UNIVERSITY OF OKLAHOMA
SCHOOL OF GEOSCIENCES

EARTH SCIENTIST

VOL. 42 | SUMMER 2018 - SUMMER 2019

ABOUT THIS ISSUE

Editor-In-Chief: Lynn Soreghan
Design: Ashley Tullius
Contributors: Geosciences Faculty, Students and Alumni

On the cover: Mareta West '37 Geology Grad
Photo Credit: Kappa Kappa Gamma

CONTACT US:
School of Geosciences
100 E. Boyd St., Room 710
Norman, OK 73019-1007

PHONE: (405) 325-3253
EMAIL: geology@ou.edu

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 Thus, accounting for the rare exceptions of years unpublished, we are now on volume 42 of the alumni magazine.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.

Earth Scientist is published annually, reporting on research, activities and programs associated with the University of Oklahoma School of Geosciences. It is prepared and distributed with private funds at no cost to the taxpayers of the State of Oklahoma.

CONTENTS

WELCOMES FROM

THE DIRECTOR 1
THE DEAN 2
THE AAC CHAIR 3

PEOPLE

FACULTY 5
STAFF 8
STUDENT ORGS 10

AWARDS

CP RESEARCH SYMPOSIUM 14
EXPO 15
STUDENT AWARDS 16

HIGHLIGHTS

FIELD CAMP 24
FIELD TRIPS AND RESEARCH 27

ALUMNI

NEWS 52
MEMORIALS 53

LETTER FROM THE DIRECTOR

In last year's Earth Scientist, I introduced myself. Now I want to introduce the future. Say hello to OU's School of Geosciences.

The Big Picture: We want OU to climb the national rankings. This is a consensus goal of the faculty, the dean and the administration, and there are particular ways to get there. In general, the path lies through research. Research leading to publications in top scientific journals is the most direct way to showcase our research and introduce us to the world beyond our campus. Research output also constitutes our gift to society, because all scientific research proceeds at an expense to others — taxpayers, industry, private donors, and scientific societies. In essence, publication forms the return-on-investment to those who have entrusted us with their support.

That said, our primary commitment is to our students, who — if we've done our jobs well— also form our essential gifts to society. If we succeed in educating students who understand the Earth system, and the importance of the planet for both providing essential resources, and sustaining life, we will have achieved our loftiest goals.

The motivating factor for us to continue as faculty is not monetary gain (stifle shocked gasps). We work in a university setting because we have a passion for both the science and the students. This is the intangible that keeps us going, even when we invariably grumble about students. Student interaction— teaching, mentoring, and the potential to make a positive difference in the world and in a life.

We cannot be successful unless our students are successful, which means we are both retaining old traditions and beginning new ones, to expose our students to as many opportunities as possible, and enabling chances for enrichment on professional and personal fronts. In this past academic year, we retained and successfully executed well-established activities such as the spring Student Expo and Research Symposium. The former attracted ~80 students from 21 schools representing 14 states, from Arizona to New York, and Mississippi to Michigan. About half presented posters, and many participated in one of the 5 short courses offered, taught by Drs. Matt Pranter, Michael Behm, Kurt Marfurt and (outside visitors) Suzanne Kairo and Art Saller. Subsequently, we conducted our own students' Research Symposium (sponsored by ConocoPhillips), in coordination with our spring AAC, to enable alumni to mingle with students and faculty.

New initiatives include our "Life After Grad School" colloquia, where students hear from recent graduates (from OU or elsewhere) on diverse geoscience career paths, our student "Lightning Talks" series in which graduate students present five-minute "elevator talks" on their research, and our "Tuesday Schmoozeday" social— a 30-minute coffee/tea where students can mix informally with faculty and staff. We continue initiatives such as generous scholarships and free tutoring for our undergraduate majors, and our First-Year fieldtrip intended to build camaraderie and bonding amongst our new undergraduates. The success of these programs have spawned new efforts to boost our graduate program, including a "Topics in Geosciences" seminar for all incoming graduate students, a new-graduate-student field trip and a student council that focuses on topics of concern, such as time-management, adviser-advisee interactions and how to survive graduate school.

We value our alumni, and I feel fortunate to have worked with Andrew Cullen as AAC Chair during my first year as Director, and now Raleigh Blumstein as incoming chair. Andrew and Raleigh have brought substantial positive energy to the AAC, and I greatly enjoy brainstorming ways to make OU a top geoscience school. One of our newest joint initiatives involves student mentoring by alumni, so if you wish to be involved, please contact us. In particular, if you know of opportunities — internships, paid or unpaid, jobs, etc., that our students could investigate, please email me (lsoreg@ou.edu).

Our faculty now include seven assistant professors, who have infused the School with a new level of energy. Our latest additions— Dr. Heather Bedle (Exploration Geophysics) and Dr. Kato Dee (Hydrogeology) are enthusiastic, energetic and already greatly valued by students and faculty.

The pages to follow showcase some of the awards, accolades and interesting activities of the year, as a result of great student and faculty efforts. To highlight just a few examples, our IBA team Andrew Layden, David Lubo-Robles, Matthew Lynch, Hannah Morgan and Cody Totten (mentored by John Pigott, aided by Bob Davis) won the Mid-continent Division, and went on to secure third place worldwide (of ~120 teams). Students from SEG student chapter (Julian Chenin and Karelia La Marca, mentored by Heather Bedle) won second place at the Gulf Coast Regional Challenge Bowl. The AAPG student group won outstanding domestic chapter. Pick and Hammer reached over 2,200 K-12 students as part of their outreach efforts. Dr. Brett Carpenter won AAPG's Inspirational Geoscience Educator award, Dr. Megan Elwood Madden shared a stage with Bill Nye (yes— The Science Guy!) and Dr. Shannon Dulin continues her outreach to thousands of listeners via her weekly "Don't Panic Geocast" podcast.

The faculty have banded together in several ways to further strengthen our School. Drs. Shannon Dulin and Andy Elwood Madden, on behalf of the faculty, successfully applied for and hosted a two-day National Association of Geoscience Teachers (NAGT) workshop focused on Building Strong Geoscience Departments. We have a committed and engaged faculty cohort, and we look forward to elevating OU's School of Geosciences on the national and international stage. Please be involved as we educate the geoscientists of the future.

-Dr. Lynn Soreghan
Director, School of Geosciences

LETTER FROM THE DEAN

J. Mike Stice

The University of Oklahoma and the Mewbourne College of Earth and Energy are proud of the many accomplishments of the School of Geociences throughout the past year. The school has been, and continues to be, a leader in a number of key areas across the industry. In addition to its reputation in the industry, the school is a campus role model for service, teaching, research and delivering a high-quality general education in geology and geophysics. At the university level, I am excited about the new leadership. Interim President Harroz assumed his new role following through on President Gallogly, bringing a much needed focus on research, graduate education and faculty support. I am equally excited about our new Director, Lynn Soreghan. Lynn has made a commitment to increasing our ranking from 54th to a top 25 School of Geosciences.

RESEARCH
Interim President Harroz has stated his plans to expand our research efforts at the university. This focus on new ideas and the capturing of additional research funding in specific focus areas such as energy research should be well-received. At the college level, we have committed to doubling research expenditures by 2025.

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
President Gallogly delivered on his promise with the first faculty pay raise in over 20 years. Following suit, Interim President Harroz has commited to pay competitive salaries coupled with a performance-based bonus structure to attract and retain the highest-quality faculty. The recently approved budget included another faculty raise for the upcoming fiscal year. All of these initiatives will strengthen the university, the college and the school. I personally want to express my full support for Interim President Harroz and 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.

LETTER FROM THE AAC CHAIR

Dear Alumni, Faculty, and Students,

As the incoming Alumni Advisory Council (AAC) Chair, I would like to start by thanking Andrew Cullen, AAC's outgoing Chair for his strong leadership and the energy he put forth to reinvigorate the AAC over the past two years. For several years, he has worked to reengage the alumni, college, school, faculty, and students along multiple fronts. He has challenged the Dean and leveraged the strength of the AAC to support the school as state funding continues to be cut. He has challenged the alumni to embrace the broader scope of education and research the school is cultivating. Over the next few years, the Executive Council wants to continue the energy and support Andrew has promoted within the alumni base including restarting the standing committees. The Executive Council consists of myself (Chair), Nicole Fritz (Vice-Chair), Tiffany Stephens (Secretary), and Rika Burr, Jason Currie, Tyler Howe, Kirk Kolar and Tiffany Stephens (Directors).

I felt it would be good to provide an introduction of your new AAC leadership team. I have served an active role in the AAC as a general member and for the past four years as Secretary and Vice-Chair. I met my wife, Angela, while taking undergraduate geology classes. We both graduated in 2000 and 2003 with a BS in Petroleum Geology and MS in Geology, respectively. I initially worked for Baker Atlas in Houston and then moved on to Hess Corporation. We then decided it was time to move back to Oklahoma to raise our family, and I took a job with Devon Energy. At Devon Energy I have spent most of my time working the geology of the Delaware Basin. Nicole Fritz is the incoming Vice-Chair, having served the prior two years as Secretary. She has worked at Devon Energy for the past six years. Prior to that, Nicole worked at Chesapeake Energy starting in 2006. She received her B.S. in Geology from OU in 2003 and went on to complete her MS in Environmental Science from the College of Engineering in 2006 and her EMBA in 2019 from OU. She loves hiking and rock collecting with her husband and two young children. Nicole is passionate about volunteering, especially with Girl Scouts, where she is a lifetime member.

Tiffany Stephens is the incoming Secretary and will serve a two-year term. She has a J.D. in Law, as well as her B.S. and M.S. in Geology from OU. She was certified with the Oklahoma Bar Association and has 13 years of experience in the oil and gas industry. She co-authored three publications before completing her thesis in paleontology. Work experience includes research with the Sam Noble Museum of Natural History; management of the Oklahoma lease process and title work for Vernon L. Smith and Associates; and geological and legal work in the energy industry for Pioneer Natural Resources Inc., Chaparral Energy LLC, Arnold Oil Properties LLC, Black Crown Energy LLC, and Duncan Oil Properties Inc., where she is currently the Exploration Manager.

As the incoming Chair of the AAC, I look forward to serving the council and supporting the school as fully as possible. As a first step, we are looking to grow our alumni involvement with the school and students. Reconnecting to as many alumni as possible is critical to the long-term sustainability of the AAC. Again, this can only be achieved when you take the first step by providing your contact information.

As such, I would like to encourage all alumni to go to the alumni page on the School of Geosciences website (http://www.ou.edu/mcee/geosciences/people/alumni) and provide updated contact information to both the school and the AAC. Alternatively, you can provide your contact information directly to the AAC by emailing me (rdblumstein@gmail.com), Nicole Fritz (Nicole.fritz@dvn.com), or Tiffany Stephens (Tstephens@wdoil.com). Please check out our newly established AAC LinkedIn group by searching for "University of Oklahoma School of Geosciences Alumni Advisory Council" or by going to the alumni page on the School's website and clicking on the link.

The Executive Council looks forward to serving the AAC and supporting the school, faculty and students.

Cheers,

Raleigh Blumstein
AAC Chair,
Fall 2019 - Spring 2021

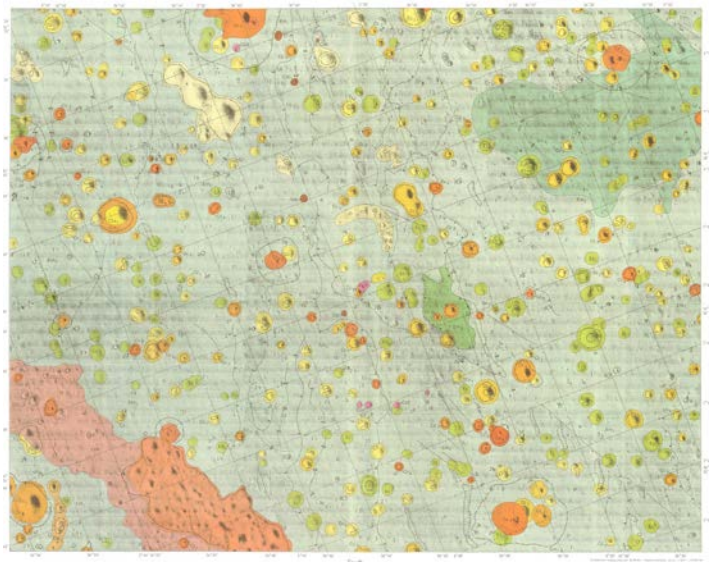
MARETA WEST - THE LUNAR MAPPER

DR. MEGAN ELWOOD MADDEN

Fifty years ago this summer, Neil Armstrong and Buzz Aldrin were the first humans to do field work on another planetary body. For a couple of pilots, they did a pretty good job collecting field samples. They and the subsequent Apollo astronauts, including Jack Schmidt (the first, and so far only, trained geologist to visit another planetary body) collected rocks, regolith and dust that have not only shaped our understanding of the Moon, but also solar system chemistry, impacts and other space weathering processes, Hadean Earth history, and terrestrial planet formation and differentiation.

However, as any good geoscientist knows, the success of your field campaign depends largely on the preliminary research necessary to choose an appropriate field site; success in terms of both scientific impact and safety. So, who pored over the images of the moon, analyzed the surface features, and chose an appropriate first landing site for both science and safety? An OU-trained geologist, of course! Mareta West (1915-1998), graduated from the University of Oklahoma with a geology degree in 1937. She grew up in Tulsa and Oklahoma City, and after studying at OU returned to OKC to work in oil and gas for over a decade. She joined the USGS in 1964 as one of the world's first planetary geologists in the the Flagstaff office. There she examined images of the surface of the moon taken during previous Apollo mission orbits to identify promising landing sites and chose the Sea of Tranquility. Once the Apollo 11 astronauts landed, she was also the first to figure out where they were located on the previous orbital images, placing them with the broader context of lunar geology. From there, the rest is history.

During her subsequent USGS career, Mareta continued to work on lunar geology and published several geologic maps of the Moon, as well as contributing to the site selection process for the additional Apollo missions. In the mid-1970's, Mareta moved on to Mars, where she used Viking images to study volcanic deposits and worked with a team of geologists to map U.S. nuclear energy plants within their broader geologic and tectonic context. She also continued her oil and gas work at the USGS, correlating the gas-rich Devonian shales in the Appalachian Basin, and eventually moved back to Oklahoma City after her retirement. Even after her death, Mareta was pushing the boundaries of human exploration. She would have been the first woman to have her ashes distributed on the moon, but sadly the SpaceX Falcon rocket exploded before it reached its lunar destination. Instead, we can honor her memory each time we look up at the Moon and think about the OU geology graduate who carefully selected humankind's first planetary field site.



GERILYN S. SOREGHAN

DIRECTOR AND EBERLY FAMILY CHAIR
DAVID L. BOREN PROFESSOR

XIAOWEI CHEN

ASSISTANT PROFESSOR

YOUNANE ABOUSLEIMAN

PROFESSOR AND
LARRY W. BRUMMETT/ ONEOK CHAIR
DIRECTOR, INTEGRATED POROMECHANICS INSTITUTE (IPMI)

KATO DEE

ASSISTANT PROFESSOR

HEATHER BEDLE

ASSISTANT PROFESSOR

SHANNON DULIN

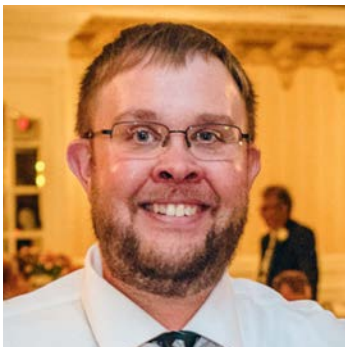
ASSISTANT PROFESSOR

MICHAEL BEHM

ASSISTANT PROFESSOR

R. DOUGLAS ELMORE

PROFESSOR AND
EDWARD MCCOLLOUGH CHAIR



BRETT M. CARPENTER

ASSISTANT PROFESSOR

ANDREW S. ELWOOD MADDEN

PROFESSOR AND
FRANK A. & HENRIETTA SCHULTZ CHAIR

GEOSCIENCES FACULTY

MEGAN E. ELWOOD MADDEN

PROFESSOR AND ROBERT E. & DORIS KLABZUBA CHAIR

KURT J. MARFURT

RESEARCH PROFESSOR

MICHAEL H. ENGEL

CLYDE BECKER CHAIR

SHANKAR MITRA

PROFESSOR AND VICTOR E. MONNETT CHAIR

XIAOLEI LIU

ASSISTANT PROFESSOR

JOHN D. PIGOTT

ASSOCIATE PROFESSOR

DAVID LONDON

JOE & ROBERT KLABZUBA CHAIR

MATTHEW J. PRANTER

PROFESSOR AND LEW AND MYRA WARD CHAIR

RICHARD LUPIA

ASSOCIATE PROFESSOR AND ASSOCIATE CURATOR, SAM NOBLE MUSEUM

ROGER M. SLATT

GUNGOLL FAMILY CHAIR
DIRECTOR, INSTITUTE FOR RESERVOIR CHARACTERIZATION

EMERITUS FACULTY

MICHAEL J. SOREGHAN
ASSOCIATE PROFESSOR

M. CHARLES GILBERT
PROFESSOR EMERITUS

BARRY L. WEAVER
ASSOCIATE PROFESSOR

CHARLES W. HARPER, JR.
PROFESSOR EMERITUS

STEVE WESTROP
ANADARKO CENTENNIAL PROFESSOR AND CURATOR, SAM NOBLE MUSEUM

G. RANDY KELLER
PROFESSOR EMERITUS

R. PAUL PHILP
PROFESSOR EMERITUS

JUDSON L. AHERN
PROFESSOR EMERITUS

ZE'EV RECHES
PROFESSOR EMERITUS

GEOSCIENCES STAFF

REBECCA FAY

ACADEMIC PROGRAMS COORDINATOR

LEAH MOSER

MANAGER OF OPERATIONS

GAIL HOLLOWAY

INSTRUCTOR AND UNDERGRADUATE RECRUITER

ASHLEY TULLIUS

COMMUNICATIONS AND EVENTS COORDINATOR

GINGER LEIVAS

FINANCIAL ASSOCIATE

ROBERT TURNER

LAB TECHNICIAN

RECOGNIZING AND HONORING OUR AMAZING STAFF IN GEOSCIENCES

DR. MEGAN ELWOOD MADDEN

Over the past year, I've had the honor of serving as chair of the Faculty Senate, representing the almost 1200 faculty on the Norman campus. I met many amazing faculty, staff, and students during my year as chair and worked on some challenging projects with university leaders, but my most meaningful experience was celebrating OU staff at the annual staff awards ceremony during Staff Appreciation week. This has been a stressful year across campus as we navigated many changes in administrative faces and policies; however, this past year was particularly stressful for the staff. Campus-wide, our staff haven't had a raise in almost five years and have dealt with several reductions in force, yet they continue to come to work and diligently support the academic mission of our University.

Our staff in the School of Geosciences are no exception and each of them is dedicated to supporting the science, education, and service missions of our School. As faculty, we could not do our jobs without the staff working both on the stage and behind the scenes to make sure that our classrooms are clean and ready for students, students are advised and enrolled in appropriate classes, our computers are networked and secure, and our graduate assistants will be paid on time, to mention just a few of the roles staff play in daily life on campus. In the School of Geosciences, our class schedules would be a mess and our students would be missing deadlines left and right without the cheerful, organized efforts of Rebecca Fay. Our vehicles and lab equipment, as well as field camp would not be maintained without Robert Turner's attention and hard work. AAC meetings, the EXPO, workshops, as well as alumni and recruiting events would never happen without Ashley Tullius's planning and expertise, in addition to her efforts supporting undergraduate and graduate students. Gail Holloway's efforts to engage students through high-quality introductory laboratory classes and the week-long Freshman Field Trip have significant positive impacts on students within our majors and across campus, and her efforts to recruit students strengthens our program. Ginger Leivas works diligently to make sure that both we and our bills are paid and key laboratory and field equipment are ordered, while also patiently walking us through each frustrating travel claim. We will certainly miss Ginny Gandy-Guedes (who recently moved to West Virginia with her wife Megan), particularly her infectious humor and caring attention for each human who walked through the door of the SGG main office. Finally, Leah Moser is the one quietly managing all these efforts, interfacing with the dean's office and other administrators across campus, providing support and information to faculty as they develop new policies and proposals, and making sure that all the pieces fit together so that the School runs smoothly.

Thank you Leah, Robert, Gail, Ashley, Ginger, and Rebecca for all that you do every day and every year to make our jobs easier. Thank you for providing the infrastructure and support we need to publish ~50 peer-reviewed articles, spend almost two million dollars on sponsored research, advise over 100 graduate students, teach more than 1600 undergrads, and engage with our community through "meteorite" identifications, workshops, school tours, and so much more each year. We couldn't do it without you!

From left to right: Ginny Gandy-Guedes, Ginger Leivas, Rebecca Fay, Gail Holloway, Leah Moser and Ashley Tullius

AAPG STUDENT CHAPTER

CARL SYMCOX, PRESIDENT

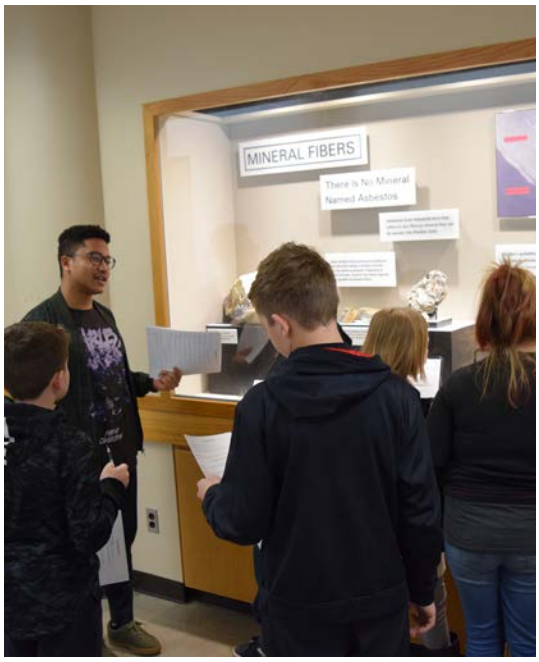
This year the OU AAPG Student Chapter continued to support its student members by striving to be the flagship student chapter in the Mid-Continent region and a premier organization across the country. In the 2018-2019 school year we started successful new programs—a Mock Interview day with oil and gas professionals cohosted with the Oklahoma City Geological Society, and a Top Golf Fundraising and Professional Networking event with the AAPG Mid-Continent YP Chapter. The organization continued with numerous educational and outreach activities, including a Rig Tour with Continental Resources, hosted numerous Lunch & Learns with SEG, and sponsored an American Red Cross blood drive. Additionally, we gained sponsorship in coordination with the Oklahoma City Geological Society to attend monthly technical talks in the city free for students. Finally, we piloted our weekly Geomixer with the help of SEG and Pick & Hammer where students, faculty, and guest speakers can mingle and network outside of the department. This has been a fantastic year for the chapter.

SEG STUDENT CHAPTER

DAVID LUBO-ROBLES, PRESIDENT

The goal this academic year was to encourage both professional and personal development for the geophysics and geology students at the University of Oklahoma. The SEG Student Chapter recruited new members, organized lunch and learns and short courses, and arranged networking events. Also, SEG partnered with AAPG Student Chapter and Pick & Hammer on several events throughout the year. SEG events included: participation in the SEG Annual Meeting in Anaheim, California; RokDoc Seismic Data Conditioning and AVO inversion Training Course; and Attribute Assisted Seismic Processing and Interpretation (AASPI) Short Course. Furthermore, the SEG Student Chapter organized several lunch and learns on Applications of Reservoir Geochemistry, Field Engineering and Hydraulic Fracturing, Hydrocarbon Effects on the Seismic Response and A Primer on AVO, Machine Learning Applications in Geoscience, Ultra-High Resolution Aeromagnetic Surveys for Drilling Hazard Avoidance and Geophysical Applications. Finally, networking events included: Top Golf Young Professionals Networking Event in fall 2018 and a weekly geo-mixer for faculty and students.

PICK & HAMMER CLUB



DANIEL MBAINAYEL, PRESIDENT

The 2018-2019 academic school year has been one of the best to date. This year Pick and Hammer organized several social and technical events, planned multiple field trips and continued a tradition of excellent community outreach.

Pick and Hammer organized 40 different social, technical and professional events this year. These events included monthly club meetings, movie nights, rock climbing, technical presentations, Eat and Meets, and many more. The Eat and Meets were started this year to help bridge the gap between students and faculty. These events gave faculty the opportunity to present their research and interact with students while exposing students to different research topics. Students were also able to learn from the technical presentations. Pick and Hammer collaborated with SEG and AAPG to host Haliburton and Noble Energy for these technical presentations. In addition to events on campus, Pick and Hammer planned off-campus activities.

This year Pick and Hammer took students to Haliburton facilities, the Chesapeake Energy campus and Turner Falls. On the Haliburton and Chesapeake trips, students were able to get a glimpse of professional life and interact with industry professionals. The Turner Falls trip was a fun excursion. These trips were not only a good break from the routine of campus life but also a good way to network and socialize. Pick and Hammer also continued the outreach program.

In the seventh year of the Haliburton K-12 Outreach program, Pick and Hammer planned and participated in 24 different outreach events. These events included school visits, interactive tours of SEC facilities, volunteering with Boy Scouts of America, Science Olympiad, Community After School Program (CASP) and many more. In addition to these events, Pick and Hammer collaborated with OGS to provide seismic workshops for teachers in Oklahoma and worked with Explorer Multimedia to record educational and interactive videos on Earth Sciences. We reached over 40 teachers and 2,300 students throughout the state of Oklahoma. All said, this has been a great year thanks to our dedicated officers, club members and support from faculty and staff!

Meet the New Faculty

DR. HEATHER BEDLE
ASSISTANT PROFESSOR

Heather Bedle received her bachelor's degree in physics from Wake Forest University in Winston-Salem, North Carolina. After spending several years as an engineer in the defense industry for Raytheon and Northrup Grumman, she decided to return to graduate school. Heather attended Northwestern University in Evanston, Illinois, and was awarded her master's and doctoral degrees based on her research primarily in seismic tomography. Following her Ph.D., Heather began working for Chevron, first in New Orleans, then in Houston. During that time, Heather worked both as a geologist - identifying prospects and drilling wells in the Gulf of Mexico, and as a geophysicist - shooting a 4D seismic survey and working as a specialist on Chevron's Rock Properties from Seismic exploration team. After almost a decade in the energy industry, Heather decided to re-enter academia. She joined the faculty at the University of Houston for two years as an Instructional Assistant Professor before starting at the University of Oklahoma in the fall of 2018.

Heather's research focuses on multidisciplinary and applied geophysical techniques with the aim of improving characterization of lithology, fluids and depositional settings of the subsurface. She and her student research group employ seismic attributes, rock physics and machine learning to better classify these systems. Current research is focused on identifying gas hydrates in regions that lack clear seismic signatures, improving techniques to discriminate under-saturated gas reservoirs, and improving workflows in seismic geomorphology.

Heather won SEG's Wiki Volunteer of the Year award last year, and is faculty advisor for OU's SEG Evolve Team and for the SEG Challenge Bowl Team. She is heavily invested in student education and outreach, and is working to incorporate new technologies such as virtual reality and cloud-based seismic analysis to improve education and research programs at OU.

Meet the New Faculty

DR. KATO TSOSIE DEE
ASSISTANT PROFESSOR

Dr. Kato Tsosie Dee joined the School of Geosciences in fall 2018 as an Assistant Professor in Hydrogeology. Prior to the University of Oklahoma, Dr. Dee was the director of the Colorado Mountain College Natural Resource Management program in Leadville, Colorado where he developed, procured funding, and implemented numerous projects related to environmental research, monitoring, reclamation, and restoration in the Central Rocky Mountains of Colorado. In addition to his academic appointment at Colorado Mountain College Dr. Dee also successfully facilitated a dynamic, collaborative watershed group in the Upper Arkansas River Watershed that addressed numerous challenges related to overall watershed health. He obtained his M.S. and B.S. in Geology from the University of Kansas and Ph.D. from the Colorado School of Mines, where his doctorate research focused on naturally occurring dissolved organic matter (DOM) variability in alpine watersheds located within mineralized zones and implications related to aquatic metal toxicity.

His current research focuses on the roles and interactions of natural organic matter with metals in natural waters that have been impacted by acid mine drainage from abandoned mines and influences on aquatic metal toxicity. In addition, Dr. Dee is also researching the significance of seasonal and climatic effects on the molecular properties of DOM that includes aromatic content. Dr. Dee utilizes spectroscopic methods that measure the absorbance, excitation, and emission properties of DOM that are indicative of their molecular composition. For example, the specific UV absorbance at the 254 nm wavelength can be related to the reactive potential (i.e. binding) of DOM. Implications of this research includes improved parameterization of DOM in geochemical models related to DOM-Metal binding interactions. Potentially, Dr. Dee's research will aid regulatory agencies who use computational approaches (i.e. Biotic Ligand Models) in establishing ambient water quality standards related to aquatic health. To support his research, Dr. Dee is in the process of establishing the Aquatic Geochemistry Laboratory in Sarkeys Energy Center that currently contains a Shimadzu TOC-L (Total Organic Carbon) analyzer, Horiba Aqualog Spectrofluorometer, several columns for the isolation of fulvic acid (a major component of DOM), and several pieces of field instrumentation. Future acquisitions will include an ICP-OES for trace metal analysis and an Ion Chromatograph (IC).

Other research interests include fate and transport of metals and hydrocarbons in groundwater, use of constructed wetlands in remediating contaminated waters, applications of environmental isotopes in groundwater, and watershed hydrology. In addition to his academic pursuits, Dr. Dee has extensive professional experience in environmental consulting, where he has participated in numerous projects related to the remediation of abandoned hard rock mines in Central Colorado, petroleum refineries, uranium mining and mill sites, and chlorinated solvent releases. More recently he assisted in characterizing extent and nature of uranium contamination in soils from abandoned uranium mines located in the Navajo Nation. He plans to leverage his professional experience in the industry to prepare future OU geoscience graduates for careers related to hydrology, environmental science and geochemistry.

Dr. Dee is excited to work with students, faculty, develop collaborations with other departments, and increase Native American student presence at OU. He has been active member of AISES (American Indian Science and Engineering Society) with plans to increase awareness of geosciences as a rewarding career for Native Americans. He strongly feels that numerous opportunities abound in geoscience for Native Americans particularly in the fields of environmental geology and natural resources.

CONOCOPHILLIPS STUDENT RESEARCH SYMPOSIUM

Every spring, the School hosts the ConocoPhillips Student Research Symposium. This is an opportunity for geoscience students at the University of Oklahoma to present their research in a poster competition. This year, 39 of our students competed in the symposium. Nine winners were recognized in the Undergraduate, Master's and Ph.D. categories. The winners are as follows:

UNDERGRADUATE

1st Place: Clayton Silver, "Seismic geomorphology of deep-water channel systems in the southern Taranaki Basin."
2nd Place: Sarah Sundberg, "Hydraulic Fracturing Induced Seismicity in the SCOOP/STACK Plays of Oklahoma."
3rd Place: Nina McCollom, "Mass Wasting Post Hurricane Maria, Puerto Rico."

MASTER'S

1st Place: Julian Chenin, "Machine Learning Multi-Attribute Analysis for Gas Hydrate Identification."
2nd Place: Dalila Jesus, "Climatic Forcings on the Deposition of Soft-Hard Bed Couplets in Black Shales: Insights from the Woodford Shale, Anadarko Basin, Oklahoma."
3rd Place: Travis Plemons, "A Fracture Characterization and Integrated Mechanical Analysis of the Upper Bone Spring Formation, Bone Canyon, Texas."

PH.D.

1st Place: Abidin Caf, "Mapping Dolomitization and Associated Reservoir Quality Using Supervised Bayesian Classification and Probabilistic Neural-Network (PNN): Leonardian Carbonates in The Midland Basin."
2nd Place: Folarin Kolawole, "Basement-Controlled Deformation of the Sedimentary Sequence in North-Central Oklahoma."
3rd Place: David Lubo-Robles, "Supervised seismic facies classification using Probabilistic Neural Networks: Which attributes should the interpreter use?"

SPRING BREAK STUDENT EXPO

In addition to the ConocoPhillips Student Research Symposium, we also hosted the Spring Break Student Expo. The Expo invites students from across the country to compete in a research poster competition, network with industry representatives, and participate in short coursers instructed by our faculty, alumni and friends.

This year 46 students participated in the poster session. Our Geosciences students swept the awards in both categories. The winners are as follows:

GEOLOGY

1st Place: Emilio Torres, "From Unconventional Reservoir Characterization, 3D Seismic multi-attribute analysis and machine learning guided geocellular modeling to Well Performance (EUR) Simulation: Woodford Shale Case Study in North of Oklahoma, USA"

2nd Place: Benmadi Milad, "Lithology, Stratigraphy, and Depositional Environment of a Complete Mississippian Sycamore Section of the I-35 Outcrop in South Central Oklahoma."

3rd Place: Carl Symcox, "Geochemistry of STACK/SCOOP Oils."

GEOPHYSICS

1st Place: Folarin Kolawole, "Faults that Cut Deep: Basement-Controlled Deformation of the Sedimentary Sequence in North-Central Oklahoma."

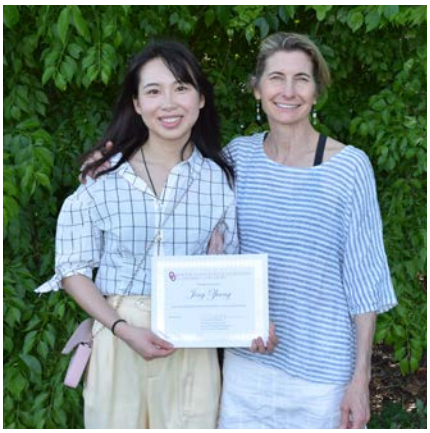
2nd Place: Abidin Caf, "Mapping Dolomitization Of Leonardian Clearfork Carbonates In The Midland Basin Using Supervised Bayesian Classification And Probabilistic Neural Network."

3rd Place: Christina Hamilton, "A Paleomagnetic and Diagenetic Study of The Kentland Impact."

SPRING AWARDS PICNIC

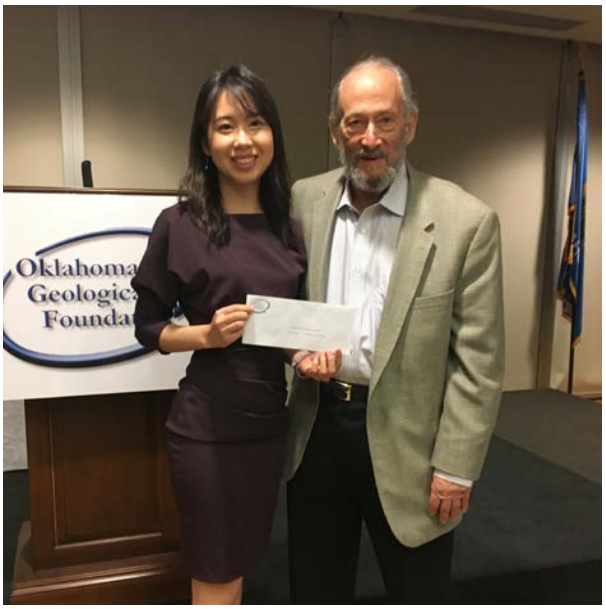
Every spring, the School of Geosciences hosts the annual Spring Awards Picnic and softball game. Students, faculty and staff enjoyed a beautiful afternoon filled with softball, barbecue and awards recognizing the achievements of our students throughout the year. This year Team Geophysics took home the softball trophy. The awards are as follows:

OUTSTANDING FRESHMAN
LOGAN DICKSON
OUTSTANDING SOPHOMORE
JOHN JOSEPH NGUYEN
OUTSTANDING JUNIOR
ZACHARY TOMLINSON
BEN HARE EXCELLENCE IN RESEARCH AWARD
TANNER SHADOAN AND JING ZHANG
STAN CUNNINGHAM EXCELLENCE IN TEACHING AWARD
FOLARIN KOLAWOLE



STUDENT HONORS AND AWARDS

- **Benmadi Milad** (spring 2018) and **Javier Tellez** (fall 2018) received the Provost Certificate of Distinction in Teaching Award
- **Dalila Jesus** was selected as the Outstanding Geoscience Student by the Tulsa Geological Society
- **Pranshu Ratre** was named a finalist in the 3-Minute Thesis competition
- The **2019 IBA Team** placed first in the Mid-Continent competition and placed third in the Worldwide competition among 124 teams.
- The **OU SEG Challenge Bowl team** took home second place at the Gulf Coast Regional SEG Challenge Bowl competition.
- The **OU AAPG Student Chapter** was recognized as an Outstanding Student Chapter at AAPG 2019.
- **Bin Lyu** and **Lennon Infante** were chosen as two of the Top 25 (out of 1,090) papers during the 2018 SEG Annual Meeting.
- **Jing Zhang** received the Suzanne Takken Memorial Grant from the Oklahoma Geological Foundation.
- **Zachary Tomlinson** was awarded the Frederick M. Black Field Camp Grant from the Oklahoma Geological Foundation.
- **Nina McCollom** was selected as the recipient of the Geological Society of Tulsa Field Camp Grant.
- **Deepankar Danwal** received the Aubra Tilley Scholarship from SEG.
- **Thomas Givens** received the Charles Gould Award honoring the Outstanding Senior in Geology.
- **Travis Vick** and **Max Firkins** received the Alan Witten Award in recognition of the Outstanding Seniors in Geophysics
- **Maxwell Mehlman** received the David Stearns Award for Outstanding Achievement.
- **Grace Barber** received the Estwing Hammer Award in recognition of her outstanding work ethic and commitment to academic excellence.



CONGRATULATIONS TO OUR 2018-2019 GRADUATES

B.S. GEOLOGY

Zhuoli Deng
Jake DuMars
Quinn Floch
Gabrielle Galvez
Eucenio Gaspar
Zhiguang Guan
Deodete Mande
Robert Mayer
Nina McCollom
Maxwell Mehlman
Courtney Milledge
Yichen Ni
Ian Smith
Siyu Wang

B.S. GEOPHYSICS

Roberto Clairmont
Max Firkins
Thomas Givens
Clayton Silver
Sarah Sundberg
Travis Vick

M.S. GEOLOGY

Tyler Bickley
Sean Blackwell
Sofia Caylor
Katherine Drummond
David Duarte
Charles Duval
Jeffrey Hardwick
Garrett Hickman
Desiree Hullaster
Calvin Layman
Ceci Lopez-Gamundi
Muizz Matemiola
Marlena McConville
Michael Miller
Travis Moreland
Sheridan Mullen
Andrew Oordt
Francis Oyebanji
Travis Plemons
Nick Rohleder
Jonathan Schwing
Cory Terrell
Luan Tran
Alexandro Vera-Aroyo

M.S. GEOPHYSICS

Ali Alshafei
Christina Hamilton
Anna Patterson
Zachary Rosson
Tanner Shadoan

PH.D. GEOLOGY

Richard Brito
Antonio Cervantes-Velazquez
Gerhard Heij
Andreina Liborius
Benmadi Milad

PH.D. GEOPHYSICS

Abdulmohsen Alali

IBA TEAM WINS THIRD PLACE IN INTERNATIONAL COMPETITION

DR. JOHN PIGOTT

Once again the University of Oklahoma's School of Geosciences has won the International Barrel Award (IBA), earning the third place Stoneley Medal out of 120 universities worldwide. This year the team members were Cody Totten, Hannah Morgan, Matthew Lynch, Andrew Layden and David Lubo-Robles led by faculty adviser Dr. John Pigott, aided by Bob Davis.

The Imperial Barrel Award was founded in 1976 by the Imperial College in London and continued until 2007 when AAPG took the Imperial Concept and expanded it to incorporate new technology, new datasets, and include students from every section and region of AAPG. Almost every country in the world has now been represented in the IBA. That first, 10 ten years ago and this year, 2019, OU won third place.

Just what is the IBA competition about? To win this global prize in petroleum exploration, university teams of five under the guidance of a faculty adviser, analyze a dataset (geology, geophysics, land, production infrastructure, and other relevant materials) in a sedimentary basin somewhere in the world. They have eight weeks to prepare for their local competition in which they then deliver their results in a 25-minute presentation to a panel of industry experts. At that time, the team must demonstrate:

- Evidence of rigorous and creative technical evaluations.
- The ability to work to a strict deadline.
- The ability to work effectively within a team.
- The ability to make decisions based on incomplete or inadequate data.
- The ability to give lucid oral presentations to a panel of senior industry experts.

If, and only if, they place first in the local competition (OU competed with seven other Mid-Continent universities in 2019), the team then must present at the national AAPG Convention and Exhibition (ACE) to a panel of International Industry judges in competition with other universities around the world.

Since 2007, OU has achieved a magnificent record of five international wins:

- 2007: third-place Stoneley Medal, Adviser Dr. Slatt
- 2008: first-place Imperial Barrel Award, Adviser Dr. Slatt
- 2013: second-place Selley Cup, Adviser Dr. Pigott
- 2014: second-place Selley Cup, Adviser Dr. Pigott
- 2019: third-place Stoneley Medal, Adviser Dr. Pigott

SEG CHALLENGE BOWL TEAM WINS SECOND

JULIAN CHENIN, M.S. STUDENT

On April 16, we had the honor to represent the University of Oklahoma's School of Geosciences at the 2019 GSH-SEG Spring Symposium: "The Resurgence of Seismic Inversion" in Houston. The event brought multiple high-profile geoscientists together to discuss the basics, recent advances and several case studies relating to seismic inversion. The event also hosted the 2019 SEG Regional Challenge Bowl competition, with the International Challenge Bowl coming this September. The Challenge Bowl is an international contest testing the depth of students' geoscience knowledge.

Six university teams from the mid-continent and the gulf coast competed against each other through several rounds of trivia questions related to the field of geology, geophysics, geography and geodesy. At the end of each round, the teams with the lowest amount of points were disqualified.

In the last round, only three teams remained: two teams from the University of Houston and one team from OU. We came close to defeating our rivals, placing second to one of the UH teams by a difference of only three points.

This was a great achievement for OU as we re-established our participation and involvement with industry organizations and societies. Furthermore, it was an enriching personal and professional experience for us as we had the opportunity to expand our geoscience knowledge and network with the high-profile geoscientists in both academia and industry. We highly encourage students to participate in future Challenge Bowls and become more involved with student activities hosted by geoscience societies. There are many learning, networking and volunteering opportunities for you and other students at OU.

DON'T PANIC GEOCAST

Drs. John Leeman and Shannon Dulin are the hosts of a weekly podcast, Don't Panic Geocast, that features discussion about the geosciences and technology, and features guests, fun paper Friday selections, and banter about recent developments in science. The podcast is released every Friday morning and is available through most podcast apps.

Leeman and Dulin are both University of Oklahoma alumni who received their undergraduate degrees in geophysics and geology, respectively. They both earned meteorology undergraduate degrees, as well. Their shared experience as double majors led them to have many discussions about the geosciences, which they turned into Don't Panic Geocast in 2014.

Their passion for education led Leeman to receive his Ph.D. from Penn State and Dulin to receive her Ph.D. from the University of Oklahoma.

When he isn't designing new instrumentation through his business, Leeman Geophysical, Leeman teaches software classes.

Dulin is an Assistant Professor of Geology and the Director of Geology at the Bartell Field Camp.

DR. SHANNON DULIN

DR. JOHN LEEMAN

DR. BRETT CARPENTER NAMED AS THE AAPG FOUNDATION'S INSPIRATIONAL GEOSCIENCE EDUCATOR AWARD RECIPIENT

Reprinted from AAPG Explorer
By Gretchen Flint

Brett Carpenter, an assistant professor in the Geology and Geophysics department at the University of Oklahoma (OU) in Norman, Oklahoma, has been named the recipient of the AAPG Foundation's 2019 Inspirational Geoscience Educator Award (IGEA).

Carpenter's research currently focuses on how fault/crustal structure and small-scale processes affect large-scale fault and crustal behavior, particularly the behavior of earth materials at shallow to central crustal conditions, where economic resources are found and where destructive earthquakes originate and propagate.

Upon notification that he had been named the 2019 IGEA recipient, Carpenter said that he was honored and grateful to the AAPG Foundation and to the group of students and colleagues who nominated him for the award.

Carpenter also recognized the "geoscience educators who inspired [him] along the way – Hobart King, Russell Dodson, Chris Marone, Cristiano Collettini, and Ze'ev Reches," who he said, "educated, challenged and inspired me throughout my academic career. They set the bar high for me and continued to move it higher as I approached it. I would not have been in a position to receive this award without them."

Carpenter grew up in the Finger Lakes region of western New York and received his bachelor's degree from Mansfield University of Pennsylvania and his master's and doctoral degrees from Pennsylvania State University. He then completed a four-year post-doctoral position at the Istituto Nazionale di Geofisica e Vulcanologia, followed by two years of additional post-doctoral research at OU.

G.S. Lynn Soreghan, department chair of OU's School of Geosciences, points out that Carpenter's "specialty of rock mechanics and seismicity, with application to petroleum geology" and "issues around induced seismicity" are an "enormous area of concern here in Oklahoma."

Furthermore, she said that Carpenter was "extremely proactive in organizing and convening international research drilling workshops aimed at planning research drilling projects to investigate induced seismicity," which were also "excellent for helping students network and become involved in research early."

Carpenter engages his classes with "design of hands-on exercises using apparatus to stimulate deformation and 3-D visualizations," she said, and often meets "personally with students to cover difficult concepts" and "provide abundant, constructive feedback on student research."

"Such attention to the educational aspects of our profession takes enormous time," Soreghan said, "but Brett is more than willing to invest that time and care. He possesses an energy and passion for geoscience and for geoscience education."

This year, Carpenter presented at the Oklahoma State University Colloquium on "Oklahoma Basement Primed for Seismic Reactivation," the American Association for the Advancement of Science's Annual Meeting on "Scientific Accomplishments at the San Andreas Fault Observatory at Depth" and was a featured guest on "Third Pod From the Sun" podcast.

In the summer, he takes the opportunity to instruct field courses and plans to co-instruct a three-week course on the geology of Italian marbles and a summer program in physical geology this year.

Folarin Kolawole, a Ph.D. graduate student at OU, said he noticed Carpenter's "passion for excellence" at their first meeting.

"He does not only impart scientific knowledge," Kolawole said, "he also tries to teach us about behavioral traits that will help us become highly effective collaborators in the work place. He genuinely cares about the success of students."

Kolawole said that having Carpenter as his professor and mentor kindled a desire to pursue an academic career in structural geology, geomechanics and geophysics.

"His warm personality, great teaching skills and genuine passion for student growth has drawn a lot of undergraduate students to our research group" and to select majoring in the geosciences, he said.

Carpenter has set high standards, not only for himself, but also for his undergraduate and graduate students to follow. He encourages his graduate students to mentor undergraduate students in their research projects. As a direct reflection of his own approach, Carpenter said of his students, "They inspire me every day."

Each year the AAPG Foundation honors a college or university professor who demonstrates professorial excellence and inspires students to study and to pursue careers in the geosciences with the IGEA and a cash prize of $6,000. Carpenter is the award's eighth recipient.

GEOLOGY FIELD CAMP

DR. SHANNON DULIN

The Bartell Field Camp Class of 2019 was the smallest yet, with 12 students. The numbers of students enrolled decreased at many field camps across the country, reflecting industry trends that started three-four years ago. The small number of students this year led to more meaningful learning interactions between the group and the instructors, plus time to do more field-tripping since 12 students can move much faster than 40! The students hit all the highlights of Cañon City Geology-Grape Creek, the Mixing Bowl and Blue Ridge, plus some new areas during the regional trip, like Dr. Dee's geohydrology field trip in Leadville and Dr. Elmore's tour of northern Colorado's structural complexities and glacial landforms. This was an unusually wet and cold year, and there were many feet of snow still on the ground in Leadville when the students were camping! Dr. Dulin gave a talk at the Cañon City Geology Club, a local geology enthusiast club that has been active for over 93 years in the area. This connected us to lots of local amateur geologists, who then took interested students on collecting trips to a local pegmatite quarry, where there were excellent graphic granites and some tourmalines for the lucky rockhounds. The class of 2019 also started a new field camp tradition, the Cairn of Completion. Erected by Ian Smith and Zac Tomlinson, the cairn post starts the new tradition of students leaving behind rocks at the end of camp. The students also composed a ceremony, which was read by Dr. Dulin as all the students placed the foundational rocks on the cairn at the end of a very successful summer field camp.

GEOPHYSICS FIELD CAMP

DR. MICHAEL BEHM

Due to a small number of applicants, it was decided to postpone the 2019 Geophysics field camp. Nonetheless, Professor Michael Behm and TA Tanner Shadoan spent five days in beautiful Cañon City, Colorado to introduce geology undergraduates to principles and practices of geophysical data acquisition, processing and interpretation. The target was the subsurface structure of the prominent hogback east of the Grape Creek fault where both seismic and electrical resistivity data were collected along a 430 m long profile.

Seismic sources included the Betsy shot gun and a sledge hammer. Thanks to the motivation of the students and luck with weather, the data acquisition run smoothly and efficiently. More than 70 shot points were collected. Data are of high quality and enable interpretation of the seismic velocity structure to maximum depths between 50 and 70 m, where shale and limestone layers can be distinguished by different P-wave velocities.

Electrical resistivity tomography (ERT) adds another layer of information and can help with subsurface interpretation. The steep dips of the two major lithologies are more apparent in the ERT image, as shale has significantly lower resistivities compared to limestone. As electrical resistivity is also sensitive to water content, we are further able to interpret significant water saturation of the limestone units.

Besides these new insights into the subsurface geology around Canon City, the main aim was of course to educate geology students about geophysics. Participants learned not only about some basics of geophysical data acquisition, but also about pitfalls in interpretation and the general ambiguity of collected field data. In accordance with the philosophy of holistic geoscience education, these Geophysics field days will contribute to a better understanding of our constraints on imaging and discussing subsurface geology.

FIRST-YEAR FIELD TRIP

BREN CABLE, UNDERGRADUTE STUDENT

After one of the most stressful weeks of the year (a.k.a. finals), I and several other geology students packed our bags for a week on the First-Year Field Trip. We did not know each other — we only knew that we were getting into these vans and heading to Colorado for a week. As first-year students, we quickly broke the ice and kindled what promised to be enduring friendships. Each day of the trip was its own adventure: we awoke early to an amazing breakfast prepared by Bob, packed our sweet sack lunches and raced to the vans. The locations we visited were incredible — in large part because we were able to view geology in the "wild" and practice identifying rocks that were not in a box in the lab. Dr. Weaver also did his best to show us a "daily dike." My favorite day of the trip was when we visited the Great Sand Dunes and Zapata Falls. Fortunately, it was not terribly windy, so we escaped the sandblasting experiences of lore. Although temperatures were high at the Dunes, they dropped perceptibly as we hiked up to Zapata Falls. As we boulder hopped up into the slot canyon, the temperature kept dropping and we finally found the source of the relief— a massive chunk of ice within the permanent shadow of the slot, gushing meltwater! I am incredibly thankful I had this opportunity to bond with classmates and experience some awesome geology. I am looking forward to getting back to classes this fall with my "Rock Squad!"

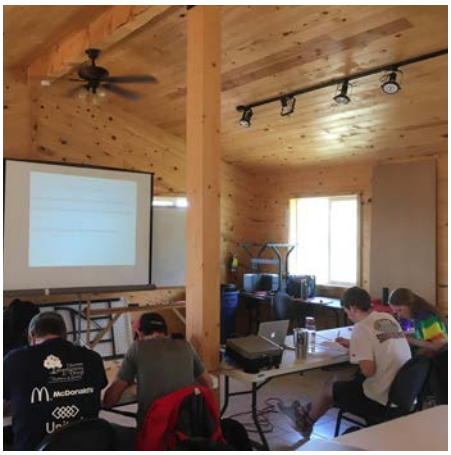
INAUGURAL INTRO TO GEOLOGY SUMMER COURSE

DR. BRETT CARPENTER

A combined course, constituted of the Dynamic Earth (GEOL 1104) and Introduction to Physical Geology (GEOL 1114), made its inaugural trip to the Bartell Field Camp. The course is designed to provide an introduction to basic Earth materials, systems and processes. It is constructed to give students a basic understanding of the Earth: its composition, landforms and dynamic processes that shape it, along with the interactions between them. Over the span of three weeks, five students completed the intense 4-credit course, with the first week spent on campus, and weeks two and three occurring at the field camp facility in Cañon City, Colorado. For comparison, one day of the course covered what students would be expected to learn in one week during a normal semester.

The group of students, with majors in construction science, criminology, environmental engineering, environmental studies, and geology were treated to the beauty of Colorado, all while learning the basics of physical geology. While in Cañon City, students used the Bartell Field Camp as a home base for lectures and lab, but traveled almost daily to geologic sites in Colorado, including Garden of the Gods, Great Sand Dunes National Park, and Florissant Fossil Beds National Monument.

When not having meals in the mess hall, students got to enjoy the "local cuisine" at the class favorites, Pizza Madness and Big Burger World. At the end of the course, students experienced the turbulent flow of the Arkansas River as it cuts down through the bedrock at its base through visits to Royal Gorge and Bighorn Sheep Canyon. With one year now in the books, the School hopes to continue offering the course in future summer sessions.



Students hard at work during lab, visiting dikes at Tunnel Drive, and challenging the Arkansas River in Bighorn Sheep Canyon

ICDP WORKSHOP: CORING THE CONTINENTAL PERMIAN

DR. LYNN SOREGHAN

In March, Lynn Soreghan hosted an International Continental Drilling Program (ICDP) workshop to investigate a potential coring program. ICDP is an international consortium that focuses on acquisition of research-based cores — essentially, the continental analog to the International Ocean Drilling Program. Acquisition of continuous cores for research lies beyond the funding capabilities of any single agency, so ICDP pools funding from member countries and hosts an annual grant competition to fund workshops and drilling projects. The scientific objectives span a wide range of Earth system investigations, from impact craters (e.g., Chicxulub), to paleoclimate (e.g., Lake Elgygytgyn), to volcanism and beyond.

The workshop attracted over 50 participants hailing from nine countries, and included a large contingent of students (from OU, elsewhere in the United States, and international). Participants spent two-and-a-half days discussing scientific and logistical issues, and one day on a field trip to view the Permian of Oklahoma (which included a daring cow rescue). All participants shared a common interest in science objectives that could be met by coring the continental Permian record primarily paleoclimate, but also auxiliary topics such as exploration of the deep microbial biosphere, and Mars-analog conditions. We discussed a dual approach consisting of a continuous core through the Permian of the Anadarko Basin, and a second site in western Europe (e.g. France), capturing both western and eastern termini of the Pangaean equator. The Permian archives Earth's penultimate icehouse collapse, as well as the assembly of Pangaea, a bizarre proliferation of redbeds, and the run-up to the largest extinction in Earth history. We hope that Oklahoma will be hosting an international project to explore these major themes in Earth history.

THE ICDP COW RESCUE

ALEX LAY, M.S. STUDENT

In March of this year, the University of Oklahoma and Dr. Lynn Soreghan hosted an International Continental Scientific Drilling Program (ICDP) workshop on "Deep Dust"—the concept of coring the continental Permian. There were attendees and presenters who were specialists in their fields from all over the globe. During the day-long field trip, the group of international geologic experts, some of whom had never been to the United States before, were treated to an experience far more Okie than anticipated. On the next-to-last stop, the group trekked over some ranchland to examine a Permian shale and dolomite outcrop but found a very sad sight amongst the rocks. A poor cow had wandered into a muddy pond at the base of the outcrop and had become stuck in the water several feet from the bank. She was stuck in all that red, clay-rich Permian mud, unable to properly move her back legs, which were splayed out behind her. The water was quite cold, and she was shivering. The group contacted the property owner and informed him of the cow's dangerous hypothermic condition, but he was a couple hours away. What had started out as a geologic trip then turned into an impromptu cow-rescue mission. Some waded out into the cold water to dig the hooves out of the mud using sticks and shovels. Others threw down rocks and branches to create a small jetty to better reach the cow. It became a total group effort of digging, pushing and linking arms to form a chain to pull her up the slippery bank. After the better part of an hour, the team had managed to drag her closer to the bank, but not all the way out. The owner was

nearly there. The muddy scientists thought they were leaving having done what they could, but when they turned around, several others hiked back from the bus to join the effort. The group resolved to give it one last go. Thankfully they stayed, because when the owner arrived with his pickup truck and rope, he was unable to navigate the rutted slope to reach the pond. Luckily there were 20-plus conference attendees willing and ready to loop this rope around the cow's belly and pull her up the bank. Everyone lined up on the rope as if they were playing tug-of-war with a giant beast (which they were). She finally came free of the mud and sat up on dry land. Everyone cheered and celebrated the successful cow rescue! The owner was very appreciative, but he was even more amazed that a random group of researchers, professors and students showed such compassion to this animal and went through such lengths to save her. This adventure certainly wasn't on the schedule, but it may very well be the unofficial highlight of the workshop.

DISSOLVED ORGANIC MATTER IN ALPINE WATERSHEDS – WHERE SNOW-PACK IS KING!

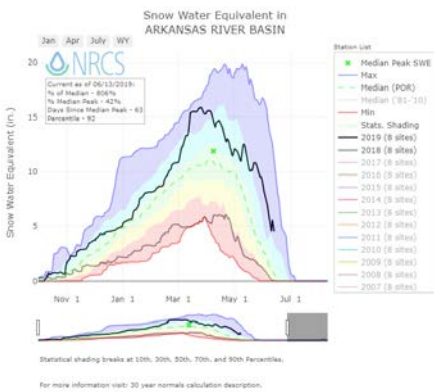
DR. KATO TSOSIE DEE

One of Dr. Dee's primary research avenues focus on the nature and distribution of organic matter in alpine watersheds in the Central Rocky Mountains in Colorado. Alpine (or mountainous) watershed hydrology is primarily controlled by seasonal snowpack coverage and melting, which results in variable hydrologic conditions from one year to the other. Along with a few graduate and undergraduate students, Dr. Dee recently completed multiple sampling events (October 2018, May 2019 and July 2019) near Leadville, Colorado, in support of his ongoing research into dissolved organic matter (DOM) within natural waters (streams and groundwater) located in alpine watersheds. One may ask why multiple sampling events throughout the year? Part of the answer can be described by comparing snow water equivalence (SWE) plots for a drought year (2018) and an unusually wet year (2019). The result is DOM from both years have very unique molecular properties that are reflective of the hydrology. One of Dr. Dee's ongoing research questions is understanding not only the climatic effects on DOM composition but the resultant reactive properties (i.e. aromatic content) related to trace metal binding, transport, and bioavailability. DOM molecular properties including aromaticity that is determined by spectroscopic methods of fluorescence and UV absorbance. The reactive properties (i.e., metal binding) of DOM can be linked to its aromatic content for which seasonal influences may likely be of significance. One of Dr. Dee's other research avenues is on DOM fractionation with Fe and Al oxyhydroxides (FeOOH and AlOOH) in waters impacted by acid mine drainage; therefore, watersheds included in this ongoing study have partially been impaired by mine drainage and contamination. DOM can be relatively dilute in natural waters (<1 to 6 mg C/L) therefore large volumes (50L) of water are needed in order to isolate and concentrate DOM for various experimentation and characterization laboratory work.

Measuring in-situ water quality in the South Fork of Lake Creek. Notice the red staining from iron oxyhydroxides!

Groundwater sampling of a well near the Arkansas River.

Through snow...and snow...field work continues on!



SNAILS AS ENVIRONMENTAL CANARIES IN LAKE TANGANYIKA

DR. MICHAEL SOREGHAN

Over the past several years, Dr. Mike Soreghan and students from OU have been collaborating with colleagues at the Universities of Kentucky and Arizona and at the British Museum to understand how environmental change is impacting habitats in Lake Tanganyika, and particularly one habitat called the "shell beds."

The shells that make up the "shell beds" come from one species of snail (Neothauma tanganyicense), which is endemic to Lake Tanganyika. The shell beds occur along several nearshore regions of the lake and consist of literally millions of shells, forming a unique substrate that hosts a number of organisms, including fish that have adapted to produce nests from the shells to lay eggs and brood young.

Over the past couple summers, the team has studied the deposits offshore of wide sandy beaches, where fishing villages have greatly expanded over the last few decades. Radiocarbon dating of individual shells in these two location suggests that the shells form two time-distinct populations—one population that peaked from 2400-1500 years ago (calBPand one that represents a population that peaked about 400 years ago with rare shells < 100 years old. OU undergraduate Bren Cable (class of 2023) has been analyzing sediment cores from offshore of the shell beds to document the nature of changes in sedimentation that correspond to these periods, and which will then help us better understand the nature of environmental change that relate to these periods of shell production and accumulation.

In addition, in the summer of 2018, Dr. Soreghan and OU undergraduate Courtney Milledge (B.S. 2019) along with a team of six others, visited a remote site along the lake shore where very little land use change has occurred to get a better understanding of the distribution and character of shell beds in a less disturbed setting, and to determine how the habitat of the live snails, which are basically absent in the other two regions, relate to the distribution of shell beds. The rarity of live snails along the more disturbed sites signal a possible conservation crisis, especially in the regions where villages have expanded, not only for the snail, but for the other organisms dependent upon the shell bed habitat.

From left: Planetary Radio host Mat Kaplan, OU astronomy professor Nate Kaib, OU geology professor Megan Elwood Madden, and Planetary Society CEO Bill

DR. MEGAN ELWOOD MADDEN TALKS SCIENCE WITH BILL NYE

DR. MEGAN ELWOOD MADDEN

Dr. Nathan Kaib from OU's Astronomy department and I hung out with Bill Nye (the Science Guy!) and Mat Kaplan from the Planetary Society on May 8 at Science Museum Oklahoma for the Planetary Society's Planetary Radio podcast. The event was organized around a new effort to renovate the Omni-Dome Theater at Science Museum Oklahoma into a world-class planetarium.

Nate and I had a blast talking about Mars, early solar system formation, brines, geochemistry and exoplanets with Bill and Mat, who are both experts in science communication and outreach. Nate and I met a few years ago when I agreed to serve on his student's Ph.D. committee. Since then, I've had the pleasure of learning more about how astronomers and physicists build computational models of the early solar system processes that lead to planet formations through collisions and accretion. During the interview, we also talked brines on Mars and how adding salt affects freezing temperatures, allowing water to remain liquid at much lower pressures and temperatures typical on the surface of Mars. We also talked about our ongoing NASA project to measure brine spectra using Raman spectroscopy in order to prepare for the next rover missions to Mars, both of which will include Raman spectrometers.

It was a pretty amazing experience, having a 30-minute conversation with Bill Nye about planetary science! Bill is very good at his job as a science communicator, identifying the parts of the science discussion that require reframing for a general audience. He provided friendly banter that guided Nate and I to use less jargon and distill the science to the core concepts that could be easily understood by the lay audience. Mat Kaplan is an excellent science communicator as well, and wove our two areas of research together into one cohesive interview. Two of my graduate students, Andrew Rodriguez, a M.S. student studying basalt weathering in Mars analog brines, and Cansu Demirel, a Ph.D. student studying how extremophiles including cynaobacteria from Antarctica that can tolerate low temperatures, high UV fluxes and high salt concentrations, can amplify chemical weathering processes, joined me at the event and it was fun to describe their work to the audience at the end. Not many graduate students can say that Bill Nye has declared their thesis research "awesome science!".

The full podcast will soon be available from Planetary Radio: http://www.planetary.org/multimedia/planetary-radio/show/

PROBING CLIMATE OF EARTH'S PENULTIMATE ICE AGE

DR. LYNN SOREGHAN

The Late Paleozoic Ice Age of 300 million years ago was Earth's penultimate "icehouse climate," and the most severe glaciation of the last half-billion years. In research published this summer (July 2019), Drs. Lynn and Mike Soreghan collaborated with climate modeler Dr. Nick Heavens (Hampton University and Space Sciences Institute) to posit that a large and sustained spike in explosive volcanism helped to condition and maintain the severe cold of the late Paleozoic icehouse. Extremely low values of atmospheric CO_2 likely caused in part by the long-term effects of land-plant evolution and erosion of Pangaean mountains, were augmented by the radiative cooling effect of stratospheric volcanic aerosols, and associated longer-term changes in ocean heat content. Atmospheric acidity caused by such sustained volcanism likely enhanced iron reactivity of aerosols (including the additional volcanic ash), fertilizing plants on land and algae in the sea and further augmenting CO_2drawdown. Once explosive volcanism began to wane, and as Pangaea aridified, the CO_2 sinks of weathering and primary production shrunk, leading to a rise in atmospheric CO_2 that ultimately precipitated Earth's only example of a transition from icehouse to greenhouse conditions on a planet with a well-developed terrestrial biosphere. As we move forward on Earth with rapidly increasing concentrations of atmospheric CO_2, stratospheric aerosol geoengineering is increasingly cited as a means to mitigate climate change. But the auxiliary effects are not fully understood, and Earth's deep time record provides cautionary tales about unanticipated effects.

The full article was published in *Geology* in July 2019. Soreghan, G.S., Soreghan, M.J., and Heavens, N.G., 2019, Explosive volcanism as a key driver of the late Paleozoic ice age: Geology, v. 47 p. 600-604.

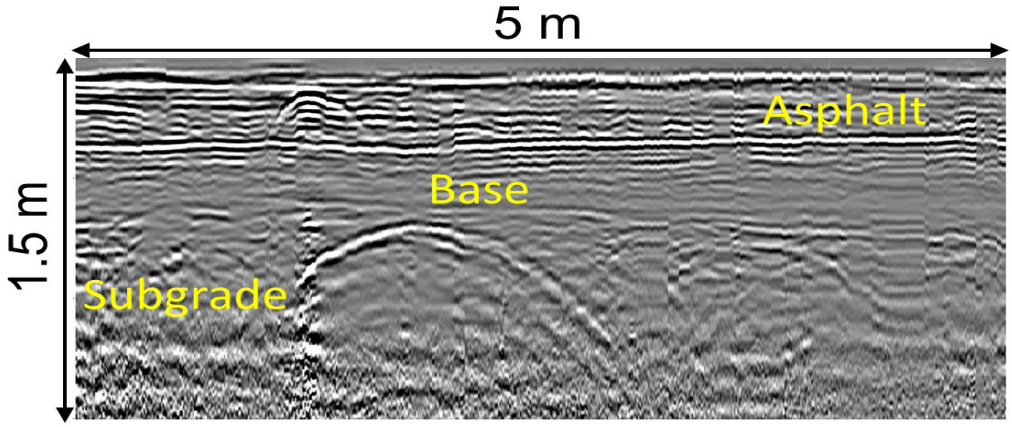
USING NEAR-SURFACE GEOPHYSICS TO ASSESS THE HEALTH OF OKLAHOMA'S ROADS

Graduate students Pranshu Ratre and Deepankar Dangwal performing GPR measurements

DR. MICHAEL BEHM

Aging and external effects such as severe weather, increasing temperature contrasts and heavy loading take a toll on Oklahoma's roads. Most prominent surface signs of potential damage are prominent cracks in the asphalt, which can be indicative of causes located in the deeper subsurface (e.g., poor soil consolidation, subsurface moisture pockets). Dr. Zaman at the School of Civil Engineering is working with the Oklahoma Department of Transportation to investigate road damages at selected locations for an improved process understanding. Dr. Behm and his graduate students Pranshu Ratre and Deepankar Dangwal contribute to this research by applying ground penetrating radar (GPR) to image the shallow asphalt and subgrade structure (Fig. 1). GPR is a geophysical imaging technique with high resolution of a few centimeters and allows us to obtain the electromagnetic subsurface reflectivity structure. The electromagnetic properties are representative of changes in compaction, water content and structural damage zones such as vertical cracks (Fig. 2). Data have been collected at three different sites, and their preliminary interpretation indicates that GPR is very well suited to image thicknesses of the top asphalt and bottom base layer of the entire pavement structure. Most importantly, GPR can answer the question of how deep the cracks penetrate, and therefore can help to identify the severity and potential causes of damage observed at the surface only.

GPR image of a 5 m long profile across road OK-7 in Garvin County. Asphalt and base layers, which both are part of the pavement, are clearly visible. Curved hyperbolic events are indicative of small-scale inclusions of air voids or other inhomogeneities in the subsurface.



A RESEARCH-INTENSIVE SEMINAR ON DEVONO-MISSISSIPPIAN MUDROCKS OF THE MIDCONTINENT

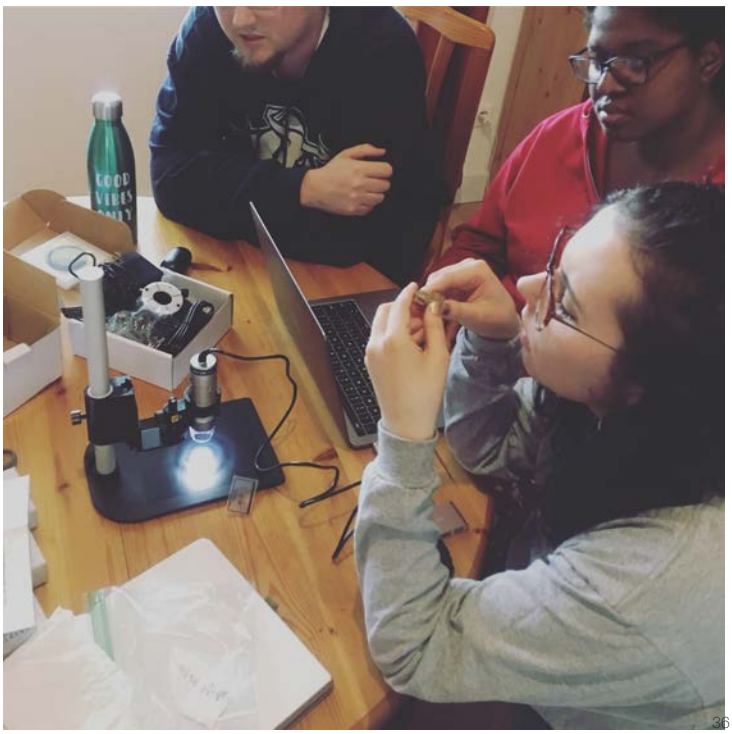
DR. LYNN SOREGHAN

In spring 2019, Drs. Lynn Soreghan (Geosciences) and Andrew Cullen (Warwick Energy) led a research seminar with six graduate students: Steve Adams, Alicia Bonar, David Duarte, Austin McGlannen, Lily Pfeifer and Cody Totten. Each student addressed a different aspect of the enigmatic Devono-Mississippian mudrocks of the North America craton: regional correlation, paleogeography, mineralogy and chemistry, detrital zircon geochronology, and grain size analysis. This work involved log correlation, outcrop and core sampling, analyses of newly collected data on geochemistry and geochronology, and a deep dive into prior studies. We successfully disaggregated several samples in order to conduct accurate granulometry (using laser particle-size analysis) of the silicate mineral fraction (after removal of biogenic silica). Results from the Sycamore Formation and the lower Caney Shale indicate that, although the final system was deposited by sediment gravity flows, the silicate fraction was probably delivered by eolian processes, and that re-worked Cambro-Ordovician sandstones are an important component in the provenance signal. These data and results are being submitted for presentation at the annual GSA meeting, and we are finalizing a manuscript for submission to a peer-reviewed journal. Our short-term approach of distributed research with the goal of publishing the outcome of the semester's work was an intensive learning experience for all, and hopefully will ultimately bear fruit as published research.

LANDSCAPES OF DEEP TIME IN THE RED EARTH OF FRANCE: RESEARCH TRAINING IN PALEOCLIMATE

LILY PFEIFER, PH.D. STUDENT

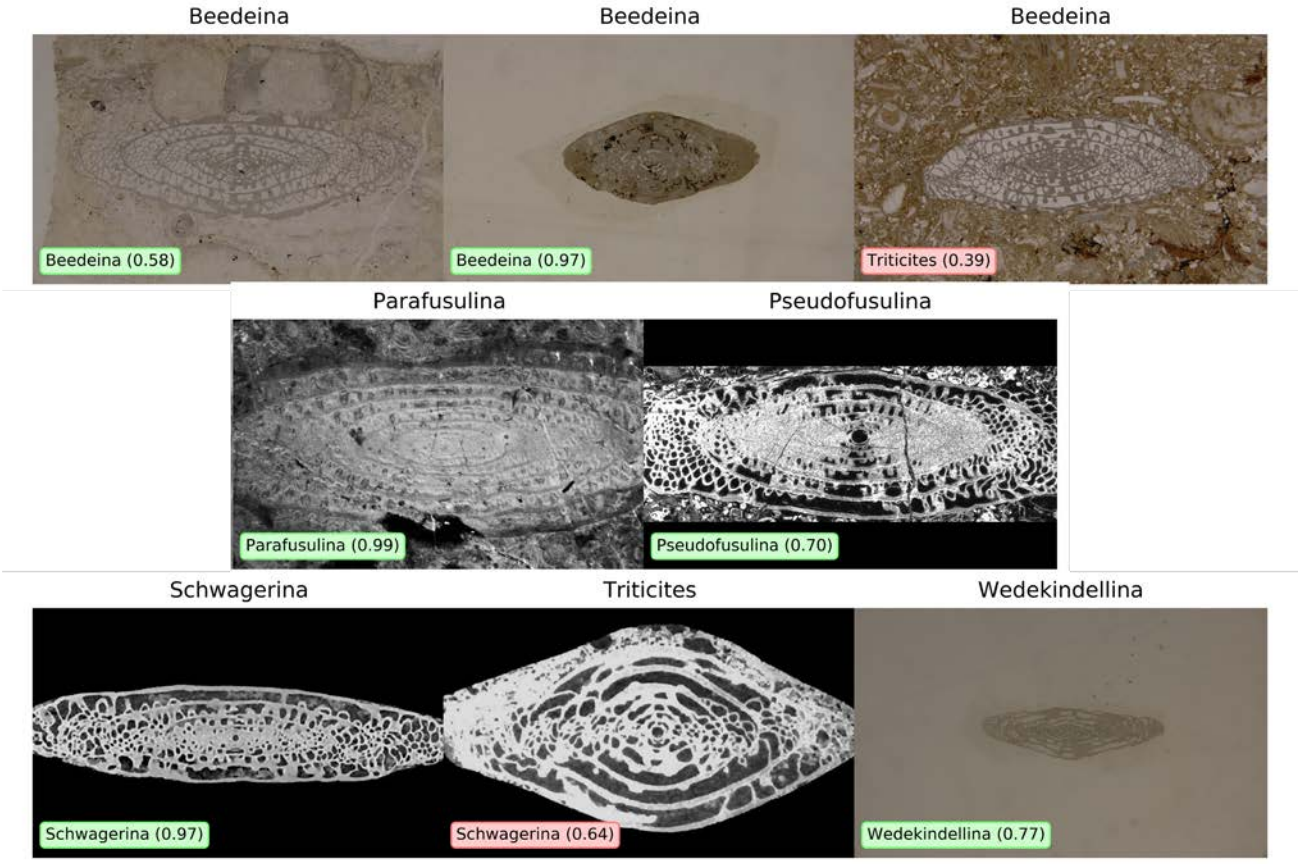
Dr. Lynn Soreghan lead the second season of an International Research Experiences for Students (IRES) program funded by the National Science Foundation (NSF) this summer. Four undergraduate students in geoscience from under-represented groups (students of Native American heritage and first-generation college students) joined Dr. Soreghan and her Ph.D. student Lily Pfeifer in southern France to gain experience in conducing paleoclimate research and to prepare for advanced work in geoscience. The IRES team continued data collection this summer to build on results from the 2018 season (presented at national GSA conference November, 2018); addressing questions about low-latitude climate conditions in eastern equatorial Pangea during the Late Paleozoic (300 Ma). This entailed sedimentology of red bed sediments and volcanic deposits from this time. Undergraduate students will be encouraged and mentored to present preliminary findings at scientific conferences later this year.



APPLICATION OF MACHINE LEARNING TO BIOSTRATIGRAPHY

RAFAEL PIRES DE LIMA, PHD STUDENT

Biostratigraphy is critical for dating and correlating sedimentary successions, as well as assessing paleoenvironmental conditions (e.g., Gooday, 1994; Culver, 2003; Kucera, 2007; Roozpeykar and Moghaddam, 2016). Biostratigraphy hinges on identification of specimens to the genus and species levels of well-established microfossil groups such as foraminifera, conodonts and palynomorphs. The complex morphology of fossil organisms requires specialists for reliable identification and systematics. Unfortunately, education and training in biostratigraphy is diminishing, greatly crippling future capacity (Farley and Armentrout, 2000, 2002). To address future needs in biostratigraphy, we are adapting techniques widely applied in the computer vision field, such as convolutional neural networks (CNN). Using methodologies similar to facial-recognition software, we are investigating how such technology can be used to help identify fusulinids in thin section.
The figure below illustrates example results obtained when adjusting modern CNN models to identify fusulinids. We collected 220 images of fusulinids from various sources (museums, online repositories, journal publications), representing eight different fusulinid genera. As the figure shows, CNN models are competent in resolving the image attributes useful for identifying the fossil genera. With appropriate data and data processing, CNN can achieve high levels of accuracy (correct classification), typically above 90%. Our findings indicate that there is a great potential for using CNN and modern technologies to help traditional geoscientific problems.



Resulting classification performed by a trained CNN. The title of the image corresponds to the expert provided genus; the bottom left text in each image shows the genus selected by the CNN as well as the probability assigned. The bounding box is green if both CNN and expert agree, red otherwise. Images not to scale.

Geoscience students visiting an active drilling rig and exploring the actual wellsite facility.

Field trip along Highway 77 at stop of the Viola formation outcrop

Tom Dunlap, member of Ardmore Geological Society, introducing basic concepts of mature oil field management

RIG TOUR HELPS STUDENTS CONNECT TEXTBOOK AND FIELD

JING ZHANG, PH.D. STUDENT

Geoscience students attended the rig tour in the Ardmore, Oklahoma, area, with the support of the Ardmore Geologic Society. The rig tour began with a field trip along the Highway 77 outcrops and briefly introduced general stratigraphy of the Arbuckle Mountain area, including oil- and gas-producing formations from the Arbuckle Group to the Hoxbar Formation. After a general geologic history was introduced, students visited a mature oil field that was discovered in 1915 and that has oil production from < 150m - 3600m with 10-15 separate reservoirs. Field developers and managers discussed the sourcing of the oil, and the stages of development of all these formations over the 100 years of development. Crystal, the field facility expert, demonstrated the daily routine of oil storage facility maintenance to the students. The third stop entailed a visit to an ongoing drilling site to show students how a wellsite is managed from the very beginning in all aspects, including budget plan, drilling operation and logging procedure. On the drilling platform, students learned how geologists and engineers work together on all the tasks. The final stop showed a waterflood facility in a mature oil field; Chuck Price demonstrated how secondary recovery brings life to an old field.

Jing Zhang, the student leader of this trip, commented at the end of the day: "This is not simply a rig tour, for our Geoscience students it is more of a valuable education and interactive learning opportunity. For the students who seek a future career in the oil and gas industry, it is better to witness how the real-life industry works and lay their hands on applications as early as possible. This tour truly helps our students build a connection between textbook and field."

DEPOSITIONAL SYSTEMS AND STRATIGRAPHY FIELD TRIP

STEVE ADAMS, PH.D. STUDENT

Every fall, Dr. Lynn Soreghan leads a field trip for her Depositional Systems and Stratigraphy course (4113/5113) to the Sacramento Mountains of New Mexico and the Guadalupe Mountains of Texas. Students learn about the depositional environments of the region from the Mississippian through the Permian, different reef-building organisms and the influence of climate and sea-level change on those systems. During the trip, students measure and describe a stratigraphic section, applying skills previously learned in the course. Highlights of the trip include a sunset at White Sands National Monument, an eight-mile round trip hike through the remarkably well-preserved Permian reef trail, and a visit to Carlsbad Caverns.

FELDSPAR THERMOMETRY IN PEGMATITES: TRUTH AND CONSEQUENCES

DR. DAVID LONDON, DR. LINDSEY E. HUNT, CHRISTINE R. SCHWING, BRANDON M. GUTTERY

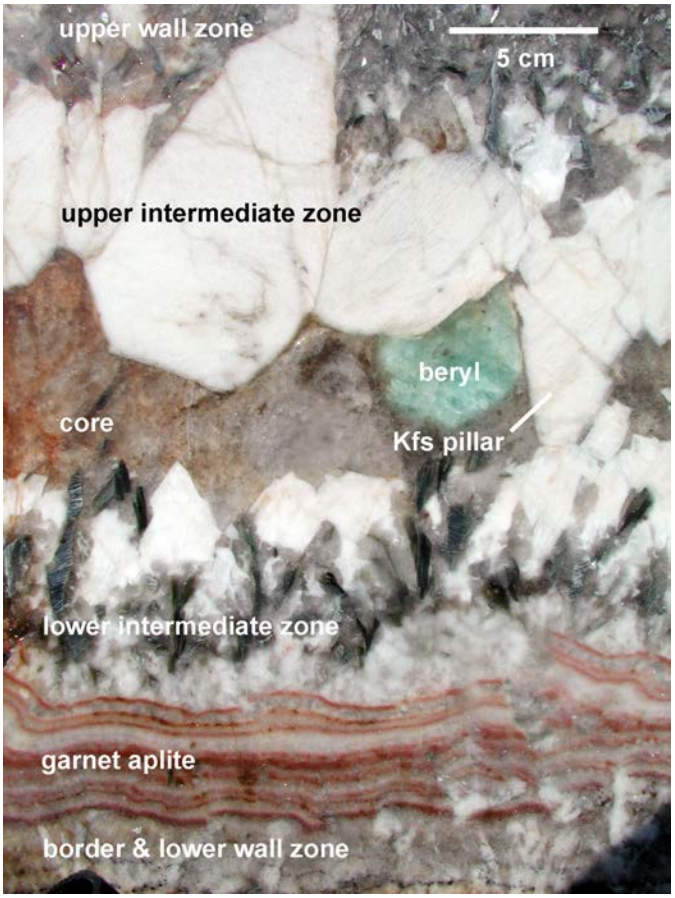


Figure. A complete cross section through the Palomar Dike, Rincon, San Diego County, California. The average temperature weighted by equal spacing (~ 3 cm) across the dike is 389°C with a 1° deviation of 36°C.

Temperatures of crystallization for all or portions of three thin granitic pegmatite dikes in southern California are derived from feldspar solvus thermometry, with supporting data from the K/Cs ratio of K-feldspar, the extent of Al/Si order in K-feldspar, and the texture of granophyre found along the margins of dikes. Although K-feldspars become perthitic and increasingly ordered toward the centers of dikes, their ratio of K/Cs falls from margin to core along trajectories that reflect fractional crystallization from silicate melt without subsequent interaction with an aqueous solution in an open system. A few sporadic samples that record loss of Cs, and consequent rise in K/Cs, validate the test of fidelity that the perthites retain their igneous compositions. Feldspar solvus thermometry from these three dikes indicates that their pegmatite-forming melts crystallized at ~ 375°-475°C. Those low temperatures are consistent with the occurrence of granophyric plagioclase-quartz intergrowths along the borders of pegmatites, thick and thin, that arise from thermal quenching of their melts against much cooler host rocks, and hence at much shallower depths than the igneous sources of the pegmatite-forming melts. The temperature profiles are nearly isothermal across the pegmatites, but where variation exists, apparent temperatures are highest along their margins or in their central domains (cores). Plagioclase shows normal fractionation of decreasing An content from margins to center, which mimics the line of descent with cooling down the solidus and solvus surfaces. However, the fractionation trends in the feldspars are attributable to their isothermal crystallization far from the equilibrium of the liquidus at a highly undercooled state, not to crystallization with cooling on the solidus surface.

In review for *Contributions to Mineralogy and Petrology* April 2019.

TEMPERATURES OF CRYSTALLIZATION WITHIN GEM-FORMING CAVITIES OF GRANITIC PEGMATITES

DR. DAVID LONDON, DR. LINDSEY E. HUNT, AND CHARLES DUVAL, M.S. STUDENT

Crystallization within miarolitic cavities in granitic pegmatites begins with the primary igneous minerals – feldspars, quartz, micas, and lesser others – along the margins of pockets and ends with the formation of zeolites, carbonates, and dense clay. The euhedral and gem-quality crystals for which many pegmatites are mined form within this interval, and they are commonly suspended in the dense clay with no points of attachment to a substrate. The sequence of mineral assemblages reflects a history of crystallization with cooling that continues to well after and to temperatures below the initial magmatic stage. Low-temperature assemblages of zeolites and clays are normally restricted to the miarolitic cavities themselves, and are not found throughout the pegmatite body. This study utilizes feldspar solvus thermometry to delineate the temperature interval over which the euhedral and gem-quality crystals form. Additional data include a survey of Al/Si order in K-feldspar and the mineralogy of the clay-size fraction from miarolitic cavities. To this end, feldspars and clay samples from 37 miarolitic cavities out of 13 pegmatite bodies were analyzed by electron beam and x-ray diffraction methods. The primary feldspars at pocket margins record a crystallization temperature of 453° ± 58°C, the same temperature at which crystallization takes place across the massive portions of pegmatite dikes. The closure of perthite exsolution occurs at 320° ± 55°C. Pairings of glassy, non-perthitic rims on K-feldspar with radial albite of cleavelandite habit record the final stages of crystallization of the primary silicates in pockets at 380° ± 83°C. The glassy rims are not perthitic because they form close enough to the closure temperature of perthite that exsolution does not ensue. Thus, the gem-forming stage is likely bracketed between ~ 450°-380°C. The zeolites, which include stilbite, laumontite, and heulandite, are restricted in their stability < 300°C. Clays enclose zeolites and formed after them. In a thermal model, a dike 1 meter thick at a depth of 7 km (ambient temperature of 160°C) cools to 450°C at its center in 11 days, and from 450°C to 385°C – the interval over which the primary silicates crystallize in pockets – in another 26 days. Increasing the host rock temperature to 300°C only extends the crystallization interval of the principal pocket silicates by another 3.5 months. The dike center reaches 275°C, at which zeolites could crystallize, in 106 days. The pegmatite achieves thermal equilibrium with the host rocks at 160°C in 2,175 years after emplacement. Clay minerals likely form and perhaps reform below ~ 200°C as the devitrified products of a remnant and flux-depleted hydrosilicate glass that partially fills the miarolitic cavities.

In preparation for *Economic Geology.*

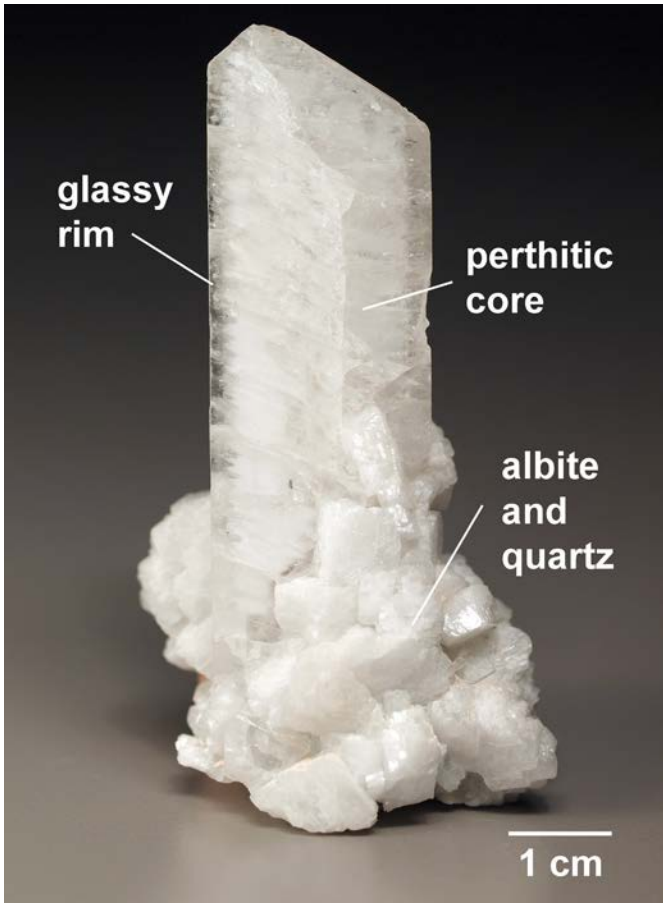


Figure. A glassy and clear, non-perthitic rim overgrowth on perthite (white) with blocky albite and quartz on the surface, Gilgit, Pakistan.

TEACHING AND RESEARCH IN THE FIELD, MILL CREEK OKLAHOMA

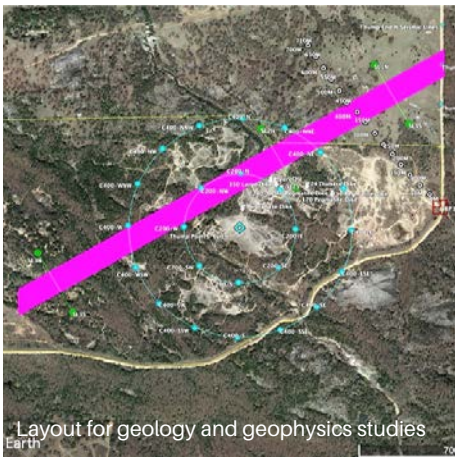
DR. BRETT CARPENTER

Over the winter, a group of three faculty and 13 students explored the Troy Granite outcrops outside of Mill Creek, Oklahoma, the area formally known as the Arbuckle Off Road Park, to complete geological and geophysical investigations, as well as drone imaging. This area is of significant interest as these rocks, which are some of the oldest in the state and, are exposed only in south-central Oklahoma. The study involved students of all academic levels, including six undergraduates, collecting data for undergraduate research projects, and learning geological and geophysical data collection techniques.

Most of our investigations focused on a structure, identified in previous trips as a strike-slip fault - a possible analog for some of the faults hosting seismicity in OK. This study is one of the first to characterize a basement-hosted fault in Oklahoma, and could only be accomplished in this area, where the basement is exposed. Electrical resistivity and magnetic susceptibility profiles were collected over the structure. Seismic studies, to study fault-zone guided waves and regional velocity anisotropy, were conducted with our seismic nodes and thumper. Finally, samples of the fault and nearby dikes, as well as high-resolution drone images, were collected. While much of the data remain to be processed, some of the data have been presented by undergraduates at the research symposium, included in MS theses, or PhD work.

The project and associated research was made possible by the generosity of the landowners, Roy Oliver and Andrea Hudgens, as well as the Martin-Marietta Mill Creek Granite Quarry, which provided critical data for the seismic studies. Furthermore, OU's Center for Autonomous Sensing and Sampling has been a great partner in collecting and processing drone images of the area at all levels of resolution.

Participants included: Dr Brett Carpenter, Dr. Ze'ev Reches, Dr. Nori Nakata, Matt Hamilton, Folarin Kolawole, Raymond Ng, Tanner Shadoan, Peiyao Li, Alex Vera Arroyo, Brandon Chase, Max Firkins, Connor Mears, Peter Reilly, Francisco Sebastian, Brittany Stroud, and Travis Vick.


Layout for geology and geophysics studies


Quad copter drone image from OU CASS

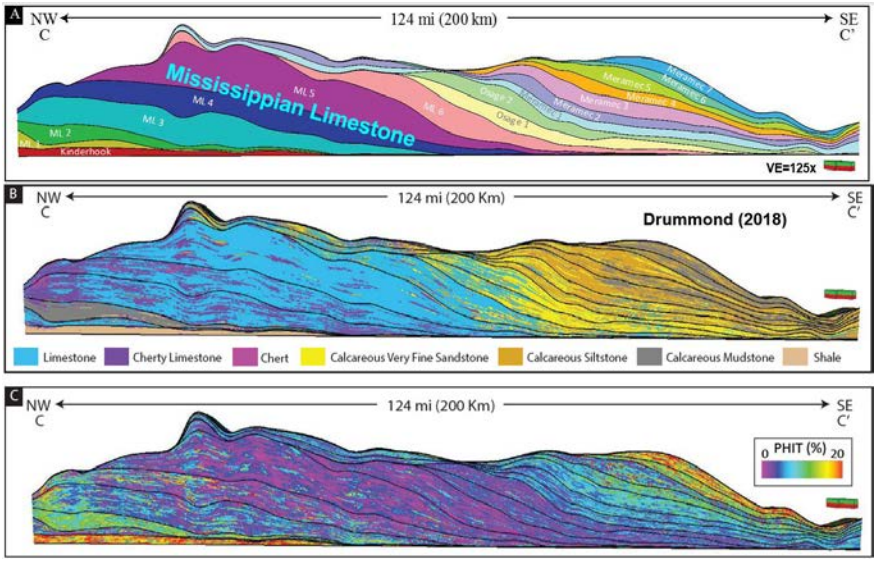

Fola Kolawole and Travis Vick preparing for the magnetic susceptibility survey


Tanner Shadoan getting ready to use the SGG thumper for a seismic study

RESERVOIR CHARACTERIZATION AND MODELING LABORATORY

DR. MATTHEW PRANTER

Reservoir Characterization and Modeling Field Trip (September 2018). Drone image of geology, geophysics, and petroleum engineering graduate students with Dr. Matt Pranter and Dr. Rex Cole (field trip leaders, far left). Fluvial deposits of the Cretaceous Mesaverde Group in background.

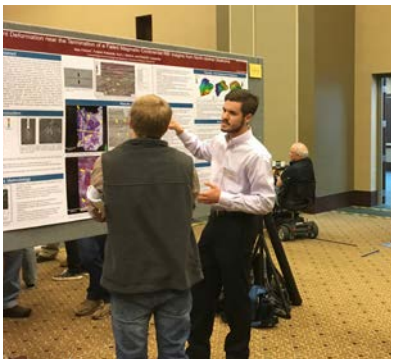


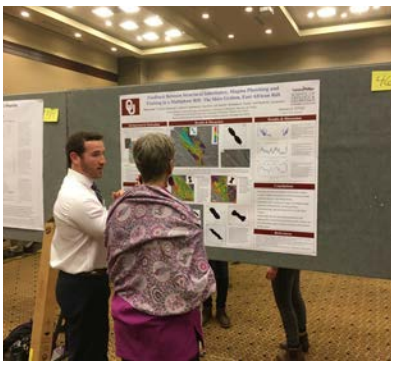
Dip-oriented models from northeastern Woods to southeastern Canadian counties showing the progradational Mississippian stratigraphic architecture (flattened on Woodford Shale), lithology and total porosity.

Dr. Matt Pranter and his students continue their research on Mississippian reservoirs of central Oklahoma with a focus on the stratigraphic and structural framework and how facies, mineralogy, petrophysical properties, fluid characteristics and operational practices relate to production behavior and recovery. Students from the RCML have analyzed subsurface reservoirs and equivalent outcrops/quarries in collaboration with students and faculty from petroleum engineering and researchers at the Oklahoma Geological Survey. Students use a range of methods and technologies from core, thin section and XRF analyses, to machine learning with well-log and seismic data, to seismic inversion and 3-D reservoir modeling. Several recent graduates from the RCML who focused on this research include Josh Miller, Katherine Drummond, Garrett Hickman and Mike Miller. Several other graduate students (Suriamin, Tellez, Corbett, Hardisty, Totten, Williams) are pursuing research on the Mississippian.

We continue the use of conventional and drone technology and outcrop modeling on well-exposed outcrop-reservoir analogs in Colorado to unravel the sequence stratigraphy and facies architecture of fluvial deposits and their implications for reservoir performance. Sarah Clark and Kelsey Lewis completed their research on the Cretaceous Burro Canyon Formation and published their work in the journal *Interpretation* and in *The Sedimentary Record*, respectively. Javier Tellez and Hannah Morgan presented results of their research at the AAPG ICE 2019 in August and the 2019 Rocky Mountain Section-AAPG in September. Students in the Reservoir Characterization and Modeling course visited this same area in Colorado and had an enlightening time on their fall field trip. We analyzed exceptional fluvial and shallow-marine outcrop analogs, and importantly, the students characterized and modeled the same formations in the course.

DR. CARPENTER'S STRUCTURAL GEOLOGY GROUP RESEARCH UPDATE





It has been a busy year for Dr. Carpenter's structural geology group. Various themes of research continue at pace and group members have presented this research at numerous regional and national conferences:

- 2018 GRC: Will Kibikas, Fola Kolawole, Tanner Shadoan
- 2018 SCEC: Tanner Shadoan
- 2018 NABG: Fola Kolawole
- 2018 AGU: Xiaofeng Chen
- 2019 AAAS National Mtg.: Dr. Carpenter
- 2019 GSA Joint Regional: Dr. Carpenter, Max Firkins, Travis Vick
- 2019 AAPG ACE: Fola Kolawole
- 2019 ARMA: Will Kibikas

In addition, the group welcomed Mengni Wu, a visiting M.S. student from China University of Petroleum, Beijing, for THREE months in the spring of 2019.

The group continues to study the structure, behavior and properties of Oklahoma's igneous basement, with applications to sedimentary sequence deformation, induced seismicity, seismic hazard and the tectonic history of the mid-continent. Dr. Carpenter's group continues to monitor crustal relaxation after the 2016 Pawnee earthquake via an NSF grant, and seismicity-induced stress changes in Oklahoma and Kansas via a new collaborative DOE grant. Furthermore, the group has branched out to study 3D basement structure in Pawnee County, Oklahoma and the properties of the caprocks over the reservoirs in the Sichuan Basin, China via collaborations with Chesapeake Energy and China, University of Petroleum, Beijing, respectively.

Dr. Carpenter convened an Earthscope Synthesis Workshop, "SAFOD: Reviewing Past Predictions, Key Results, And Future Directions" (http://www.earthscope.org/articles/SAFOD_gold_standard), and continues to work on the Drilling Investigation of Seismogenic Crust in Oklahoma (DISCO) project as well.

With the assistance and generosity of the MCEE Dean's office, Geosciences, and Dr. Abousleiman, Dr. Carpenter has been upgrading the experimental equipment. Combined with other equipment upgrades and purchases, students in Geosciences will have access to one of the most versatile rock mechanics labs in the world (full update next year).

Dr. Carpenter would like to congratulate Travis Vick, Tanner Shadoan and Alex Vera Arroyo for degree completions. The group welcomes Max Firkins, and Paul Gilbert who will begin M.S. degrees. Dr. Carpenter also wishes good luck to Xiaofeng Chen, who is moving on to TAMU to work with some of the excellent scientists in their experimental rock mechanics lab.

CONVENTIONAL CHARACTERIZATION OF UNCONVENTIONAL RESOURCE SHALES

DR. ROGER SLATT

Back in the day, a corporate mission statement read: "find more oil and gas." Today's mission statement is much more elaborate under the general heading of "Improve Shareholder Value." Under this scenario one has to decipher terminology and activity, including: free cash flow, debt reduction, financial asset base, financial risk, organic and inorganic growth, prospect portfolio, etc., to make a technically oriented geoscientist's head spin. Ultimately, many of these activities center around hydrocarbon productivity, which has a more refined set of terminology and activity, and a strong geoscience checklist, including: reservoir stratal (dis)continuity, compartmentalization, volume, thermal maturity, thickness and acreage, brittleness, pore network and reservoir quality, pressure, and seismic attributes, focused to increasing shareholder value.

This latter set of activities fall under the umbrella of Reservoir Characterization, which plays a major role in increasing productivity and should be required for each well drilled or seismic shot, to ultimately improve or maximize shareholder value. In simpler terms, geology and related scientific disciplines form the pedestal upon which sits the various reservoirs and their performance.

To meet this challenge, we have formed a student-led, consortium-sponsored team with the goal of improving shareholder value through enhanced understanding of the properties of the reservoir and how those properties relate to producing oil and/or gas. More than 30 students have received graduate degrees since inception of OU's Reservoir Characterization Institute (IRC) six years ago, which is currently focused on geoscience properties of unconventional resource shales, by studying Oklahoma's Devonian Woodford Shale. Currently, Oklahoma is the fourth-largest active hydrocarbon-producing state, largely boosted by production from unconventional resource shales such as the Woodford and adjacent Meramec-Sycamore formations. An additional 70+ students have graduated from the IRC with theses and dissertations in related topics like sequence stratigraphy, scanning electron microscopy and organic geochemistry (in conjunction with students of Dr. Philp and Dr. Marfurt).

Although many sophisticated, expensive instruments/techniques have been developed by many organizations, including those at OU, to characterize shale reservoir properties, we have relied on established common, conventional methodologies. This has allowed us to maintain the student-led shale consortium, with a low membership fee, yet provides value in the form of concepts, ideas, completed detailed projects and analogs. Documented applications include: (1) conventional methodologies, sometimes with modifications, are cost effective; (2) regional organic-rich, thick, sweet spots and preferred target landing zones are predictable based upon a robust depositional model developed at the Institute; (3) this model provides a good analog for other global, siliceous, and some carbonate-rich shales; (4) key geomechanical, organic/inorganic geochemical, compositional, petrophysical and geophysical properties have been documented, some of which influence fluid/rock distribution, migration and fluid-rock interactions, (5) fractures related to production; and (6) geologic influence on early production decline.

The conventional methodologies we employ are: sedimentology/stratigraphy, well log and seismic reflection mapping and cross section, inorganic chemistry by X-ray fluorescence (XRF) and gamma ray spectroscopy, X-ray diffraction (XRD) and thin section mineralogy and porosity; high resolution scanning electron microscopy, isotopes, biostratigraphy, organic/petroleum geochemistry, rock hardness, fracture/fault/fold analysis, and integrated mapping and modeling of documented reservoir and related properties for volumetric and fluid flow estimation. Well exposed outcrops are a central part of our studies for resolving analog geological complexities at wellbore, interwell and regional scales. Integration of these diverse data sets is key to successfully applying a useful reservoir characterization to ultimately increase shareholder value through improved productivity. The scale of integration and characterization will depend upon the objective(s) of a particular project, which should ultimately lead to enhanced reservoir performance and operational efficiencies.

OU PERMIAN BASIN RESEARCH GROUP

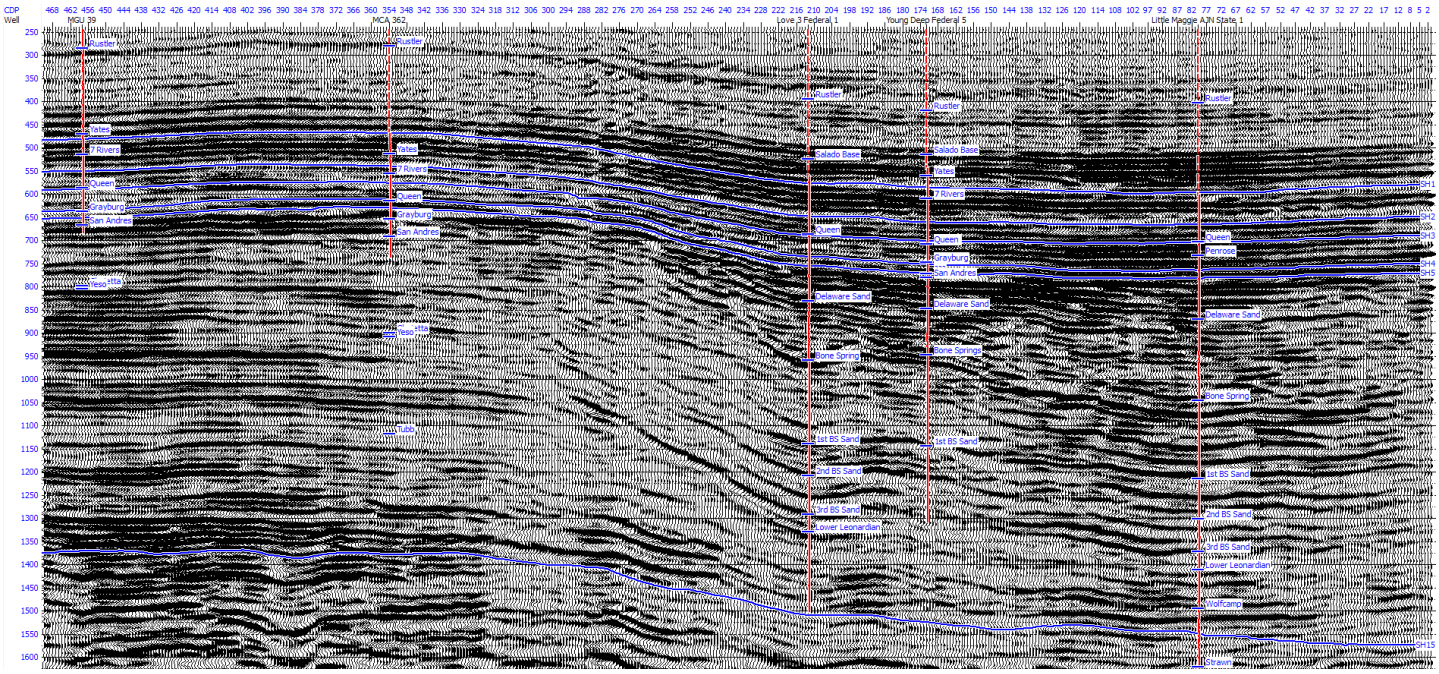
DR. JOHN PIGOTT

The OU Permian Basin Research Group focuses upon integrating the outcrop with the subsurface in order to understand aspects of the petroleum system evolution of one of the world's most prolific Super Basins: the Permian of West Texas-New Mexico. Supervision of graduate students in their thesis and dissertation investigations in geological-geophysical-petroleum engineering studies are conducted by Dr. John Pigott with collaborations with Drs. Heather Bedle, R. Douglas Elmore, Kulwadee Pigott, Matt Pranter, and Zulfiquar Reza. Data for analyses range from public and proprietary domains of acquisition and without exception are state-of-the-art.

Topics and those students heading up the investigations of 2018-2019 are:

- LiDar XRF of Yates High-Resolution Sequence Stratigraphy – Aimee Plowman
- LiDar of fractures in Bone Canyon and Schmidt Hammer Ductility - Travis Plemons
- LiDar integrated with XRF/spectral gamma ray of Bone Canyon Sequence Stratigraphy – Andy Brown
- LiDar 3D Seismic Stratigraphy of sediment gravity flow chutes in Shummard Canyon – Matt Lynch
- LiDar Schmidt hammer XRF for ductility in Shummard Canyon – Andrew Layden
- LiDar XRF Hi Res Sequence Stratigraphy of the Bone Spring Formation at Rest Stop Canyon – Jordan Renner
- LiDar Schmidt hammer XRF for ductility at Rest Stop Canyon – Ryan Forrest
- High-Resolution 3D Seismic Stratigraphy of Leonardian Shelf to Basin Sea Level Response – Cy Frazier
- Petrophysical High-Resolution Sequence Stratigraphy of Bone 2 in Northern Delaware – Tyler Bickley
- Quantitative 3D Seismic Stratigraphy of the Bone Springs in Northern Delaware Basin – Ru Zhai
- LiDar XRF analysis of Guadalupian Tsunamiites – Travis Moreland
- 3D Quantitative Seismicmic Stratigraphyigraphy of the Midland and Delaware Basins – Abidin Caf
- XRF High-Resolution Chemo-Stratigraphyigraphy of McKittrick Canyon – Chenxi Xu
- LiDar- Schmidt Hammer Forward Seismic Model of McKittrick Canyon – Zhuabo Wang
- Reservoir Modeling of the Bone Spring Formation– Tien Phan
- Integrated petrophysical-geological-geophysical analysis of resource play production histories – Joseph Snyder

HOW STUDENTS MAY BEGIN TO INTERPRET ANCIENT CARBONATES



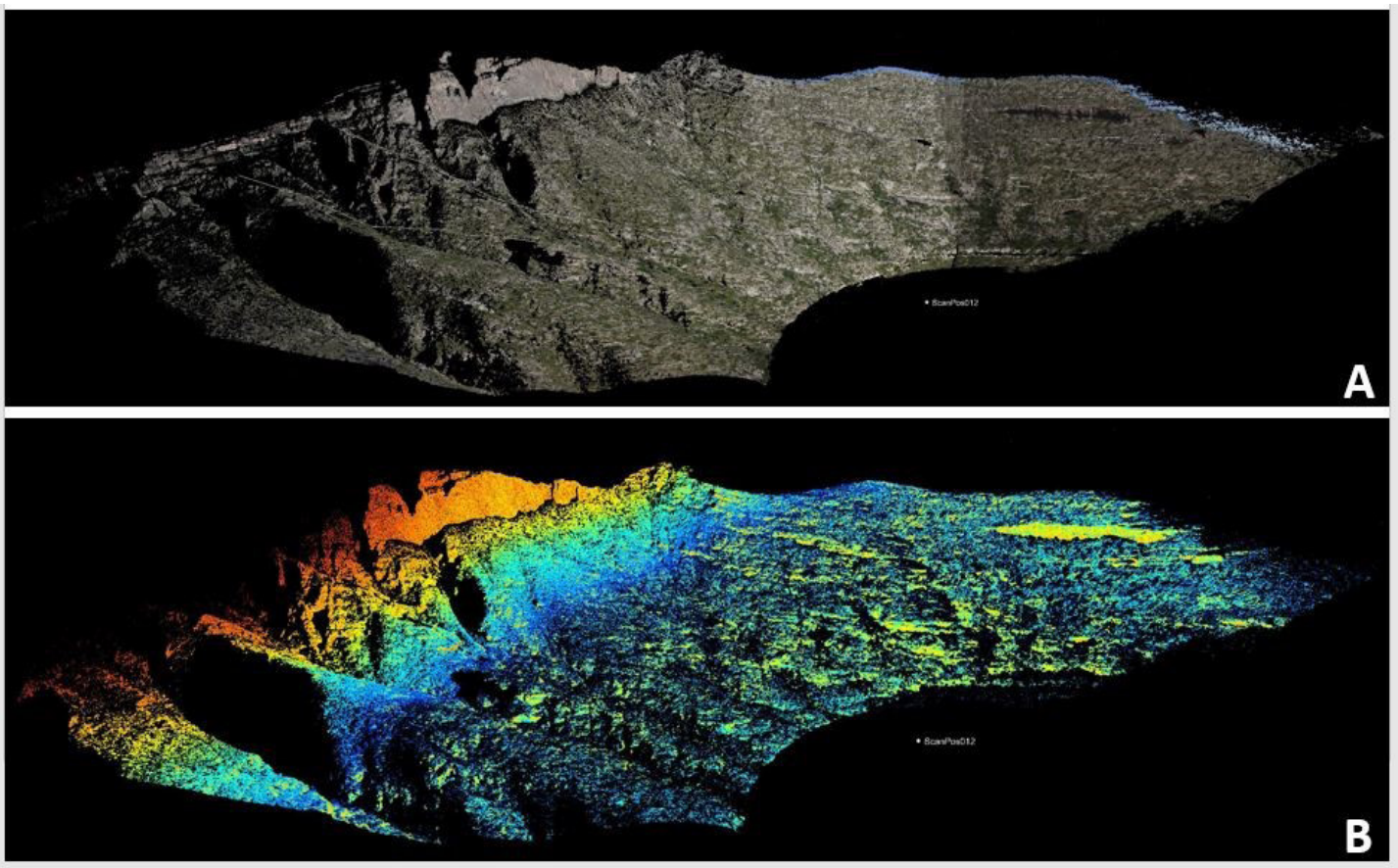
To study the Permian, one has to look at carbonates closely, both the modern and the ancient. And when one has only a reflection seismic image, not only must one understand how seismic is acquired, processed and interpreted, one desperately needs geologic constraint. For example, this is a reflection seismic image of the Permian somewhere in New Mexico. So the question is, what are we looking at? For example, where is the reef? To better interpret and understand such images, students first must study the modern.

Well, first, one can prepare for the Permian by learning to scuba dive in Cancun.

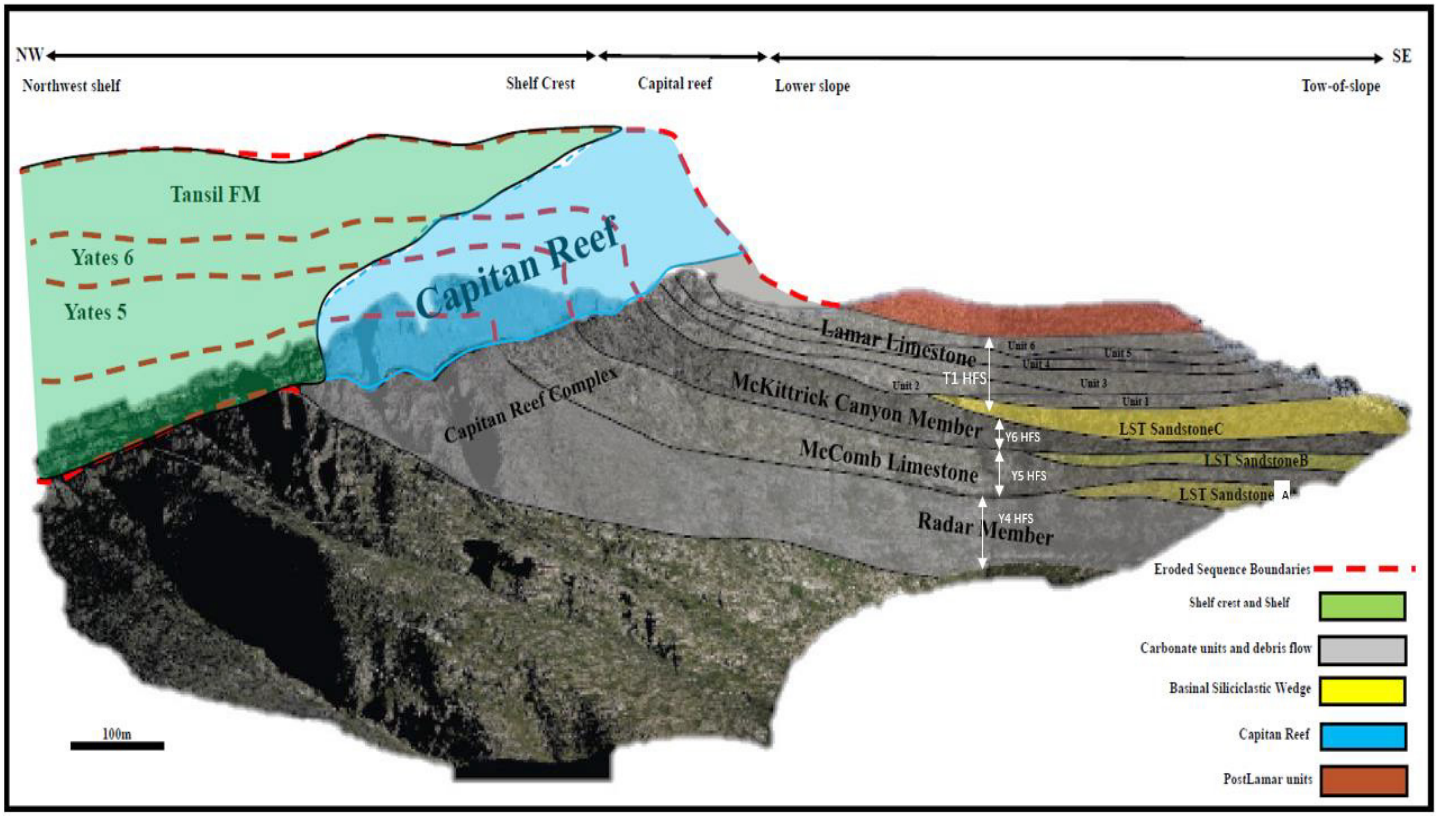
Then, going underwater, they can study the subtidal reef in the Caribbean in preparation for seeing those in outcrop in the Permian of West Texas-New Mexico.

Not all carbonate processes occur underwater. Students are examining the supratidal on Sooner Key in Florida by walking carefully on the 'phytokarst'.

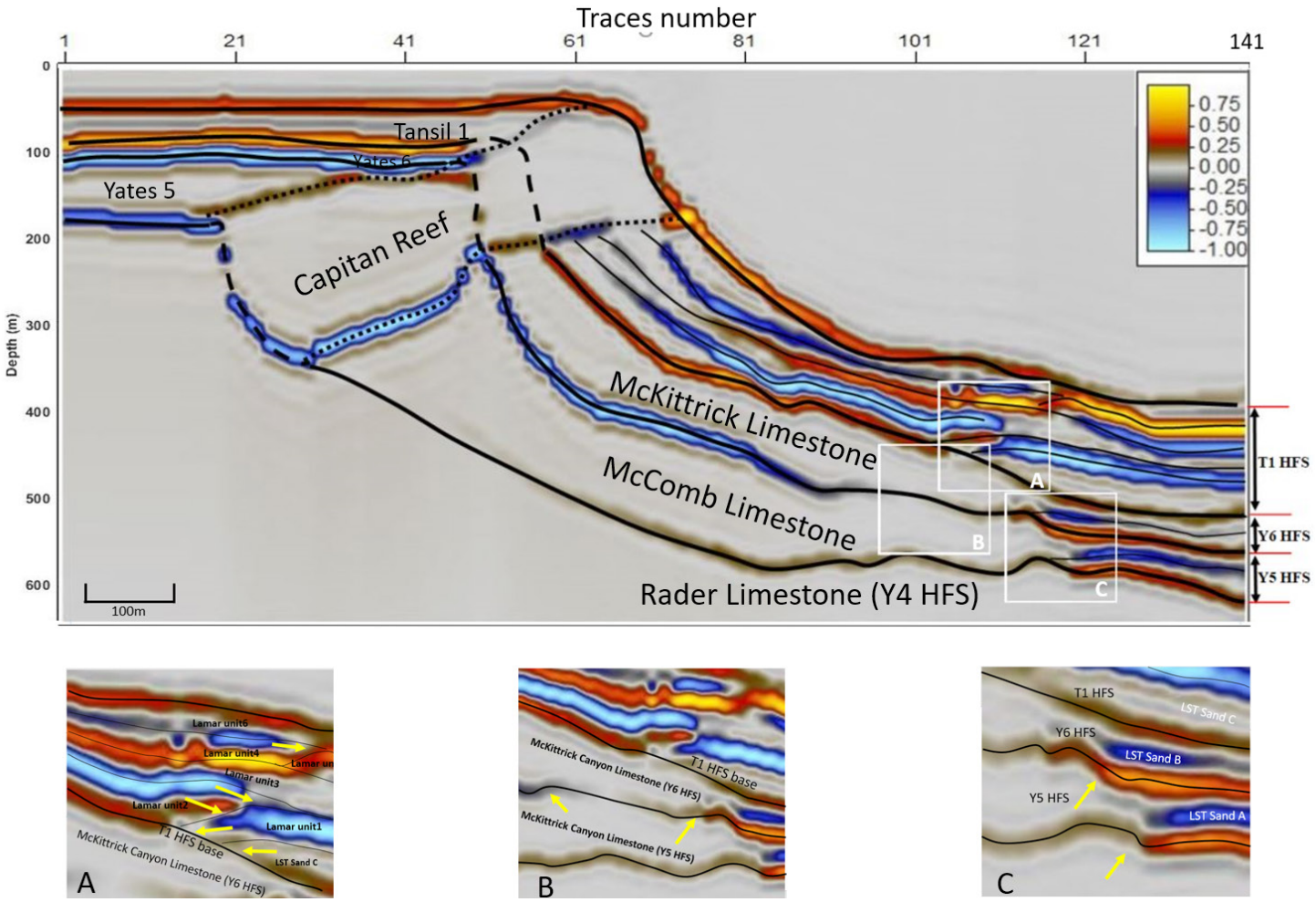
Now, in McKittrick Canyon, one may use the LiDar to geophysically image the outcrop so that a forward model can be constructed of what a comparable reflection seismic would image.



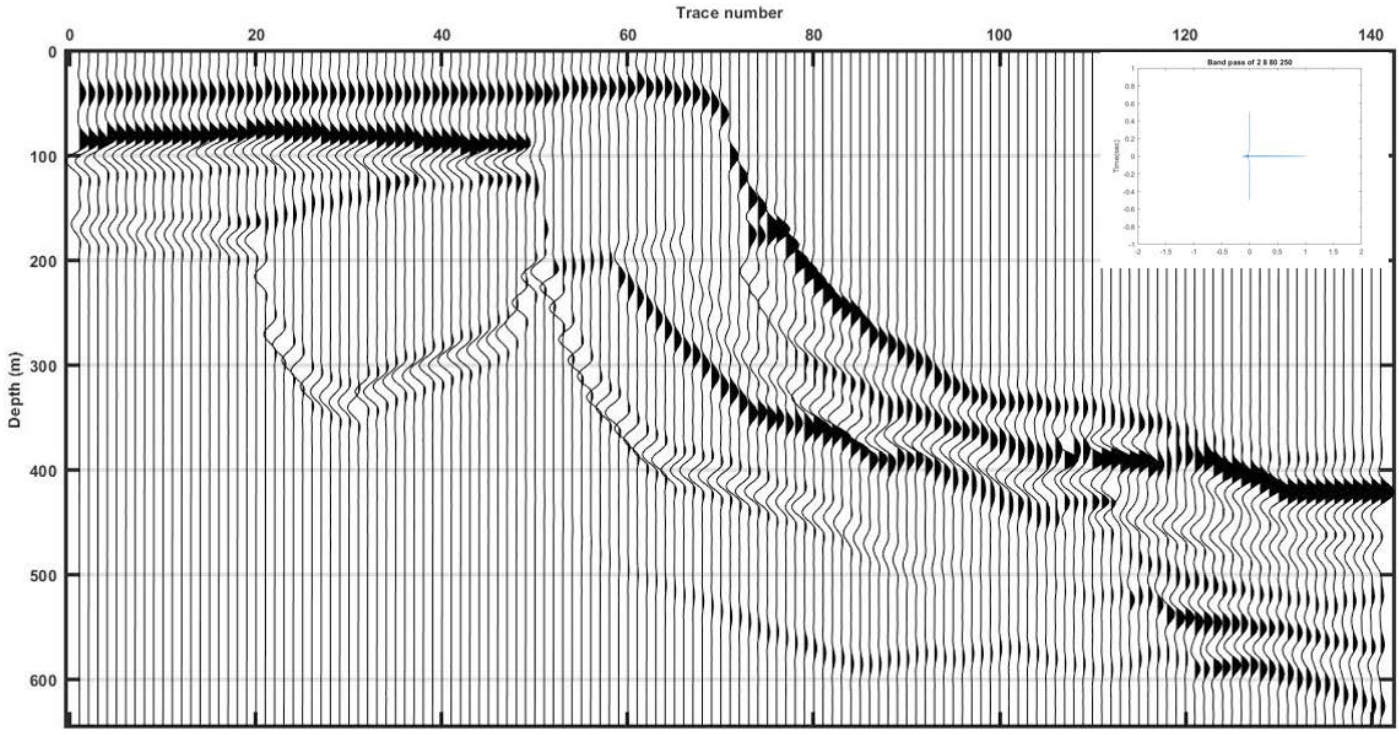
For example, in A is what the casual observer see: the North side of McKittrick Canyon imaged with LiDar. But in B, after a bit of processing is the resulting image with a range of 1 km and mm resolution!



Next, applying some ground truth from walking out the strata, this is what the geologist sees: the supratidal Yates Fm, the subtidal Capitan Reef Fm, and the deep McKittrick Ls. So this is what a Cancun reef tract looked like some 260 million years ago!



After a bit more processing this is what the geophysicist sees, which helps tremendously when trying to interpret seismic without the constraint of an outcrop!



Now, one can compare this information in this image to that of the first one and begin to see patterns - flat lines (reflections) indicating the paleo supratidal shelf and lagoon, gently to steeply inclined lines representing the reef, and then concave upward lines representing the deeper deposits.

DR. CHEN'S RESEARCH GROUP UPDATE

In 2018, Dr. Xiaowei Chen and her group published seven peer reviewed papers, and presented 16 abstracts at international and regional conferences. Studies from her group addressed induced seismicity in Oklahoma.

• Chen et al., (2018) combined pore pressure modeling with seismological analysis of an earthquake sequence near Guthrie, and found strong correlation between injected volumes and seismic moment.

• Qin et al., (2018) performed detailed analysis of an earthquake sequence in western Oklahoma, and found evidence for stress interactions between different fault segments, suggesting that earthquakes themselves influence subsequent earthquakes.

• Haffener et al., (2018) performed meta-data analysis to understand relationships between earthquakes and injection wells. A large-scale analysis shows that densely clustered injection wells can influence earthquakes up to 40 km away, facilitated by the high diffusivity value in the Arbuckle Group where fluid injection is occurring. On the other hand, individual sequences are predominately occurring in the crystalline basement, featuring lower diffusivities.. Moreover, most sequences exhibit downward migration from shallow to deeper depths. These behaviors are consistent with a two-layered migration model with fractures in crystalline basement reactivated by wide-spread stress perturbations from fluid injected into an upper permeable layer.

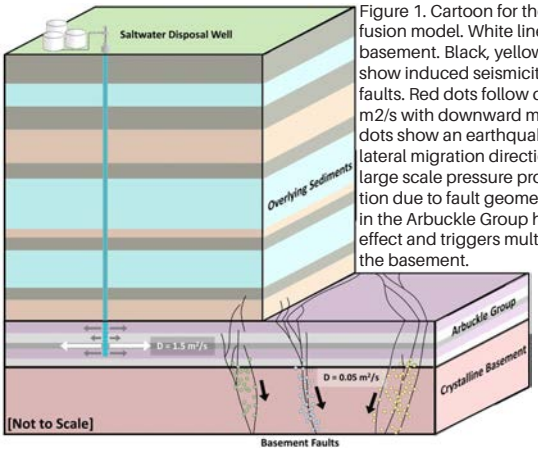


Figure 1. Cartoon for the two layered diffusion model. White lines are faults in the basement. Black, yellow, and green dots show induced seismicity along individual faults. Red dots follow diffusivity of 0.05 m2/s with downward migration. Yellow dots show an earthquake sequence with lateral migration direction opposite to large scale pressure propagation direction due to fault geometry. Fluid injected in the Arbuckle Group has long range effect and triggers multiple sequences in the basement.

Pei et al., (2018) performed tomographic imaging of Oklahoma, and found that spatial distributions of large earthquakes (M>4) correlate with basement seismic velocity anomalies and gravity/magnetic anomalies. Thus, although most earthquakes in Oklahoma relate to fluid injection, the spatial occurrence pattern of larger earthquakes are controlled by geological structure.

• Cheng & Chen (2018) analyzed seismicity in the Salton Sea geothermal field in southern California, and investigated the influence of geothermal operations on seismicity. The geothermal operations primarily affect microearthquakes (i.e., M<2), but large earthquakes (i.e., M>3) do not have obvious relationships with geothermal activities. This is consistent with studies in Oklahoma, where Haffener et al., (2018) and Pei et al., (2018) found that large earthquake statistics are more comparable to tectonic sequences, and their spatial location appear to be controlled by large-scale geological structure.

• Wu et al. (2018) analyzed stress changes from individual earthquakes of four major sequences: 2016 M5 Fairview/Cushing, 2016 M5.8 Pawnee and 2011 M5.7 Prague, and found that source parameters are comparable to natural earthquakes in similar tectonic settings.

• Sweet et al. (2018) documented the basic data performance of community-driven seismic experiments near Enid, Oklahoma. This open dataset will be used by many researchers worldwide.

Ongoing research involves:

• Detailed modeling of small earthquakes (Wu et al., 2019). This study links rupture process of a Mw4 earthquake and aftershock triggering during a sequence in central Oklahoma.

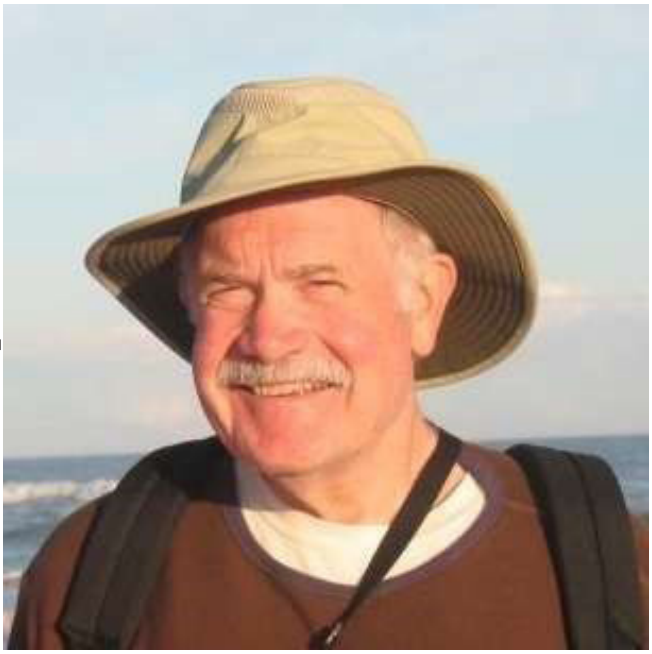
• Dr. Chen received funding from USGS NEHRP program (with Co-PI Dr. Jake Walter , OGS) to perform detailed analysis of stress heterogeneity in Oklahoma, focusing on western Oklahoma and the influence of pore pressure on stress orientations. This study involves Drs. Brett Carpenter, Jake Walter, Daniel Trugman (LANL) and Matt Weingarten (SDSU) and students Yan Qin and Qimin Wu.

• Collaborating with Drs. Nori Nakata and Kurt Marfurt on hydraulic fracturing induced seismicity. This includes a legacy dataset of hydraulic fracturing from 1997, and a recent dataset from Chesapeake. Collaborating with Dr. Jake Walter, Dr. Chen, undergraduate student Sarah Sundberg and graduate student Yan Qin are untangling the relationship between hydraulic fracturing and induced earthquakes in the Scoop & Stack play.

• Student Angie Ortega is performing detailed analysis of seismic waveforms to constrain absolute earthquake depth, which is often poorly constrained. This could improve our understanding of how industry activities trigger earthquakes. Detailed waveform analysis will enable a higher level of confidence in depth determination. The goal is to understand whether wastewater disposal-induced earthquakes have different depths compared to hydraulic fracturing-induced earthquakes, and relationships among earthquake depth, injection layer, and basement interface.

• Collaboration with Dr. Rachel Abercrombie (Boston University) on developing better methods to compute source parameters.

DR. KENNETH TAYLOR RECEIVES INTERNATIONAL RECOGNITION



Reprinted from CAS Newsletter No. 8, December 2018

The Société Géologique de France recognized C.B. Hudson/Torchmark Presidential Professor Emeritus Kenneth Taylor's many contributions to understanding the history of geology by awarding him the "Prix Wegmann" for 2018. The prestigious lifetime achievement award has been presented at irregular intervals since 1984. Taylor, who served on the faculty of the Department of History of Science, is the seventh individual and only the second American to receive the award.

Previously, Taylor has won the Geological Society of America's Mary C. Rabbitt Award in 2007 and the Geological Society of London's Sue Tyler Friedman Medal in 1998. These three awards, from the British, American and French national geological societies, "are pretty much the triple crown for the history of geology," said Hunter Heyck, current chair of the History of Science department. Taylor is now one of only two people ever to have been awarded all three.

Taylor became a faculty member at OU in 1967. He served as department chair for 14 years and completed a four-year term (2012-16) as president of the International Commission on the History of Geological Sciences, a commission of both the International Union of Geological Sciences and the International Union of History and Philosophy of Science and Technology.

Taylor's research has been directed mainly toward improved understanding of how geology, a comparatively new scientific discipline, began to develop into a recognizably distinct field of science during the second half of the 18th century. His work has addressed in particular the roles played in this process by French scientific figures. He says that this research aims broadly at grasping the beginnings of a geological mindset, which he considers to be "a scientific outlook widely shared among earth scientists, one that inserts the dimension of time into the examination of nature, and tries to identify and explain the natural processes that account for the enormous changes the terrestrial environment has undergone over a very long period, and continues to undergo in the present."

ALUMNI NEWS

Nicole Fritz completed her Executive MBA program in April 2019 from the University of Oklahoma Price College of Business.

Jonathan Funk married Claire Funk on June 14, 2019.

Dustin Dewett says, "You may recall, that I began at the University with one child back in 2009. I had my second child during the finals week of the spring 2010 semester and my third during my final year of my M.S. in 2013. In 2014, as I prepared to begin my Ph.D., my wife and I had our fourth. Now, late last semester, we had our fifth."

Deborah Sacrey participated in a podcast interview with Vern Stefanic on the AAPG website about careers and new technology. It can be found here: https://www.aapg.org/videos/interview/Articleid/53602/machine-learning-with-deborah-sacrey

Ann Ojeda is an Assistant Professor in the Geosciences Department at Auburn University, leading the new Auburn Biogeochemistry Group. Their research addresses questions related to water contamination from organic compounds in the coupled natural and human systems.

UPCOMING EVENTS

Fall 2019 AAC Meeting
September 20, 2019

SEG Meeting
September 15-18 Booth #1317

GSA Meeting
September 22-25 Booth #449
Alumni Reception:
September 23
5:00 PM - 7:00 PM
Russell Room at the Hyatt Regency

AGU Meeting
December 9-13 Booth #1129

Spring Break Student Expo
March 13, 2020

Spring 2020 AAC Meeting & ConocoPhillips Student Research Symposium
April 3, 2020

MEMORIALS

IN MEMORY OF OUR ALUMNI GONE TOO SOON

Reported as of August 2019 to OU Development

Charles W. Cathey
Edwin C. Lookabaugh
John D. Sollenberger
J. David Rambo
Hershel Jones
Thomas E. Neudecker
Jack Warren Hudack
Robert W. Allen
Victor J. Veroda
Edward J. Ackman
Thomas J. Jones
John A. Trigg
Ann McCormick Cooper
Mark Aldridge Melton
Donald W. Crosby
C. Wayne Greenlee
John Lester Tucker
Clare Ann Bernero
Ronald G. Maples
Otis D. Hibbard
Robert B. Branson
James Wylie Waldrip
T. L. Rowland
Jerry Wayne Diehl
Charles R. Edgerton
Roger Feenstra
Joe Edgar Hedge
Robert Carl Larson
Forrest Wilson Hood
Kenneth N. McKinney
John Snyder McCulloch
Camille C. Despot
O. E. Sawyer
Jean Milton Robicheaux
Joe Lynn Russell
Sterling B. Jones

TECHNOLOGY REBEL AND EARLY-DAY WILDCATTER STANDS ON SOLID GROUND

Reprinted with permission from Sooner Magazine, Summer 2018
By Chip Minty

The oil business has changed a lot since Robert Allen discovered his passion for rocks more than 70 years ago. Today's oil wells cost millions to drill, and today's geologists lean on computers and other digital advancements, like three dimensional seismic technology and visualization rooms with rainbows of geological strata splashed across giant screens.

Allen has no problem with that, just as long as he doesn't have to use it. He's happy in his Ardmore office, plotting the complexities of southern Oklahoma geology with paper and pencil, just as he's done for decades.

"I have not come along with technology," says the 95-year-old petroleum geologist. "I'm computer illiterate, totally. When they first came out, computers didn't know capital letters, and they didn't even put spaces between words. I decided I'm not going to put up with it.

"I don't even know about 3-D. I don't pay attention to that stuff. I'm stupid when it comes to 3-D seismic, but I think I understand the subsurface."

Allen earned his geology degree from the University of Oklahoma after serving in Europe during World War II. He began his career with Globe Oil and Refining Co. in 1949 and moved to Continental Oil Co. in 1954. He left Continental in 1962 and has been an independent geologist ever since.

Despite his rebel stand against technology, he has earned the admiration and respect of petroleum geologists from all over Oklahoma and the country.

Accolades include the 2010 Distinguished Service Award from OU's Mewbourne College of Earth and Energy and the 2010 Legends Award from the Oklahoma City Geological Foundation. That same year, he was recognized with a special award from the American Association of Petroleum Geologists. He was also honored with a certificate of merit from the Mid-Continent section of the American Association of Petroleum Geologists in 2005 and has been given an honorary lifetime membership in the Ardmore Geological Society.

Allen is beloved in the geological community, says David Brown, associate director of the Oklahoma Geological Survey on OU's Norman campus.

"He's just a nice guy, and such an unselfish person, always willing to take the time to teach people about Oklahoma geology."

Brown was an OU geology student when he first met Allen nearly 40 years ago. Brown was hiking alone through the Arbuckle Mountains, getting a first-hand look at the rocks he was studying in class when he encountered Allen, leading a small group tour.

Since then, Brown has bumped into Allen and his Arbuckle tours on several occasions.

Allen gave up leading the groups a few years ago, but he still comes into the office every day to identify potential drilling prospects for clients and to help manage the Ardmore Sample Cut and Library, a massive collection of geological information comprising more than a century of Oklahoma's drilling history.

Located in downtown Ardmore, the library contains information on every well drilled in Oklahoma to 2016, when Allen stopped keeping track. Though much of the information is now available online through other libraries, geologists still search through stacks of carefully organized boxes, combing through card files by hand.

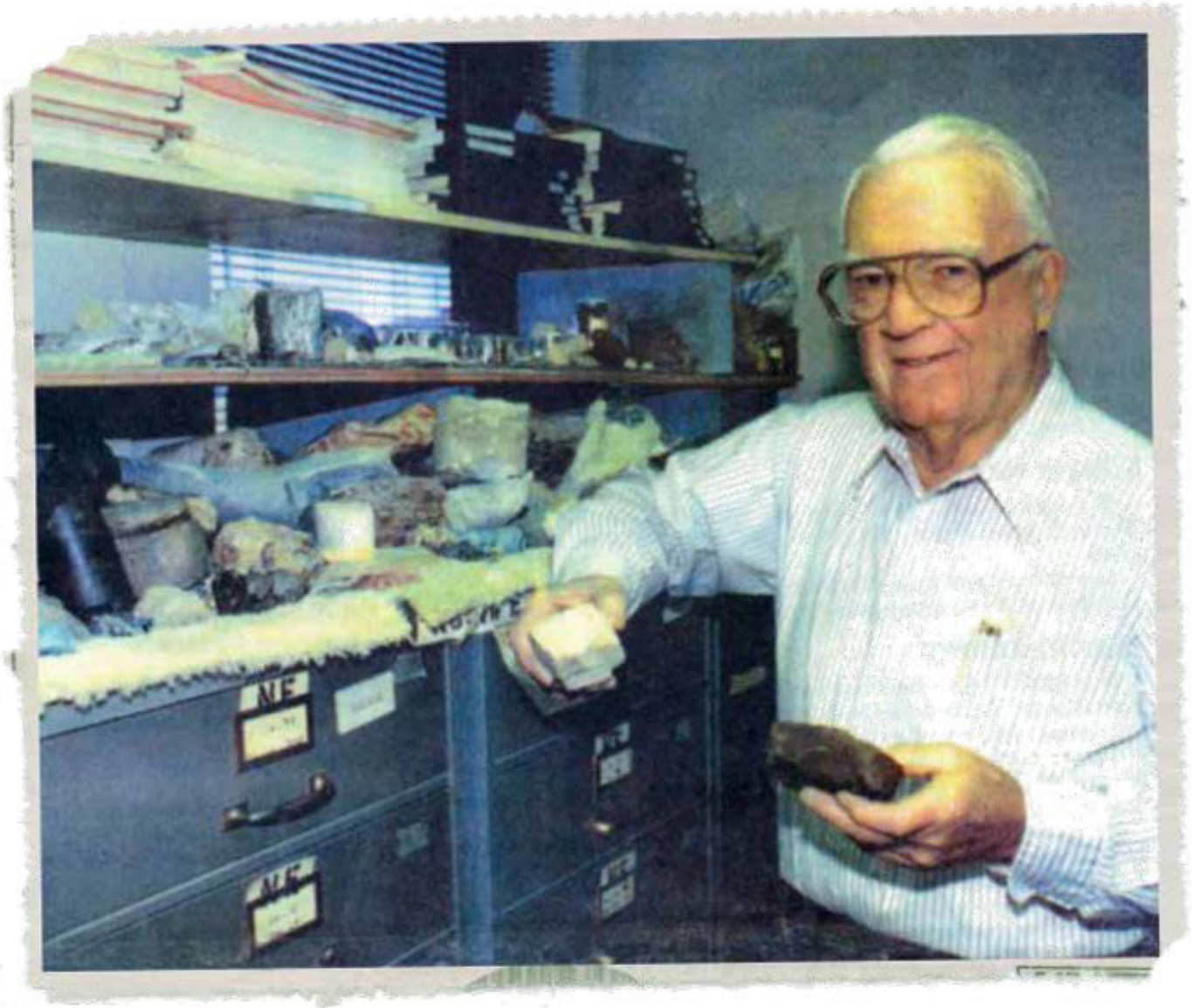
Allen takes pride in doing things the old way. To him, there's a personal connection to the rocks. His years as a field geologist were spent on hundreds of drilling sites across Oklahoma, where he would study rock cuttings as they emerged from the hole and visualize where the drill bit was digging. Electronic logging data was important, but the big decisions came down to the rock samples he could hold in his hands.

He still goes back to the first well project he ever worked on in 1949, the Patty No. 1, just east of Comanche in southern Oklahoma. He loves to tell how he and his team were evaluating marginal well log results, trying to determine whether to complete the well or simply plug it and move on.

Pointing to oil-laden sandstone cuttings recovered from the bottom of the hole, Allen thought the well had promise. Others pointed to the well log, which gave narrow indications that hydrocarbons were there. The decision was risky, and the completion operation was costly, but Allen's argument was convincing, so the team acquiesced and set the pipe.

As it turned out, the well was a big producer, and it's still pumping oil 68 years later, Allen says with a smile.

"The samples proved to be right. The log wasn't," he says. Allen likes that story because it illustrates a truth about geology that has never really changed through the years: When there's doubt, you can trust the rocks more than the technology.



A newspaper clipping from the Daily Ardmorite features OU alumnus Robert Allen showing off two of his favorite rock samples from a collection of thousands. Allen has knowledge and passion for interpreting rocks that has led to many productive oil wells over the years.

"That's just the way it works," Allen says. Brown could not agree more. "The good ones like to see the rocks because, at the end of the day, that's where the truth is."

Technology plays an important role in modern geology, Brown says, but Allen's intuitive understanding of rock structures, folds and faults is a lost art.

"He has it in his head. He's the geologist's geologist, that's what Bob is. He didn't have a lot of technology when he was young. Using a flying analogy, he's a stick-and-rudder kind of guy. He's the real deal."

Petroleum geologist Bob Davis has known Allen for 10 years and considers him a true wildcat explorer who has made new discoveries in areas outside of established fields.

"There are not that many wildcatters left because the business is pretty risky," says Davis, a retired engineer and petroleum geologist with Schlumberger.

Allen says his life's work is driven by his passion for the geology of southern Oklahoma and his love for teaching others.

"People don't understand how complex and how beautiful this geology is," Allen says. "You just don't find it everyplace in the world. I've taken hundreds of people on field trips to the Arbuckles because I want to tell people what we have in southern Oklahoma. They don't understand it all, but that's OK."

In the Arbuckles, visitors can stand on rock that's more than 300 million years old, he says, and they can see ancient outcrops that pose wonders of fantastic proportions.

"When you look at the Cretaceous period of southeast Oklahoma, and you compare it to the White Cliffs of Dover in England, it's the same rock! How'd it get there?" Allen asks.

"Rocks are beautiful, and geology is important for everyone to understand, not just geologists."

FACULTY GRANTS AND PUBLICATIONS 2018

Younane Abousleiman
Effort Distribution: T20, R60, S20
Journal Articles
Liu, C., Mehrabian, A., Abousleiman, Y. (2018). "Theory and Analytical Solutions to Coupled Processes of Transport and Deformation in Dual-Porosity Dual-Permeability Poro-Chemo-Electro-Elastic Media." ASME Journal of Applied Mechanics, Vol. 85, No. 11, 111006-1 - 111006-13, DOI: https://doi.org/10.1115/1.4040890.

Liu, C., Abousleiman, Y. (2018). "Multiporosity/Multipermeability Inclined-Wellbore Solutions With Mudcake Effects." SPE Journal, DOI: https://doi.org/10.2118/191135-PA.

Mehrabian, A., Abousleiman, Y. (2018). "Theory and analytical solution to Cryer's problem of N-porosity and N-permeability poroelasticity." Journal of the Mechanics and Physics of Solids, Vol. 118, 218-227, DOI: https://doi.org/10.1016/j.jmps.2018.05.011.

Chen, S. L., Abousleiman, Y. (2018). "Cavity expansion in strain hardening frictional soils under drained condition." International Journal for Numerical and Analytical Methods in Geomechanics, Vol. 42, No. 1, 132-142, DOI: https://doi.org/10.1002/nag.2718.

Liu, C., Hoang, S. K., Abousleiman, Y. (2018). "Responses of chemically active and naturally fractured shale under time-dependent mechanical loading and ionic solution exposure." International Journal for Numerical and Analytical Methods in Geomechanics, Vol. 42, No. 1, 34-69, DOI: https://doi.org/10.1002/nag.2713.

Grants
Abousleiman, Y., "Geomechanics Gas Shale Consortium," Various Oil Companies, , $3,179,834. (January 1, 2005 - December 31, 2017).
Abousleiman, Y., "PoroMechanics Institute Consortium," Various Oil Companies, $6,412,357. (January 1, 2000 - December 31, 2017).

Michael Behm
Effort Distribution: T45, R45, S10
Journal Articles
Behm, M. (2018). "Reflections from the Inner Core Recorded during a Regional Active Source Survey: Implications for the Feasibility of Deep Earth Studies with Nodal Arrays." Seismological Research Letters, Vol. 89, No. 5, 1698-1707, DOI: https://doi.org/10.1785/0220180018.

Brett M. Carpenter
Effort Distribution: T45, R45, S10
Journal Articles
Liao, Z., Liu, H., Carpenter, B. M., Marfurt, K. J., Reches, Z. (2018). "Analysis of Fault Damage-Zones Using 3D Seismic Coherence in the Anadarko Basin, Oklahoma." AAPG Bulletin, DOI: 10.1306/1219181413417207.

Qin, Y., Chen, X., Carpenter, B. M., Kolawole, F. (2018). "Coulomb Stress Transfer Influences Fault Reactivation in Areas of Wastewater Injection." Geophysical Research Letters, DOI: 10.1029/2018GL079713. https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018GL079713?af=R&.

Rabinowitz, H., Savage, H., Skarbek, R., Ikari, M., Carpenter, B. M., Collettini, C. (2018). "Frictional Behavior of Input Sediments to the Hikurangi Trench, New Zealand." Geochemistry, Geophysics, and Geosystems, DOI: 10.1029/2018GC007633.

Grants
Carpenter, B. M., "EarthScope Synthesis Workshop on SAFOD Reviewing Past Predictions, Key Results, and Future Directions," National Science Foundation - Earthscope, Federal, $16,485. (May 1, 2018 - April 30, 2019).

Carpenter, B. M., Reches, Z., "Drilling Investigation of Seismogenic Crust in Oklahoma," Southern California Earthquake Center, $4,648. (February 1, 2018 - January 31, 2019).

Carpenter, B. M., Reches, Z., "Drilling Investigation of Seismogenic Crust in Oklahoma," MCEE Dean's Office, The University of Oklahoma, $36,322. (April 2018 - August 2018).

Carpenter, B. M., Reches, Z., "Drilling Investigation of Seismogenic Crust in Oklahoma," International Continental Scientific Drilling Program, $32,259. (August 2017 - August 2018).

Xiaowei Chen
Effort Distritubtion: T45, R45, S10
Journal Articles
Sweet, J. R., Anderson, K. R., Bilek, S., Brudzinski, M., Chen, X., Deshon, H., Hayward, C., Karplus, M., Keranen, K., Langston, C., Lin, F.-C., Magnani, B., Woodward, R. L. (2018). "A community experiment to record the full seismic wavefield in Oklahoma." Seismological Research Letters, DOI: https://doi.org/10.1785/0220180079.

Cheng, Y., Chen, X. (2018). "Characteristics of seismicity inside and outside the Salton Sea Geothermal Field." Bulletin of the Seismological Society of America, DOI: https://doi.org/10.1785/0120170311. https://pubs.geoscienceworld.org/ssa/bssa/article-abstract/531227/characteristics-of-seismicity-inside-and-outside.

Haffener, J., Chen, X., Murray, K. E. (2018). "Multi-scale analysis of spatiotemporal relationship between injection and seismicity in Oklahoma." Journal of Geophysical Research - Solid Earth, DOI: https://doi.org/10.1029/2018JB015512. https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018JB015512.

Pei, S., Peng, Z., Chen, X. (2018). "Locations of injection-induced earthquakes in Oklahoma controlled by crustal structures." Journal of Geophysical Research - Solid Earth, DOI: https://doi.org/10.1002/2017JB014983. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2017JB014983.

Wu, Q., Chapman, M., Chen, X. (2018). "Stress Drop Variations of Induced Earthquakes in Oklahoma." Bulletin of the Seismological Society of America, DOI: https://doi.org/10.1785/0120170335.

Chen, X., Haffener, J., Goebel, T. W., Meng, X., Peng, Z., Chang, J. (2018). "Temporal correlation between seismic moment and injection volume for an induced earthquake sequence in central Oklahoma." Journal of Geophysical Research - Solid Earth, DOI: https://doi.org/10.1002/2017JB014694

Qin, Y., Chen, X., Carpenter, B. M., Kolawole, F. (2018). "Coulomb Stress Transfer Influences Fault Reactivation in Areas of Wastewater Injection." Geophysical Research Letters, DOI: 10.1029/2018GL079713. https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2018GL079713?af=R&.

Grants
Neeman, H.J., and 30 others, "Acquisition of a Regional Resource for Long-term Archiving of Large Scale Research Data Collections," National Science Foundation, $967,755.00. (September 1, 2018 - August 31, 2021).

Chen, X. , "Collaborative Research: Multi-scale validation of earthquake source parameters to resolve any spatial, temporal or magnitude-dependent variability at Parkfield, CA," National Science Foundation, $224,262.00. (March 15, 2016 - March 14, 2020)

*Effort Distribution: T= Teaching, R=Research, S=Service

Nakata, N., Chen, X., "(Diablo) High-Frequency Ground-Motion Prediction using a 3D Subsurface Structure at the Diablo Canyon, California," University of California-Southern California Earthquake Center, $20,000. (February 1, 2018 - January 31, 2019).

Chen, X., "Probing the characteristics of earthquake source complexity in areas of structural complexity," University of California-Southern California Earthquake Center, $15,000.00. (February 1, 2018 - January 31, 2019).

Chen, X., Walter, J., "Roles of stress heterogeneity and stress interaction in induced seismicity: example from the Fairview/Woodward area in Oklahoma," U.S. Department of the Interior, U.S. Geological Survey, $52,705.00. (May 18, 2018—May 17, 2019).

Shannon A. Dulin
Effort Distribution: T70, R20, S10
Carvajal, C. P., Soreghan, G. S., Isaacson, P. E., Ma, C., Hinnov, L., Dulin, S. A. (2018). "Atmospheric dust from the Pennsylvanian Copacabana Formation (Bolivia): A high-resolution record of paleoclimate and volcanism from northwestern Gondwana." Gondwana Research, Vol. 58, 105-121.

R. Douglas Elmore
Effort Distribution: T40, R40, S20
Book Chapter
Weber, J. C., Elmore, D., Hamilton, C, Alder, A., Pope, M., Koeberl, C, 2018, On the Backs of Giants – Geology of the Kentland Impact Structure, Newton County (Kentland) Quarry, Indiana (USA) – Building on Ray Gutschick's Legacy, The Geological Society of America Field Guide 51, p1-15.

Journal Articles
Kondas, M., Filipiak, P., Paszkowski, M. M., Elmore, R. D., Jelonek, I., Kasprzyk, M. (2018). "The organic matter composition of the Devonian/Carboniferous deposits (South Flank of Arbuckle Anticline, Oklahoma, USA)." International Journal of Coal Geology, Vol. v. 198, p. 88-99, DOI: https://doi.org/10.1016/j.coal.2018.08.010.

Roberts, J., Elmore, R. D. (2018). "A diagenetic study of the Woodford Shale in the southeastern Anadarko Basin, Oklahoma, USA: Evidence for hydrothermal alteration in mineralized fractures." Interpretation v. 6, SC1-SC13, doi.org/10.1190/INT-2017-0071.1., 13, DOI: doi.org/10.1190/INT-2017-0071.1.

Grants
Elmore, R. D., "Diagenetic study of Meramec, Major and Garvin counties, Oklahoma," Devon Energy Corporation, $97,093.00. (January 30, 2017 - June 30, 2019).

Elmore, R. D., "Diagenetic study of Wolfcampian cores, Texas," Devon Energy Corporation, $150,173.00. (2014 - December 2018).
Elmore, R.D., Outreach by the OU School of Geology and Geophysics to local K12 Schools, Halliburton, $20,000 (August 15, 2018—August 14, 2019).

Elmore, R.D., "Characterization of the Basement and Fluid conduits in Arbuckle Group," OGS-Governor's office Oklahoma, $85,000. (March 2016 – June 30, 2018).

Andrew S. Elwood Madden
Effort Distribution: T40, R40, S20
Journal Articles
Tabet, W., Cerato, A., Madden, A. S., Jentoft, R. (2018). "Characterization of Hydration Products Formation and Strength Development in Cement-Stabilized Kaolinite using TG and XRD." ASCE Journal of Materials in Civil Engineering, DOI: 10.1061/(ASCE)MT.1943-5533.0002454.

Legett, C., Pritchett, B. N., Phillips-Lander, C. M., Madden, A. S., Elwood Madden, M. E. (2018). "Jarosite dissolution rates in perchlorate brine." Icarus, Vol. 301, 189-195, DOI: doi.10.1016/j.icarus.2017.06.031.

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

Megan E. Elwood Madden
Effort Distribution: T30, R40, S30
Journal Articles
McGraw, L. M., McCollom, N. M., Phillips-Lander, C. M., Elwood Madden, M. E. (2018). "Measuring Sulfate and Perchlorate in High Salinity Planetary Waters using Raman Spectroscopy." ACS Earth and Space Chemistry, Vol. 2, No. 10, 1068-1074, DOI: DOI: 10.1021/acsearthspacechem.8b00082.

Joo, Y. J., Soreghan, A. M., Elwood Madden, M. E., Soreghan, G. S. (2018). "Quantification of particle shape by an automated image analysis system: a case study in natural sediment samples from extreme climates." Geosciences Journal, Vol. 22, No. 4, 525-532, DOI: doi.org/10.1007/s12303-018-0025-0.

Joo, Y. J., Elwood Madden, M. E., Soreghan, G. S. (2018). "Anomalously low chemical weathering in fluvial sediment of a tropical watershed (Puerto Rico)." Geology, Vol. 46, No. 8, 691-694, DOI: https://doi.org/10.1130/G40315.1.3

Phillips-Lander, C. M., Parnell, S. R., McGraw, L. E., Elwood Madden, M. E. (2018). "Carbonate dissolution rates in high salinity brines: Implications for post-Noachian chemical weathering on Mars." Icarus, Vol. 307, 281-293, DOI: https://doi.org/10.1016/j.icarus.2017.10.024.

Legett, C., Pritchett, B. N., Phillips-Lander, C. M., Madden, A. S., Elwood Madden, M. E. (2018). "Jarosite dissolution rates in perchlorate brine." Icarus, Vol. 301, 189-195, DOI: doi.10.1016/j.icarus.2017.06.031.

Grants
Elwood Madden, M. E , "PDART Step-2: Raman Spectral Database of Aqueous Solutions for Planetary Science," NASA - Headquarters, $99,401. (February 13, 2018 - February 12, 2021).

Soreghan, G. S. , Elwood Madden, M. E , "Quantifying Surface Area in Muds from the Antarctic Dry Valleys: Implications for Weathering in Glacial Systems," National Science Foundation, $351,785.00. (June 1, 2016 - May 31, 2019).

Michael H. Engel
Effort Distribtuion: T50, R30, S20
Journal Articles
Connan, J., Kavak, O., Saglamtimur, H., Engel, M. H., Zumberge, A., Zumberge, J. E. (2018). "A geochemical study of bitumen residues on ceramics excavated from Early Bronze age graves (3000-2900 BCE) at Basur Höyük in SE Turkey." Organic Geochemistry, 115, 1-11.

Frederickson, J. A., Engel, M. H., Cifelli, R. L. (2018). "Niche partitioning in theropod dinosaurs: Diet and habitat preference in predators from the uppermost Cedar Mountain formation." Nature, Scientific Reports, 1-13, DOI: 8:17872, DOI: 10.1038/s41598-018-35689-6.

G. Randy Keller
Journal Articles
Stein, C., Stein, S., Elling, R., Keller, G.R., Kley, J. (2018). "Is the "Grenville Front" in the central United States really a Grenville Front?", GSA Today, p. 1465-1470.

Stern, R. J., Keller, G.R., and Li, S. (2018). "Continental Crust of China: A Brief Guide for the Perplexed." Earth-Science Reviews, v.179, p.72–94, DOI: 10.1016/j.earscirev.2018.01.020.

Stein, S., Stein, C., Elling, R., Kley, J., Keller, G.R., Wysession, M., Rooney, T., Frederiksen, A., Mouch, R. (2018). "Insights from North America's failed Midcontinent Rift into the evolution of continental rifts and passive continental margins." Tectonophysics, v. 744, p. 403-421.

Xiaolei Liu
Effort Distribution: T45, R45, S10
Journal Articles
Zeng, Z., Liu, X. L., Wei, J.H., Summons, R.E., Welander, P.V., 2018. Calditol-linked membrane lipids are required for acid tolerance in Sulfolobus acidocaldarius. Proceedings of the National Academy of Sciences 115, 12932–12937.

Liu X.-L., Lipp J.S., Elling F., Birgel D., Summons R.E., Hinrichs K.-U., 2018. Predominance of the parallel glycerol arrangement in archaeal tetraethers from marine subsurface sediments: structural features revealed by degradation products. Organic Geochemistry, 115, 12–23.

Grants
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).

David London
Effort Distribution: T35, R40, S25
Journal Articles
London, D. (2018). "Ore-Forming Processes within Granitic Pegmatites." Ore Geology Reviews, Vol. 101, 349-383.

London, D. (2018). "Reading pegmatites: what quartz and feldspar say." Rocks & Minerals, Vol. 93, 320-336.

Maner, J. L., London, D. (2018). "Fractionation of the isotopes of boron between granitic melt and aqueous solution at 700°C and 800°C (200 MPa)." Chemical Geology, Vol. 489, 16-27.

Grants
London, David, "An Experimental Calibration of the Fractionation of Boron Isotopes among Granitic Melt, Aqueous Fluid, and Tourmaline," National Science Foundation, $314,562.00. (June 15, 2016 - May 31, 2018).

Richard Lupia
Effort Distribution: T40, R40, S20
Grants
Landis, M., Lupia, R. A., "Digitization TCN: Collaborative Research: The Pteridological Collections Consortium: An integrative approach to pteridophyte diversity over the last 420 million," Yale University, University. (August 1, 2018 - July 31, 2021).

Kurt J. Marfurt
Effort Distribution: T40, R40, S20
Book
Marfurt, K. J. Seismic attributes as the framework for data integaration through the life of the oil field, Tulsa: Society of Exploration Geophysics, 450.

Journal Articles
Liao, Z., Liu, H., Carpenter, B. M., Marfurt, K. J., Reches, Z. (2018). "Analysis of Fault Damage-Zones Using 3D Seismic Coherence in the Anadarko Basin, Oklahoma." AAPG Bulletin, DOI: 10.1306/1219181413417207.

Alali, A., G. Machado, and Marfurt, K.J., (2018). "Attribute-assisted footprint suppression using a 2D continuous wavelet transform." Interpretation, 6, T457-T470.

Chopra, S., and Marfurt, K.J. (2018). "Coherence attribute applications on seismic data in its many guises – Part 1." Interpretation, 6, T521-T529.

Chopra, S., and Marfurt, K.J., (2018). "Coherence attribute applications on seismic data in its many guises – Part 2." Interpretation, 6, T531-T541.

Infante-Paez, L., and Marfurt, K.J., (2018). "In-context interpretation: Avoiding pitfalls in misidentification of igneous bodies in seismic data." Interpretation, 6, SL29-SL42.

Li, F., Qi, J., Lyu, B., and Marfurt, K.J., (2018). "Multispectral coherence." Interpretation, 6, T61-T69.

Lyu, B., Su, Q., and Marfurt, K.J., (2018). "Tomographic velocity analysis and wave-equation depth migration in an overthrust terrain: A case study from the Tuha Basin, China." Interpretation, 6, T1-T13.

Qi, X., and Marfurt, K.J. (2018). "Volumetric aberrancy to map subtle faults and flexures." Interpretation, 6, T248-T365.

Zhao, T., Li, F., and Marfurt, K.J. (2018). "Seismic attribute selection for unsupervised seismic facies analysis using user-guided data-adaptive weights." Geophysics, 83, O31-O44.

Grants
Sondergeld, C. H., Rai, C. S., Devegowda, D., Ousseini Tinni, A., Marfurt, K. J., Pranter, M. J., "Reservoir Characterization in Unconventional Oil & Gas Reservoirs," Marathon Oil Company. (September 1, 2017 - August 31, 2020).

Marfurt, K. J., "Consortium: Regional Woodford Shale stratigraphy, Oklahoma," Various Oil Companies. (January 2013 - January 2019).

Marfurt, K. J., "Attribute-Assisted Seismic Processing and Interpretation Consortium," Various Oil Companies, $2,253,975.00. (January 2008 - December 2018).

Shankar Mitra
Effort Distribution: T40, R40, S20

Nori Nakata
Effort Distribution: T45, R45, S10
Grants
Walter, J., Nakata, N., "NSFPLR-NERC: TIME (Thwaites Interdisciplinary Margin Evolution) - The Role of Shear Margin Dynamics in the Future Evolution of Thwaites Drainage Basin," University of California-Santa Cruz. (April 1, 2018 - March 31, 2023).

Neeman, H. J. and 30 others, "Acquisition of a Regional Resource for Long-term Archiving of Large Scale Research Data Collections," National Science Foundation, $967,755.00. (September 1, 2018 - August 31, 2021).

John D. Pigott
Effort Distribution: T40, R40, S20
Journal Articles
Metawalli, F., Pigott, J., Ramada, F.S., El-Khadragy, A. A., Alfify, W.A. (2018). "Reservoir Characterization, Tut oil field, North Western Desert, Egypt,." Environmental Earth Sciences, Vol. 77, 77-143.

R. Paul Philp
Journal Articles
Miceli Romero, A.A., Nguyen, T., Philip, R. . (2018) Subsurface and outcrop organic geochemistry of the Eagle Ford shale in West, Southwest, Central and East Texas. AAPG Bull. 102(7), 1379-2412.

Connock, G.T., Nguyen, T., Philip, R.P. (2018). Elucidating environmental fluctuations concomitant with Woodford shale deposition: An integration of sequence stratigraphy and organic geochemistry. AAPG Bulletin, 102(6), 959-986.

Van Groos, P.G., Koster, P.B., Hatzinger, S.H., Streger, S.V., Philip, R.P., Kuder, T. (2018). Carbon isotope fractionation of 1,2-dibromoethane (EDB) by biological and abiotic processes. Environ. Sci. Technol. On line version: DOI: 10.1021/acs.est.7b05224

Ojeda, A.S., Widener, J., Aston, C.E., Philip, R.P. (2018). ESRD and ESRD-DM associated with lignite-containing aquifers in the U.S. Gulf Coast region of Arkansas, Louisiana, and Texas. International Journal of Hygiene and Environmental Health, 221 (6), 958-966. https://doi.org/10.1016/j.ijheh.2018.05.002.

Ojeda, A.S., Ford, S.D., Gallucci, R.M., Ihnat, M.A., Philip, R.P. (2018). Geochemical Characterization and Renal Cell Toxicity of Water-Soluble Extracts from Gulf Coast Lignite. Environ Geochem Health. https://doi.org/10.1007/s10653-018-0196-7.

Matthew J. Pranter
Effort Distribution: T40, R40, S20
Journal Articles
Suriamin, F., Pranter, M. J. (2018). "Stratigraphic and lithofacies control on pore characteristics of Mississippian limestone and chert reservoirs of north-central Oklahoma." Interpretation, V. 6, No. 4, T1001-T1022, DOI: 10.1190/int-2017-0204.1. http://dx.doi.org/10.1190/int-2017-0204.1.

Wethington, N. W., Pranter, M. J. (2018). "Stratigraphic architecture of the Mississippian limestone through integrated electrofacies classification, Hardtner field area, Kansas and Oklahoma." Interpretation, V. 6, No. 4, T1095-T1115, DOI: 10.1190/int-2018-0042.1. http://dx.doi.org/10.1190/int-2018-0042.1.

Lewis, K., Pranter, M. J., Reza, Z. A., Cole, R. (2018). "Fluvial Architecture of the Burro Canyon Formation using UAV-Based Photogrammetry: Implications for Reservoir Performance, Rattlesnake Canyon, Colorado." The Sedimentary Record, V. 16, No. 3, 4-10.

Clark, S., Pranter, M. J., Cole, R., Reza, Z. A. (2018). "Fluvial architecture of the Burro Canyon Formation using UAV-based photogrammetry and outcrop-based modeling: implications for reservoir performance, Escalante Canyon, southwestern Piceance Basin, Colorado." Interpretation, v. 1-67.

Gogri, M. P., Rohleder, J. M., Kabir, C. S., Pranter, M. J., Reza, Z. A. (2018). "Prognosis for Safe Water-Disposal-Well Operations and Practices That Are Based on Reservoir Flow Modeling and Real-Time Performance Analysis." SPE Reservoir Evaluation & Engineering, Vol. 21, No. 03, 576-592, DOI: 10.2118/187083-pa. http://dx.doi.org/10.2118/187083-pa.

Grants
Sondergeld, C. H., Rai, C. S., Devegowda, D., Ousseini Tinni, A., Marfurt, K. J., Pranter, M.J., "Reservoir Characterization in Unconventional Oil & Gas Reservoirs," Marathon Oil Company. (September 1, 2017 - August 31, 2020).

Ze'ev Reches
Journal Articles
Liao, Z., Liu, H., Carpenter, B. M., Marfurt, K. J., Reches, Z. (2018). "Analysis of Fault Damage-Zones Using 3D Seismic Coherence in the Anadarko Basin, Oklahoma." AAPG Bulletin, DOI: 10.1306/1219181413417207.

Grants
Reches, Z., "Investigating Earthquake Source Processes in the Laboratory," National Science Foundation, $331,996.00. (July 1, 2016 - June 30, 2019).

Reches, Z., "Rock mechanics of reservoir rocks," China University of Petroleum, $35,782.00. (October 7, 2018 - March 31, 2019).

Roger M. Slatt
Effort Distribution: T40, R40, S20
Grants
Slatt, R.M., "Consortium: Regional Woodford Shale stratigraphy, Oklahoma," Various Oil Companies. (January 1, 2013 - January 31, 2019).

Gerilyn S. Soreghan
Effort Distribution: T30, R20, S50
Journal Articles
Carvajal, C. P., Soreghan, G. S., Isaacson, P. E., Ma, C., Hinnov, L., Dulin, S. A. (2018). "Atmospheric dust from the Pennsylvanian Copacabana Formation (Bolivia): A high-resolution record of paleoclimate and volcanism from northwestern Gondwana." Gondwana Research, V. 58, 105-121.

Smith, C., Soreghan, G. S., Ohta, T. (2018). "Scanning electron microscope (SEM) microtextural analysis as a paleoclimate tool for fluvial deposits: a modern test." Geological Society of America Bulletin, V. 130, 1256-1272, DOI: https://doi.org/10.1130/B31692.1.

Soreghan, M. J., Swift, M. M., Soreghan, G. S. (2018). "Provenance of Permian eolian and related strata in the North American midcontinent: Tectonic and climatic controls on sediment dispersal in western tropical Pangea." Geological Society of America Special Paper, V. 540, 27, DOI: https://doi.org/10.1130/2018.2540(28).

Joo, Y. J., Soreghan, A. M., Elwood Madden, M. E., Soreghan, G. S. (2018). "Quantification of particle shape by an automated image analysis system: a case study in natural sediment samples from extreme climates." Geosciences Journal, V. 22, No. 4, 525-532, DOI: doi.org/10.1007/s12303-018-0025-0.

Joo, Y. J., Elwood Madden, M. E., Soreghan, G. S. (2018). "Anomalously low chemical weathering in fluvial sediment of a tropical watershed (Puerto Rico)." Geology, V. 46, No. 8, 691-694, DOI: https://doi.org/10.1130/G40315.1.

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

Soreghan, G.S., "Deep Dust: Probing Continental Climate of the Late Paleozoic Icehouse-Greenhouse Transition," International Continental Drilling Program, $77,810.00. (October 1, 2018 - September 30, 2019).

Soreghan, G.S., "ELT COLLABORATIVE RESEARCH: Investigating the Biotic and Paleoclimatic Consequences of Dust in the Late Paleozoic," National Science Foundation, $473,116.00. (September 1, 2013 - August 31, 2019).

Soreghan, G.S., Elwood Madden, M.E., "Quantifying Surface Area in Muds from the Antarctic Dry Valleys: Implications for Weathering in Glacial Systems," National Science Foundation, $351,785.00. (June 1, 2016 - May 31, 2019).

Michael J. Soreghan
Effort Distribution: T40, R40, S20
Journal Articles
Busch, J., Soreghan, M. J., de Beurs, K. M., McGlue, M., Kimirei, I., Cohen, A., Ryan, E. (2018). "Linking watershed disturbance with nearshore sedimentation and the shell beds of Lake Tanganyika (Mahale Mountains, Tanzania)." Environmental Earth Sciences, Vol. 77, 514.

Soreghan, M. J., Swift, M. M., Soreghan, G. S. (2018). "Provenance of Permian eolian and related strata in the North American midcontinent: Tectonic and climatic controls on sediment dispersal in western tropical Pangea." Geological Society of America Special Paper, Vol. 540, 27, DOI: https://doi.org/10.1130/2018.2540(28).

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

Soreghan, M.J., "The origin and time averaging of Lake Tanganyika shell beds: Implications for conservation and paleoecology of large tropical lakes," National Science Foundation, $314,000.00. (September 1, 2014 - August 31, 2019).

Barry L. Weaver
Effort Distribution: T60, R20, S20

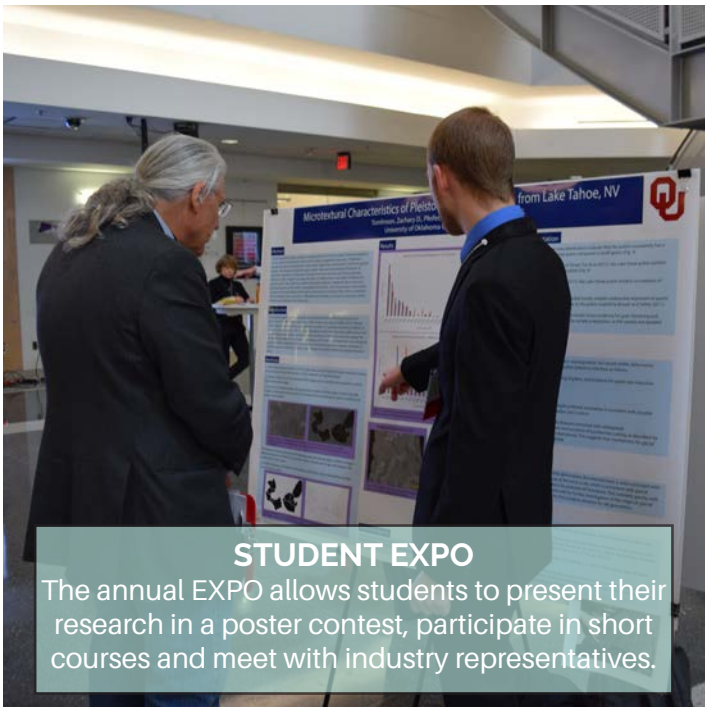
Stephen R. Westrop
Effort Distribution: T40, R30, S30
Journal Articles
Westrop, S. R., Landing, E., Dengler, A. A. (2018). ""Pseudocryptic" species of the Middle Cambrian trilobite Eodiscus Hartt in Walcott, 1884, from Avalonian and Laurentian Newfoundland." Canadian Journal of Earth Sciences, Vol. 55, 997–1019.

Grants
Westrop, S.R., "Digitization PEN: Expanding and enhancing a TCN digitizing fossils to reconstruct evolving ecosystems the Cretaceous Western Interior Seaway," National Science Foundation, $102,369.00. (September 1, 2017 - August 31, 2020).

YOUR CONTRIBUTION MATTERS

FIELD TRIPS
Field trips are incorporated into many courses to bring our students opportunities for hands-on experience in the field. Recent field trip destinations include: Galveston, Texas, Carlsbad, New Mexico and Yellowstone, Wyoming.

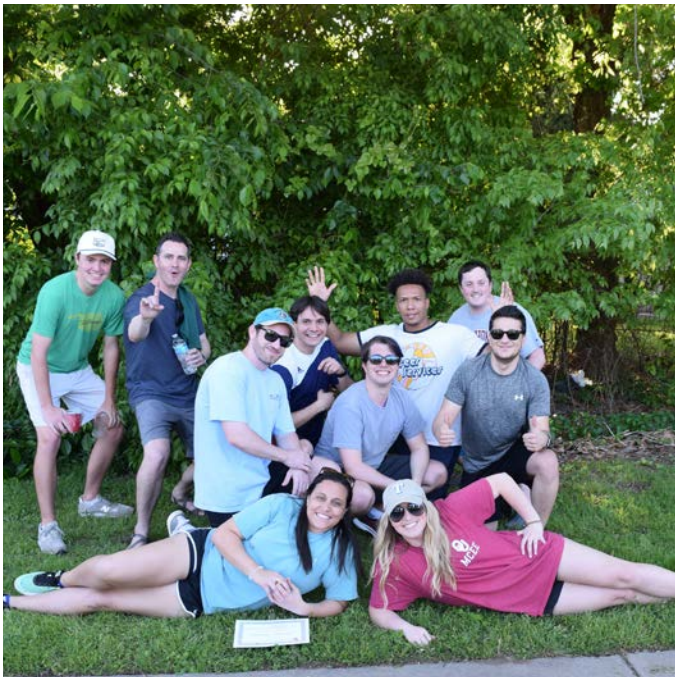
TA SUPPORT
Provides crucial graduate student support to help us elevate the status and impact of our program.



STUDENT EXPO
The annual EXPO allows students to present their research in a poster contest, participate in short courses and meet with industry representatives.

KEEP IN TOUCH WITH THE SCHOOL OF GEOSCIENCES

VISIT **GEOSCIENCES.OU.EDU** TO LEARN ABOUT UPCOMING EVENTS AND WAYS TO GET INVOLVED



FOLLOW US ON SOCIAL MEDIA

Facebook: @ougeosciences
Twitter: @ougeosciences
Instagram: @ougeosciences

MEWBOURNE COLLEGE OF EARTH AND ENERGY

SCHOOL OF GEOSCIENCES

The UNIVERSITY *of* OKLAHOMA