

SPRING 2019

M
EARTH

GEOSCIENCE NEWS

**For Alumni and Friends of the Department of Earth and Environmental Sciences
The University of Michigan**





Greetings from Ann Arbor! I hope your past year has been met with good fortune. For us here in the upper Midwest, there has been a lot going on! First, you'll probably notice that you expected Chris Poulsen's picture and annual note, and instead you are looking at a new face. In May of this past year, Chris took on a position as Associate Dean of Natural Sciences for LSA. While we were remiss to see Chris' chairmanship tenure in our own department terminate prematurely, we are thrilled to see him take on this important role in the College and know that we will continue to benefit from his leadership.

As a result, I've stepped into the role of Acting Chair for 2018-19 and I am honored to do so. My research background is in tectonics and geomorphology, and I've been in the department since I was hired as a newly-minted assistant professor in 2006. For the past four years under Chris' chair leadership, I've been serving as the Associate Chair for Graduate Studies. Chris left big shoes to fill and leading such a talented group of energetic faculty, staff and students has been an exciting ride. I am happy to report on the accomplishments and successes of our department over the past year.

Change hasn't been limited to just the leadership, there have been some substantial investments made in the development of new facilities in our building, on campus, and at our field station. Ingrid Hendy leads the new Michigan Elemental Analysis Laboratory or 'MEAL' for short, replacing the old KECK department facility. This lab features a new Thermo Element (HR-ICP-MS) and ICAP quadrupole mass spectrometer, which will be capable of serving our department researchers, as well as attracting collaborations from across campus and around the country. Additionally, with the recent hire of Asst. Professor Jena Johnson, the Michigan ExoBiology Laboratory was developed to investigate microbe-mineral interactions that explore the evolution of metabolism during the Early Earth, particularly focused on the progression of oxidation of our atmosphere in the Precambrian. With the recent completion of the Biological Sciences Building, our paleontologists took up a new home in a newly created UM Museum of Paleontology, which houses state of the art classroom and specimen preparation facilities. Finally, construction is nearing completion of a renewed, state-of-the-art Stable Isotope Laboratory that will serve the needs of Profs. Julia Cole, Sierra Petersen and Kacey Lohmann. The Department strives to develop and maintain world class laboratories in all the fields of the Earth and environmental sciences.

We are also so excited about the nearing completion of a major renovation at our Camp Davis field station! After many years of planning and with the generous support of alumni and friends, new cabins and much needed infrastructure are being built, including 30 new student cabins. To celebrate this renewal and 90 years since the first courses were taught at Camp Davis, the Department will sponsor an Alumni Reunion in this coming summer. We hope that you will be able to join us and revisit your memories of this special place in all of our hearts. More information about this activity can be found at <https://goo.gl/31vs1P>.

All these new facilities greatly benefit the experience of our graduate and undergraduate students in terms of their access to frontier research and experience in the classroom and field. So I'm also happy to report that following our 2014 high in undergraduate enrollment of 160 majors that our student majors have once again started to steeply climb. We currently have 133 majors and 40 minors in our program and expect that number to grow to our 2014 peak by the end of the winter term. Over the past five years we've maintained a growth of more than double our undergraduate enrollment rate compared to the previous decade. We expect that to grow even further as interest in natural sciences across the college is increasing, in part due to the exciting job opportunities that the sciences provide. Landing that first job after college or grad school continues to be at the forefront of our students' minds, and we deeply appreciate the increased involvement of alumni support for providing career guidance and internship opportunity. We have a newly developed "Career" webpage and offer in-house career counseling to our students through a new staff position. Involvement in career mentoring is another way alumni can greatly enrich the opportunities of our current students, and we encourage you to think about ways you can help.

Last, I'd like to extend a special thank you for your support of the Department and encourage you to keep in touch. As a community, we all benefit from hearing what you are up to and how Michigan continues to affect your life.

Warmly,
Marin

WHEN YOU GIVE TO MICHIGAN EARTH.....

.....IT MATTERS

Every year your donations to the Department help create new opportunities while sustaining activities and programs that support our students and faculty. This last year the number of alumni, friends and corporations that gave exceeded levels seen in the past. Notably, the Department received a major endowment from the Sharma family that will provide support for graduate student tuition stipends (*see page 20*). This, in combination with the generous gifts provided by all of you, ensures that we are able to attract and retain some of the nation's brightest and best in our graduate program.



Donations to our EARTH CAMP fund have allowed us to continue to offer a transformative program that recruits highly motivated, under-represented high school students from Michigan communities to increase the diversity of students majoring in Earth and Environmental Sciences. This program, in its fourth year, has been highly successful with all nineteen students now enrolled in college, and five are majoring in Earth science. Your gifts will allow us to sustain this important initiative (*see page 29*).

With great anticipation, Camp Davis is finally undergoing its long needed renovations. This has been made possible by you after many years of dedicated efforts in fundraising. In celebration, we are holding the 90th year Camp Davis Reunion this summer and hope to have you join us (*see page 5*).

There are so many critical activities that are made possible through your gifts. Six field excursions were offered to students who otherwise would not have had the hands-on experiences necessary to become a geologist. Research support and travel funds for national meetings have enabled both graduate and undergraduate students the opportunity to present their findings and to network with the leaders in their field. Without your past and future support, these enriching programs would not be possible.



THANK YOU. *You have helped make and keep EARTH strong.*

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COVER PAGE PHOTO

Camp Davis Cabins as they were from 1929 until 2018. Renovation of all of the original cabins and infrastructure is currently underway. See article on Page 4.

Photo by Kacey Lohmann

FUND RAISING

HELP SUPPORT MORE FIELD EXCURSIONS: NATIONAL AND INTERNATIONAL TRIPS

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HELP US SUPPORT EARTH CAMP AND OUTREACH

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Geoscience News is compiled periodically for alumni and friends of the Department of Earth and Environmental Sciences at the University of Michigan, Ann Arbor, MI 48109-1005

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Camp Davis Gazette



Above: Students study basalt outcrops associated with the Yellowstone hotspot track near Island Park, ID.

With incredible excitement, quite a bit of nostalgia, and a bit of nervousness about the timeline and weather, the student cabin renovation and recreation building project kicked off in August this year, just days after the last classes departed Camp Davis for the return trip to Ann Arbor.

More than five years in planning and preparation, this major renovation project will replace the 90-year-old student cabins and the Johnston Hall recreation building, which collapsed in a snow and ice storm two winters ago. It has been gratifying to hear from many alumni about their memories of the student cabins and their time at Camp Davis. At the same time, replacing the infrastructure that supported the student cabins and bath houses had become a matter of increasing urgency with each passing year.

When completed in April, 30 new heated, insulated and wildfire-resistant student cabins will be constructed, and all utilities on the student side of Camp, including electrical, water, fire suppression, and waste management systems, will be replaced and routed underground. Johnston Hall will be reconstructed across from the dining hall as a new three-season multi-purpose building, with adjacent student laundry facilities. Construction is moving along quickly, with all underground utility work and footings and foundations completed. A new fire access road is under construction, as of this writing, and new cabins, which were built off-site in Idaho Falls, began arriving at Camp the week before Christmas 2018.

In anticipation of the completion of this project, and to celebrate the incredible efforts and support of the College of Literature, Science, and the Arts, our Department, and, most importantly, our alumni, without whom this project would never have gotten off the ground, we are planning an alumni reunion event and cabin dedication August 16-22, 2019 (see information on facing page).

As in previous years, we were able to offer a full slate of Earth and environmental sciences courses at Camp Davis this past summer, although we wrapped up classes earlier than usual to allow the renovation to get underway. Our minds are already turning as we think about the possibilities that our new facilities will open up for teaching, research, conferences, and workshops, and I'm certain that there

will be exciting new educational opportunities for our students in the next few years.

I hope that many of you are able to make it to Camp Davis next summer for our alumni event and dedication. In the meantime, thank you to all of our alumni who support Camp Davis through gifts for renovations, yearly operations, and student scholarships. We are proud to lead Camp Davis into its 90th year of operation, and we could not do it without your support.

Nathan Niemi
Camp Davis Director



THE LAST 440's to enjoy the rustic Camp Davis cabins prior to the major renovation that is taking place this Winter were taught by **John Geissman (BS'73,MS'76,PhD'80)**. There are lots of recollections of hard work in the field, late nights in the classroom, and fun with their colleagues, much of this embodied in the years of graffiti ornamenting the cabin walls. This archive is now lost, but will forever be present in our memories of Camp Davis' past.

CAMP DAVIS REUNION 2019
90th Anniversary
and
Student Cabin Dedication
August 16 to 22, 2019

Join us at Camp Davis to celebrate our 90th year of operation, dedicate new cabins, and enjoy a week of activities in the Jackson, Wyoming area.

Schedule:

Friday August 16: Arrival by dinner

Saturday August 17: Cabin dedication at 3 pm

Sunday August 18-Wednesday August 21

Activities in and around Camp Davis

Lectures, hiking, rafting, horseback riding

Thursday August 22: Departure after breakfast

If you would like to confirm a spot at the reunion or get additional information visit our site at:

<https://goo.gl/31vs1P>

Or, e-mail Michigan-Earth@umich.edu.



Above: New foundations are being poured for the student cabins (center and right rows), while the foundation for the new student recreation building, to replace Johnston Hall, can be seen at the upper left of the photo, near the dining hall.



SOFT ROCK SPRING FIELD TRIP GO WEST: FROM ANN ARBOR TO WEST TEXAS

FIELD EXCURSIONS — WEST TEXAS AND THE SW



Preparing students for section measuring in Penn-Permian section in Dry Canyon, NM. Photo by Peter Knoop

Appalachian Mountains. Sequences reflecting fluvial to deltaic systems are exceptionally exposed in this area.

The group then proceeded westward through Oklahoma where stops in Permian-aged tidal flat evaporite sequences revealed extensive gypsum deposits: an excellent prelude to examining the Permian and Triassic units in Palo Duro Canyon. Finally, after several days, we arrived at the Permian Basin where we spent three days hiking the Permian Reef Trail in McKittrick Canyon, visiting Carlsbad Caverns and examining the basal sections of sandstones and evaporites.

ABOVE RIGHT: Ian Donnelly and Monique Perez documenting lithologies while measuring a stratigraphic section in Dry Canyon, New Mexico. Photo by Peter Knoop

The Soft Rock Spring Field Trip continues to live and flourish. This year, **Peter Knoop (MS'94)** and **Kacey Lohmann (Professor)** led a great group of 30 students from Ann Arbor, across the Midwest, to Texas and New Mexico. While examining the geologic archives in outcrops and quarries along the way, students built a framework of the evolution of North American geology, enabling them to envision the progression of sedimentary environments in response to regional tectonic and global eustatic events.

Early stops included the Paleozoic sequences of southern Indiana examining Ordovician through Mississippian carbonates and shales exposed in spectacular outcrops. Passing through thick sequences of Pennsylvanian clastics, the group became aware of the magnitude of erosion and transport of sediment from the emerging



HOW TO SHOW YOUR SUPPORT

Gifts to the Field Excursion Fund - #366013 will be used to defray the cost to our students of field experiences in the U.S. and abroad. Such experiences are vital to developing the geological perspective necessary to support the needs of our society in the future.

Give with the enclosed envelope or go to the Department home page and click on "Give Online".

<http://lsa.umich.edu/earth/alumni-friends/victors-campaign.html>





ABOVE: This year's group in the Permian Basin at the base of El Capitan.
Photo by Peter Knoop

Though the Permian Reef is one of the more spectacular features and foci of the trip, the excursion was only at its half way point. We continued into New Mexico to acquaint the students with measuring, describing and interpreting sections in Dry Canyon. Here excellent exposures of algal mounds and cyclic Penn-Permian carbonates are available replete with paleosols and coastal marine deposits. While in the area, we took a quick trip to White Sands National Monument,

an excellent locality to learn first hand processes of eolian transport and deposition.

Proceeding southward to the Franklin Mountains, the class made several stops along the TransMountain highway west of El Paso, where Precambrian sediments and metamorphic rocks are excellently exposed along the road. While camping in the Davis Mountains, several day-trips into and around Big Bend provided a glimpse into volcanic rocks and the deformed Paleozoic sequences associated with late Carboniferous deformation around Marathon. In addition to looking at the Caballos Novaculite, the highly-deformed Pennsylvanian Hammond Fm. turbidite sequence was one of the highlights providing students with experience in deep shelf environments comparable in time to the shallow water sediments examined earlier on the trip. Heading homeward across the Edwards Plateau, Cretaceous rudist reef and shallow restricted carbonates provided a contrast to the Paleozoic units that were the focus of the earlier trip.

On the final days of the trip home, camping on the beach near Port Arthur, TX, afforded an opportunity to have a crayfish and shrimp boil as a final field trip banquet. After 100 pounds of crayfish, corn, and potatoes, we proceeded to western Alabama to a unique site at Moscow Landing near Demopolis, AL. Here, the Upper Cretaceous Prairie Bluff Chalk is disconformably overlain by the Paleocene Clayton Fm. This is interpreted to have formed as a result of the tsunami associated with bolide impact at the K/P boundary. A spectacularly complicated series of outcrops. Then Home.

The students thank all who have helped make these trips possible with your generous donations to the Field Excursion Fund. Thank you from all of our hearts....



Michigan Spirit is demonstrated wherever students travel. In the Salt Flats of West Texas, MICHIGAN is spelled out with El Capitan in the distance. Photo by Kacey Lohmann

SEDIMENTARY GEOLOGY

INDIANA AND KENTUCKY

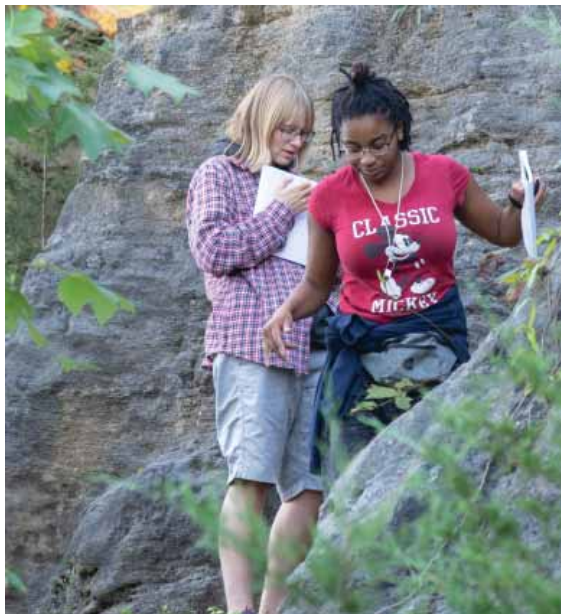
CLASS FIELD TRIPS



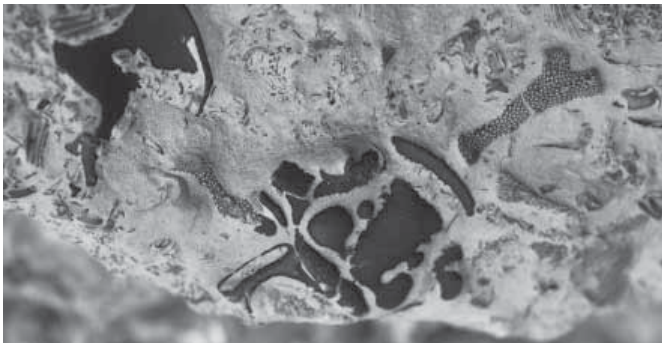
Kacey Lohmann professing about biopeloosparites and the myriad of primary sedimentary structures in the Salem Limestone near Bloomington, IN.

Professor Kacey Lohmann led two field trips this last year associated with his Sedimentary Geology course. This class has remained a popular option for students with enrollments ranging from 40 to 70 people each Fall. This year, this trip explored the geology from Ann Arbor, through Indiana and into northern Kentucky. Highlights included the Fort Wayne Ardmore Avenue Quarry to examine the Upper Silurian and Middle Devonian units that are separated by a distinctive disconformity. The trip continued through central Indiana to the classic Late Silurian Pipe Creek Junior Quarry where reef core and flank facies are exceptionally exposed. Each year with increased removal of limestone, some of the best and well preserved Silurian reefal facies are gradually disappearing. After a long drive southward beyond Bloomington, exposures of Mississippian-aged limestones begin to appear. The renowned "Indiana Limestone" from which many of the University's building are constructed, and also the Empire State Building, provides a glimpse into facies characteristic of the environments reflective of the broad late Paleozoic epeiric seas. Replete with fossiliferous and oolitic grainstones, these units provide students with field experience in observing, documenting and interpreting sedimentary structures and environments. The trip continued into Kentucky to observe the Ordovician through Devonian sequence between Jeffersonville, Indiana and Frankfort, Kentucky.

For the aspiring paleontologists, after a cold and wet night of camping in Clifty Falls State park by Madison, Indiana, the trip concluded with an extended stop in the Late Ordovician Whitewater Formation where students learned the pleasures of section measuring in preparation for their field course at Camp Davis in Wyoming. These sections, containing a diversity of brachiopods, crinoids, trilobites and bryozoa, serve as the final hooray for a short but fruitful excursion into the geological wonders of the Midwest.



Above: Emmiline Wolowiec and Ariana Mann, undergraduate majors, traversing the outcrops in search of blastoids and crinoids. Photo by Peter Knoop



Left: Head of an Ordovician Trilobite from the Whitewater Formation. Photo by Kacey Lohmann.

OCEANOGRAPHY IN ITALY

AN INTERNATIONAL EXPERIENCE



This July a group of 15 students, including 4 Earth majors or minors who took 'Intro Oceanography' in Winter 2018, joined **Michela Arnaboldi (Lecturer II)** for '*Oceanography in Italy*', a 3-weeks class across Italy organized by CGIS (Center for Global and International Studies) focused on the coastal geology of Italy. We spent our time on both coasts, exploring the Adriatic, including the Venice lagoon, and the Tyrrhenian coast, right off of Rome. The first two weeks were spent on the eastern side of Italy where we visited the delta of the largest river in Italy, the Po River, and the associated lagoons including Venice and Chioggia. We visited the pumping stations that must run constantly to keep land dry and habitable. Our excursions included examination of aquaculture mussel and clam farms, eel canning operations and we saw the effects of overfishing on towns and villages. During our time in Venice, we witnessed the high spring tide with water bubbling up from Piazza San Marco. Here we also sampled plankton from the river delta, and took sand and shell samples at the beach. We spent our last week in Rome, on the western side of Italy. In this region at Ostia Antica, we were able to see the extent of sea level rise that has taken place since Roman times and witness how the Roman aqueduct system worked and still works today. In Rome, we revisited the issue of overfishing, visited FAO and a fish market at Eataly, and were able to observe the remarkable difference between the two coasts with a visit to Santa Severa.

It goes without saying, we sampled all kinds of incredible food, visited museums and monuments, and had a taste of *La Dolce Vita*.

PHYSICAL OCEANOGRAPHY

A CRUISE ON THE LAURENTIAN



Above: Group photo in *Silverside's* berth. Students learned the joys of tight sleeping quarters while exploring this WWII submarine.



Below: The class examining the catch from a plankton tow. Students from left to right - **Nate Johnson, Roi Memmesheimer, and Lance Dreisbach.**

Left: This invasive species of freshwater shrimp was found during their trip.



CLASS FIELD TRIPS

This year, for the sixth time, students participated on a field trip aboard the *R/V Laurentian* for EARTH 421 (Introductory Physical Oceanography), taught by **Associate Professor Brian Arbic**. The trip gives U-M students the opportunity to deploy oceanographic instruments such as sidescan sonar, Ponar sediment grabs, conductivity-temperature-depth (CTD) profilers, etc. The field trip is optional, but as usual, most of the students in the class undertook the trip, which took place Nov. 9-10. Fourteen U-M students and personnel--eleven 421 students, the class grader (Paige Martin, a physics graduate student who works with Arbic), Arbic, and **Professor Julia Cole**-- participated. Professor Cole, a new member of our department, used the trip as a scouting experience, and is considering running similar trips in her own courses. The *R/V Laurentian*, which was once owned by U-M, is now the workhorse large vessel for NOAA research on the Great Lakes. We spent the night of November 9 on the *Silversides*, a WWII-era submarine [see photo]. This year featured the windiest weather we have seen. Due to gale-force winds, the crew could not take the ship off the dock. The students, led by the NOAA crew, still managed to deploy most of the equipment we usually deploy, from the sitting ship.



Above: **Alina Drebin** deploys a remote vessel as part of the on-board science exercises.

We thank the generous donors to the Department who enable the financial support of this trip, which is always a highlight of EARTH 421 for both students and faculty.

STRUCTURAL GEOLOGY

THE APPALACHIANS

Professor Ben van der Pluijm again ran his group of Structural Geology students in the study of the deformation in the Appalachians. This three day field trip comprised a caravan of 6 university minivans to transport the Michigan undergraduates and a support team of 5 graduate students. They were lucky again, with clear, yet very cold weather. Forecasts had predicted 2-4 inches of snow, which fortunately never came. This year's group was really great. All sites were accessible even with such a large group. They saw great structures, had nice group meals, and slept in luxurious Super8 lodging. Overall a spectacular trip!



Group photo on day 3 at the NW-stepping ramp anticline (or fault-bend fold) of Willis Mtn, that is marked by ridge-forming Silurian sandstone/quartzite.

Photos by Nikolas Midttun.

STRATIGRAPHY AND BASIN ANALYSIS

THE PALEOZOIC OF OHIO

Naomi Levin (Associate Professor) and 5 undergraduate and 3 graduate students spent the April 14 weekend looking into the geology and stratigraphy of Ordovician and Silurian rocks in western Ohio. The trip was a culmination of the skills they learned in EARTH 467 (Stratigraphy and Basin Analysis) and focused on making direct observations of sedimentary sequences to evaluate depositional environments and basin evolution.

On the second day, the group got up early to beat the midday rains and spent the morning measuring multiple stratigraphic sections in Oakes Quarry Park, east of Dayton, to characterize temporal and lateral variation in the lower Silurian Brassfield Formation. This part of the section was chock full of fossils (e.g., crinoids, brachiopods, corals, bryozoans, sponges, molluscs, and trace fossils). The group didn't need signs to find the fossils but this group photo seems appropriate in the context of topics on relative age dating that the students tackled earlier in the semester.



On the way south, the group stopped to examine the Greenfield Dolomite at the top of the sequence and tried to make sense of the mounds exposed on the bedding surface along the Maumee River in Side Cut Metropark. Everyone else along the river was taking advantage of the good fishing and had no interest in the 430 Ma rocks.

Alumni News

Sam Haines (PhD,2008): It's official - starting next month, Sam will be a Senior Research Fellow at Nanyang Technological University in Singapore. He will be working on the major fault zones of the Nepali Himalaya, with seismic imaging, section balancing and fault rocks from these structures as a member of Judith Hubbard's group. The paperwork has taken a long time, but he and his wife, Monamie, are excited to begin a life in SE Asia.

Raymond M. Coveney Jr (MS'68, PhD'72) gives a little advice to the new generation of students based on his own and past experiences.

"Follow your passion! When I was a freshman undergrad at another institution in 1960 during the "Eisenhower Recession," my advisor, who happened to be a chemistry professor, told me that majoring in geology would not be a good move. Though I was wet behind the ears, I replied that no one could tell what the prospects would be four years hence; so I continued on in geology. I don't hold his advice against the chemist; he was probably doing his best.

Meanwhile, six years later, after graduation and military service, industry and the market had recovered and job prospects were truly excellent. However I chose, on the advice of my Tufts professor, to continue on to grad school, AT MICHIGAN. After finishing my PhD there I turned down several offers from the mining industry to become a professor at a relatively new state university in a major city.

Now I am officially retired but still doing geology because I like to. It's been a good life. So I would advise geology students to decide what they want to do, perhaps follow their true passion whether it's doing geology or making a ton of money. And to be wary of advice from peers others well-intended , but to consider every reasonable option and make your own choice."

Sir Alex Halliday (Former U-M Professor) a geochemistry professor at University of Oxford and president of the UK's Royal Society was recently named director of Columbia University's EARTH INSTITUTE. Alex is known for his groundbreaking research in isotope geochemistry helping us understand the formation and evolution of planets to deciphering the natural processes that modulate Earth's climate. He was just recently appointed as a **Knight Bachelor** by the Queen of England. What a greatly deserved honor!!!



Elizabeth Oliphant (BS'18) received a Fulbright Fellowship in Indonesia to study geothermal energy and volcanism. While at Michigan, she completed a senior thesis that examined the isotopic variation within Cretaceous bivalve shells from Antarctica. Using high resolution stable and clumped isotope measurements she was able to posit the onset of reproduction in extinct molluscs, a necessary precedent to utilizing these materials for reconstruction of seasonal scaled climate variability.

Left: Liz mapping volcanic fields in Indonesia as part of her Fulbright Fellowship.



Dave Levine (BS'15, MS'16) is loving life as an exploration geologist with Kinross Gold Corporation at the Fort Knox gold deposit in Alaska. He has been enjoying fishing, hunting and all that Alaska has to offer. He was recently accepted to the Generation Gold program with Kinross Gold, and will spend the next three years at two different sites learning mining best practices in a variety of roles. His first stop will be the underground Kupol gold mine in the Russian Far East, where he will continue to gain experience in the mining industry.

Anne Rosett (BS'18) is an exploration geologist with Barrick Gold Corporation in Elko, NV. Barrick is the world's largest gold mining company and Anne is currently part of the discovery team for the world-class Fourmile deposit and does a mix of field work, core logging, and data processing and interpretation.



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<http://lsa.umich.edu/earth/alumni-friends/profile-update>

NEW DEPARTMENT FACILITIES

MICHIGAN ELEMENTAL ANALYSIS LABORATORY

INGRID HENDY, DIRECTOR

Organisms, physical and chemical processes change the relative abundance of elements in the rocks, skeletons and waters of our planet. Using the elemental composition of materials, we can piece together Earth's history, identify unknown dangers in our environment and tap into new resources. Amongst the instruments in our elemental toolbox is the inductively coupled plasma mass spectrometer (ICP-MS). Ions are generated when sample in solution is sprayed into a plasma. When these ions are passed onto a mass spectrometer, the concentration of different elements and their isotopes can be determined based on their mass-to-charge ratio. ICP-MS instruments are popular because in a matter of minutes the concentrations of elements with wide range of atomic masses, from $^6\text{Lithium}$ to $^{238}\text{Uranium}$ can be determined.

The Department of Earth and Environmental Sciences has a long history of providing elemental analysis in the former Keck Lab on the 4th floor, however this much used space has just reopened its doors as the Michigan Elemental Analysis Lab (MEAL). The lab space has been completely renovated to accommodate two new inductively coupled mass spectrometers (ICP-MS) – a Quadrupole ICP-MS and a High Resolution ICP-MS. Effectively the new lab will provide solution-based elemental analysis on a variety of materials from rock through natural waters in concentration ranges from ppm to ppt (parts per trillion) in biological, environmental, geological, and industrial materials.

Long time ICP-MS technician Ted Huston took the opportunity to retire when the Keck lab closed for renovation. In the beginning of September, Angela Dial joined the department to run MEAL. Angela received her PhD on 'The Magnesium isotopic composition of Cenozoic seawater' from Florida State University with Bill Landing. There she had responsibility for both the Q-ICP-MS and the multi-collector ICP-MS, analyzing the elemental and isotopic composition of elements in a range of biological to inorganic materials. From Florida, Angela moved to Lamont Doherty Earth Observatory to manage the ICP-MS in the Biology- and Paleo-Environment research group.



Ingrid Hendy (Professor) and Angela Dial injecting sample into new ELEMENT High Resolution ICP-MS. This instrument is capable of measurements of elemental concentration in the parts per trillion to quadrillion levels. Also available in the facility is a quadrupole mass spectrometer for rapid determination of elemental analysis at higher concentrations. Photo by Dale Austin.

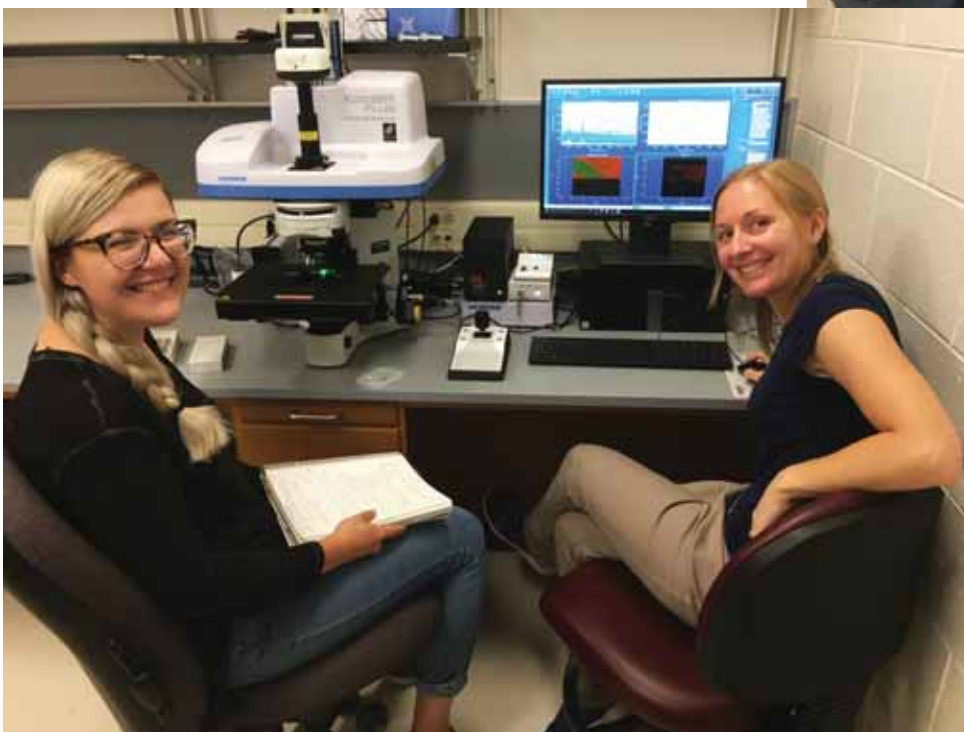
MICHIGAN EXOBIOLOGY LABORATORY

JENA JOHNSON, DIRECTOR

After teaching Geomicrobiology and part of Earth & Environmental Sciences in the Rockies at Camp Davis during my first semester and summer here at Michigan, I'm excited to report that the Microbe-Mineral lab is now up and running! We are beginning a range of projects to understand the evolution of early metabolisms including research to determine the seawater metal concentrations across the Precambrian, a project looking at how mineral inclusions get incorporated into chert at several Japanese silica sinter deposits, and a project now funded by the NASA Exobiology program re-creating the earliest minerals in Banded Iron Formations! Our double glovebox system lets us conduct oxygen-sensitive mineralization experiments with anaerobic microbes such as iron-oxidizing phototrophs, and our new Raman Microscope system is a state-of-the-art combination petrographic and fluorescence (biological) microscope with 1-micron Raman mineral mapping capabilities that will be dually functioning for examining microbe-mineral interactions at the micron scale and identifying mineralogy in newly formed wet precipitates and mapping rock and thin section surfaces.

Undergrad **Samantha Theuer** has begun her senior thesis in the lab to explore the iron minerals that form in anoxic water bodies like those potentially in underground fractures on Mars and under ice sheets on Europa, with different extents of environmental oxidation. We'll update you next year what she discovers!

Right: Sammy Theuer learning how to do experiments in an oxygen-free atmosphere glove box,



Left: Sammy Theuer and Jena Johnson (Assistant Professor) using the new Raman Microscope system which was recently installed into the laboratory facility.

MICHIGAN MUSEUM OF PALEONTOLOGY

MUSEUM ON THE MOVE

2018 marks the close of two major moves for the University of Michigan Museum of Paleontology (UMMP), where four members of the Earth and Environmental Sciences faculty have curatorial appointments (Tomasz Baumiller, Daniel Fisher, Matt Friedman, Jeffrey Wilson). The first of these moves began several years ago, and involved the careful organization, packing, and transportation of the UMMP's precious fossil collections to the state-of-the-art Research Museums Center (RMC). Located on the southern edge of Ann Arbor, RMC houses U-M's priceless archive of paleontological, botanical, zoological, and anthropological collections, which are widely recognized as among some of the most significant in world. This is no simple task: the UMMP's holdings alone include well over two million fossil specimens (two million invertebrates, 80,000 vertebrates, 15,000 plants), and were distributed among several locations on the Ann Arbor campus. Unlike the previous homes of U-M's paleontological collections, RMC provides the climate control necessary for the long-term stability of these irreplaceable specimens. New collections areas of RMC are complemented by two fossil preparation labs and a large open lab that provides a flexible work area.

While fossil specimens continued heading south during the summer of 2018, UMMP's staff and curators were headed just a few dozen yards north from their old home at the Ruthven Museums Building to the new Biological Sciences Building (BSB). In addition to UMMP, BSB houses the departments of Ecology and Evolutionary Biology and Molecular, Cellular and Developmental Biology, as well as the public exhibits and staff spaces of the University of Michigan Museum of Natural History. BSB includes a digitally equipped specimen-based classroom for undergraduate and graduate paleontology courses offered by Earth and Environmental Sciences, UMMP offices and labs, and a visible fossil preparation lab with large windows opening into public areas that places UMMP's research on display. New exhibits in the Museum of Natural History are slated to open in 2019, and prominently feature the discoveries of past and present U-M paleontologists.

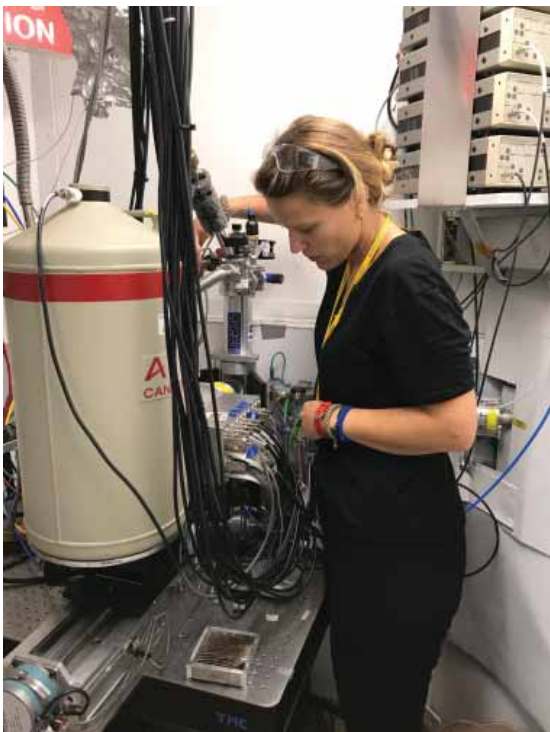
Preparation lab for the University of Michigan Museum of Paleontology, visible from the University of Michigan Museum of Natural History atrium in the Biological Sciences Building. *Photos by Matt Freidman*



Laboratory for EARTH 437 (Evolution of Vertebrates) being held in specimen-based classroom of the Biological Sciences Building.



What happens in the Arctic doesn't stay in the Arctic...
Associate Professor Rose Cory's Arctic Research Program



About a quarter of the landmass in the Northern Hemisphere is underlain by permafrost (permanently frozen) soil. Frozen in permafrost soils is more than twice the carbon as in the atmosphere. As the Arctic is warming faster than the rest of the Earth, permafrost soils are thawing. Once thawed, the carbon held in permafrost soils is turned into carbon dioxide, a greenhouse gas that warms Earth. Thus, release of previously frozen carbon from permafrost soils is a feedback cycle that will reinforce warming everywhere on Earth. To find out how much and how fast carbon from permafrost soils will be released as greenhouse gases, graduate students from Rose Cory's lab, Jenny Bowen and Adrianna Trusiak, conduct field work in the Alaskan Arctic and then travel with the soil they collect to several national laboratories and institutes across the USA for analysis on state-of-the-art instruments: from the Stanford Synchrotron Radiation Lightsource (Menlo Park, CA), to the Environmental Molecular Sciences Laboratory at Pacific Northwest National Laboratory (Richland, WA), to Woods Hole Oceanographic Institute (Woods Hole, MA). Data collected by the graduate students is determining how carbon emissions in the Arctic will change as it continues to warm.

LEFT: *Adrianna Trusiak performing analyses on the Stanford Synchrotron Radiation Lightsource. Photos by Rose Cory*

MICHIGAN SHAKES

While the University of Michigan football team was routing Nebraska on Sept. 22 at the Big House, a small digital seismometer inside a Michigan Stadium storage closet recorded all the ground shaking generated by the sellout crowd of 111,037. Designed to record ground motion during earthquakes, the portable device is being used this season by **Ben van der Pluijm (Professor)**. Ben — in a project he calls Michigan Shake— measured vibrations tied to crowd response after every touchdown, field goal, interception and punt return during all of the home football games.

During the Nebraska game, which U-M won 56-10, the crowd erupted at 10:27 in the first quarter when U-M fullback Ben Mason scored the first points of the game on a one-yard run. That touchdown produced the biggest audience response of the first three U-M home games, measuring a 3.4 on van der Pluijm's self-created Michigan Magnitude scale. It's not the first time that seismometers have picked up ground-shaking vibrations during football games. In 1988, a seismometer in a building near Louisiana State University's football stadium detected the crowd's reaction following the final pass in LSU's upset win over Auburn University, which became known in local lore as the Earthquake Game. Some university researchers have even attempted to assign earthquake-equivalent magnitudes to the ground-shaking antics of football fans. Scientists at one school claimed the home crowd erupted with the force of a magnitude-5.7 earthquake during a double-overtime win over an out-of-state rival several years ago. "That's wrong," van der Pluijm said. The energy released by spectators at football games—even when it's a capacity crowd at the Big House, the nation's largest football stadium—is miniscule compared to the energy of even modest-sized earthquakes. The most boisterous touchdown celebration likely registers no more than a magnitude-1 on the seismic magnitude scale. Even so, the logarithmic Michigan Magnitude scale that van der Pluijm devised allows him to compare discrete shaking events during individual football events.

More information about the project is available at the Michigan Shake website: <http://ben.earth.lsa.umich.edu>. However, fans are not yet able to track crowd response in real time by checking the website during the game. The data undergoes some processing before it's loaded to the site after each home game.



The Raspberry Shake Portable Seismometer taking its place in Michigan Stadium "THE BIG HOUSE".

This contribution was extracted from the University Record article of 10 October 2018 which was written by Jim Erickson.

FACULTY NEWS

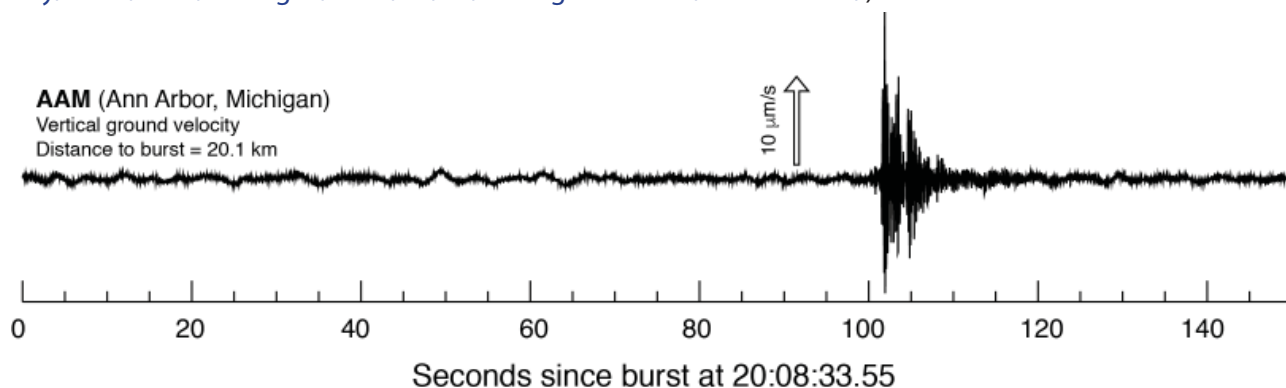
Meteors over Michigan: A Flash and a Blast

Jeroen Ritsema and Eric Hetland

Jeroen Ritsema (Professor) and Eric Hetland (Associate Professor) recently completed an analysis of a bolide occurrence north of Ann Arbor. Here is a summary of their findings.

On January 16, 2018 just after 8 pm, a 2–3 feet diameter bolide disintegrated in the upper atmosphere over Hamburg Township, about 15 miles north of Ann Arbor. People across the Great Lakes region as far away as Chicago saw bright flashes and some heard loud sounds. Seismometers recorded ground shaking with an intensity similar to what would be generated by a local earthquake with a magnitude of 2.5. Small meteorites (classified as H4 chondrites) were found in freshly fallen snow in the days after the burst.

More than a thousand meteoroids of this size enter the atmosphere every year but it is rare that a variety of scientific instruments record their terminal bursts. The flashes produced by the Hamburg meteor were detected by the All-sky meteor camera at Oberlin College and by the Geostationary Lightning Mapper on NOAA's GOES-16 spacecraft. Seven seismometers in Michigan, Ohio, and Ontario and fifty infrasound sensors across the eastern United States recorded the sound from the burst. Using these data, faculty members Jeroen Ritsema and Eric Hetland, with colleagues from the University of California at San Diego, estimated that the burst occurred about 1 mile to the SE of Strawberry Lake at a height of 14–16 miles and with a yield of 0.8–8.1 tons of TNT equivalent. The analysis was published in the August 22, 2018 issue of *Seismological Research Letters*. For more information and photographs of the burst, see (<https://eu.freep.com/story/news/local/michigan/2018/08/20/michigan-meteor/1012325002/>).



Ground motion at seismic station AAM near the Mattheaei Botanical Gardens. The sound from the Hamburg burst is recorded at about 101 seconds after the light flash.

Nathan Sheldon (Professor) was recently promoted and **Rebecca Dzombak** and **Rebekah Stein (PhD Candidates)** both advanced to PhD Candidacy. In June 2018, Nathan stepped down after five years as the Associate Director of U-M's Program in the Environment (PitE). Members of his research group did fieldwork all over the world (see individual updates), including in Norway, Iceland, and British Columbia, as well as Washington, Oregon, Idaho, Colorado, Utah, and Michigan. Four new undergraduate researchers began this fall in Nathan's group, bringing the lab up to six in total, who are working on an array of projects that span from modern soil and lake sampling to analyzing billion year old rocks. Along with **Ben Passey (Associate Professor)**, Nathan and ten other PI's were recently awarded \$2.7m from an NSF Integrated Earth Systems project that will spend the next five years working to decipher climatic and geomorphic changes in the Green River Basin (WY, UT, CO) during the early Eocene climatic optimum. Nathan is the project's overall paleoclimate lead scientist and Ben will be applying "triple oxygen" isotope geochemistry to lake and floodplain carbonates.

Sierra Petersen (Asst Prof) graduated PhD student Kyle Meyer and senior thesis student Elizabeth Oliphant, and has recruited a new student **Jade Zhang**, three new undergraduates, and a postdoc **Matt Jones**. Jade's first thesis project is to reconstruct past interglacial climate in the Atlantic and Caribbean as an analog for future global warming. Undergraduate **Steven Wedel** will be comparing modern and interglacial climate in the Caribbean, specifically from Turks and Caicos samples. Undergraduate **Serena Scholz** began her third year and is wrapping up a first project on the Mid-Miocene Climatic Optimum and is now looking at Eocene climate in Europe using giant gastropod fossils. **Rebecca Heaman** (Earth minor) is investigating the behavior of clumped isotopes in modern gastropod fossils from the Atlantic coast as a comparison to Serena's project. Postdoc **Matt Jones** is planning to study Ocean Anoxic Event 2 in the Western Interior Seaway. OAE2 was a crazy period during the mid-Cretaceous when large areas of the ocean went anoxic.

Adam Simon (Professor) was promoted and graduated two of his six graduate students. **Brian Konecke (PhD'18)** successfully defended his dissertation and is now a postdoctoral fellow with NASA at the Johnson Space Center, and **Gephen Sadove (MS'18)** is now a staff scientist with Geosyntec Consultants. Four graduate students continue their work to better understand the evolution of mineral systems needed to sustain our growing population. Four undergraduate students completed senior honors theses in his research group, investigating heat treatment of gemstones, public perception among hunters and fishermen of fracking and natural gas production in New York and Pennsylvania, renewable energy potential of the Ann Arbor Public Schools, and the carbon isotope composition of fluid inclusions in magnetite. Five other undergraduates worked with his group to develop environmental case studies focused on deforestation in Indonesia for the purpose of growing oil palm, rural electrification in Brazil, and the carbon footprint of Zero Waste events; these cases are web based and available for teachers to incorporate into high school (APES) and college classrooms (<https://www.learnala.com>). Seven other undergraduates worked with our group to assess the carbon footprint of our campus and develop financially and technologically realistic solutions to reduce campus emissions. On the home front, Adam's four children and their academic and extracurricular schedules keep him busy.

Kacey Lohmann (Professor) had another exceptional year. He recently graduated **Kyle Meyer (PhD' 18)** whose work on Cretaceous paleoclimate reconstructions provided a baseline for latitudinal temperature variations across North America during the latest Cretaceous. Perhaps most intriguing is Kyle's work on incorporating Hg analysis of shell material from these same sites to provide a link between massive volcanic eruptive phases with intervals of global warming. This research finding posits the natural cause of such warming to volcanic flatulence of CO² as a primary trigger of warming at this time. In addition to his research interests, Kacey continues to serve as one of the undergraduate advisors, a time-consuming task, though a very gratifying undertaking. His interest in leading the major annual Spring Soft Rock Field trip has not waned, though he notes that "as age begins to creep upon us all, the mountains seem to be getting taller and steeper, and the Grand Canyon deeper". Alternatively, students could be becoming more physically fit: Kacey uses this as his reason for "taking up the rear" on some of the longer hikes. Nevertheless, he will continue contributing to teaching, field instruction and laboratory research.



Lohmann lecturing about delta front facies in Brick Kiln Quarry near Grand Ledge, MI. Photo by Rachel Antieau



Ben van der Pluijm and collaborators are continuing their research on orogenic geofluid sources and timing, focusing on the US and Canadian Rockies and the US Appalachians. Colleagues in Europe provide facilities that are optimized for mass spectrometry of clays, while U-M's Ar geochronology lab dates and quantitative XRD measurements complement these O-H data. This summer, **Erin Lynch (PhD'18)** completed her degree on orogenic fluid fingerprinting and now shares her talents at Shell, following an academia-to-industry path of many of his recent PhD students.

Disappointed by the lack of solid Earth events in Michigan (good news for everyone else), Ben decided to ask 100,000+ people in Ann Arbor's Big House to help create shake signals for use in his new Intro Geology class (E119, "Earth Interactions"). A piece on his Michigan Shake project is elsewhere in this issue, and the website at <https://ben.earth.lsa.umich.edu/seismo/michiganshake.html> has details and some results.

LEFT: *As a reward, Ben got the Michigan Stadium to himself to throw some seismometers.*

Yihe Huang (Assistant Professor) recently recruited two new graduate students, **Marlon Ramos (PhD Cand)** and **Prithvi Thakur (PhD Cand)**, both of whom have made great progress in their earthquake models. Their presentations at the 2018 Seismological Society of America Annual meeting were well received. Marlon and Yihe also went to the NSF PREEVENTS (Prediction of and Resilience against Extreme Events) meeting in Washington in September. Their Cascadia earthquake scenario project was one of the fifteen projects funded by NSF PREEVENTS last year, despite the fact that the funding rate is 8-10%. Interestingly there is only one other UM project, in Climate and Space Sciences and Engineering that was funded by PREEVENTS this year. Instead of working on earthquakes, they are researching extreme space weather events! Yihe is very happy to see that her previous postdoc **Semechah Lui** receive an assistant professor job at University of Toronto Mississauga and just started working there this fall. She received her bachelor's degree in our department and worked with **Eric Hetland** on her undergrad research project. Her postdoctoral work with Yihe was focused on induced seismicity. She found there is a relationship between the locations of injection wells and the rupture propagation directions of induced earthquakes, which can be integrated into the hazard analysis of induced seismicity.

Yihe's research group was out in the field during November to deploy seismometers around Lake Erie. This project, in collaboration with Michigan State, aims at detecting and better understanding earthquakes in Lake Erie. Eight seismometers have been installed at farms and in a yard behind a residence within ~5 miles from the lake shoreline between Newport, MI and Port Clinton, OH. This project could not happen without the support of students (Emily Boswell, Samuel Haugland, Olivia Helprin, Jamie Lackner, Sophie Lin, Meichen Liu, Prithvi Thakur, Jing Ci Neo and Dongdong Yao) and staff (Craig Delap, Paula Frank, Anne Hudon and Owen Neil)!



Yihe's research group is seen digging a deep entrenchment to position a full-time seismometer. Though hard work, at least they completed the installations before Winter.

G. D. SHARMA ENDOWMENT FOR GRADUATE STUDIES



G. D. Sharma (PhD'61) created a generous endowment to help provide financial support for graduate students of the Department. G.D. graduated with a BSC in 1952 from Benaras Hindu University in India after which he received his Diplom in 1958 from the Swiss Federal Institute Technology and then joined U-M to continue for a PhD under the direction of Kenneth Landes on the "Geology of the Peter's Field, St. Claire County, Michigan". As has been told, upon coming to Michigan, G.D. did not realize the high costs of attending the University and was going to take a two year job as a field assistant in Antarctica to support his future studies. Upon hearing of his plans, the then Chair, James T. Wilson, managed to find graduate student support that allowed him to continue without a hiatus in studies. His success continued after his PhD as he began as a Professor at the University of Alaska, Fairbanks, where he created the renowned Petroleum Development Laboratory. His insightful works culminated in his treatise on "The Alaskan Shelf" and as a consultant for the Norwegian government where he established another Petroleum Research Institute. We thank him for his generosity and his legacy will remain as a major contributor to the field of Geology, the Department, and the University. **OUR MOST SINCERE THANKS!**



IN MEMORIAM

In Memoriam: John Joseph Amoruso

John Joseph Amoruso (MS'57) passed away on 29 January 2018 at the age of 88 years. He was born in Portsmouth, New Hampshire and received his BS in Geology at Tufts University in 1952. After spending three years in the Navy, he attended the University of Michigan to obtain his Master's in Geology in 1957. It was during his tenure in the Department that he met his beloved wife, Camille, who at the time was studying in the School of Pharmacy. His love for finding oil began with a summer position in Oklahoma with Stanolind Oil Company. After finishing his Master's degree he began his career with Pan American Petroleum until he became an independent in Houston with the creation of this own company, Amoruso Petroleum. His exploration took him to regions throughout the US, including Texas, Arkansas, Louisiana, Colorado, Wyoming and Nebraska. With a special focus on Jurassic and Cretaceous of Texas, he continued to be a leader in exploration with numerous successes. The pinnacle of his career is marked by his discovery of the deep Bossier "tight gas" sand reservoir in Texas. This discovery, in the absence of modern day seismic data, was based on his exploration model which predicted the presence of turbidite sand reservoirs in the Bossier distal from the Cotton Valley carbonate platform shelf margin. This discovery, now named the "Amoruso Field" is one of the largest gas discoveries in the United States in recent times. This field held an amazing 3 trillion cubic feet of natural gas.



IN MEMORIAM



John Amoruso ca. 1955 during his time at Michigan.

John's contributions span far greater than his prominence in the petroleum industry. He was a leader and contributor to numerous professional organizations and to the University of Michigan. He is being remembered as one dedicated to service. He served as a mentor to younger colleagues, students and professors as he interacted with them at meetings and during his frequent visits to the University of Michigan, a place close to his heart. He was amongst the founding members of the Department's Alumni Advisory Board, on which he as served as chairman from 1987 through 1988. He was also the first to receive the Department's *Distinguished Alumni Honor Award* in 2013. It was during his presentation at the time of the award that he revealed the true history of his decision to pursue a career in geology. His dislike and lack of proficiency in math drove him to focus on geology, where he could apply his intuitive skills and breadth of knowledge to become a successful explorationist and businessman. He certainly made the right choice.

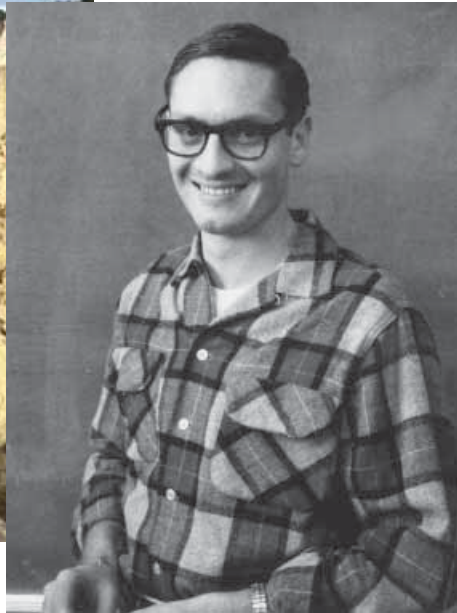
The Department will miss his unfaltering support and dedication.

Portions extracted from the Houston Chronicle, February 2018.

In Memoriam: Darwin “Dar” R. Spearing



Dar Spearing doing what he loved. Here shown in Yellowstone National Park.



A glimpse into the past in this photo archived from the time he was a graduate student at Michigan.

Darwin “Dar” Spearing (MS’56, PhD’ 69) passed away 23 September 2018 at the age of 79. Having completed his thesis research on the *Stratigraphy, Sedimentation & Tectonic History of the Paleocene-Eocene Hoback Formation*, he ventured into the petroleum industry. Later, he pursued his true passion, working with geology in the field and as a science communicator. This manifested in years working as a National Park Ranger, while also contributing numerous volumes to the *Roadside Geology* series. This included contributions for Texas, Louisiana, and Wyoming. We all will miss his dedication and desire to share his passion for Geology.



Dar apparently liked to document events in his life through a series of cartoons. From our archives we have found these drawings apparently made during his time at Camp Davis. His sketches reflect days of hard work, with associated breaks, and frustration during plane tabling exercises. Perhaps it is through these experiences that he developed his love of the field, of the mountains, and of Geology.

In Memoriam: Andrew Joseph Biebuyck



Andrew Joseph Biebuyck (BS'2013) was born 5 July 1990 in Royal Oak, Michigan and died tragically in a climbing accident in Canon City, Colorado on December 16, 2017. Andrew was a true athlete and scholar. During his life he was a champion wrestler and participated in numerous marathons, triathlons and was an avid climber. While studying at the University of Michigan, in addition to his excellent scholastic achievements, he was an enthusiastic participant on numerous field excursions, including trips to northern Spain and our two week exploration of the geology of Texas and New Mexico. After completing his degree in Geology at the University of Michigan, he worked for a short while as a quality-control technician in Farmington Hills prior to accepting a position as a geological technician at the Virginia Department of Mines, Minerals, and Energy. Subsequently, he joined NAEVA Geophysics in Charlottesville as a geologist. He was planning to return to graduate study to expand his skills and continue on with his productive career as a geologist. We will miss his energy and his captivating personality.

TO HONOR DREW'S LIFE AND HIS PASSION FOR GEOLOGY ESTABLISHMENT OF A CAMP DAVIS MEMORIAL SCHOLARSHIP

Drew discovered his love of geology at the University of Michigan and conducted his first geological fieldwork at U-M's Camp Davis in Wyoming. Drew's friends and family have created the AJB Memorial Scholarship as a way to remember Drew and share his love of geology with new generations of students. Drew's scholarship will support undergraduates who attend Camp Davis for summer classes, where they will learn first-hand about some of the most scenic and interesting geology, ecology, and history in North America. As we continue to mourn Drew, your gift to the Andrew Joseph Biebuyck Memorial Scholarship will be greatly appreciated. To learn more about the scholarship, contact Erin Biebuyck at ekbiebuyck@gmail.com. To make a gift, go to <https://goo.gl/EiZQsv>.



In Memoriam: Robert (Bob) H. Dott Jr.

Robert (Bob) Dott Jr. passed away on February 27, 2018 after battling lymphoma for 11 years. Bob was born in Tulsa, OK on 2 June 1929 and then moved to Norman and later started his college career at the University of Oklahoma. Following the footsteps of his father and grandfather, he then later attended the University of Michigan where he received his BS (1950) and MS (1951) degrees. It was during this time that he met his wife, Nancy, who was also taking a geology class. Following his studies in Michigan, he then attended Columbia University where he completed his PhD.

After a two year stint in the Air Force, Bob worked with the petroleum industry in Oregon and California for a short period before he accepted a faculty position at the University of Wisconsin in 1958. During his academic career, Bob was known as one of the most respected sedimentary geologists in the world. His work focused on clastic sedimentary systems which ranged in age from the Precambrian to the Recent. As a pioneer in establishing the significance of sedimentary bedforms, his most highly cited work was with *Hummocky Stratification* and his research on the Cambrian sequences of the Baraboo Hills in Wisconsin. He was a major contributor to the field of sedimentology and strong supporter of the Geology departments of both Wisconsin and Michigan. We will miss his enlightening conversations on the history of the geological sciences and the nature of life.



In Memoriam: Curtis Lee Lundy

Curtis Lee Lundy (BS'54, MS'58), died on 18 April 2018 from complications of congestive heart failure. Curt attended the University of Michigan and completed his BS degree in Geology and Mineralogy in 1954. He then joined the US Navy. During his time in the military, as First Lieutenant, he served with the crew of the icebreaker USS Glacier on Operation Deep Freeze which established two Antarctic research bases. After his short career in the Navy, Curt returned to Michigan where he completed his MS degree.



His career quickly changed in 1958 to one of an exploration geologist with Carter Oil Company. From here he joined the staff of Michigan Consolidated Gas Company from which he retired in 1995 after attaining the position of Senior Geologist of Geology, Reservoir and Environmental Engineering.

Curt never forgot about the Department during his professional career or after retirement. He served on our Alumni Advisory Board and was a frequent participant at annual meetings and gatherings. We all have fond memories of the years that he shared his time and energy to help the Department grow and prosper.

In Memoriam: Icaro "Ike" Vitorello



Icaro (Ike) Vitorello (BS'72, MS'75, PhD'78) passed away on April 25, 2018 in Sao Jose dos Campos, Brazil at the age of 77. During his time in Ann Arbor, Ike worked with faculty members **Henry Pollack**, **Rob Van der Voo**, and fellow grad student **Steve Henry (PhD 1981)**. During most of his long career Ike was a senior research scientist at the Instituto Nacional de Pesquisas Espaciais (INPE, the Brazilian National Institute of Space Research) in Sao Jose dos Campos. His work there principally addressed the crustal and upper mantle structure of Brazil, using geomagnetic and electromagnetic field data, integrated with ground-based and satellite gravimetry, and other remote sensing observations. In his activities Ike was extensively engaged in helping students and young researchers get their careers off on a solid foundation. His many contributions were recognized by his colleagues when he was elected to the Brazilian Academy of Sciences in 2011.

In Memoriam: Ernest Willard Marshall

Ernest Willard Marshall (MS'50, PhD'77) passed away on 15 June 2017 in Rockland Maine after several years of diminishing health. During WWII he enlisted in the Navy and served until August 1946, participating in such activities as "Operation Crossroads" which involved the testing of nuclear weapons on Bikini Atoll in the Marshall Islands. After leaving the Navy, he completed his Master's degree examining the formation of ice crystals in lakes. This work continued in his work with the Naval Reserves Corps of Engineers where he applied his knowledge to aircraft operation in ice covered regions such as Alaska. He continued his academic career, completing his PhD at Michigan in 1977 under the direction of James T. Wilson, this time examining the "Geology of the Great Lakes Ice Cover." His love of the sea continued after his retirement at which point he moved to Maine and continued to sail the ocean, taking on long and challenging cruises on his sailboat into northern regions of eastern North America. He was laid to rest with full military honors in Camden, Maine on June, 23, 2017.

RIGHT: Photo of "Ernie" Marshall during his Alaskan adventures ca. 1953.

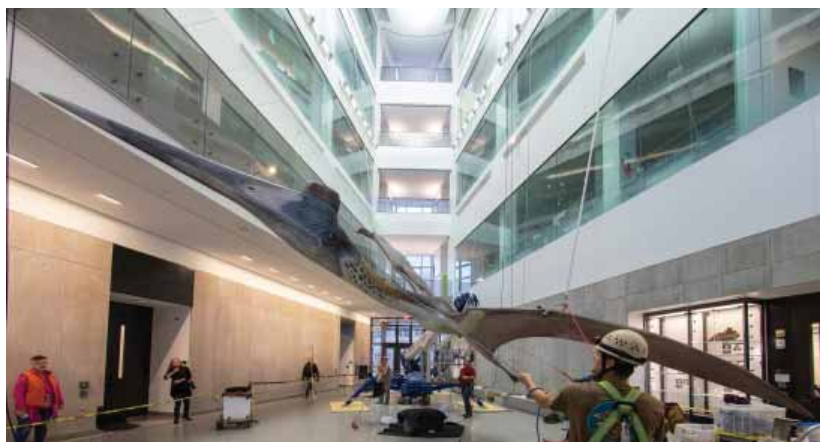


IN MEMORIAM

A NEW NEIGHBOR IN THE MUSEUM OF PALEONTOLOGY *QUETZALCOATLUS*

From early December 2018, several Earth and Environmental Sciences faculty and students affiliated with the Museum of Paleontology (UMMP) found they had a new neighbor in the Biological Sciences Building (BSB): a life-sized model of the flying reptile *Quetzalcoatlus*. With a 35 foot wingspan, this reconstruction dominates BSB's west atrium and is the latest addition to a facility that already prominently features past and current research by Earth/UMMP faculty in the form of fossil whale and mastodon skeletons installed in the east atrium earlier in 2018. These displays represent the first stages of the opening of the new Museum of Natural History (UMMNH), scheduled to open in 2019.

Quetzalcoatlus is noteworthy for being one of the last-surviving pterosaurs, a group of extinct flying reptiles closely related to—but not included within—dinosaurs. Fossils of *Quetzalcoatlus* are known from the Maastrichtian, just before the massive extinction event that wiped out many groups of plants and animals. *Quetzalcoatlus* and its closest



Quetzalcoatlus takes to flight. Photo by Linda Garcia

relatives are the largest flying animals to ever evolve, and are so big that some have questioned whether they could actually take to the skies. Earth and UMMP graduate student Kierstin Rosenbach and her supervisor and Earth faculty/UMMP curator **Jeff Wilson (Associate Professor)** consulted on aspects of UMMNH's *Quetzalcoatlus* installation, and are describing fossils of a new species of related giant pterosaur collected on an expedition to Jordan. "My research focuses on some of the last surviving pterosaurs," says Rosenbach. "We're using these fossils to understand the diversity of pterosaurs in the Late Cretaceous, and how their anatomy can inform us of flight capacity in exceptionally large pterosaurs."



Big Foot takes on another meaning. Photo by Linda Garcia



Victors for Michigan

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LEFT: *Tristan Childress during summer internship at Red Dog Zinc Mine in Alaska.*

VICTORS FOR MICHIGAN – STUDENT RESEARCH

Marlon Ramos (PhD Cand) generated physics-based numerical models for a future Cascadia subduction zone earthquake to study how and why large ruptures may penetrate to deeper depths along this fault. This work has implications for stronger shaking near major cities such as Seattle or Portland.

Prithvi Thakur (PhD Cand) is studying the magnitude-frequency distribution of earthquakes simulated on a two dimensional strike-slip fault with a damaged fault zone surrounding the active fault. He is trying to understand what makes the distribution transition from a stick-slip behavior to a Gutenberg-Richter type power law behavior. The presence of damaged zones, similar to observations along active faults like San Andreas, promotes the power law behavior in contrast to the stick-slip behavior observed in a homogeneous medium.

Rebekah Stein (PhD Cand) spent her summer collecting modern leaf, leaf litter, and soil samples (O-horizons) across a wide precipitation and topographic range among National Parks and Forests in the Pacific Northwest and Southwest/Rocky Mountain region and even got to meet and sample from Pando, the "Trembling Giant" and oldest living organism (>80,000 years).

Sarah Katz is one of our first year graduate student working on triple oxygen isotopes of meteoric waters and lacustrine carbonates in the Junín region of the Peruvian Andes. She is focused on the Lake Junín system to characterize the ¹⁷O signal to groundtruth modern waters and carbonates prior to applying them to paleo reconstructions of climate.

Sharon Grim (PhD Cand) analyzed the last batch of samples for her dissertation research on anoxic cyanobacteria in a submerged sinkhole in Lake Huron. These microbes thrive in low oxygen environments, and characterizing their ecology will enable an understanding of the biological and ecological impacts on oxygen production in the Proterozoic.

Allison Pease (PhD Cand) spent her summer doing experiments to determine the Fe-S and (FeNi_{0.12})-S liquidus at high pressures (24 GPa) as part of the InSight mission to Mars that has been tasked with determining the state and size of the core of the planet. These data yield "insight" into current constraints on the Martian core and how the core will solidify at a given composition.

Jordan Hood is a Master's student conducting research on cores from one of the tusks of the Yukagir mammoth, an adult male woolly mammoth (*Mammuthus primigenius*) found in Siberia, to determine whether microCT data and the X-ray attenuation profile of annual features (similar to tree rings) in tusk dentin are sufficient to correlate years from one core to the next.

Sam Haugland (PhD Cand) spent a month at the University Sao Paulo collaborating with their seismologists to image the lower mantle beneath Brazil with their national seismic array.

Zack Quirk is a first year graduate student working with **Assistant Professor Selena Smith** and hit the ground running with submission of his first manuscript that describes fossil flora material from the Pleistocene of Georgia.

Alex Thompson (PhD Cand) spent much of the summer working on a project investigating the impacts of Saharan dust on northern African rainfall. He ran several climate model simulations that included more complex dust aerosolcloud interactions in order to better understand the microphysical processes leading to rainfall changes during the Holocene African Humid Period.

Rebecca Dzombak (PhD Cand) worked in two high-latitude locations this year: Norway and Iceland. In Norway, she sampled Precambrian basalts and weathering surfaces as part of her work constraining changes in terrestrial nutrient cycling over geologic time. In Iceland, she sampled modern soils as potential analogues for early terrestrial environments as well as looking at all the gorgeous waterfalls and braided rivers. Although sampling modern soils and fossilized soils 2.5 billion years old may seem counter intuitive, she uses both to better understand how terrestrial nutrient availability co-evolved with the atmosphere and early life.

First year graduate student **Fabian Hardy** earned an honorable mention by the National Science Foundation for his graduate research fellowship proposal that focused on Miocene fossils preserved in ash layers in central Nevada.

First year graduate student **Jackie Wrage** jump-started her graduate studies by spending part of her summer with collaborators in Germany learning to conduct experiments to simulate volcanic processes and is now analyzing the compositions of diffusion-couple experiments that simulate magma mixing between mafic and felsic material at magmatic conditions of subduction zones, to understand the mobility of sulfur and metals.

Maria Alejandra Rodriguez Mustafa's (PhD PreCand) research focuses on the study of Iron-Oxide-Copper-Gold (IOCG) and Iron-Oxide-Apatite (IOA) deposits and their genetic relationships using trace element geochemistry of magnetite plus Fe-O isotope pairs to decipher the origin of metals and fluids to better understand the ore genesis. Currently, she is working with samples from Chile, and is looking forward to expanding her research towards other occurrences in the western margin of South America to ultimately constrain an unified formation model for IOA and IOCG deposits.

Brian Konecke (PhD'19) had a chaotic, yet fruitful year. In late August, Brian and wife Kate happily welcomed the newest member to their family, Ann Lucy Konecke. Brian defended his dissertation in December and is moving to Houston to become a NASA Postdoctoral Fellow at the Johnson Space Center in Houston where he will investigate the volatile abundance and evolution of lunar magmatism.

Will Bender (PhD'19) finished his graduate research on metal contaminant geochemistry in solution and at the mineral-water interface. His research focuses on how carbonate complex formation affects the redox kinetics of aqueous uranium, neptunium, and plutonium with implications for the solubility and mobility of these radioactive species in the environment.

STUDENT INTERNSHIPS GOVERNMENT AND INDUSTRY CONNECTIONS

Tristan Childress (PhD Cand) spent last summer working with Teck's Red Dog Exploration team in the Arctic Circle of Alaska. Red Dog Mine is a zinc and lead mine located in the western foothills of the Brooks Range and is the world's largest producer of zinc, accounting for 10% of global supply. Last year, Teck announced the newly discovered 80-150 Mt 16- 18% Zn+Pb Aktiguruq deposit to investors and the world. This year, the exploration team is conducting geotechnical drilling and regional drilling to better define the zinc orebody and prepare for the structural obstacles that will be encountered when constructing the new underground mine in coming years.

RIGHT: Mining operation at the Red Dog Zinc Mine in Alaska. Photo by Tristan Childress.



Phoebe Aron (PhD Cand) worked with the Office of Water Quality and Technology, the water utility in Washington, DC. This organization ensures Washington residents always have clean, safe drinking water. Phoebe's task involved analyzing fifteen years of metals data to better understand the location and sources of lead in tap water in the utility's service. Here's the upshot: if you have the type of kitchen faucet with the very convenient flexible, extendable hose, let your water run for a seconds before you use it! Particles tend to accumulate in that hose when water is stagnant. She is continuing her work in characterizing natural variation in the isotopic composition of plant water and ¹⁷O anomalies in precipitation and river water.

This summer **Nikita La Cruz (PhD Cand)** had the opportunity to do an internship with the ExxonMobil Corporation. Her internship was in the exploration company and her project involved exploring for hydrocarbon resources in fractured basement rocks in the South China Sea. In addition to learning about hydrocarbon systems and how to explore for these resources, she also got to interact with geoscientists from all over the world, and a few of the leaders of the organization. Also, she was able to learn from, and interact with members of the team that was involved with the company's discovery in her home country, Guyana. It was fascinating for her to learn about all the science that is required in the entire process from exploration for, to development, production and refining/ processing of hydrocarbon resources for society's use. Finally, it was also equally fascinating for her to learn about how devoted the company is to conducting all of its operations safely.



Students examining the Cretaceous-Paleogene boundary section at Moscow Landing, Alabama. At this locality, a major disconformity is present that is believed to reflect the effects of the impact of a bolide around the Yucatan Peninsula which resulted in a major tsunami extending its effects far into North America coincident with the Mississippian Embayment. Photo by Kacey Lohmann

Scholarships and Fellowships 2018

Camp Davis Scholarships

Richard F. Sidder Fund Scholarship: B. Galliana, J. Lackner

Jillian Drow Memorial Endowed Scholarship: C. Bagnall

Kornfield Family Camp Davis Scholarship: K. Hildwein, H. Kalis, J. Mati, R. Mount, S. Theuer, O. Thomas

Judith H. Turneure Memorial Scholarship: S. Caplan, K. Hildwein, J. Mati, L. Plescher, S. Yang



Shell Camp Davis Scholarship: J. Belke, S. Callaghan, T. Flynn, K. Jeppesen, A. Long, E. Lopes, R. Masse, S. McDowell, M. Mullins, L. Munro, L. Rasmussen, S. Ruan, K. Schissler, T. Shirai, R. Soulliere, S. Yoo

Graduate Fellowships

Reynolds M. Denning Memorial Fellowship: E. Crowther, B. Koenke

William Herbert Hobbs Fellowship: M. Robbins

Russell C. Hussey Scholarship: A. Kurz, P. Thakur

Earnest A. Novak Scholarship: M. Calagero, G. Han, K. Meyer, A. Thompson, A. Van de Guchte, S. Washburn

Henry N. Pollack Graduate Endowed Graduate Fellowship in Geological Sciences: P. Aron, K. Rosenbach

Chester B. Slawson Memorial Scholarship: W. Bender, N. La Cruz

Stewart R. Wallace Fellowship: H. Shen, Y., Wang

EARTH CAMP - 2018



Earth Camp has reached a new milestone – four of our alumni from the 2015 cohort matriculated to the University of Michigan this fall to pursue STEM majors. Erica, Jackson, Jordan, and Ponette were a part of the first Earth Camp cohort to start in 10th grade and return for three summer experiences, the final one in Wyoming. Erica and Jordan plan to major in Earth and Environmental Sciences, Jackson is pursuing aerospace engineering, and Ponette is working towards a computer science degree. We are supporting them financially and academically through an NSF Grant and the Earth Scholar program that provides funds for a laptop, as well as mentoring throughout the year from professors, current students, and alumni.

We look forward to the next cohort of Earth Camp alumni to arrive on campus next fall – those who spent a week in Wyoming this summer. Many of these 20 high-school seniors came to campus with their families this fall for an application workshop, tour of our lab facilities, and a tailgate meet-and-greet with graduate students and professors. We will be working with them this fall through the application process.

Lastly, we have a new cohort of twenty 10th grade students who had their first Earth Camp experience this summer on campus and at Sleeping Bear Dunes. They were an engaged and fun group that we look forward to continuing to see in the Earth Camp program.

Earth Camp is provided at no-cost to participating students and made possible by financial support from: individual donors, Shell Oil, LSA, the Dept. of Earth and Environmental Sciences, and the U-M Office of DEI. As Earth Camp continues to grow and reach more students, we aim to increase our funding from outside sources. If you have ideas or are able to help with our fundraising efforts, please contact jennamun@umich.edu.

If you would like to help support the future of EARTH CAMP, please give to the Departmental Fund: Student Outreach Programs #325538



Generous Supporters of the Department 2018

The Department would like to acknowledge the generous corporate, foundation, and individual gifts it has received over the last year (July 1, 2017– June 30, 2018). These gifts are invaluable in supporting our graduate and undergraduate programs, our education and outreach efforts, and for attracting and retaining the highest quality faculty and staff. To all those that have given -- **Victors for Michigan --THANK YOU AND GO BLUE!**

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GIVING BLUE DAY-2018

Each year, the University sponsors a global outreach during Giving Blue Day to encourage all alumni to support activities and initiatives at both the Department and University level. This year **EARTH is #1 in LS&A** with 107 donors and 110 gifts. Donors included graduate and undergraduate students, staff, faculty, alumni and friends helping us reach an impressive goal of nearly \$20,000 in one day. These funds enable support of Camp Davis, Student Outreach Programs, Student Fellowships, and the Department's Strategic Fund. We thank you again for your continuing support of EARTH and its students.



HONORS AND AWARDS 2018

SPECIAL ACHIEVEMENT IN GIS AWARD



Peter Knoop (MS'94), now with LSA-IT, received a SAG award from ESRI, the global leader in spatial analytics, for his innovative application of mapping, data analytics, and thoughtful leadership in higher education research and teaching. Peter has been a major contributor to the Department by integrating GIS into many of our field activities including participating in over 25 Department field trips and Camp Davis teaching. CONGRATULATIONS!!

ANNUAL AWARDS – 2018

Eugene and Elizabeth Singer Award for Academic Excellence in Geology:

Serena Scholz
Sirawich Pipatprathanporn

Camp Davis Field Geologist Award:

Will Arnuk
Isabel Engelhart
Ryan Horwitz
Ian Vamossy

Alumni Undergraduate Award:

Drake Yarian

Undergraduate Academic Excellence Award:

Austin Carter
Will Arnuk

Outstanding Graduate Student Instructor Award:

Sean Hurt
Kyle Meyer
Alyssa Abbey

John Dorr Graduate Academic Achievement Award:

Trever Hines
Peng Ni

DISTINGUISHED MEXICAN AWARD

Joaquin Ruiz (PhD'81) Received this award on 15 September 2018 to celebrate the 208th Anniversary of the Independence of Mexico. Only 31 of its citizens who reside around the World have been given this prestigious award to acknowledge their professional excellence.

ROBERT CHAN AWARD 2018

Rodney Ewing (Professor Emeritus) received this distinction in recognition of his "interdisciplinary and multidisciplinary" work and outstanding science on the effects of radiation on materials. In addition, this award recognizes his ability to communicate the nature of this science to a broad audience.

AGU FELLOWS- 2018

Gerald "Jerry" Dickson (MS'93, PhD'96) was elected as an AGU Fellow this year. He is one of 62 awardees this year recognized for the exceptional contributions to the science and prominence in their field.

FELLOW OF THE AAAS

Chris Poulsen (Professor) was recently elected as a Fellow of the American Association for the Advancement of Science.

GSA OUTSTANDING PUBLICATION

Arlo Weil (MS'97, PhD'00) was honored for his recent work by the Structural Geology and Tectonics Division of the GSA.

HERMELIN AWARD

John Greene (BS'63, MS'70) received this award from the University of Michigan to recognize his volunteer efforts on behalf of the University.

GSA RESEARCH GRANTS 2018

Rebecca Dzombak (PhD Cand) and Rebekah Stein(PhD PreCand) were recipients of GSA Research Grants.

NSF RESEARCH COORDINATION NETWORK STUDENT COLLABORATION GRANT

Rebekah Stein (PhD Cand) received this internationally competitive grant to support her research.

Recipients of Earth and Environmental Science Undergraduate Degrees Academic Year 2017 to 2018

BACHELOR OF SCIENCE HONORS THESES

William Arnuk	<i>Solar Feasibility of the Ann Arbor Public School</i>
Austin Carter	<i>The oxygen and hydrogen isotope evolution of snow, firn, and ice throughout a melt season on Wolverine Glacier, AK</i>
Anna Harkness	<i>Fire Frequency and C⁴ Vegetation Expansion in the Barstow Formation</i>
Sara Leon	<i>Mercury Contamination of Channel Bed Sediment in the South River, VA</i>
Elizabeth Oliphant	<i>Reconstructing Past Climate and Life Cycles of Extinct Bivalve Species through Stable and Clumped Isotopic Variations</i>
Elizabeth Rogers	<i>An investigation of volatiles in magnetite and their relation to IOA ore forming fluids</i>
Anne Rosett	<i>Geochemical Fingerprinting and Thermal Heat Treatment of Spinel from Tanzania and Mozambique to Address Supply Chain Challenges in the Colored Gemstone Market</i>
Cassandra Seltzer	<i>Eutectic melting in MgO-MgCO³ binary system with implications for Earth's deep carbon cycle</i>
Lauren Vanwagoner	<i>$\Delta^{13}C$ values in palms and relation to atmospheric C concentrations, phylogeny, climate, and growth form.</i>

MAJORS

Noor Ahmad
William Arnuk
Celeste Bakr
Allison Birkbeck
Austin Carter
Charlotte Connop
Auston Cook
Sarah Dieck
Anna Harkness
Denton Holder
Scott Johnston
Sara Leon
Alexander London
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Thomas Spoor
Zavonte Stephens
McKenzie Straub

Lauren Vanwagoner
Samuel Whitehead
So Young Yang
Drake Yarian

MINORS

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Evan Scieszka
Alexandria Shand
Zavonte Stephens
Clara Tift
Kathryn Tovar
Samuel Whitehead
Alexandra Wisbiski
Darin Wong

Recent Doctoral Dissertations

Alyssa Abbey	<i>Assessing Rio Grande rift evolution and interaction with the southern Rocky Mountains using techniques in low-temperature thermochronometry</i>
Joseph El Adli	<i>Reproductive Life Histories of Woolly Mammoths</i>
Benjamin Gebarski	<i>The electronic and atomic structure of actinide contaminants at the mineral-fluid interface</i>
Chenghuan Guo	<i>Multicomponent Diffusion in Basaltic Melts</i>
Trever Hines	<i>Transient Ground Deformation in Tectonically Active Regions and Implications for the Mechanical Behavior of the Crust and Upper Mantle</i>
Sean Hurt	<i>The Structure and Thermodynamic Properties of Alkali and Alkaline Earth Carbonate Liquids</i>
Katharine Loughney	<i>Taphonomy and paleoenvironments of the Middle Miocene Barstow Formation, Mojave Desert, California</i>
Conrad Luecke	<i>Motions in The Oceans; Potential and Kinetic Energy, and Turbulent Dissipation</i>
Erin Lynch	<i>Geofluids and mountain building: Integrated isotopic studies of deformed, clay-rich rocks</i>
Ross Maguire	<i>An integrated geophysical approach to investigating thermal and chemical heterogeneity in Earth's mantle</i>
Kyle Meyer	<i>Novel Paleoclimate and Paleoenvironmental Applications of Stable and Radiogenic Isotope and Elemental Geochemistry from the Holocene through the Cretaceous</i>
Yi Niu	<i>Applications of Noble Gases in Hydrogeology in Fractured, Fast Infiltration Systems — From the Greenland and Columbia Ice Sheets to Hawaii</i>
Xiaofei Pu	<i>New Constraints on Temperature, Oxygen Fugacity and H₂O content of Subduction Basalts Based on Olivine-Melt Equilibrium</i>
Spencer Washburn	<i>Mercury Stable Isotopes as Tracers in the Environment: Applications to Aquatic and Natural Gas Systems</i>

Recent Masters Theses

Aislinn Deely	<i>Photon dose affects dissolved organic matter apparent quantum yields in Alaskan Arctic surface waters</i>
Joseph El Adli	<i>Season of death of the Bowser Road mastodon</i>
Gabrielle Farina	<i>1500 years of anchovy and sardine population response to coastal upwelling off Southern California</i>
Ryan Gabelman	<i>Olivine-melt thermometry, hygrometry and oxybarometry applied to lavas erupted from the Mascola volcanic field, western Mexico</i>
Matthew Medina	<i>Genomic and transcriptomic evidence for niche partitioning among sulfate-reducing bacteria in redox-stratified cyanobacterial mats of the Middle Island Sinkhole</i>
Molly Range	<i>Global Simulation of the Chicxulub Impact Tsunami</i>
Gephen Sadove	<i>Structurally bound S²⁻, S¹⁻, S⁴⁺, S⁶⁺ in apatite: The redox evolution of ore fluids at the Phillips Mine ore deposit, New York, USA</i>



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Lecturers: M. Arnaboldi

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Back Page: *Camp Davis student cabins prior to renovation. Photo by Peter Knoop*

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The University of Michigan
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Out with the Old : In with the New
Student Cabins on the West side as they were and as we remember them

REMEMBER How Michigan impacted your life

CONSIDER How your gift can impact tomorrow's students

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