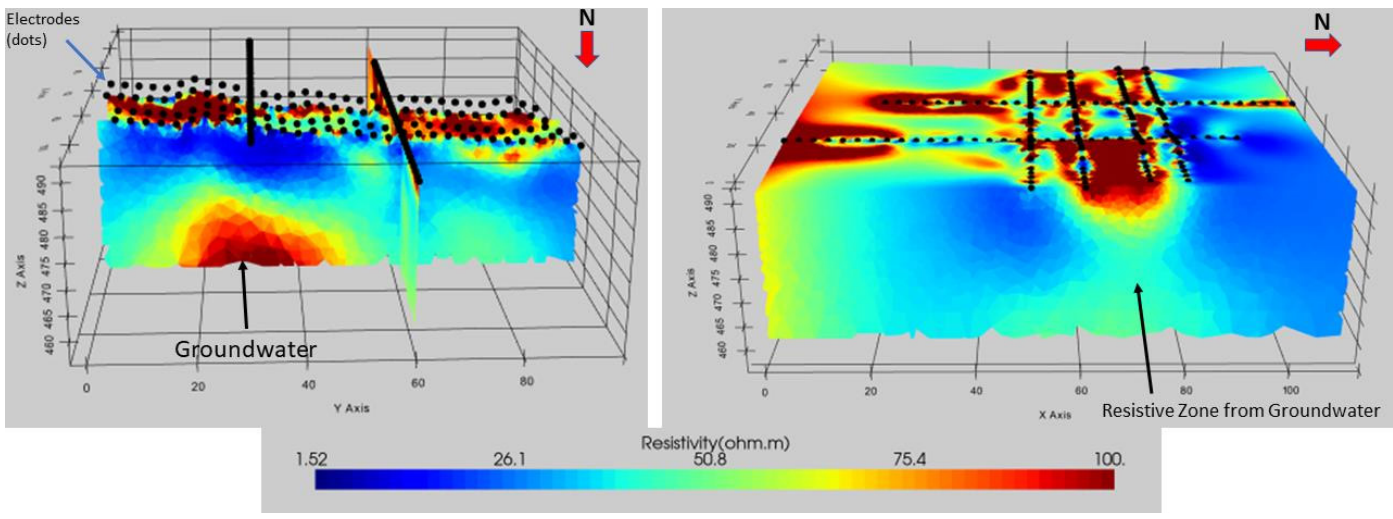


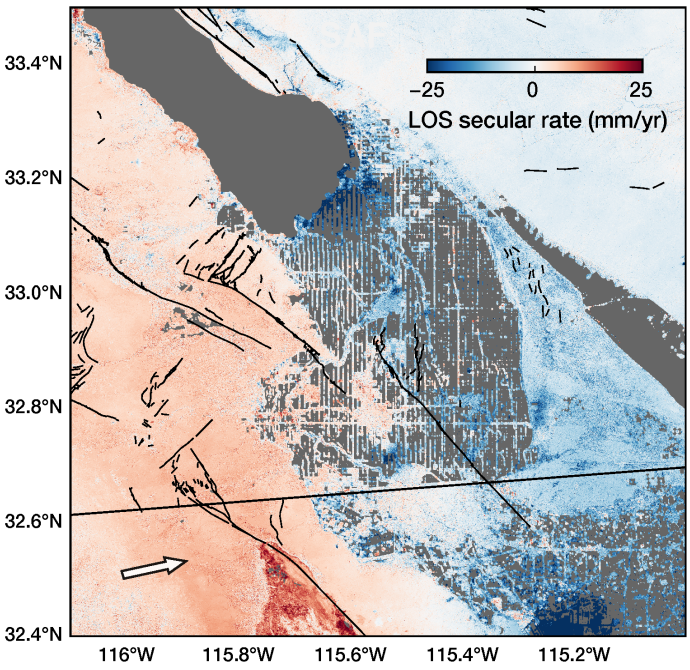
Figure 1 - 3D resistivity map of the study area in Sentinel, OK. Deep resistive features (marked by black arrows) are possible locations non-clayey aquifers.

Deciphering Dynamic Solid Earth Processes Across Scales

Junle Jiang, Ph.D.

The Earth's crust is constantly changing due to natural processes and human activities. These changes can take a dramatic form in geohazards such as earthquakes, landslides, and volcano eruptions, or a subtle form in slow ground movement such as fault creep and land subsidence. Modern geophysical observations using land-, air-, and space-based techniques are increasingly capable of monitoring geological processes at wide-ranging time scales, whereas advanced computational modeling can help bridge the insights from lab-, reservoir-, and crustal-scale observations. Integrating geophysical data and computation to advance our knowledge about the solid Earth is the central mission of the Crustal Dynamics and Computational Geophysics Group, that I lead. Our research group address geophysical problems using numerical modeling of elastodynamic, frictional, and poro-/visco-elastic processes in the Earth's lithosphere, along with analysis and inference of geodetic and seismic data and uncertainty quantification. Currently, three graduate students in the group are pursuing research topics about deformation and fluid injection in geothermal fields and the fault zone response following major earthquakes in subduction zones and crustal faults. Some of these projects are supported by the National Science Foundation and Southern California Earthquake Center. We also have ongoing collaborative projects with other researchers at the School and the Oklahoma Geological Survey, e.g., to study the controlling factors of seismic swarms in volcanic and geothermal environments, and landslide susceptibility in Oklahoma and Arkansas.

While the research interests in our group are broad and diverse, a unifying theme is to use high-resolution geophysical observations and physical modeling to better reveal a multiscale picture of short-term crustal dynamics and geohazards. While deciphering these geological phenomena is fascinating in itself, these efforts will be increasingly imperative as society needs to efficiently extract energy, mineral, and groundwater resources in the subsurface and mitigate induced hazards.



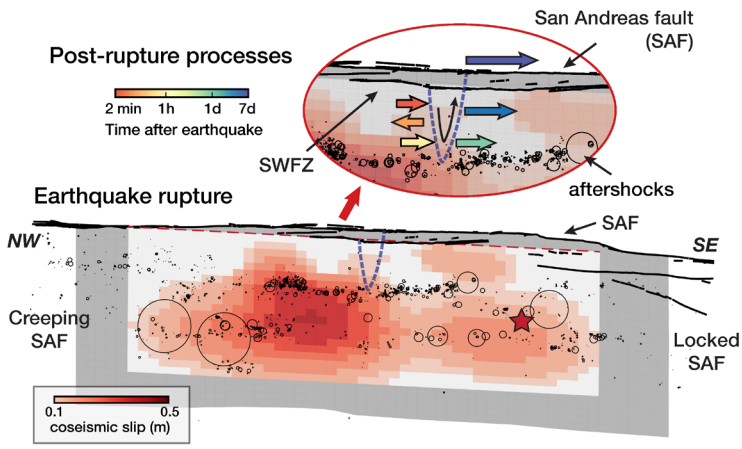


Figure 1. (left) Satellite-based measurements of ground deformation due to tectonics and geothermal operations in the Imperial Valley, California

Figure 2. (above) Fault slip and seismicity associated with a major earthquake inferred from seismic and geodetic data.

Bartell Field Camp

Shannon Dulin, Ph.D.

The 11th year of the Bartell Field Camp started off with something highly unusual—17 inches of snow at camp! While flurries are not unusual during the first few days of camp—heck, my year at field camp started with a half inch of snow on the ground!—the amount received this year was highly irregular and resulted in a delay of one day to the start of field camp. I wanted to know how irregular this event was, so I dusted off my meteorology degree and got into the historical weather data. I had to go back to 1990 to find any significant snowfall in May, which was 9.7" total for the month over a few days. There was 12.2" recorded in May of 1973, although the one-day max snowfall was 8.4". Another snowy year was 1971 with 7.8" total. The May 21, 2022, storm produced an official 10" at the weather observing station, the highest one day total I found in the past 50 years! Luckily, it had been in the 90's the week before and we didn't even have to get the tractor out to plow the snow, but we did have to wait a day for everything to melt before everyone could safely navigate the road to the field station. Fortunately, we have a large fireplace in the mess hall, which burned for three days straight as the temps slowly climbed back up into 70's and 80's over the next week.

This was the first full six week camp in the last two years due to COVID-19 disrupting the world. We started off slowly to make sure everyone had their bearings with respect to navigating a topographic map and memorizing the stratigraphy. We visited our normal haunts of Grape Creek and the Mixing Bowl, as well as some jaunts to Blue Ridge to look at metamorphics and Ruby Mountain to map some amazing Cenozoic volcanics.

The regional field trip this year, led by Professor Kato Dee, ventured a little farther than usual. The students camped near Vernal, Utah, and got to visit Dinosaur National Monument. This lagerstätten was a vertebrate extravaganza, showing students not only a world-class fossil locality, but also showing facies changes in the units they are used to seeing in camp. The purpose of the regional trip is not only to have a fun time, but to understand how facies can change over distance and help to envision the 3D nature of the sedimentary units they study for six weeks! The students then moved on to Leadville, where they visited mines, learned about regional hydrogeology, and became acquainted with acid mine drainage remediation techniques.

Even more exciting this year is the fact that one of our alumni, Professor Brandon Spencer, spent his first year assisting Professor Jim Puckette in running Oklahoma State's field camp! Maybe OU and OSU will reunite on a few field trips in the future. One thing is for sure, the breadth of tectonic regimes available in and around Cañon City never ceases to amaze me and it is easy to see why so many geology camps call this location home for the summer field season.

Bartell Field

Many of you may not have visited camp since your time there (or not all if you graduated before 2011)! Alumni are always welcome to visit, just contact Bartell Field Camp Director, Shannon Dulin, for information. If you are interested in learning about giving opportunities for camp infrastructure or field trips, please visit: ou.edu/mcee/geosciences/give

Camp

Memorials

In memory of our alumni gone too soon

Perry Evert Barnhart
Henry Bercutt
Joe Allen Bradley
Scott Dale Bruner
James Kirk Ervin
Otis Otto Fox
Charles A. Hassenfratz
William Franklin Howell
Robert A. Johnston
Jackson Gary Jones
David A. Kotila
Robert T. Lane
Lorraine Hoyle Lewis
Dick Bradford Mason
William Edward McDaniel
Harold Arthur Merrill
James William Odom
James Bryant Park
Alvin M. Phillips
Larry Leon Piatt
Donald Leon Reese
R. L. Rountree
Richard Frank Shaw
Avery Edward Smith
Edward S Spragins
R. Clark Taylor

**as reported to OU Development through July 2022*

Alumni News

Don Walker (2004) started a new position as staff geologist at Southwestern Energy in Spring, Texas on June 13, 2022.

Kevin Woller (M.S. Geophysics, 1978) retired from Pioneer Natural Resources and is currently living in Nicholasville, Kentucky. Prior to Pioneer Natural Resources, he worked for Mobil Oil Co. He is a visiting scholar at the University of Kentucky and does some geophysical consulting for the oil and gas industry.

Faculty Year in Review

**This document lists, for each faculty member, publications and grants active in CY 2020, classes taught in CY 2021 and graduate students completed during spring 2021, summer, 2021 and fall 2021. Please note that faculty have varied effort distributions, listed as proportions devoted to Teaching (T), Research (R), and Service (S).*

YOUNANE ABOUSLEIMAN
Effort Distribution: T20, R60, S20
Journal Articles
Abousleiman, Y., Phan, D. T., Liu, C., Al Tammar, M., Han, Y. (2021). Application of artificial intelligent to predict Time-Dependent Mud-Weight Windows in Real Time. *SPE Journal* (1-21).

Abousleiman, Y., Hur, J., Hull, K. L., Qomi, M.J. A. (2021). Reactive force field for modeling oxidative degradation of organic matter in geological formations. *RSC Advances*, 11(47).

HEATHER BEDLE
Effort Distribution: T40, R40, S20
Journal Articles
Bedle, H., Lou, X., van der Lee, S. (2021). Continental Tectonics Inferred from High-Resolution Imaging of the Mantle Beneath the United States, Through the Combination of USArray Data Types. *Geochemistry, Geophysics, Geosystems*, 22(10). 10.1029/2021gc009674.

Bedle, H., Cooper, C., and C. Frost, Nature versus Nurture: Preservation and Destruction of Archean Cratons, *Tectonics*, e2021TC006714, 2021 doi: 10.1029/2021TC006714.

Buist, C., Bedle, H., Rine, M., Pigott, J. D. (2021). Enhancing Paleoreef Reservoir Characterization through Machine Learning and Multi-Attribute Seismic Analysis: Silurian Reef Examples from the Michigan Basin. *Geosciences*, 11(3), 142. 10.3390/geosciences11030142.

Silver, C., Bedle, H. (2021). Evolution of a Late Miocene Deep-Water Depositional System in the Southern Taranaki Basin, New Zealand. *Geosciences*, 11(8), 329. 10.3390/geosciences11080329.

Karen M. Leopoldino Oliveira, Heather Bedle, and Karelia La Marca Molina, (2021), "Identification of polygonal faulting from legacy 3D seismic data in vintage Gulf of Mexico data using seismic attributes," *Interpretation* 9: C23-C28.

Silver, C., Bedle, H. (2021). Overbank sediment waves in the southern Taranaki Basin, New Zealand. *Interpretation*, 9(1), C11-C15. 10.1190/int-2020-0011.1.

Clairmont, R., Bedle, H., Marfurt, K. J., Wang, Y. (2021). Seismic Attribute Analyses and Attenuation Applications for Detecting Gas Hydrate Presence. *Geosciences*, 11(11), 450. 10.3390/geosciences111110450.

Chenin, J., Silver, C., Bedle, H. (2021). Seismic geomorphology anomalies within a Pliocene Deepwater channel complex in the Taranaki Basin, offshore New Zealand. *Interpretation*, 1-27. 10.1190/int-2020-0037.1.

Grants
Bedle, H., "Understanding and unraveling the seismic waveforms related to low saturation gas.," Sponsored by American Chemical Society, Petroleum Research Fund, Non Profit, $110,000. (September 1, 2021 - August 31, 2023).

Bedle, Heather and Kurt J. Marfurt, "Attribute-Assisted Seismic Processing and Interpretation Consortium," Sponsored by Various Oil Companies, Industry, $6,201,915.00. (January 2008 - December 2021).

Teaching
GPHY 3423 Intro to Petroleum Geology/Geophysics
GPHY 4874 Seismic Exploration
GPHY 5533 Quant Seismic Interpretation
GPHY 5970 Advanced Seismic Exploration
GPHY/GEOL 6970 Multidisciplinary Exploration
GPHY 6970 Works Flows in 3D Seismic

Student Completed (Spring 2021 – Fall 2021)
Clairmont, Roberto, M.S., "Seismic Attribute Analyses and Attenuation Applications for Detecting Gas Hydrate Presence."

Mora Ortiz, Jose Pedro, M.S., "A Comparison of Coherence Enhancement, Probabilistic Neural Network, and Convolutional Neural Network Fault Imaging with Manual Interpretation in The Taranaki Basin Area, New Zealand."

Perico, Edimar, M.S., "Application of Seismic Attributes and Machine Learning Clustering Techniques to the Characterization of Faults in A Post-Salt Reservoir, Jubarte Field (Campos Basin)."

Silver, Clayton, M.S., "Seismic-Based Characterization Of A Carbonate Gas Storage Reservoir Assisted By Machine Learning Techniques."

MICHAEL BEHM
Effort Distribution: T45, R45, S10
Journals
Ghos, S., Ali, S. A., Zaman, M., Chen, D.-H., Hobson, K. R., Behm, M. (2021). Evaluation of Transverse Cracking in Flexible Pavements using Field Investigation and AASHTOWare Pavement ME Design. *International Journal of Pavement Research and Technology*.

Ghos, S., Ali, S. A., Zaman, M., Hobson, K. R., Mendez Larrain, M. M., Behm, M. (2021). Factors Contributing to Fatigue Cracking in Flexible Pavements in Oklahoma: A Case Study Using Laboratory and Field Investigation and AASHTOWare Simulation. *Journal of Testing and Evaluatio*n, 50(2).

Richmond, D., Pigott, J. D., Lupia, R. A., Behm, M., Hein, D. (2021). Carbonate mound springs of the Upper Jurassic Morrison Formation of central Montana and the paleoclimatic significance for the northern foreland basin. *Geology of the Intermountain West,* 8, 1-26.

McGlue, M., Yeager, K., Soreghan, M. J., Behm, M., Kimirei, I., Cohen, A., Apse, C., Limbu, P., Smiley, R., Doering, D., Lucas, J., Mbonde, A., McIntyre, P. (2021). Spatial variability in nearshore sediment pollution in Lake Tanganyika (East Africa) and implications for fisheries conservation. *Anthropocene,* 33, 100281. doi.org/10.1016/j.ancene.2021.100281.

Grants
Soreghan, G. S., Behm, M., Dulin, S. A., "Collaborative Research: Equatorial Glaciation and Landscape Burial in the Late Paleozoic: Implications for Pangaean Climate and Tectonics," Sponsored by National Science Foundation, Federal, $449,032. (September 1, 2019 - August 31, 2022).

BRETT CARPENTER
Effort Distribution: T40, R40, S20
Journal Articles
Kibikas, W., Ghassemi, A., Carpenter, B. M. (2021). Evaluating the mechanical properties of carbonate and evaporite caprocks in the Sichuan Basin, *Journal of Asian Earth Sciences X*. 10.1016/j.jaesx.2021.100063.

Zhang, L., Liao, Z., Long, K., Carpenter, B. M., Zou, H., Hao, F. (2021). Fundamental constraints of lithologically-controlled fault networks on gas migration and accumulation for fractured carbonates in the western Sichuan Basin, China. *Journal of Petroleum Science and Engineering*. 10.1016/j.petrol.2021.109502.

Karam, P., Mitra, S., Marfurt, K. J., Carpenter, B. M. (2021). Synthetic transfer zone characterization using seismic attributes, Taranaki Basin, New Zealand. *Interpretation*. 10.1190/int-2020-0138.1.

Ortega-Romo, A., Walter, J., Chen, X., Carpenter, B. M. (2021). Spatially distinct tectonic zones across Oklahoma inferred from shear wave splitting. *Seismological Research Letters*. 10.1785/0220200237.

Hamilton, M., Carpenter, B. M., Johnston, C., Kolawole, F., Evans, S., Elmore, R. D. (2021). Fractured, altered, and faulted basement in northeastern Oklahoma: Implications for induced seismicity. *Journal of Structural Geology*. 10.1016/j.jsg.2021.104330.

Grants
Chen, X., Carpenter, B. M., "Collaborative Research: Roles of rupture complexity, geological structure, stress interaction on earthquake sequences," Sponsored by National Science Foundation, Federal, $399,438. (August 1, 2021 - July 31, 2024).

Walter, J., Ghassemi, A., Carpenter, B. M., "Refining principal stress measurements in reservoir underburden in regions of induced seismicity through seismological tools, laboratory experiments, and theory," Sponsored by Electric Power Research Institute, Inc., Non Profit, $495,423. (October 1, 2018 - September 30, 2022).

Carpenter, B. M., Reches, Z., "Geotrib: A Tribological Facility for The Analyses of Friction, Wear, and Lubrication of Geo-Systems," Sponsored by National Science Foundation, Federal, $302,315. (August 1, 2020 - July 31, 2022).

Carpenter, B. M., "Laboratory Constraints on Slip Evolution in Sedimentary Lithologies," Sponsored by Chevron, U.S.A., Industry, $70,000. (December 31, 2018 - December 30, 2021).

Teaching
GEOL 3003 Structural Geology/Stratigraphy
GEOL 3114 Structural Geology
GEOL 4970/5970 Fracture, Faults, Earthquakes

Students Completed (Spring 2021 – Fall 2021)
Firkins, Max, M.S., “Seismic Characterization of Intra-Basement Deformation and its Influence On the Overlying Sedimentary Strata: Implications for Tectonic Evolution and Induced Seismicity in Northern Oklahoma.”

Gilbert, Paul, M.S., “Fracture Characterization and Analysis Along the Blaine Escarpment of Northwestern Oklahoma.”

Kibikas, William, Ph.D., “Characterizing Rock Properties and Their Impact on the Mechanical Behavior of Crystalline Basement and Caprocks.”

Ratre, Pranshu, Ph.D., “Investigating The Regional And Local Structure of Oklahoma's Crust Using Induced Earthquakes.”

XIAOWEI CHEN
Effort Distribution: T40, R40, S20
Journal Articles
Patel, S., Marfurt, K. J., Kolawole, F., Walter, J., Chen, X. (2021). Seismic illumination of small-offset Seismogenic faults, Anadarko Basin, Oklahoma. *Interpretation*.

Ortega-Romo, A., Walter, J., Chen, X., Carpenter, B. M. (2021). Spatially distinct tectonic zones across Oklahoma inferred from shear wave splitting. *Seismological Research Letters*. 10.1785/0220200237.

Ortega, A., Chen, X. (2021). Spatiotemporal Clustering of Seismicity during the 2018 Kilauea Volcanic Eruption. *Geophysical Research Letters*. https://doi.org/10.1029/2020GL090859.

Pennington, C., Chen, X., Abercrombie, R., Wu, Q. (2021). Cross Validation of Stress Drop Estimates and Interpretations for the 2011 Prague, OK, Earthquake Sequence Using Multiple Methods. *Journal of Geophysical Research: Solid Earth*. 126(3). DOI:10.1029/2020JB020888

Abercrombie, R. E., Trugman, D. T., Shearer, P. M, Chen, X., Zhang, J., Pennington, C., Hardebeck, J. L., Goebel, T., Ruhl, C. J. (2021) Does Earthquake Stress Drop Increase with Depth in the Crust?, *Journal of Geophysical Research: Solid Earth*, 126, e2021JB022314.

He, L., Wu, Q., Chen, X., Sun, X., Guo, Z., & Chen, Y. J. (2021). Detailed 3D seismic velocity structure of the Prague, Oklahoma fault zone and the implications for induced seismicity. *Geophysical Research Letters*, 48, e2021GL096137.

Grants
Neeman, H.J., and 30 others, "Acquisition of a Regional Resource for Long-term Archiving of Large Scale Research Data Collections," Sponsored by National Science Foundation, Federal, $967,755. (September 1, 2018 - August 31, 2021).

Nation Chen, X., Carpenter, B. M., "Collaborative Research: Roles of rupture complexity, geological structure, stress interaction on earthquake sequences," Sponsored by National Science Foundation, Federal. (August 1, 2021 - July 31, 2024).

Ghassemi, A., Chen, X., "Application of Advanced Techniques for Determination of Reservoir-Scale Stress State at FORGE," Sponsored by U.S. Department of Energy, Federal. (October 1, 2021 - December 31, 2023).

Chen, X., "RII Track-4: Illuminating the Dark Subsurface using Fiber Optic Distributed Acoustic Sensing (DAS) Array," Sponsored by National Science Foundation, Federal, $227,876. (February 1, 2021 - January 31, 2023).al Science Foundation, $967,755.00. (September 1, 2018 - August 31, 2021).

Chen, X. "Roles of foreshocks in triggering large earthquakes and stress drop validation", SCEC, $22,000. (February 1, 2021 – January 31, 2022).

Chen, X., "Rupture Complexity of Small and Moderate Earthquakes in the 2019 Ridgecrest Earthquake Sequence: Implications for Variabilities in Stress Drop Estimates and Ground Motions," SCEC, $9,300. (February 1, 2021 – January 31, 2022).

Chen, X., "Subsurface Illumination with Ultra-Dense DAS array", OU Faculty Investment Program (FIP), $15,000 (January 2020 – December 2022).

Teaching
GPHY 1103 Adventures in Geophysics
GPHY 4413/5413 Global Geophysics
GPHY 4970/5970 Induced Seismicity

Students Completed (Spring 2020– Fall 2020)
Zhang, Jiewen, Ph.D., "Multiscale Analysis of Seismic Event Source Parameter Resolution and Characterization."

KATO DEE
Effort Distribution: T40, R40, S20
Grants
Dee, K. T., Elwood Madden, M. E., Madden, A. S., "Acquisition of an ICP-OES and IC to Increase Hydrological and Geochemical Research and Education in the School of Geosciences at the University of Oklahoma," Sponsored by National Science Foundation, Federal. (September 1, 2021 - August 31, 2023).

Dee, Kato T., "Lower Sullivan Climax Mine PA/SI and Lancaster/Tip-Top Mine Post Removal Action Sampling," Sponsored by U.S. Department of Agriculture, Forestry Service, Federal. (May 10, 2019 - May 1, 2020)
.
Kirstetter, P.E., and 9 others, "Enhancing Communities Preparedness and Resilience to Post-Wildfire Hydrology in Mountainous Areas," Sponsored by National Science Foundation, Federal, $41,287. (January 15, 2021 - March 28, 2022).

Dee, K. T., "Distribution and Molecular Characterization of Groundwater Dissolved Organic Matter in the Central Oklahoma Aquifer: Relations to Arsenic Fate and Transport," Sponsored by Vice President of Research, The University of Oklahoma, $15,000. (June 2021 - May 2022).

Teaching
GEOL 1114 Physical Geology
GEOL 4633/5633 Field Methods in Hydrogeology

Students Completed (Spring 2021 – Fall 2021)
Foluso, Joy, M.S., "Hydrogeochemistry of a Heterogeneous Aquifer Located in Unaweep Canyon, Mesa County, Western Colorado."

Gallagher, Chelsey, M.S., "Seasonal Influences on the Molecular And Metal Binding Properties of Groundwater & Surface Water Dissolved Organic Matter (Dom) in An Alpine Watershed Located in Central Colorado."

SHANNON A. DULIN
Effort Distribution: T70, R15, S15
Journal Article
Crow, R., Schwing, J., Karlstrom, K., Heizler, M., Pearthree, P., House, P. K., Dulin, S. A., Janecke, S. U., Stelton, M., Crossey, L. (2021). Redefining the age of the lower Colorado River, southwestern United States. *Geology*, 49(6), 611-616

Grants
Soreghan, Gerilyn S., Behm, Michael, Dulin, Shannon A., "Collaborative Research: Equatorial Glaciation and Landscape Burial in the Late Paleozoic: Implications for Pangaean Climate and Tectonics," Sponsored by National Science Foundation, Federal, $449,032.00. (September 1, 2019 - August 31, 2022).

Teaching
GEOL/METR 1034 Native Science and Earth Systems
GEOL 1114 Physical Geology
GEOL 1124 Earth History
GEOL 3123 Introductory Field Geology
GEOL 4136 Field Geology
GEOL 4533/5533 Earth's Past Climate
GPHY 5364 Paleomagnetism

R. DOUGLAS ELMORE
Effort Distribution: T40, R40, S20
Journal Articles
Duarte, D., Benmadi, M., Elmore, R. D., Pranter, M. J., Slatt, R. M. (2021). Diagenetic controls on reservoir quality of a mixed carbonate-siliciclastic system: Sycamore Formation, Sho-Vel-Tum Field, Oklahoma, USA. *Marine and Petroleum Geology*.

Hamilton, M., Carpenter, B. M., Johnston, C., Kolawole, F., Evans, S., Elmore, R. D. (2021). Fractured, altered, and faulted basement in northeastern Oklahoma: Implications for induced seismicity. *Journal of Structural Geology*. 10.1016/j.jsg.2021.104330.

Teaching
GEOL 3233 Sedimentary/Petrology

Students Completed (Spring 2021 – Fall 2021)
Hamilton, Matt, Ph.D., "Tectonics and Alteration of Oklahoma Basement Rocks."

Simpson, Emily, M.S., "A Comparison of Potentially Impact-Related Diagenesis in Impact Structures with Carbonate Targets."

Smith, Elizabeth, M.S., "An Integrated Paleomagnetic and Diagenetic Study of the Womble Shale in The Benton Uplift, Arkansas."

Teixeira, Delcio, M.S., "Integrated Diagenetic and Paleomagnetic Study Of The Sycamore Formation In The Southern Flank Of The Arbuckle Anticline, Southern Oklahoma."

ANDREW S. ELWOOD MADDEN
T25, R40, S35
Journal Articles
Elwood Madden, M. E., Cullen, M., Phillips-Lander, Madden, A. S. (2021). Siderite Dissolution in Mars-Analog Brines: Kinetics and Reaction Products. *Planetary Science Journal, 2*. https://doi.org/10.3847/PSJ/ac13a3.

Grants
Dee, K. T., Elwood Madden, M. E., Madden, A. S., "Acquisition of an ICP-OES and IC to Increase Hydrological and Geochemical Research and Education in the School of Geosciences at the University of Oklahoma," Sponsored by National Science Foundation, Federal. (September 1, 2021 - August 31, 2023).

Krumholz, Lee R., Callaghan, Amy V., Madden, Andrew S., Sankaranarayanan, Krithivasan, "RII Track-2 FEC: Building Genome-to-Phenome Infrastructure for Regulating Methane in Deep and Extreme Environments (BuG ReMeDEE)," Sponsored by South Dakota School of Mines and Technology, $1,414,387.00. (August 1, 2017 - July 31, 2021).

Teaching
GEOL 1114 Physical Geology
GEOL 2224 Mineral Sciences

Students Completed (Spring 2021 – Fall 2021)
Tomlinson, Zachary, M.S., "Impacts of Well Pumping on Trace Metals in the Central Oklahoma Aquifer, Norman, OK."

Wu, Tengfei, Ph.D., "Chemostratigraphy, Mineral Distributions and Water Chemistry Analysis of the Green River Formation, Piceance Basin, Northwestern Colorado."

MEGAN E. ELWOOD MADDEN
Effort Distribution: T25, R40, S35
Journal Articles
Mason, D. P., Elwood Madden, M. E. (2022). Raman Spectroscopy of High Salinity Brines and Ices. *Icarus*.

Floyd, C. D., Soreghan, G. S., Elwood Madden, M. E. (2021). Cyanobacterial weathering in warming periglacial sediments: implications for nutrient cycling and potential biosignatures. *Permafrost and Periglacial Processes*.

Phillips-Lander, C. M., Miler, J., Elwood Madden, M. E. (2021). Albite Dissolution Rates in Brine: Implications for Mars. *Icarus*.

Elwood Madden, M. E., Cullen, M., Phillips-Lander, Madden, A. S. (2021). Siderite Dissolution in Mars-Analog Brines: Kinetics and Reaction Products. *Planetary Science Journal*, 2.

Grants
Elwood Madden, Megan E, Jane, Irungu, Snyder, Lori A, Cerato, Amy, Fahes, Mashhad M, Martin, Elinor R, Soreghan, Gerilyn S, "EAGER Gold Rewards: removing barriers and supporting geoscience diversity leaders through hiring, evaluation, and award criteria and processes.," Sponsored by National Science Foundation, Federal, $299,878.00. (September 15, 2020 - August 31, 2022).

Elwood Madden, Megan E., "Characterizing the geochemical formation conditions of jarosite and alunite outcrops on Mars in the context of lab experiments and field observations," Sponsored by SETI Institute, Non Profit. $48,684.00. (November 1, 2019 - April 30, 2022).

Soreghan, Gerilyn S, Elwood Madden, Megan E, "Quantifying Surface Area in Muds from the Antarctic Dry Valleys: Implications for Weathering in Glacial Systems," Sponsored by National Science Foundation, Federal, $351,785.00. (June 1, 2016 - May 31, 2021).

Elwood Madden, Megan E.,"PDART Step-2: Raman Spectral Database of Aqueous Solutions for Planetary Science," Sponsored by NASA - Headquarters, Federal. $380,855.00. (February 13, 2018 - February 12, 2021).

Kornelson, K. A., Snyder, L. A., Elwood Madden, M. E., "University of Oklahoma: Meaningful evaluation of effective and inclusive teaching," Sponsored by Howard Hughes Medical Institute, Non Profit. (April 1, 2021 - March 31, 2023).

Dee, K. T., Elwood Madden, M. E., Madden, A. S., "Acquisition of an ICP-OES and IC to Increase Hydrological and Geochemical Research and Education in the School of Geosciences at the University of Oklahoma," Sponsored by National Science Foundation, Federal. (September 1, 2021 - August 31, 2023).

MICHAEL H. ENGEL
Effort Distribution: T50, R30, S20
Journal Articles
Connan, J., Engel, M. H., Jackson, R. B., Priestman, S., Vosmer, T., Zumberge, A. (2021). Geochemical analysis of two samples of bitumen from jars discovered on Muhut and Masirah Islands (Oman). *Separations, 8*(182).

Alkhafaji, M., Connan, J., Engel, M. H., Al-Jubouri, S. (2021). Origin, biodegradation and water washing of bitumen from the Mishraq Sulfur Mine, northern Iraq. *Journal of Marine and Petroleum Geology, 124*(104786).

Teaching
GEOL 1104 Dynamic Earth
GEOL 3633 Introduction to Oceanography

Students Completed (Spring 2021 – Fall 2021)
Symcox, Carl, Ph.D., “Geochemistry of The Stack and Scoop Oil Plays, Anadarko Basin, Oklahoma.”

CAITLIN HODGES
Effort Distribution: T40, R40, S20
Manuscript
Hodges, C. A., Brantley, S. L., Sharifironizi, M., Forsythe, B., Tang, Q., Carpenter, N., Kaye, J. (2021). Soil carbon dioxide flux partitioning in a calcareous watershed with agricultural impacts (vol. 126). *Journal of Geophysical Research: Biogeosciences* 10.1029/2021JG006379.

Grants
Hodges, C. A., "Quantifying the Mechanisms and Biogeochemical Impact of Anaerobic Microsites in Upland Soils," Sponsored by U.S. Dept. of Agriculture, National Institute of Food and Agriculture, Federal. (September 1, 2021 - May 31, 2023).

Teaching
GEOL 5970 Biogeochem of Critical Zone

JUNLE JIANG
Effort Distribution: T40, R40, S20
Journal Articles
Jiang, J., Bock, Y., Klein, E. (2021). Coevolving early afterslip and aftershock signatures of a San Andreas fault rupture. *Science Advances*, 7(15).

Jiang, J., Lohman, R. B. (2021). Coherence-guided InSAR deformation analysis in the presence of ongoing land surface changes in the Imperial Valley, California. *Remote Sensing of Environment*, 253, 112160.

Grants
Jiang, J., "Advancing Simulations of Sequences of Earthquakes and Aseismic Slip (SEAS)," Sponsored by Southern California Earthquake Center & National Science Foundation, Federal, $20,000. (February 1, 2020 - January 31, 2021).

Jiang, J., "Advancing Simulations of Sequences of Earthquakes and Aseismic Slip (SEAS)," Sponsored by Southern California Earthquake Center & National Science Foundation, Federal, $26,700. (February 1, 2021 - January 31, 2022).

Jiang, J., "Distinguishing between tectonic and anthropogenic processes in the Salton Sea Geothermal Field," Sponsored by Southern California Earthquake Center & National Science Foundation, Federal, $27,000. (February 1, 2020 - January 31, 2022).

Teaching
GPHY 4970/5970 Remote Sensing Crustal Geophysics
GPHY 5020 Computational Geophysics

XIAOLEI LIU
Effort Distribution: T40, R40, S20
Grants
Liu, X., "Collaborative Research: Tackling the paleoaltimetry in the arid continental interior with molecular biomarkers and testing the punctuated uplift of Tibetan Plateau," Sponsored by Louisiana State University, University, $51,977. (August 1, 2020 - July 31, 2023).

Liu, Xiaolei, "The isotope composition of complete archaeal tetraethers analyzed separately in parallel and antiparallel glycerol configurations: a potential approach to disentangle signals of heterogeneous sources," Sponsored by American Chemical Society, Petroleum Research Fund, Non Profit, $110,000.00. (January 1, 2020 - August 31, 2022).

Nanny, M., and 14 others, "NSF-MRI: Acquisition of an Inductively Coupled Plasma Mass Spectrometer (ICP-MS) System to Enable Elemental Analysis in Research, Training and Education," National Science Foundation, $396,778.00. (August 15, 2018 - July 31, 2021).

Teaching
GEOL 1114 Physical Geology
GEOL 6103 Petroleum Geochemistry

Students Complete (Spring 2021 – Fall 2021)
Connock, Greg, Ph.D., “Novel Biomarker Application Reveals the Microbial Ecological Dynamics Surrounding Oceanic Anoxic Event Ii (Oae-2).”

Parks, Derek, M.S., “Application of A Novel LCMS Method to Analyze Polar Biomarkers of the Woodford Shale, Wyche Farm Shale Pit, Oklahoma.”

RICHARD A. LUPIA
Effort Distribution: T40, R40, S20
(split appointment w/museum)
Book Chapter
Lupia, R. A., Wyckoff, D. G., Benefield, P. (2021). Low magnification examination of experimentally heated Frisco chert flakes: light microscopy versus scanning electron microscopy. *The Calf Creek Horizon: A Mid-Holocene Hunter-Gatherer Adaptation in the Central and Southern Plains of North America*. Texas: Texas A&M University Press.

Journal Articles
Richmond, D., Pigott, J. D., Lupia, R. A., Behm, M., Hein, D. (2021). Carbonate mound springs of the Upper Jurassic Morrison Formation of central Montana and the paleoclimatic significance for the northern foreland basin. *Geology of the Intermountain West, 8*, 1-26

Grants
Lupia, Richard A., Cifelli, Richard L., "Collaborative Research: Time of Transformation: integrating the dynamic biotic, geologic, and climate systems of North America during the Early to Late Cretaceous transition," Sponsored by National Science Foundation, Federal. (August 15, 2019 - July 31, 2024). $406,609

Landis, Margaret, Lupia, Richard A., "Digitization TCN: Collaborative Research: The Pteridological Collections Consortium: An integrative approach to pteridophyte diversity over the last 420 million," Sponsored by Yale University, University. (August 1, 2018 - July 31, 2021). $38,937

Teaching
GEOL 3513 Invertebrate Paleontology
GEOL 5413 Paleobotany

KURT J. MARFURT
Research Professor
Journal Articles
Mora Ortiz, J. P., Bedle, H., Marfurt, K. J. (2021). Fault enhancement using probabilistic neural networks and Laplacian of a Gaussian filter: a case study in the Great South Basin, New Zealand. *Interpretation*, 1-50. 10.1190/int-2021-0127.1. http://dx.doi.org/10.1190/int-2021-0127.1

Clairmont, R., Bedle, H., Marfurt, K. J., Wang, Y. (2021). Seismic Attribute Analyses and Attenuation Applications for Detecting Gas Hydrate Presence. *Geosciences, 11*(11), 450. 10.3390/geosciences111110450. http://dx.doi.org/10.3390/geosciences11110450

Dewett, D. T., Pigott, J. D., Marfurt, K. J. (2021). A review of seismic attribute taxonomies, discussion of their historical use, and presentation of a seismic attribute communication framework using data analysis concepts. *Interpretation, 9*(3).

Karam, P., Mitra, S., Marfurt, K. J., Carpenter, B. M. (2021). Synthetic transfer zone characterization using seismic attributes, Taranaki Basin, New Zealand. *Interpretation*. 10.1190/int-2020-0138.1.

Hardisty, L., Pranter, M. J., Devegowda, D., Marfurt, K. J., Sondergeld, C. H., Rai, C. S., Gupta, I., Han, H., Dang, S., McLain, C., Larese, R. (2021). Stratigraphic variability of Mississippian Meramec chemofacies and petrophysical properties using machine learning and geostatistical modeling, STACK trend, Anadarko Basin, Oklahoma. *Interpretation*.

Lubo-Robles, D., Ha, Laksmivarahan, S., Marfurt, K. J., Pranter, M. J. (2021). Exhaustive Probabilistic Neural Network for attribute selection and supervised seismic facies classification. *Interpretation*.

Students Completed (Spring 2021 – Fall 2021)
Ha, Thang, Ph.D., "Seismic Data Conditioning, Attribute Analysis, and Machine-Learning Facies Classification: Applications to Texas Panhandle, Australia, New Zealand, and Gulf of Mexico."

Sinha, Saurabh, Ph.D., "Statistical and Deep Learning Methods for Geoscience Problems."

SHANKAR MITRA
Effort Distribution: T40, R40, S20
Karam, P., Mitra, S., Marfurt, K. J., Carpenter, B. M. (2021). Synthetic transfer zone characterization using seismic attributes, Taranaki Basin, New Zealand. *Interpretation*. 10.1190/int-2020-0138.1.

JOHN D. PIGOTT
Effort Distribution: T40, R40, S20
Journal Articles
Abdel-Fattah, M. I., Mahdi, A. Q., Theyab, M. A., Pigott, J. D., Abd-Allah, Z. M., Radwan, A. E. (2021). Lithofacies classification and sequence stratigraphic description as a guide for the prediction and distribution of carbonate reservoir quality: A case study of the Upper Cretaceous Khasib Formation (East Baghdad oilfield, central Iraq). *Journal of Petroleum Science and Engineering, 209*.

Buist, C., Bedle, H., Rine, M., Pigott, J. D. (2021). Enhancing Paleoreef Reservoir Characterization through Machine Learning and Multi-Attribute Seismic Analysis: Silurian Reef Examples from the Michigan Basin. *Geosciences, 11*(3), 142. 10.3390/geosciences11030142.

Dewett, D. T., Pigott, J. D., Marfurt, K. J. (2021). A review of seismic attribute taxonomies, discussion of their historical use, and presentation of a seismic attribute communication framework using data analysis concepts. *Interpretation, 9*(3).

Richmond, D., Pigott, J. D., Lupia, R. A., Behm, M., Hein, D. (2021). Carbonate mound springs of the Upper Jurassic Morrison Formation of central Montana and the paleoclimatic significance for the northern foreland basin. *Geology of the Intermountain West, 8*, 1-26.

Caf, A. B., Pigott, J. D. (2021). Dolomitization geometry and reservoir quality from supervised Bayesian classification and probabilistic neural networks: Midland Basin Leonardian Wichita and Clear Fork Formations. *Interpretation, 9*.

Teaching
GEOL 1114 Physical Geology

Students Completed (Spring 2021 – Fall 2021)
Broaddus, Carson, M.S., "Global Reconnaissance of Reef Spur and Groove Variability: A Systematic Geomoporhic Classification."

Crandall, Kurt, M.S., "Photogrammetric Sand Grainsize Analysis of a Circumnavigational Sampling of Beaches of the Big Island of Hawaii: Possible Insight into Controlling Processes and Provenance."

Dewett, Dustin, Ph.D., "Taxonomic Classification for Pragmatic Machine Learning Application?"

Renner, Jordan, M.S., "Data-Driven Analysis of Horizontal Well Performance in the Anadarko Basin Using Digital Well Log Clustering Techniques and Sequence Stratigraphy."

MATTHEW J. PRANTER
Effort Distribution: T40, R40, S20
Journal Articles
Duarte, D., Benmadi, M., Elmore, R. D., Pranter, M. J., Slatt, R. M. (2021). Diagenetic controls on reservoir quality of a mixed carbonate-siliciclastic system: Sycamore Formation, Sho-Vel-Tum Field, Oklahoma, USA. *Marine and Petroleum Geology*.

Drummond, K., Pranter, M. J., Grammer, G. M. (2021). Regional stratigraphy and proximal-todistal variation of lithology and porosity within a mixed carbonate-siliciclastic system, Mississippian strata of northern and central Oklahoma. *Interpretation*.

Suriamin, F., Pranter, M. J. (2021). Lithofacies, depositional, and diagenetic controls on the reservoir quality of the Mississippian mixed siliciclastic-carbonate system, eastern Anadarko Basin, Oklahoma, USA. *Interpretation*.

Hardisty, L., Pranter, M. J., Devegowda, D., Marfurt, K. J., Sondergeld, C. H., Rai, C. S., Gupta, I., Han, H., Dang, S., McLain, C., Larese, R. (2021). Stratigraphic variability of Mississippian Meramec chemofacies and petrophysical properties using machine learning and geostatistical modeling, STACK trend, Anadarko Basin, Oklahoma. *Interpretation*.

Lubo-Robles, D., Ha, Laksmivarahan, S., Marfurt, K. J., Pranter, M. J. (2021). Exhaustive Probabilistic Neural Network for attribute selection and supervised seismic facies classification. *Interpretation*.

Miller, M., Pranter, M. J., Devegowda, D., Gupta, I., Marfurt, K. J., Sondergeld, C. H., Rai, C. S., McLain, C., Larese, R., Packwood, J. (2021). Mississippian Meramec lithologies and petrophysical property variability, stack trend, Anadarko Basin, Oklahoma. *Interpretation: Special Issue on STACK Play, Oklahoma*.

Tellez, J., Pranter, M. J., Sondergeld, C. H., Rai, C. S., Fu, J., Han, H., Dang, S., McLain, C. (2021). Mechanical stratigraphy of Mississippian strata using machine learning and seismic-based reservoir characterization and modeling, Anadarko Basin, Oklahoma. *Interpretation: Special Issue on STACK Play, Oklahoma*.

Teaching
GPHY 3423 Intro to Petroleum Geology/Geophysics
GEOL 4133 Petroleum Geology
GEOL 4233 Subsurface Methods
GEOL 6970 Advanced Surface Methods
GEOL 6970 Reservoir Characterization Field Seminar
GEOL/GPHY Machine Learning in Geosciences

Students Completed (Spring 2021 – Fall 2021)
Duarte, David, Ph.D., "Stratigraphic and Diagenetic Controls on Petrofacies and Reservoir-Quality Variability Using Semi-Supervised and Supervised Machine Learning Methods: Sycamore Formation, Sho-Vel-Tum Field, Oklahoma, USA."

Morgan, Hannah, M.S., "Sedimentology, Chemofacies, and Stratigraphic Architecture of the Lower Cretaceous Burro Canyon Formation, Ninemile Hill, Unaweep Canyon, Colorado."

Tellez, Javier, Ph.D., "Integrated Characterization of Tight Siliciclastic Reservoirs: Examples from the Cretaceous Burro Canyon Formation, Colorado, and Mississippian Meramec Strata, Oklahoma."

ZEEV RECHES
Professor Emeritus
Grants
Carpenter, Brett M, Reches, Zeev, "Geotrib: A Tribological Facility for The Analyses of Friction, Wear, and Lubrication of Geo-Systems," Sponsored by National Science Foundation, Federal, $302,315.00. (August 1, 2020 – July 31, 2022).

Reches, Zeev, "Rock Mechanics of Reservoir Rocks," Sponsored by China University of Petroleum, Industry, $33,696.00. (March 1, 2020 – March 9, 2022).

SINA SANEIYAN
Effort Distribution: T40, R40, S20
Journal Articles
Saneiyan, S., Slater, L. D. (2021). Complex conductivity signatures of compressive deformation and shear failure in soils. Engineering Geology, 291(May), 106219.

Saneiyan, S., Ntarlagiannis, D., Colwell, F. (2021). Complex conductivity signatures of microbial induced calcite precipitation, field and laboratory scales. Geophysical Journal International, 224(3), 1811–1824.

Teaching
GEOL 1114 Physical Geology

GERILYN S. SOREGHAN
Effort Distribution: T20, R30, S50
Journal Articles
Pfeifer, L. S., Birkett, B. A., Van Den Driessche, J., Pochat, S., Soreghan, G. S. (2021). Ice-crystal traces imply ephemeral freezing in early Permian equatorial Pangea. *Geology, 49*, 1397-1401. 10.1130/G49011.1.

Pfeifer, L. S., Soreghan, G. S., Pochat, S., Van Den Dreissche, J. (2021). Loess in eastern equatorial Pangea archives a dusty atmosphere and possible upland glaciation. *Geological Society of America Bulletin, 133*(1/2), 379-392. 10.1130/B35590.1.

Patterson, A., Behm, M., Chwatal, W., Flores-Orozco, A., Wang, Y., Soreghan, G. S. (2021). Seismic Reflection and Electrical Resistivity Imaging Support Pre-Quaternary Glaciation in the Rocky Mountains (Unaweep Canyon, Colorado). *Geophysical Research Letters, 48*, e2021GL094706. 10.1029/2021GL094706.

Floyd, C. D., Soreghan, G. S., Elwood Madden, M. E. (2021). Cyanobacterial weathering in warming periglacial sediments: implications for nutrient cycling and potential biosignatures. *Permafrost and Periglacial Processes*.

Grants
Elwood Madden, Megan E, Jane, Irungu, Snyder, Lori A, Cerato, Amy, Fahs, Machhad M, Martin, Elinor R, Soreghan, Gerilyn S, "EAGER Gold Rewards: removing barriers and supporting geoscience diversity leaders through hiring, evaluation, and award criteria and processes.," Sponsored by National Science Foundation, Federal, $299,878.00. (September 15, 2020 – August 31, 2022).

Soreghan, Gerilyn S., Behm, Michael, Dulin, Shannon A., "COLLABORATIVE RESEARCH: Equatorial Glaciation and Landscape Burial in the Late Paleozoic: Implications for Pangaean Climate and Tectonics," Sponsored by National Science Foundation, Federal, $449,032.00. (September 1, 2019 – August 31, 2023).

Soreghan, Gerilyn S, Elwood Madden, Megan E, "Quantifying Surface Area in Muds from the Antarctic Dry Valleys: Implications for Weathering in Glacial Systems," Sponsored by National Science Foundation, Federal, $351,785.00. (June 1, 2016 – May 31, 2022).

Soreghan, Gerilyn S., Soreghan, Michael J., "IRES: Landscapes of Deep Time in the Red Earth of France: Research Training in Paleoclimate," Sponsored by National Science Foundation, Federal, $249,953.00. (September 1, 2017 – August 31, 2022).

Soreghan, G. S., Feille, K. K., "Collaborative Research: Probing Causal Links Among Volcanism, Dust, and Carbon Burial in the Permian - a Harbinger of the Future?," Sponsored by National Science Foundation, Federal, $363,742. (September 1, 2021 - August 31, 2024).

Teaching
GEOL 1114 Physical Geology
GEOL 4113/5113 Depositional Systems and Stratigraphy

Students Completed (Spring 2021 – Fall 2021)
Kelly, Patrick, M.S., "Giant Grains in the Akiyoshi Limestone: A Record of Atmospheric Circulation Over the Panthalassic Ocean."

MICHAEL J. SOREGHAN
Effort Distribution: T40, R40, S20
Journal Articles
Kolawole, F., Firkin, M., Thuwaiba, A. W., Atekwana, E., Soreghan, M. J. (2021). Rift Transfer Zones and the Stages of Rift Linkage in Active Segmented Continental Rift Systems. *Basin Research, 33*, 2984-3020.

McGlue, M., Yeager, K., Soreghan, M. J., Behm, M., Kimirei, I., Cohen, A., Apse, C., Limbu, P., Smiley, R., Doering, D., Lucas, J., Mbonde, A., McIntyre, P. (2021). Spatial variability in nearshore sediment pollution in Lake Tanganyika (East Africa) and implications for fisheries conservation. *Anthropocene, 33*, 100281. doi.org/10.1016/j.ancene.2021.100281.

Ivory, S., McGlue, M., Peterman, C., Baldwin, P., Lucas, J., Cohen, A., Russell, J., Saroni, J., Msaky, E., Kimirei, I., Soreghan, M. J. (2021). Climate, vegetation, and weathering across space and time in Lake Tanganyika (tropical eastern Africa). *Quaternary Science Advances, 3*. doi.org/10.1016/j.qsa.2021.100023.

Grants
Soreghan, Gerilyn S., Soreghan, Michael J., "IRES: Landscapes of Deep Time in the Red Earth of France: Research Training in Paleoclimate," Sponsored by National Science Foundation, Federal, $249,953.00. (September 1, 2017 - August 31, 2020).

Teaching
HON 2973 DeepTime: Earth's Diary
HON 2973 Climate Change Literacy
HON 3993 The Earth System
HON 3993 Oklahoma Natural Resources
GEOL 1124 Dynamic Earth
GEOL 3013 Geology of Oklahoma

Students Completed (Spring 2021 – Fall 2021)
Jesus, Dalia, M.S., "U/Pb Detrital Zircon Provenance of Mid-Pennsylvanian Sediments Into The Anadarko Basin: Implications For Paleogeography And Sequence Stratigraphy."

Barry L. Weaver
Effort Distribution: T60, R20, S20
Teaching
GEOL 1003 Volcanoes and Earthquakes
GEOL 3223 Igneous/Metamorphic Petrology

STEPHEN R. WESTROP
Effort Distribution: T40, R30, S30
(split appointment w/museum)
Grants
Westrop, Stephen R., "Digitization PEN: Expanding and enhancing a TCN digitizing fossils to reconstruct evolving ecosystems the Cretaceous Western Interior Seaway," Sponsored by National Science Foundation, Federal, $102,369.00. (September 1, 2017 - August 31, 2020).

Teaching
GEOL 1024 History of Earth and Life

SUPPORT GEOSCIENCES

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Field Trips

Enrichment field trips provide our students the opportunity to gain hands-on training in the field throughout their educational experiences.

Bartell Field Camp

Our field camp is located in Cañon City, Colorado. The required six-week course teaches students about the history of the Rocky Mountains and Western United States through field work, applying what they have learned in previous courses.

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