FALL 2017

EARTH

Geoscience News

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

Chair's Corner

Dear Alumni and Friends,

To say this has been a tumultuous year at the University is an understatement. There have been protests against racism and climate change, and marches in support of women and science, among others. Walking with my teenage daughter and 11,000 others across campus and through Ann Arbor in support of science was an unforgettable experience. The campus has also experienced several incidents of intolerance in the form of racist and hateful graffiti. These are upsetting events, ones that we didn't think could happen on this campus in 2017. Though our department has not been specifically targeted, these incidents are a reminder to us all that our goal to provide an open and welcoming atmosphere for all of our students, staff and faculty is far from accomplished. Our department continues to work toward this goal at many levels.

As part of the demonstration against racism, our building has recently come under the spotlight for its name, and was the focus of a student-led rally that temporarily halted traffic on Church Street and mild defacement of our building sign (see photo). Our building's namesake, Clarence C. Little, was a former U-M President (1925-1929) and made lasting contributions to cancer and genetics research. He was also an outspoken and leading eugenicist, who argued for legislation to "restrict the reproduction of the misfit…[by] compulsory sterilization"[1] and promoted anti-miscegenation laws, and colluded with the tobacco industry to obscure the link between cigarettes and cancer. Our department has no allegiance to the name, and can do better than associate itself with the repulsive and discredited ideas espoused by Little.

A case by several U-M faculty and students to rename the building is pending. Incidentally, **Professor John Dorr**, the department chair at the time that the building was changed from the Medical Science II Building, wrote a letter in 1968 to the Regents objecting and offering alternative names. Dorr's oppositions were more practical than high-minded; he argued that the building name should have some connection to the function (East University, Natural Science II) or tradition (Houghton, Leverett) of the building and was concerned that "Little" would attach a diminutive connotation to the department. As a long-time occupant of the C.C. Little Building, I'm less concerned that the building name serve as a label of or tribute to our profession—it never has before. Rather, at a time when we're actively trying to be more inclusive and broaden representation in the earth sciences, the building name should reflect our aspirations.

On a different note, we are thrilled to welcome three new faculty to our ranks—**Professors Julia Cole, Jena Johnson,** and **Sierra Petersen**. Julia joins us from the University of Arizona. She is a pioneer in the use of corals and cave deposits for generating paleoclimate records. Her research has specifically focused on understanding tropical Pacific variability (including El Niño-La Niña) and the history of drought in the western US, both issues of great societal relevance. Jena comes to us from the University of Colorado, where she was an Agouron Postdoctoral Fellow. She is a geobiologist who studies minerals in ancient sedimentary rocks and through laboratory experiments using spectroscopic and microscale imaging tools and geochemical techniques. Her research examines the interactions between geology, chemistry, and biology to understand the evolution of early life and its impact on Earth's environments. Sierra, though a new faculty member, is not new to us. She was formerly a post-doc working with **Kacey Lohmann**. She uses geochemical techniques to develop proxy records of past environmental conditions preserved in ancient marine sediments. During her post-doc, Sierra reconstructed past temperatures on Seymour Island, offshore of the Antarctica Peninsula, leading up to the Cretaceous-Paleogene mass extinction event.

In other faculty news, I am delighted to report that **Professor Youxue Zhang** and **Research Professor Jeffery Alt** were elected Fellows of the American Geophysical Union, joining current departmental fellows **Professor Joel Blum** and **Emeritus Professors Phil Meyers, Ted Moore, Henry Pollack** and **Rob Van der Voo**. This is a tremendous honor— only

one in a thousand members is elected to AGU Fellowship each year. Among other notable faculty achievements, **Professor Ingrid Hendy** was promoted to Professor with tenure and **Professor Rose Cory** to Associate Professor with tenure; **Professor Kacey Lohmann** won the 2017 Excellence in Departmental Advising Award; and **Professor Adam Simon** was awarded a 2017 Provost's Teaching Innovation Prize. It is both humbling and inspiring to work with such hard-working and talented colleagues.

In my first letter as Chair in fall 2014, I announced that we had begun plans to renovate the student cabins at Camp Davis. During the last three years, we've been busy developing architectural plans, pulling permits, and figuring out how we would pay for it all as renovation estimates rose from $3.8 to $6.5 million due to rising construction costs. We're now closer than ever and anticipate, pending the Regents' approval (fingers crossed), to break ground in fall 2018 and have the cabins in place for summer 2019. Though we're not there yet, I would like to thank all who have contributed to this effort, including the College, Camp Director **Nathan Niemi** and Camp Manager **Chris Malvica**, and especially our alumni and friends, who have given more than $2 million to support Camp Davis. (If you were waiting to make a donation to the renovation, it's not too late!) These gifts guarantee that future generations of undergraduate students will benefit from the tremendous educational opportunity that the Camp Davis field station provides.

I'm proud to announce that for the second year in a row, our department again set the Giving Blue Day standard in the College for participation and total amount of donations! Eighty-one alumni, students, faculty and staff gave to directly support student research and field opportunities. The Department will participate in Giving Blue Day again this year, which will take place on Tuesday, November 28th. Please consider giving! All gifts will be used to support students.

In closing, I thank you for your continued support of the Department and encourage you to keep in touch. We'd love to hear from you and to learn how UM has touched your life.

Warmest regards,
Chris

[1] "Sees a Super-Race Evolved by Science," New York Times, 8/25/1932

COVER PAGE PHOTO

Spring Soft-Rock Field Excursion to the Colorado Plateau and nearby geological attractions: Here students are seen on their journey down Bryce Canyon with Peter Knoop leading the way.
Photo by Kacey Lohmann

FUND RAISING

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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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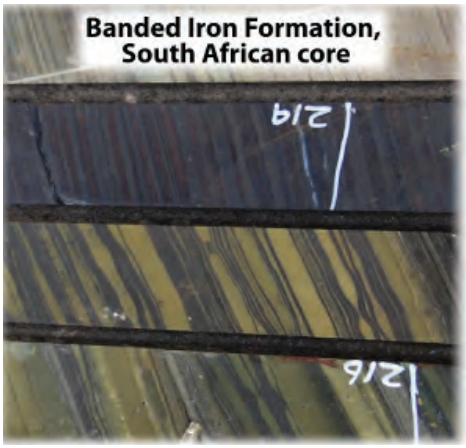
JENA JOHNSON

NEW FACULTY
GEOBIOLOGY

I have long been intrigued by how the history and evolution of life on Earth are tied to the evolving climate and surface chemistry of our planet. In high school, I learned about Geobiology, a field that explores the evolution of life and environments through chemical signals safeguarded in the geologic record – I was hooked! I majored in a self-designed Geobiology major at Brown University (2005-2009), where I was able to take many classes in the Earth, Environmental and Planetary Sciences department as well as in the Biology and Chemistry departments. I then pursued a PhD at Caltech in Geobiology (2010-2015), investigating the evolution of photosynthesis and rise of atmospheric oxygen through the manganese mineral record. As I embarked on the second half of my PhD, I recognized the importance of performing laboratory experiments and studying field analogue environments in order to correctly interpret clues in the rock record. I began a collaboration with microbiologists to study the mineral products formed by manganese-based metabolisms. I continued gaining expertise linking aquatic chemistry with geomicrobiology in a postdoctoral position at the University of Colorado, Boulder.

I look forward to bringing my excitement about early Earth geochemistry and geobiology related to manganese and iron to the Earth and Environmental Sciences Department at Michigan. My lab will specialize in the investigation of redox cycling in anoxic environments. This research will combine analyses of the best geologic archives of early Earth (for example, cores from South Africa shown below) in addition to lab experiments performed in anoxic glove boxes and investigations into modern analogues for the Precambrian ocean. My current projects explore the Archean iron cycle through a combination of (1) nanoscale analyses on ancient samples, (2) abiotic and biological experiments that will constrain the formation mechanism of observed ancient iron minerals, and (3) investigations of modern lake analogues for the Archean ocean. Future research in my lab will focus on iron and manganese geochemistry during the evolution of photosynthesis and will measure the impact of the rise in molecular oxygen on these elemental cycles. -- Jena Johnson



Banded Iron Formation, South African core

Crater lake in Mexico: Analogue for the Archean ocean

NEW FACULTY
GEOCHEMISTRY -- PALEOCLIMATE

SIERRA PETERSEN

Most discussions of climate change focus on the visible—melting ice caps, rising sea level, disappearing habitats. It is less often considered how climate touches life and leaves a record at every level – even down to the isotopic composition of natural materials (tree wood, glacial ice, clam shells) that can preserve a record of climate in times past. Study of these invisible climate signatures drives my research.

As a kid, every summer I left Chicago behind to tramp around national parks with my family. Gazing into the Grand Canyon, I got a sense for the immensity of geologic time. Hiking, skiing, and camping in the mountains ignited my interest in Earth science. When I was 16, I volunteered at The Mammoth Site in South Dakota, brushing dirt from 25,000 year-old mammoth bones and imagining the environment in which these ancient beings lived. A few years later, as part of my first real research experience as a Caltech undergraduate, I returned to The Mammoth Site to quantify how strikingly different climate during the Last Glacial Maximum was from climate today using a brand new isotopic tool (the clumped isotope paleothermometer).

My initial love affair with geology and geochemistry never waned, and after I graduated Caltech in 2009 with a degree in geochemistry I moved on to pursue a Ph.D. in geochemistry, paleoclimatology, and paleoceanography at Harvard University (2009-2014). Winning an NSF Ocean Sciences Postdoctoral Research Fellowship brought me to University of Michigan in 2014 to study past climate using the same isotopic tools I began my research career with almost a decade before at Caltech.

I continue to be interested in revealing climates of the past, but my research focus has gradually slipped further and further back in time since my initial foray looking at the Last Glacial Maximum. I follow my nose to the most exciting and unusual intervals of climate change, such as the Eocene-Oligocene Transition when Antarctica first became glaciated (rather quickly in geologic terms!), and the end of the Cretaceous period when dinosaurs and many other organisms abruptly went extinct as the result of either massive Deccan Traps volcanism in India, the Chicxulub meteorite impact, or a combination of both [spoiler: I think it's both]. Going forward, my research group will continue to use stable and clumped isotopic techniques to reconstruct past climate, focusing on questions of past ocean circulation, ocean-climate interactions and climate-extinction connections.

I am thrilled to be starting as an assistant professor in the Earth and Environmental Sciences Department at U-M this fall. This department has been a good home for me for the past three years and hopefully for many more to come. I will co-direct the soon-to-be-renovated Stable Isotope Laboratory with Professors Kacey Lohmann and Julie Cole, and will be primarily responsible for the clumped isotope capabilities of the lab. I look forward to exciting internal collaborations with many in the department, especially the core group of paleoclimate-focused faculty that has grown into a powerhouse in recent years.

-- Sierra Petersen

Left: *Exceedingly well-preserved bivalves from Antarctica that were used to document climate change across the K/P boundary.*

Above: *My work takes me from the laboratory into the field for sampling of geological materials used for chemical and isotopic analysis.*

JULIA COLE

NEW FACULTY
PALEOCLIMATE

I've spent the past 25 years in the geologically spectacular settings of Tucson and Boulder, but returning to the Midwest holds a special excitement for me. My interest in science and nature originates from summers in west Michigan, and my love of the ocean from the Great Lakes. I'm an interdisciplinary paleo-environmental scientist with a passion for science communication, and I am thrilled to be joining the U-M department of Earth and Environmental Sciences this year.

My research focuses on environmental change that has substantial ecological or human impacts. I develop and analyze paleoclimate records from the isotopic and elemental geochemistry of carbonates, mainly corals and cave formations. A major emphasis throughout my career has been to better understand El Niño and its impacts through time. Right now, my lab group is producing coral records that span the Pacific, from Isla Darwin (Galápagos, Ecuador) to Darwin, Australia, to refine our understanding of El Niño variability on time scales relevant to people.

El Niño has major hydroclimatic impacts that are costly to human and natural systems. My group is also exploring ways to improve the record of drought in the southwestern U.S. and elsewhere, using cave formations dating to the Holocene and beyond. I also collaborate with an interdisciplinary group that includes climate modelers and social scientists to improve how we identify, quantify, and convey the risk of megadrought broadly. By understanding the natural causes of hydroclimatic variability, we can ensure that they are accounted for in climate models, resource management, and assessments of future climate risks.

I am committed to improving how we translate science to the general public, to decision-makers and stakeholders, and across disciplines. My own experience as a climate scientist has provided fertile ground for a lot of learning on this subject. I have held several fellowships related to climate science communication, and I have both received and led diverse trainings to improve communication skills. I look forward to doing more of that at U-M.

By working on coral reefs for nearly three decades, I've witnessed firsthand the accelerating degradation of this iconic ecosystem throughout the tropics. Over half the world's reef corals have died in the past few decades, as the oceans warm. At the Biosphere2 in Arizona, I lead a group that is working to revitalize the Biosphere 2 ocean and build an experimental coral reef. This facility will allow us to develop, test, and deploy potential ways to address the reef crisis, without further endangering natural reefs.

At UM, I am looking forward to building a new lab group, advancing my work on climate and environmental variability, and taking advantage of new opportunities to bring science closer to real world issues. -- Julie Cole

Above: The Biosphere 2 houses the world's largest ocean-under-glass. We are revitalizing this unique facility to support an experimental reef where we can develop, test, and deploy ways to build reef resilience.

Monitoring cave dripwaters helps us understand our records better. Here in Kartchner Caverns State Park, AZ, water samples are collected monthly for isotopic and geochemical analysis.

Center: Not all corals are sampled on SCUBA. Here I'm drilling a fossil coral on the shore, helped by a national park ranger.

Grand Canyon of the Yellowstone with late afternoon storms.

We will finally see some long-anticipated changes, and one unexpected one, at Camp Davis. Over the summer, the College and the Department developed a plan to move forward with renovations of the student cabins at Camp Davis. There was mutual agreement that this renovation was an overdue necessity, and we are incredibly pleased that it will begin within the next year.

Unfortunately, this past winter was one of the snowiest on record in Jackson, and a mid-winter stretch of heavy snowfall and hurricane-force winds caused damage throughout Jackson Hole and Hoback Valley. Both the Dorr-Kelly classroom building and Johnston Hall, the student recreation building, suffered damage from this storm, with Johnston Hall completely collapsing. The University's insurance plans will rebuild Johnston Hall, and we are in the process of designing a replacement structure that we hope will be constructed together with the student cabins next year.

Students have the opportunity to visit a trench opened by the USGS across the Teton fault north of Jackson Lake.

Camp Davis Student Cabin Renovations Are Underway!

After years of planning, renovation of the student cabins will begin at Camp Davis. The renovation plans include ~30 new three-season student cabins with bathrooms and a complete overhaul of infrastructure (electrical, water, sewer, and fire suppression). We continue to raise funds to cover the cost of this renovation and deeply appreciate the donations and commitments that have been made to date. For more information, please visit the Camp Davis Renovation Webpage, http://lsa.umich.edu/earth/camp-davis/camp-renovations.html.

On the academic front, we were able to offer a full slate of courses at Camp Davis again this summer, as well as put the Camp facility to some less common uses. The 2017 eclipse came right across Jackson and Grand Teton, and the area was flooded with visitors. Faculty from U-M's Astronomy Department set up solar observing telescopes at Camp to view the eclipse, and several alumni, as well as scientists from CU Boulder and the Denver Museum of Science, took advantage of Camp's proximity to Jackson to observe the eclipse.

In addition, in what we believe was a first, U-M's President, Mark Schlissel, visited Camp Davis this summer. As so many of us have, he found it to be a unique and special place. We look forward to the upcoming renovations that will keep it that way for many years to come.

Nathan Niemi

Camp Davis Director

A Personal Statement: CLIMB EVERY MOUNTAIN

by Alexis Rankin
EARTH 202 - Spring 2017
Camp Davis, Wyoming

The first mountain I climbed in Wyoming wasn't even really a mountain. Mt. Ann is located directly behind Camp Davis, the Rocky Mountain Field Station owned and operated by the University of Michigan where students of all majors can take Earth, environmental, American culture and ecology classes during the summer — so it's a typical first hike for new students. When my class of about 20 students arrived after a two-and-a-half-day cross-country caravan trip, we were told that we would be the next group to make the inaugural climb and that it would be an easy hike — the perfect starting point for a month of intense summits.

The hike began with our professors taking the lead while the class fell into a single-file line behind them. Our GSIs rounded up the back, carrying a cumbersome whiteboard for field lectures and prepared with bear spray and satellite radios. To my embarrassment and surprise, I found myself literally huffing and puffing after the first five minutes. All I could think was: "When will this incline end? It has to flatten out eventually. I can't breathe!" Our professors noticed our sluggish pace and made several educational stops where we identified flowers and trees.

For me, the breaks were never long enough. As we climbed, I started to doubt myself.

If this wassupposed to be our easiest hike, how was I going to survive the rest of the month? Worst-case scenarios were playing through my head, the most dramatic of which involved me calling home for a plane ticket back to Michigan.
I had never been so relieved and proud as the moment I reached the top of Mt. Ann after six hours of hiking. Surrounded by bright-yellow wildflowers and a view of the Grand Tetons in the distance, we sat down and had class right there on top of the mountain.

The rest of my month at Camp Davis was spent climbing actual mountains, as I would later learn to differentiate between the "glorified hill" that is Mt. Ann and the overwhelming monstrosities which are the Grand Tetons.

We hiked to an elevation of 11,000 feet on our first Teton hike, which dwarfed Mt. Ann in elevation and distance. As we walked, the trail transformed from forest, to open flower covered hills, to snow covered inclines that lead to snowball fights, belly slides, and a dramatic slip-and-slide trip back down. Making it to the top was even more rewarding than Mt. Ann and the view made every mile worth it. There was a palpable excitement as we all took photos, gathering for a group picture with the block 'M' Michigan flag prominently featured. We still had a quick lesson, scribbling in our orange field notebooks as our professor described the life of 500,000 year-old stromatolites that were still present at the top.
I was exhausted by the time we made it back down, but I could already tell I was becoming acclimated to my new life in Wyoming. My tolerance for the thin air was growing, my body didn't protest like it had on my first climb and I wasn't plagued with thoughts of self-doubt, but was instead surprisingly impressed by my accomplishment.

On our second free day, we were fresh off a four-day camping trip in Yellowstone, and had chosen to camp in the Gros Ventre range and spend the Fourth of July in the Tetons. The crowds were intense due to the holiday, but we were determined to make it to Phelps Lake, where there was a perfect rock for cliff jumping. The class had split into groups for various activities, but each of us made it to the rock at some point that day, all with the intention of jumping into the freezing glacial melt.

My stomach had been turning all morning in anticipation and my anxiety grew rapidly as I watched my friends jump off one by one, some more gracefully than others. By the time it was my turn, I had already been sitting at the top for what felt like hours, nervously talking to people who had already jumped several times, trying to gain some confidence from their experience. Every time I approached the edge I was pulled back by the sight of the water 20 feet below me and the jutting edge of the rock — I'd have to propel myself forward to avoid it.

When I finally made the jump after at least 20 false starts, I was rewarded by cheers and applause that drowned out my scream. I collided with the icy water in a discombobulating blast. The fall was disorienting as the high drop leaves you in the air far longer expected. I came out of the water to another round of applause (I'm sure the other tourists were just happy that I was finally off the rock) as I swam to the edge where my classmates were waiting.

Like most of my Camp Davis experiences, I was surprised by and proud of myself. Just as I would have regretted not going to Camp Davis or not finishing the first hike, I would have left Phelps Lake hating myself if I were the only person who didn't experience the jump. While not all my challenges in Ann Arbor can be equated to those at Camp Davis, it is comforting to think that if I jumped 20 feet into an icy lake or hiked to 11,000 feet I can pretty much do anything. On the last day our class we hiked Mt. Ann together one last time. We had just taken our final exam and spent the day relaxing in Jackson. We all wanted to end our trip the way it started. It had been just over three weeks since our first hike, but everything had already changed drastically. The hike was familiar yet entirely different as the trail had grown over and new wildflowers had come into season while the old ones now towered above our heads. But we had grown too. What had once been a challenging six-hour endeavor was now a relaxing and nostalgic conclusion that barely lasted an hour and a half.

While I had been looking forward to attending Camp Davis since high school, I was still nervous about the challenge that committing to a monthlong class in Wyoming with 20 strangers would bring. Everything about it was out of my comfort zone, but I knew that not only did I have to do it — it's one way to fulfill the practical experience requirement for the PitE major — but I wanted to do it. As stressful as those first few days were, I am so thankful that I didn't let my fear and anxiety hold me back.
My time at Camp Davis reinforced my passion for the environment and my confidence — personal and academic.

Alexis Rankin is currently Senior Photo Editor of the *Michigan Daily*. Her article relates her experiences while taking EARTH 202 *Introduction to Earth and Environmental Science in the Rockies*. This is one of several courses which utilize the Camp Davis Rocky Mountain Field Station near Jackson Hole, Wyoming. *This article was previously published in the Michigan Daily. Visit the link:*
https://issuu.com/michigandaily/docs/2017-10-04

On the recent trip to the Grand Canyon, students stopped at the Desert View Watchtower and provided this unique opportunity for a group photograph. Photo by Peter Knoop

SHELL OIL COMPANY SUMMER FIELD TRIP
GO WEST: FROM ANN ARBOR TO THE GRAND CANYON

As part of an ongoing tradition started by Bruce Wilkinson in the late 70's, the Soft Rock Group takes a long field trip for students to come face to face with real rocks occurring in real places. This year, Kacey Lohmann and Peter Knoop led a two week excursion from Ann Arbor to the Colorado Plateau region, to provide students who were unable to participate on the New Zealand international trip, the chance to get into the field. Driving from Ann Arbor provides us the ability to see the geology from Ann Arbor, across the Midwest, and finally to the expansive exposures of the Grand Canyon region.

Our attempts to examine lower Paleozoic sequences in southeastern Missouri were thwarted by extensive rains and flooding. This required that we spend the first night in motels, rather than our typical camping experiences. Flooding was so bad that the following evening, this motel was flooded by rising waters from the adjacent rivers. Fortunately, as we moved westward to Kansas we were able to escape the rain and examine the classic Carboniferous cyclothems of southeastern Kansas and then the Permo-Triassic clastics at Palo Duro Canyon, Texas.

Megan Hendrick, Chenghuag Goa, and Samuel Whitehead *examine microstructure of petrified wood. Photo by K. Lohmann*

Our trips always try to include aspects of the regional history and culture where possible. This year we visited the Chaco Cultural National Historic Park which preserves the densest habitation site of the ancient Pueblo peoples. The mountains surrounding this site have excellent exposures of the late Cretaceous inland sea deposits with classic off-shore to fore-shore regressive sequences. Then, off toward the Grand Canyon and other locales.

In addition to the renowned geology of the Grand Canyon, this region possesses such a diverse array of geological features, that the bulk of our trip focusses on excursions within the numerous national parks. The long day hike to the bottom of the Canyon on Bright Angel Trail is the most challenging for most of the students (and for the aging faculty), but the sequences here provide a stark contrast to the younger

This trip was generously supported by a grant from Shell Oil Company and by the Endowed Field Excursion Fund established by an anonymous donor. THANK YOU!!

The group at Plateau Point down Bright Angel Trail in the Grand Canyon. Photo by Knoop

units that are examined in the neighboring parks. Perhaps most spectacular are our visits to Zion, Capital Reef and Bryce. The hike to Observation Point in Zion is impressive not only for the beautifully exposed cross-bedding in the Jurassic eolian deposits, but also the volume and extent of material that was transported to and deposited in this area.

While our trip was largely free of rain, other than the harsh beginning in Missouri, the last days in Utah were increasingly wet, with rain in afternoons, and dew covered tents in the mornings. After a long visit to the Great Southwest, we made a rapid return to Ann Arbor.

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

***Lohmann** professing about Carboniferous phylloid algal reefs exposed in southeastern Kansas cyclothems.*

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 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

Photo by Peter Knoop

New Zealand Field Trip 2017

In May, Tim Stahl, an NSF Postdoctoral Fellow at the University of Michigan, and Assoc. Prof. Nathan Niemi led 22 U-M students on a three-week field trip to New Zealand. The theme of the trip was *The intersection of Earth, Environment, and Humans in New Zealand.* Tim completed a PhD at the University of Canterbury in Christchurch, New Zealand, in 2014, with a focus on earthquake geology. Tim's deep knowledge of the region, combined with that of the local geoscientists he was able to engage, made for an incredible trip for the students. From landslides to earthquakes to volcanos to glaciers, we had a chance to see it all on both the North and South Islands. We could fill an entire newsletter with highlights from this trip, but we hope that these photographs give you insight into the experience. We are grateful to the Department, and International Institute at the University and an anonymous alumnus donor for making this trip feasible for our students.

Photos credits: N. Niemi or N. Midttun (grad student) unless otherwise noted.

STRUCTURAL GEOLOGY
Spring in the Appalachians

The 2017 Structural Geology class field trip went to the Maryland Appalachians. **Ben van der Pluijm** took 29 students to several classic Appalachian stops on a beautiful April long weekend. Wonderful field stops to see, sketch and discuss structural geology in its natural habitat. We saw lots of folds, cleavage, veins and faults, working from orogenic interior in the east (Blue Ridge) to foreland in the west (Valley and Ridge) along a MD road transect in the central Appalachians. The group picture on a sunny Sunday morning is at the overlook of the Wills Mountain Narrows. Here, the dissection of Wills Mountain by Wills Creek exposes a gently-dipping southeast limb and a steeply-dipping northwest limb that are part of a large fault-bend fold above a major thrust fault ramp in the subsurface, which is characteristic of the Valley-and-Ridge.

The classic Martinsburg Shale locality in Maryland. This stop is a real test for geologists to respond quickly to the oncoming train. Note that Ben van der Pluijm stands significantly away from the group, and the tracks.

This year's trip also stopped at the classic locality of the Martinsburg Shale where structural geologists have argued for fluid escape being responsible for cleavage formation during folding. Today, we now know that microfolding and chemical transformations are the mechanisms here and elsewhere for the formation of the slaty cleavage.

Professor Kacey Lohmann led two field trips this year for the Sedimentary Geology course before the weather began to show the signs of winter. This included a day trip to the classic clay pits and river walk at Grand Ledge west of Lansing, MI. This was the first experience for some students of actually touching and working with real rock outcrops rather than seeing only laboratory specimens. Following a couple hours of observations and field documentation, the students began to synthesize their interpretations into a realistic paleo-environmental reconstruction. The exposure of a spectacular fining upward sequence within a meandering river channel was the hit of the day. Here, large clay clasts, encased in sandstone, form the basal lag deposits along the cut bank contact. A more complete picture of the Pennsylvanian environments developed after the students examined the beach sequences exposed along the River Walk in Fitzgerald Park. A really great day of looking at clastic rocks!!

Bekah Stein *and* **Mark Robbins** *examine the basal lag deposit adjacent to a cut bank exposure of a meander system in Pennsylvanian-aged outcrops at the Face Brick Quarry at Grand Ledge, MI.*

In late September, the second trip visited the classic localities of Indiana and northern Kentucky. We were privileged to be able to visit the Pipe Creek Junior quarry near Gas City Indiana, as it is becoming increasingly difficult to gain access to working quarries and mines due to liability concerns. Nevertheless, Irwin Materials, Inc. granted us about 3 hour visit to this classic upper Silurian limestone reef replete with fossils, large pisolite-filled dikes, and steeply dipping flank beds. We thank both the company and the Senior Geologist, John Havens, for this opportunity.

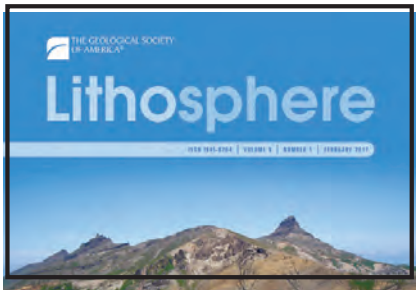
Heading southward, we explored the skeletal grainstones of Mississippian age. These are the classic units of the "Indiana Limestone" that have been building materials for so many structures throughout the US, including the Empire State Building.

Our final day of the three day excursion took us to the shores of the Ohio River in Jeffersonville where bedding plane exposures of limestones are exposed at Falls of the Ohio. This unit, the Jeffersonville Ls., is a Devonian-aged biostromal sequence with excellent corals, stromatoporoids and other fossils. Lastly, to provide for fossil collecting and section measuring, we examined the late-Ordovician sequences north of Madison and Southgate, Indiana. Both of these localities possess some of the most fossiliferous units in the region.

Despite the paucity of bedrock exposures in Michigan, these short class field trips give students an opportunity to see rocks in natural settings. We thank our alumni for providing funds that help sponsor these for both classes and for our Spring and Summer excursions. THANK YOU.

Top photo and above left: Falls of the Ohio River in Jeffersonville, IN. Here students (left to right: ***Ian Donnelly, Bianca Gallian****, and* ***Tommy Flynn****) examine excellent bedding plane exposures of the Jeffersonville Ls. Right Photo:* ***Rose Popma*** *admires large scale cross-stratification in the Mississippian Salem Ls. near Bedford, IN. All photos by K. C Lohmann*

Alumni News



CELEBRATION OF STRUCTURAL GEOLOGY AND TECTONICS GROUP

This past year a digital themed issue in the Geological Society of America (GSA) journal, Lithosphere, was organized to celebrate the long-standing contributions of the Geology Department's structural geology and tectonic research group headed by Ben van der Pluijm and Rob Van der Voo. Research from this group has been diverse and prolific, focusing on everything from the structural and temporal evolution of orogenic systems, to global geodynamics and plate tectonics, to the temporal evolution of the geodynamo, to the intricacies and methodologies of paleomagnetism, rock magnetism, geochronology and fabric analysis applied to regions from around the world. Motivation for the themed issue came from a pair of special sessions at the 2015 GSA meeting in Baltimore, MD. The session focused on Ben's scholarly contributions was titled, 'Perspectives on Orogenic Evolution, Dating Brittle Faults and Mylonitic Shear Zones, Bending Mountains, and Assembling Supercontinents: A Session to Honor the Career of Ben Van Der Pluijm' (chaired by alumni Arlo Weil, Eric Tohver, Bernard Housen and Samuel Haines), while the session focused on Rob's contributions was titled, 'Rotations, Oroclinal Bending; Variscan-Alleghenian Nondipoles; Diagenetic Enigmatic Remagnetizations; Vignettes of Orogenies and Oceans: A Celebration of Rob Van der Voo's Career' (chaired by alumni John Geissman and Joseph Meert). Arlo Weil was the Lithosphere editor in charge of the themed issue, with many of the published articles being authored by past participants of the structural geology and tectonic research group. Content from the themed issue can be found on Lithosphere's webpage (*https://www.geosociety.org/GSA/Publications/Journals/lithosphere/GSA/pubs/lithosphere/edBoard.aspx*).

After ending his work at Round Mountain, Nevada, at the end of March, **David Levine (BS'15, MS'16)** has since been enjoying his new job at Fort Knox in Alaska. He writes "I have been running a program at the mine focused on better understanding the control of mineralization with the help of spectral analysis and geochemistry. I have been able to use all that I learned down in Nevada to be successful here in Alaska. It is great to be continuing my career at another world class gold deposit. Outside of work I have been thoroughly enjoying my summer in Fairbanks. With close to 24 hours of sunlight, there is loads to do and not enough time. My summer has been spent traveling around the state with lots of fishing and cycling thrown in. As winter approaches, I have been doing some hunting and preparing for another part of the Alaskan lifestyle... the cold. While out and about in town, I ran into **Doug Christensen (MS'79, PhD'87)**, a former geo-student at U-M, at a local watering hole, and he wanted me to give everyone his best. Wherever I go, I seem to always run into Michigan graduates!"

David Blake "Our Man on Mars"

David Blake (PhD'83,Postdoc'84) and his wife Carol Straford returned to Michigan this Fall for our Smith Lecture Series. Both Carol and Dave received their PhD's from Michigan. Dave subsequently began working at NASA AMES Research Center where he has become quite famous for his work on developing instrumentation for the Mars Rover Program and Carol became a very successful patent lawyer. His system, **CheMin**, a minaturized X-ray Diffraction system has been operational on Mars for the last 5 years. The engineering concept is inspirational with samples drilled from the Mars surface being directly analyzed on site. This work has provided new insights into the nature of the early Mars atmosphere and the evolution of sedimentary layers comprising the lower part of Mt. Sharp. Dave, the Department is very proud of your accomplishmentsand achievements. Keep it up!!

UPDATE YOUR ALUMNI PROFILE AND EMAIL

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

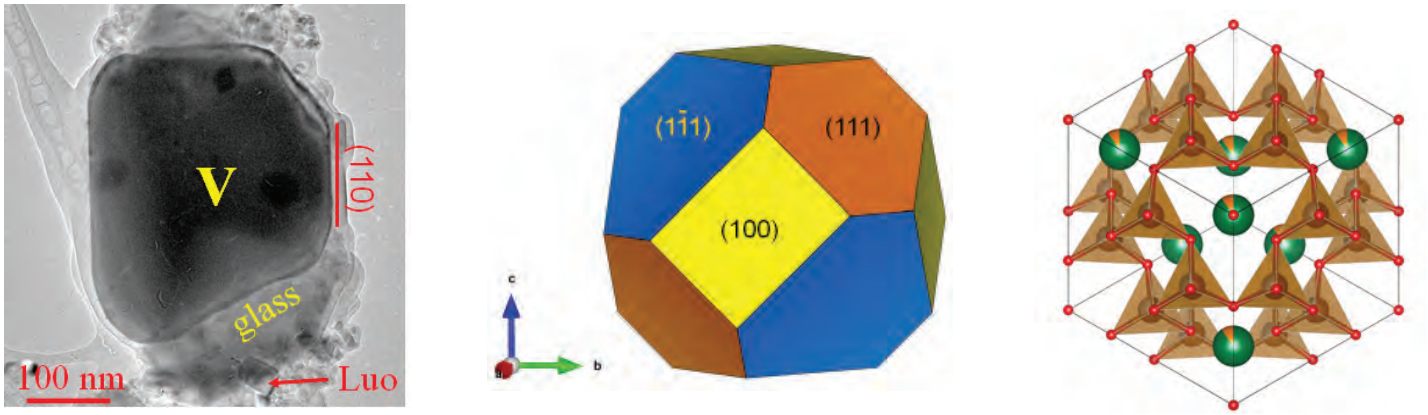
Valleyite

A New Mineral in Basaltic Rocks

Magnetic minerals are important for recording Earth's paleo-magnetic field. Common magnetic minerals are magnetite, maghemite and pyrrhotite. Recently, a research team at the University of Wisconsin discovered a new magnetic mineral, ***Valleyite*** with stoichiometry of $Ca_4Fe_3+6O_{13}$ in basaltic glass and scoria from the late Pleistocene Menan Volcanic Complex near Rexburg, Idaho, USA. The new mineral occurs as euhedral crystals with sizes of several hundreds of nanometers (*see Figures below*). They crystallized at high temperature in an oxidizing environment. Valleyite has the sodalite-type structure with cubic symmetry. Ferric iron and a small amount of Al are in tetrahedral sites that form a cage-like framework. Ca atoms are in the cage sites.

The new mineral is named after **John W. Valley (MS' 77, PhD'80)**, Charles R. Van Hise Distinguished Professor of Geoscience at UW-Madison. Valley received his PhD from the University of Michigan working with **Eric Essene (Professor)** in the Adirondack Mountains. He has taught at UW since 1983 and was President of the Mineralogical Society of America from 2005 to 2006. His contributions to mineralogy, petrology and geochemistry have led to a deeper understanding of crustal evolution from early Earth to the Anthropocene. Both the mineral species and name have been approved by Commission on New Minerals, Nomenclature and Classification (CNMNC) of the International Mineralogical Association. Because valleyite is a new crystalline material, its magnetic and chemical properties may have applications in materials science and are being further investigated as function of temperature and composition.

Valleyite could be viewed as petrologically related to the silicate mineral, esseneite ($CaFe_3+AlSiO_6$), which is named for Eric Essene and also forms at high temperature, low pressure, and high oxygen fugacity. The minerals are linked by the reaction: esseneite = aluminous valleyite + SiO_2. It is not yet known whether valleyite is stabilized relative to esseneite by temperature, silica activity, or other substitutions. We hope that Eric's many former students and those who knew him will join us to toast Eric and speculate on this puzzle, which he would have loved.



Left: Transmission electron microscopic image showing a valleyite crystal (V) together with basaltic glass and much smaller crystals of luogufengite (Luo, ε-Fe2O3). Center: Ideal morphology of valleyite with crystallographic forms of {100}, {111} and {1 1}. Left: Polyhedral model of the cubic valleyite structure projected along the [111] direction. Brown tetrahedra: (Fe,Al)O4; Large green balls: Ca; Small red balls: O.

This article was prepared by Huifang Xu
Department of Geoscience
University of Wisconsin-Madison

FACULTY NEWS

Brian Arbic (Assoc Professor) and his lab saw the departure of one research scientist, one postdoc, one graduate student, and one undergraduate student. Joseph Ansong, who started in the lab as a postdoc and later became a research scientist, departed for a faculty position at the University of Ghana. **Amanda O'Rourke**, a postdoc, obtained a research scientist position in the Johns Hopkins University Applied Physics Laboratory. **Anna Savage (PhD'17)** is now a postdoc at Scripps Institution of Oceanography. **Ji Ye (BS'17),** an undergraduate in the group and a departmental major, wrote an honors thesis and is now traveling the world for the next year, as one of four winners of the highly competitive University of Michigan Bonderman Fellowship. While Arbic is on a one-year sabbatical in France, remaining members of the Arbic lab include **Paige Martin**, a physics PhD student who joined Arbic, **Professor Adam Simon**, and others at the Coastal Ocean Environment Summer School in Ghana (coessing.org), **Conrad Luecke**, an Earth student who is spending his final year at Scripps, **Molly Range**, a new fifth-year MS student, and **Arin Nelson**, a new postdoc (PhD University of Colorado). The Arbic lab has 5 publications thus far in 2017, with more coming, and obtained two new grants (one from NASA and one from the US Navy).

For **Ben van der Pluijm (Professor)** the 2016/17 academic year was an exciting time with the successful completion of two PhD theses. Samantha Nemkin (PhD'17), in a project with **Rob Van der Voo (Prof Emeritus),** finalized her research on synfolding remagnetization, showing this is very common in the Rocky Mountains and its equivalent in Mexico. A third paper, on the Monterrey orocline in northern Mexico, was just accepted for publication. **Austin Boles (PhD'17)** completed his studies on clays in a range of deformation settings, and the development of a more advanced X-ray clay characterization method. Beyond published work, a couple of papers remain under review, including results from surface outcrop analysis along New Zealand's Alpine Fault and Rietveld quantification of clays. The continuing research of graduate student **Erin Lynch (PhD Cand)** focuses on geofluid fingerprinting in the Rockies and Appalachians, building on a recently published study in the Argentine Precordillera that finds a regional climate signal in fault rocks. She is in her final year with a Rackham Predoctoral Award, allowing time to complete and defend her dissertation in mid-2018.

Ben has expanded his professional efforts and outreach activities in societal resilience, which is the focus of a Fall class and will be incorporated in future teaching of introductory geology. An optimistic presentation on "*The Human Era: Living in the Anthropocene*" was offered in several professional and public venues, including an U-M alumni trip in sunny (!) SE Alaska (picture). The AGU journal *Earth's Future*, dealing with the science of the Anthropocene, continues to grow and seems well-received by colleagues (if journal impact factors mean anything) and the public (based on Altmetics). Some personal travel, meetings and service trips, and a new puppy, Luca, keep Ben and Lies nicely occupied. Their sons, Wouter and Robert, decided to support Delta Airlines by moving to Boston and San Francisco for their work.

Steve Kesler (Professor Emeritus) joined five other economic geologists to write Future Global Mineral Resources, the latest volume in *Geochemical Perspectives*, a publication of the European Association of Geochemists. The volume was written to dispel the erroneous opinion among geochemists and the general public that we are running out of mineral resources. The new volume includes summaries of how mineral deposits form, how they are found, and how they are produced, along with new estimates of Earth's ultimate resources based on the geochemistry and mineralogy of trace elements in the crust. Using copper, a critically important metal, as an example, they show that potential long-term resources are likely to be thousands of times larger than amounts in known deposits, but that these resources must be found and produced. They argue that geologists, who understand Earth better than most citizens, have a responsibility to help educate the public to this challenge as we attempt to supply society with its essential minerals.

No, **Rose Cory (Assoc Professor)** does not see every river through Rose-Colored glasses, this arctic river actually turned pink after a big storm during summer 2017, likely due to high loads of iron rich sediment, clays and glacial flour. Because the Cory Lab is studying the role of iron in carbon cycling in the Arctic, sampling this pink (iron-rich) river did help them see storms in a more positive light.

The last year was a transitional year for **Nathan Sheldon's (Assoc Professor)** research group, with **Allie Tessin (PhD '16)** and **Tim Gallagher (PhD'16)** completing their degrees and three new students (**Becca Dzombak, Kevin Ortiz, and Bekah Stein**) starting in the group. Allie received a Marie Curie Postdoctoral Fellowship to continue her carer at the University of Leeds and Tim received an NSF Postdoctoral Fellowship to work at the University of Texas. Recent PhD alum **Ethan Hyland (PhD'14)** completed his post-doc at the University of Washington and started a tenure track position at North Carolina State University, followed closely by his glaciologist wife **Carli Arendt (PhD'15)** who started her tenure track position at NCSU this fall. Members of his group did fieldwork all over the world on a variety of projects, including in China and India, and I taught a new field-centered course (EARTH 296) that spent a week in Florida looking at issues of water and environmental sustainability from Lake Okeechobee down to the Florida Keys. Current students in the group received a number of grants to support their research, highlighted by Becca's "Lewis and Clark Exploration in Astrobiology" award from the American Philosophical Society that will support extended fieldwork in Iceland during 2017-2018. Ongoing funded research by his group continues in the twin areas of paleoclimatology and biogeochemistry, and a number of members of the group also contributed materials, written work, or time to the redevelopment of the Planet Earth exhibit in U-M's new Natural History Museum, which is slated to open in 2019.

Jeroen Ritsema (Professor) took the seismology students and postdocs on a field trip to Comerica Park after another successful year. **Sam Haugland (PhD Cand)** worked on seismic wave scattering in the deep mantle with our regular summer visitor Professor Satoshi Kaneshima from Kyushu University in Japan. Sam has published a paper on the mixing of fragments of oceanic crust in the lower mantle. His paper on the elastic properties of eclogite at deep-mantle pressures and temperatures will appear later this year. **Ross Maguire (PhD Cand)** has published two papers on the structure of thermal plumes ascending from the core-mantle boundary and how plumes are imaged by seismic tomography. Ross is currently developing seismic reflection sections of the North American upper mantle. **Russel Wilcox-Cline (PhD PreCand)** has continued his analysis of wave amplitudes to understand wave attenuation and wave focusing in the mantle. He is also working with **Eric Hetland (Professor)** using statistical methods to infer crustal stress from earthquake focal mechanisms and finite slip models. **Carlos Chaves (PostDoc)** has worked on theoretical aspects of wave reflection and wave diffraction. Carlos's research is aimed at estimating the depths of phase transitions in the mantle transition zone and the thermochemical structure of the core-mantle boundary region. Several undergraduate students have worked in our lab. Using global catalogs of earthquake focal mechanism solutions, **Wardah Mohammad Fadil (BS Honors'17)** completed honors thesis research on the seismicity of the Indo-Australian Plate. **Graham Gerdes** measured the reflection coefficient of P waves reflecting off the outer core to determine fine scale layering at the base of the mantle. **Sirawich ("Pete") Pipatprathanporn** is a new student in the lab. He will participate in new research on the tomographic imaging of the mantle beneath North America.

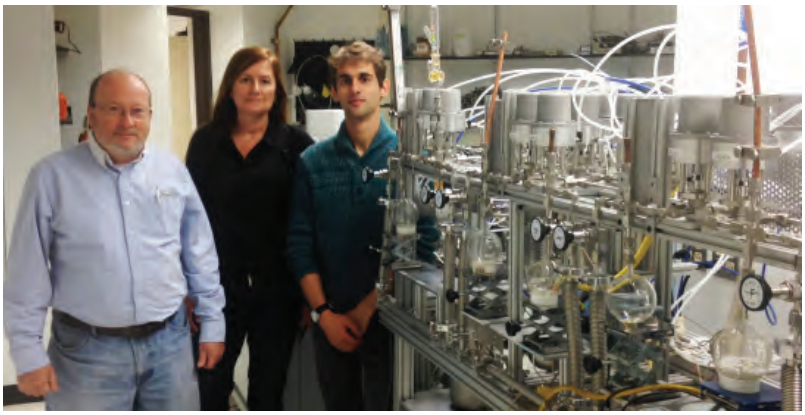
Adam Simon (Assoc Professor) and his on-campus and off-campus families had a great 2017. My wife Alicia transitioned into a position in the UM Provost's office, our older daughter had a great first year of college, our 15 year old son is now at eye level with Adam and showing no signs of slowing down, our younger daughter became a Bat Mitzvah, and our younger son won the 5th grade state of Michigan Math Olympiad. In early 2017, I accompanied graduate students **Nikita La Cruz (PhD Cand), Tristan Childress (PhD Cand)** and **Brian Konecke (PhD Cand)** with colleagues from the Universidad de Chile, including UM alum **Martin Reich (PhD'88),** for field work at the El Laco mineral deposit in northern Chile, and in July, returned to Chile for a second round of field work with Tristan Childress and new graduate student **Maria Mustafa (PhD PreCand)**. A couple of work trips to Japan and China, two weeks of educational outreach in Ghana, and teaching an energy field course out of Camp Davis made for a great year.

This has been an exciting year for the **Selena Smith's (Asst Professor)** Plant Evolution, Paleobotany, and Paleoecology Research lab! Graduate students have been on fieldwork to India, China, Europe, Wyoming, Colorado, and Florida collecting specimens and samples for their thesis work. We've welcomed several new undergraduates in the lab too, who are helping out in various ways and undertaking their own research projects. **Kelly Matsunaga (PhD Cand)** did field work in India searching for fossil palms from the Deccan Intertrappean Series with **Becca Dzombak (PhD PreCand), Nathan Sheldon (Assoc Professor)**, and our Indian colleagues Drs. Bandana Samant and Dashrath Mohabey. Kelly also survived swarms of mosquitos during fieldwork to collect modern comparative palm fruits at Fairchild National Tropical Botanical Garden in Florida in August. Kelly's been busy CT scanning fossils and the modern fruits on our (now 1 year-old) Nikon microCT – stay tuned for results! **Molly Ng (PhD Cand)** and **Bekah Stein (PhD PreCand)** braved

long train rides, rainy hot weather, and foreign customs in China as they travelled around looking for their focal plants to sample. Congratulations to Kelly for receiving an NSF Dissertation Improvement Grant to study the historical biogeography of palms, and to Molly for being awarded an NSF Graduate Research Fellowship to support her project on the ecophysiological and niche evolution of redwoods and relatives.

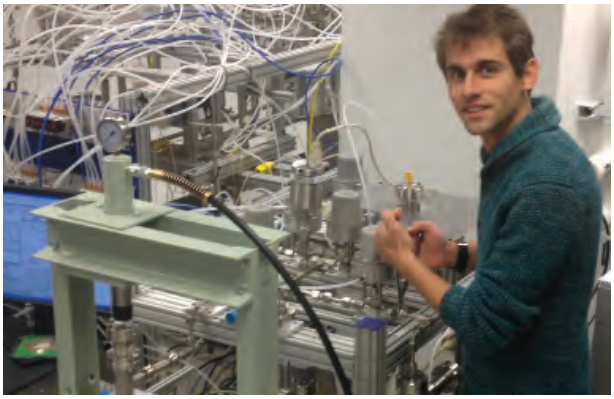
The big news in **Assoicate Professor Naomi Levin's** group is that the construction of the new lab (Iso Paleo Lab), co-directed with **Ben Passey (Assoc Professor),** finished this summer. Two (new!) Nu mass spectrometers were installed in August and moving into the lab has continued in the Fall. This involved setting up existing equipment and building new additional custom peripherals. Postdocs **Ian Winkelstern** (working with Ben) and **Emily Beverly** (working with Naomi) have been critical to this process. The laboratory will have a range of capabilities but its focus will be on high-precision triple oxygen isotope measurements in waters, carbonates, silicates and whatever else we can convert to O_2 for an isotopic measurement. Emily Beverly joined the lab as a postdoc in January 2017. Emily has been awarded an NSF-EAR postdoctoral fellowship to develop records of late Pleistocene drought in eastern Africa using triple oxygen isotope compositions of paleosols. This work is part of a greater effort to use triple oxygen isotopes in soil carbonates, lake carbonates and fossil teeth to evaluate paleoaridity and squeeze more information out of oxygen isotope records. There's a lot of work to do on this front and it will be a major part of Naomi's research program in the next several years. While Naomi's research on triple oxygen isotopes extends her research to questions of Holocene paleoclimate in South America and the hydroclimate of the western US, she maintains her research program in eastern Africa, with active projects in the southern Kenyan Rift and in the Afar Rift. Naomi is recruiting graduate students for Fall 2018 and looking forward to ramping up the re-building of her research group since her move to UM.

Professor Clara Castro's research group is now taking full advantage of their newly built line for analysis of noble gases in fluids. This new line, which is connected to two new mass spectrometers, a Thermo Helix SFT and an Argus VI, was fully brought into service in April. It includes 6 loading ports for samples and a double-head cryotrap which allows for simultaneous separation of He and Ne in a "low-temperature" chamber while Ar, Kr and Xe are separated in the "high-temperature" chamber. Measurements of noble gases from fluid samples are carried out simultaneously on the Helix SFT and the Argus VI in multi-collection mode. The line is fully automated with the extraction and purification lines running under Labview control. Associate Research Scientist **Dr. Chris Hall** and Postdoc Fellow **Dr. Julien Amalberti** were instrumental in the development of this new line. This new system allows us to achieve extremely high precision measurements on a routine basis for all noble gases.



Fluid Line. Chris Hall, Clara Castro and Julien Amalberti, from left to right.

Multiple research projects have already benefited from these high precision measurements. These include a study to fingerprint the origin of methane in shallow groundwater within the Barnett Shale footprint in Texas (**Tao Wen PhD'17**), a freshwater study in the island of Maui to better characterize their hydrologic system (**Yi Niu, PhD Cand'18**), and a study of the Cerro Prieto Geothermal system in Mexico with collaborators in Canada (Prof. Daniele Pinti) and Mexico (Prof. Aida Hernandez). The latest project benefiting from the new line is a collaboration with Saudi Aramco with the goal of characterizing the noble gas signature of the Unaziah Formation natural gas in Saudi Arabia (new graduate student Guolei Han).



Julien Amalberti working on the Rock Line

Another major project underway in the Noble Gas Lab is the construction of another noble gas line, this time to extract and purify noble gases in rocks and glass. This project is led by Dr. Julien Amalberti with the support of Dr. Chris Hall. The extraction line includes three crushers activated by a hydraulic press, an infrared radiation furnace and an induction furnace. The crushers will be dedicated to the analysis of fluid inclusions. The infrared radiation furnace and the induction furnace are both used to extract noble gases from the crystal lattice and fluid inclusions. The extraction method is based on the diffusion of the gases through the mineral or bulk rock (infrared radiation furnace) or through melt (induction furnace). Construction of this line is expected to be completed by early 2018 and will open up a host of new collaborations, both within the department and elsewhere.

UNIVERSITY OF MICHIGAN

By recommendation of the Office of the Provost,
the Center for Research on Learning and Teaching (CRLT),
and the University Library, the

Provost's Teaching Innovation Prize

is awarded to

Adam Simon & Peter Knoop

in recognition of the pedagogical innovation

Mapping Possibilities for U-M's Energy Independence

May 2017

Paul N. Courant
Interim Provost and Executive Vice President fo

Adam Simon teaching during field excursion in Ontario.

Peter Knoop working with students in the field during a recent classroom excursion to Indiana and Kentucky.

Adam Simon (Assoc Professor) and **Peter Knoop (MS'94)** developed a semester-long project for Simon's "Mineral Resources, Economics and the Environment" course, taught annually to ~130 students from across the academic spectrum, including natural sciences, the Ford School of Public Policy, Engineering, Architecture, and Ross Business School. The project has students focus on energy resources through the lens of electricity consumption at U-M. The project grew from Simon's concern that too many students, if not all, enter this course with their heads filled with "alternative facts", to the point that there is collective delusion about fundamental energy concepts; especially renewable energy. This project is a vehicle for students to test their intuitive theories by having the students do an intensive study of U-M's energy infrastructure. Students learn how to conduct such a study, what methods are appropriate for problem-solving, and, most importantly, recognize that their results, rooted in reality, make the energy crisis both a fascinating and daunting challenge that their generation can solve. Simon and Knoop want students to learn that solving our energy crisis requires thinking outside the box, bursting bubbles of culture and politics. That there are common, factual realities for energy, around which all students need to start having meaningful conversations about change. Importantly, students learn that they can investigate problems on their own.

This excerpt was taken from the University Record and the full citation can be found at:
https://record.umich.edu/articles/five-faculty-teams-awarded-provosts-teaching-innovation-prize

The College of Literature, Science, and the Arts

is pleased to present the

Excellence in Departmental Advising Award

to

Kyger Lohmann
Department of Earth and Environmental Sciences

for exceptional dedication to the educational experiences of undergraduate students

Awarded this 18th day of September, 2017

M | LSA

Andrew Martin, Dean
Professor of Political Science and Statistics
College of Literature, Science, and the Arts
University of Michigan

EXCELLENCE IN DEPARTMENTAL ADVISING

The College of Literature Science and Arts presented an award to **Kacey Lohmann (Professor)** for his efforts in advising undergraduate students in Earth and Environmental Sciences. Only two such awards were made by the College this year. Kacey has provided students guidance in matching their academic pursuits with their long term career goals. We applaud his efforts and hope that he continues to contribute to the critical mission of student advising.

MICHIGAN HISTORY

Inspired by the bicentennial of the University of Michigan, and a pressing need to empty out some storage space, we have been gathering photographs, documents, and objects relating to the history of the Department of Earth and Environmental Sciences. Some of these items were placed in storage decades ago. Many were preserved by now-retired Bill Wilcox. We also have tens of thousands of photographs taken by faculty, staff, and students.

The collection has lantern slides from the early twentieth century, prints, negatives, reprints, brochures, obituaries and clippings of alumni and faculty. There are about 1500 student ID photos from the 1950's through 1980's. There is also material about the purchase of Camp Davis, the construction of its cabins, and its original water supply. The earliest item is dated 1898; the latest is this year.

All of this has been scanned and catalogued in a database, and the bulk of it deposited in the Bentley Historical Library. The total collection is archived in some 173,000 files. The collage on these pages is a small sample from the collection.

If you have material that you would like to contribute to the Department, or you are curious to know if we still have a copy of some fondly remembered photograph, email Dale Austin (*mrwizard@umich.edu*) or *michigan-earth@umich.edu*.


THE GROS VENTRE SLIDE
Jack: Ain't he "a'dorr'able"
QUIZ AREA
POORMAN
Who's got a match?
Fig. 31. — Mine de Kimberley en 1875. — Côté sud.
CAMP DAV
UNIVERS
OF
MICHIGA
EARTH & ENVIRONMENTAL SC
UNIVERSITY OF MICHIGAN

In Memoriam: Erle Kaufman

Erle Galen Kaufmann (BS'55, MS'56, PhD'61) passed away on December 16, 2016 at his home after an extended illness. Erle was born in the Washington, DC area and ultimately attended the University of Michigan for all of this college degrees. Following his time in Ann Arbor, he held numerous prestigious positions including: the U.S. National Museum, Smithsonian Institution; Professor and Chair of the Department of Geological Sciences, University of Colorado, Boulder; and, Professor and Professor Emeritus at Indiana University Bloomington.

Erle is noted for his numerous contributions to the fields of Stratigraphy and Paleontology with his primary focus on the Cretaceous for which he received numerous national and international awards. These include: the R.C. Moore Medal for Excellence in Paleontology awarded by Society for Sedimentary Geology; the Gilbert Harris Award for Lifetime Excellence in Systematic Paleontology from the Paleontological Research Institution; the W.H. Twenhofel Medal for Outstanding Contributions and Sustained Excellence in Sedimentary Geology of the Society for Sedimentary Geology; and in 2014 with the Paleontological Society's Medal for Advancement in Knowledge in Paleontology.

Erle's contributions in paleontology and stratigraphy remain as the foundation of Cretaceous research in North America. He will be warmly remembered by all who were blessed to have met and worked with him.

In Memoriam: Paul Fenske (1925-2017)

Paul R. Fenske (MS '51), formerly Executive Director, Water Resources Center at the Desert Research Institute of the University of Nevada System and Research Professor of Hydrology and Geology, University of Nevada-Reno, died on June 14th, 2017. He was 92. Known as a fine research scientist as well as engaging teacher of undergraduate and graduate students, he was also a sparkling conversationalist who enjoyed the company of his family and his friends, particularly during the later years of his life.

Born in Ellensburg, Washington on May 15, 1925, Paul entered the South Dakota School of Mines in Rapid City in 1943, and in October of that year, left for military service during World War II on the U.S. Territory of Guam. After his discharge on April 23, 1946, he completed his studies in Geological Engineering, which he followed with a master's degree in Geology at the University of Michigan, graduating in 1951.

Paul Fenske began his career as an oil exploration geologist at the Magnolia Petroleum Company in Bismarck, North Dakota. He continued that work in Midland and Lubbock, Texas before pursuing a PhD in Geology at the University of Colorado, Boulder, graduating in 1962. He taught briefly as an Assistant Professor of Geology at Idaho State University, prior to accepting a position in research at Teledyne Isotopes in Palo Alto, California. In 1971, he was appointed Research Professor at the Desert Research Institute, University of Nevada in Reno, and from 1984 served as Executive Director of the Water Resources Center, at the time the largest of DRI's research groups. At DRI, Fenske managed ground-breaking research efforts investigating the movement of contaminants through desert groundwater systems. In doing so, he improved the understanding of the hydrologic process, work which found direct application to other problems of hazardous waste contamination. For all of those who remember Paul, we will miss him. He left this world a better place.

In Memoriam: Leon Reiter **(MS'68, MA'70, PhD'71)** passed away on September 6, 2017. Leon was a seismolgist in the Nuclear Regulartory Commssion and author of *Earthquake Hazard Analysis*, published the the Columbia Univesity Press in 1991.

Victors for Michigan

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

Kirk Townsend spent his summer building a model to rapidly estimate rock strength based on the relief structure of mountain ranges, and is optimistic that this approach may improve co-seismic landslide forecasting models. Kirk also collected and started processing samples for apatite (U-Th)/He low-temperature thermochronology from the Western Transverse Ranges of southern California. By quantifying rates of exhumation throughout the region, he hopes to understand how strain resulting from regional convergence has been distributed onto active faults through time.

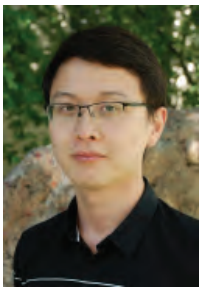
Alex Thompson used CESM to simulate the Sahara desert region in Northern Africa during the mid-Holocene (6000 yrs BP) with varying conditions: mid-Holocene vegetation or desert, low or high soil albedo, and low or high dust emissions. These simulations are for a study Alex is performing that will analyze the varying effect that vegetation, soil albedo, and dust emissions have on mid-Holocene North African hydroclimate.

Marlon Ramos is conducting numerical simulations of potential M9-type earthquakes along the Cascadia Subduction Zone with the goal of improving ground motion estimates, shedding light on the physical manifestation of episodic-tremor and slow-slip (ETSS) in the context of earthquake fault slip, and tsunami hazard.

Erin Lynch is working on decoding the fluid history of both the Appalachian and the Cordilleran mountains of North America. Using stable isotopic and radiogenic isotopic analysis of potassium-rich clay minerals in faults and folded shales, Erin traces both the composition of orogenic fluids and the timing of their involvement in deformation.

Maria Alejandra Mustafa did field work in Chile to collect samples from Iron-Oxide-Copper-Gold (IOCG) and Iron-Oxide-Apatite (IOA) deposits in order to investigate their genetic relationships. She is using a variety of geochemical techniques to analyze magnetite samples from several deposits in order to fingerprint the source of ore fluids responsible for mineralization.

Alex Tye conducted a geologic mapping campaign in the Greater Caucasus of Azerbaijan. Using maps and cross sections from the Greater Caucasus together with geo- and thermochronology, Alex hopes to better understand the geodynamic transition from subduction to collision in a young mountain range as well as how deformation has been distributed over time in the Arabia-Eurasia collision zone.



Guolei Han is focusing on the utilization of noble gas isotopes in various geological system, like geothermal field and oil field where hydraulic fracturing is being used. Topics like precipitation pattern and climate changes in a certain area may also be included.

Adrianna Trusiak is focusing on understanding the role of iron in the arctic carbon cycle. Adrianna spent this summer in the Alaskan Arctic studying the role of water flow and vegetation on the iron and organic carbon cycling in soil waters.

Rebecca Dzombak traveled to central India with fellow PhD student Kelly Matsunaga to sample fossil soils from the Deccan Traps as part of an ongoing project to constrain paleoclimate and paleoenvironments in India during the K-Pg. These sites are of interest due to their proximity to the Traps, which should reflect conditions on land before, during, and after volcanism. Preliminary results of this work suggests a surprisingly stable climate during this time.

Derek Smith spent his summer conducting weekly experiments to measure decay and production rates of hydrogen peroxide in western Lake Erie from two different sources: photochemical reactions with dissolved organic matter and as a by-product of aerobic microbial metabolisms. Derek is interested in how the relative importance of these two sources of H_2O_2 change temporally over the summer as light intensity changes and cyanobacterial harmful algae blooms (CHABs) develop in the lake. CHABs are a threat to drinking water safety and availability because bloom-forming cyanobacteria produce toxic compounds. Because H_2O_2 acts as an antimicrobial compound, understanding controls on environmental H_2O_2 can aid our understanding of the production of toxins and other biological processes during Lake Erie CHABs.

Prithvi Thakur is studying the effect of damaged zones in active fault on repeating earthquakes using earthquake cycle simulations. Prithvi is looking at how the geometry and velocity contrast in damaged zones evolve in subsequent earthquake cycles and how does it affect the hypocenter location and recurrence intervals of the earthquake cycle.

Tariq Kareem is describing new vertebrate fauna from the Cretaceous of India, focusing on notosuchians, a group of primitive crocodilians, that existed from mid Jurassic to mid Cenozoic. These animals were unique and bizarre as crocodilians in that they weren't exclusively carnivores, and some were clear herbivores.

Juliana Mesa is studying intraplate basalts from the Tepic-Zacoalco rift in Mexico. Temperature, water content and oxidation state values are determined by applying petrological tools such as the olivine-melt Ni-thermometer , plagioclase hygrometer, and Fe-Ti two-oxide thermometer and oxybarometer. The results are expected to constrain mantle source components and magmatic conditions at the onset of crystallization.

Will Bender is studying chemical reactions in solution and at mineral-water interfaces that govern mineral stability and metal contaminant mobility. To do this, Will employs a combination of experimental, analytical, and computational approaches. At the moment, Will is focused on the redox behavior of uranium and plutonium.

Sophia Macarewich is modeling the roles of CO_2, orbital-forcing, and vegetation-climate feedbacks in promoting glacial-interglacial transitions during the Late Paleozoic Ice Age. This summer, Sophia developed the "control" simulations, where vegetation has a minimal effect on the Earth system. These initial simulations will serve as a baseline to compare with vegetation experiments, where she will modify the morphologic, physiological, and phenological characteristics of modelled vegetation to better represent ancient vegetation in Earth system models.

Gephen Sadove spent the summer at the Leibniz Universität in Hannover, Germany, learning state of the art experimental techniques with faculty in chemistry to recreate the high temperatures and pressures of volcanic systems in order to study the mobility of sulfur and metals in magmas. She is also investigating how the oxidation state of sulfur in the mineral apatite from magnetite-apatite ore deposits can shed light on ore deposit formation.

Spencer Washburn is using mercury stable isotope ratios to gain a greater understanding of the complex biogeochemical cycling of mercury in fluvial systems and the environment. In particular, Spencer is focused on studying mercury contaminated rivers in Virginia and California, where a greater understanding of the transformations that mercury undergoes as it cycles through these environments could inform remediation efforts.

Sooyeon Kim is investigating mechanisms of wettability alteration on mineral surfaces. Sooyeon uses surface analysis techniques to characterize the morphology changes of mineral surfaces when oil components are adsorbed, and employs computational modeling to describe the processes in molecular-level.

Rebekah Stein is looking at stable carbon isotope values of leaf tissue since the start of the Industrial Revolution in relation to climate variables (mean annual precipitation, atmospheric carbon dioxide concentration, mean annual temperature, atmospheric carbon isotope values, etc.) Rebekah working on applying this to hyperthermal events in the paleoclimate to reconstruct sources of large changes in atmospheric CO2. This past summer, Rebekah spent 3 weeks collecting modern and historical specimens in China to look at regional isotopic carbon trends in an area with a far more recent Industrial Revolution.

Sha Chen is measuring trace element distribution between olivine crystals and olivine hosted melt inclusions, which she will use to investigate geological processes in magmatic systems on Earth's Moon. Sha is also trying to determine whether the Moon is enriched in water by measuring the water concentration in melt inclusions.

Nikita La Cruz spent her summer doing an industry internship with a junior exploration company (Alicanto Minerals Limited) in her home country, Guyana. In addition to leading the company's base metal exploration program, Nikita collected gold and heavy mineral samples that she will analyze as part of the third project of her dissertation, which will focus on understanding the formation of gold and potentially other types of deposits in Guyana. During her time in Guyana, Nikita was also fortunate to speak to students at her high school about the importance of geoscience education; present her research at the national mining week conference; attend a Society for Geology Applied to Ore Deposits field trip, which sought to understand gold mineralization in the Guiana Shield; and speak with small, medium and large scale gold miners about mining and their mining practices.

Brian Konecke is combining experimental techniques, and analyses of natural samples, to investigate the redox, distribution, and isotopic systematics of sulfur between apatite and co-existing silicate melt(s). Brian is also leading a project working with several UM undergraduate (EARTH) students to develop unconventional methods to heat-treat precious gemstones, such as sapphires, rubies, and spinel.

Tristan Childress spent the summer doing exploration geology at the world-class Red Dog zinc and lead mine in the Brooks Range of northern Alaska. The Red Dog deposit, a small but high quality sphalerite and galena bearing Mesozoic Sed-Ex deposit, supplies 5% of global zinc consumption and is the second largest producer of zinc in the world. In an effort to locate and resolve new deposits and potential future resources, Tristan worked with the Teck American Inc. exploration team assisting with field mapping, core logging, and the drilling program which included five active surface drills and 40,000 ft+ of drilling this season.

Scholarships/Fellowships 2017

Camp Davis Scholarships

Sidder Endowment Scholarship Fund: H. DeHetre

Kornfield Family Camp Davis Fund: E. Alexander, A. Lemrow, E. Parkansky, M. Provax, A. Soleimany, E. Sorenson

Turneaure Scholarship Fund: P. Hawkins, .R. Ignace, O. LaJoie, B. Louria, A. Rankin, S. Searles

Shell Camp Davis Scholarship Fund: L. Abdale, A. Birkbeck, A. Harknesss, A Kaznowski, M. Martinez-Silva, Z. McFaul, K. Nelson, T. Noffsinger, D. Picard, A. Rosett, T. Spoor, M. McKenna, I. Vamossy, L. VanWagoner, S. Whitehead, A. Wilson, A. Zandee, H. DeHetre

Graduate Fellowships

Reynolds M. Denning Memorial: B. Konecke

William Herbert Hobbs Fellowship in Geology: M. Robbins

Russell C. Hussey Scholarship: A. Boles, Rebecca Dzombak
Susan M. Kruger Scholarship Fund: E Lynch

Earnest A. Novak Scholarship Fund: S. Grim, X, Pu

Henry N. Pollack Graduate Endowed Graduate Fellowship in Geological Sciences: J. Bowen, A. Capobianco, T. Hines, K. Loughney, R. Maquire, S. Nedrich, A. Tye

Shell Oil Company Fellowship Fund: N. Midtun

Chester B. Slawson Memorial Fund: Young Jae Kim, Daniel Korfeh, Nikolas Midttun, Sarah Walker

Stewart R. Wallace Fellowship: K. Matsunaga, S. Nedrich, K. Townsend

EARTH CAMP -- 2017

Eighteen Earth Camp students saw their 3-year long wait come to fruition in July – Earth Camp expanded to take them to Wyoming for an 8-day outdoor learning experience. They met and hiked with local geologists, climbed mountains they never thought possible, and were captivated by the rich geology of the Tetons and Yellowstone.

The students started the week flying into the Jackson, WY airport – they were already in awe just from that experience – I think the airport had more SnapChat and Instagram posts sent during their arrival than any other time during the summer!

Like most Camp Davis courses, the first day was spent hiking up Mt. Anne to prepare the students for the hikes ahead, refresh their sedimentary rock knowledge, and see normal faulting "in action". We were lucky to be joined by John Hebberger from The Geologists of Jackson Hole. He put most of the group and counselors to shame by flying up Mt. Anne in record time with the first group of students. Lucky for us he came prepared with maps and knowledge and took over the geology lesson for the day. Over the course of the hike, we had three students who kept coming over the walkie talkie to tell us they were going to turn back, but each time, decided to go "a bit farther" and eventually the whole group made it to the top. Very proud of the group effort!

After that it was off to Yellowstone. We hit all the highlights and climbed a few more peaks. I was extremely impressed with our staff – former Camp Davis students who whipped out their field notebooks and took over the geology lessons at various stops. Our final morning, we got the eighteen high-school students to wake up at 5am to go look for wolves – and we were not disappointed. In Hayden Valley, we found a wolf pack with pups visible at the edge of the forest.

We spent our final days in the Tetons. In addition to the amazing geology, the students learned valuable lessons such as: a 20% chance of rain in Jackson means a 100% chance of a hailstorm in the Tetons. We were at Phelps Lake when we figured that one out, but everyone smiled and laughed as they waited out their first hailstorm in the wilderness under the pine trees. The week ended with over ½ of our group completing the 16.4-mile hike to Lake Solitude.

I feel incredibly lucky to have experienced Yellowstone and the Tetons with these students seeing it for the first time and watching them step outside their comfort zone to push themselves to learn and experience the world in a way they never had before. Thank you to Shell Oil Company and The University of Michigan for making Earth Camp possible for these students.

Looking over Jenny Lake from Inspiration Point in the Tetons. Photo by Jenna Munson

The rest of the summer can be summed up in a thank you from one of the students:

I'm so grateful, the past 3 years have been the best trips I have been on in my entire life. The trip to Yellowstone this year was perfect for me, it's been my dream to go there for a long time and I would say the trip to Yellowstone went beyond my expectations. I feel so thankful and lucky to have these experiences that I've been able to have though the Earth Camp. Earth Camp has definitely helped me decide what I want to go into in the future - I want to do something with the Earth/ Environmental sciences, if not major in, minor in at least. I am definitely planning on applying for the University of Michigan. I learned a lot at Earth Camp the last 3 years and I plan to go back later on when I have the time and money and use what I learned to show others. Earth Camp has taught me to reach for my goals and that I can never set them to high because you just never know. I've also met so many great people at Earth Camp people I plan on staying in touch with even though earth camp is over. Once again, I would like to sincerely thank you for these opportunities. These trips have always been the highlight of my summer vacations.

Generous Supporters of the Department 2017

The Department would like to acknowledge the generous corporate, foundation, and individual gifts it has received over the last year (July 1, 2016– June 30, 2017). 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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Pioneer Natural Resources USA, Inc.
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Early in the day, when everyone could still stand. From left rear to front: Gerry Dickens, Linda Ivany, Kacey Lohmann, Gab Bowen, Bruce Wilkinson, and Carl Drummond. Photo by K. C Lohmann

BRUCE WILKINSON TURNS 75!!

Bruce Wilkinson (Professor Emeritus) was treated to a surprise birthday party at his farm near Syracuse, New York. His wife secretly arranged for several of his past colleagues to converge on the morning of his birthday, using a variety of excuses to hide their true intentions. For example, Lying through their teeth, **Kacey Lohmann (Professor)** and **Carl Drummond (MS'91, PhD' 94)** said they were just stopping by on their way to a teaching conference in Albany. The plot thickened, however, as **Gerry Dickens (PhD'96)** and **Gab Bowen (BS'99)** also made an unannounced entrance. After a whole day of barbecue, a continuous supply of carbonated beverage, and hours of chatter about geology and the future fate of the world, Bruce awoke the next morning, all his old colleagues having returned to their respective lives, one day older yet feeling like he was young again at Michigan.

HONORS AND AWARDS

USGS/NAGT INTERNSHIPS - 2017

Lindsey Abdale (BS '17)is at the Reston Virginia office with the Mineral Resources Division.

Sophia Fall (BS '17) is working as an intern in Millersburg Michigan to investigate the prevention of migration of invasive fish using low voltage systems.

Megan Hendrick (BS '17) is mapping features of the Missoula Floods from the Portland Oregon office.

Molly Range (BS '17) is examining microfossils as Paleocene/Eocene paleoenviroments while at the Reston Virginia facility.

Katherine Swager (BS'17) is working in collaboration with Union College on the nature of subsurface groundwater networks.

ANNUAL AWARDS – 2017

Eugene and Elizabeth Singer Award for Academic Excellence in Geology:
Charlotte Connop

Camp Davis Field Geologist Award:
Michael Radke
Katherine Swager
Alex Dworman
Raquel Goosey

Alumni Undergraduate Award:
Megan Hendrick

Outstanding Graduate Student Instructor Award:
Erin Lynch
Will Bender
Joseph El Adli

John Dorr Graduate Academic Achievement Award:
Tim Gallagher
Richard Fiorella

NATIONAL ACADEMY OF SCIENCES

Jim Zachos (Postdoctoral Fellow '93) was elected to the National Academy of Sciences. This is one of the highest honors given to scientists in this country. Jim continues to teach at the University of California at Santa Cruz and undertake ground-breaking paleoclimate research with a particular focus on times of abrupt climate change. Shown on the left is core retreived in 2003 on IODP Leg 208 of the Paleocene/Eocene boundary. We are very proud that Michigan was part of his stellar past. *Photo by Stephen Schellenberg*

GSA George P. Woollard Award Geophysics Division

Susan Beck (PhD'87) received this prestigious award for her pioneering work in Geophysics

AGU OUTSTANDING REVIEWER 2016

Andrea Dutton (PhD'00) received this honor for her outstanding service as a reviewer for the AGU.

GSA FELLOWS 2017

Marin Clark (Assoc Professor) was elected a GSA Fellow in 2017.

AGU FELLOWS

Susan Schwartz (MS '83, PhD'88), Jeff Alt (Research Professor), Gerald Dickens (PhD'96), George Helfrich (BS'75,ND'84) and **Youxue Zhang (Professor)** were recently honored with inclusion with the elite status of Fellow of the American Geophysical Union.

GSA RESEARCH GRANTS 2017

Rebecca Dzombak (PhD Cand) and Nikolas Midttun (PhD PreCand) were recipients of GSA Research Grants in 2017.

UNDERGRADUATE LIBRARY RESEARCH AWARD: MAISE AWARD 2017

Anne Rosett (BS'18) was the recipient of one of three awards for single term research projects provided by the University of Michigan Libraries. Her research focused on the geological history of the Los Angeles Basin.

Recipients of Earth and Environmental Science Undergraduate Degrees

BACHELOR OF SCIENCE HONORS THESES

Junjie Dong	*Assessing the fate of slab-derived metallic melt in deep Earth through experimental investigation of its wetting behavior at high pressure*
Wardah Mohammad-Fadil	*Analysis of Intraplate Earthquakes and Deformation in the Indo-Australian Plate: Moment Tensor and Focal Depth Modeling*
Ji Yeh	*Aliasing of High-Frequency Sea Surface Height Signals in Swath Satellite Altimetry*

MAJORS

Lindsey Abdale-Beadle
Noor Ahmad
Brennen Arnett
Noah Attal
Mysha Bryan
Shelby DeVuyst
Junjie Dong
Alex Dworman
Matthew Edelstein
Gabrielle Farina
Sienna Fasel
Emma Forbes
Graham Gerdes
Jacob Grogin
Megan Hendrick
Natalie Hite
Krishna Hu
Erin Hull
Naomi Huntley
Scott Johnston
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Tania Lopez
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Kevin Miller
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Richard Moreau III
Molly Moroz
Kaitlin Myers
Matthew Oates
Chiedozie Okorie
Samuel Pressman
Spencer Price
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Cameron Seeley
Alyssa Sherman
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Thomas Spoor
McKenzie Straub
Julian Tabron
McKenna Thayer
Ngawang Tsetan
Ian Vamossy
Kameron Vanburen
Zachary Watson
Ariana Wilson
Megan Wiltse
Greeny Wong
Ji Ye
Andrea Zandee
Peiyun Zhu

MINORS

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Rosemary Kelley
Angelika Kurthen
Teresa LaForest
Nichole Lohrke
Yang Lu
Jack Magri
Rebecca Mohr
Sarah Myers
Brienne O'Donnell
Christianna Pedley
Chase Richmond

Recent Doctoral Dissertations

Austin Boles	*Clay neomineralization and the timing, thermal conditions, and geofluid history of upper crustal deformation zones*
Trever Hines	*Transient Ground Deformation in Tectonically Active Regions and Implications for the Mechanical Behavior of the Crust and Upper Mantle*
Tiffany Napier	*Unraveling Santa Barbara Basin lithogenic sediment composition and application to southern California Quaternary hydroclimate*
Sara Nedrich	*Functional mechanics of concavo-convex articulations and neurocentral sutures in the vertebral column of sauropod dinosaurs*
Samantha Nemkin	*Paleomagnetism of carbonates and the synfolding test in the North American Cordillera*
Peng Ni	*Copper diffusion in silicate melts and melt inclusion study on volatiles in the lunar interior*
Sarah Walker	*The atomic and electronic structure of contaminants at the mineral-fluid interface*
Tao Wen	*Development of Noble Gas Techniques to Fingerprint Shale Gas and to Trace Sources of Hydrocarbons in Groundwater*

Recent Masters Theses

Forrest Gilfoy	*Thermal State and Solidification Regime of the Martian Core: Insights from the Fe-Ni-S Liquidus at 20 GPa*
Daniel Korfeh, Jr.	*The Chemistry of Magnetite from the Pea Ridge Iron Oxide Deposit, Missouri, U.S.A.*

Professional Meeting Lands Students Jobs

From Left to Right: ***Francois Robert, Nikkita Cruz, Tristan Childress, James Jolles,*** and ***Lindsey Abdale, Tania Lopez, and Dan Core (PhD'04)****. Photo by Adam Simon.*

Student field trip to the *Prospectors and Developers Association of Canada* where they met with **Francois Robert**, post doc with **Bill Kelly (Prof Emeritus)** in the early 1980's, and now Vice-President, Global Exploration, Barrick Gold Corporation, the biggest gold company in the world. Student participation in such meetings is critical to developing the contacts with industry. As a result of networking at the meeting, both **Lindsey Abdale (BS'17)** and **Tania Lopez (BS'17)** are employed in the industry. Our Department supports these activities with endowment funds provided by our generous alumni.

WHEN YOU CONTRIBUTE WHERE DOES YOUR MONEY GO?

TO INSPIRE ...
TO EDUCATE .....
TO CREATE .....
THE NEXT GENERATION OF MICHIGAN SCIENTISTS

IT IS IMPORTANT!!
THANK YOU!

Chair: Chris Poulsen

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Affiliated Faculty, Research Faculty and Postdoctoral Fellows: J. Alt, J. Amalberti, C. Badgley, J. Bassis, E. Beverly, G.A. Burton, C. Chaves, J. Demers, M. Flanner, J. Geissman, J. Gleason, C. Hall, S. Huang, J. Klatt, G. Keppel-Aleks, Z. Li, M. Marcano, J. Moerman, K. Murray, A. Nelson, D. Patriarche, K. Pratt, C. Skinner, A. Steiner, S. Wing, I. Winkelstern, A. Wolf, P. van Keken, F. Zhang, F. Zhu

Lecturers: M. Arnaboldi

Emeritus Faculty: C. W. Beck, R. Ewing, P. Gingerich, W. C. Kelly, S. E. Kesler, P. A. Meyers, T. C. Moore, S. B. Mukasa, J. R. O'Neil, S. I. Outcalt, R. M. Owen, D. R. Peacor, H. N. Pollack, D. K. Rea, G. R. Smith, J. C. G. Walker, L. M. Walter, B. H. Wilkinson, R. Van der Voo

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The Regents of the University of Michigan: Michael J. Behm, Grand Blanc; Mark J. Bernstein, Ann Arbor; Shauna Ryder Diggs, Grosse Pointe; Denise Ilitch, Bingham Farms; Andrea Fischer Newman, Ann Arbor; Andrew C. Richner, Grosse Pointe Park; Katherine E. White, Ann Arbor; Ron Weiser, Ann Arbor, Mark S. Schlissel, ex officio

Back Page: Kacey Lohmann *is exploring the wonders of Arches National Monument with students at the conclusion of the Spring Soft Rock Field Excursion. Photo by Peter Knoop*

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GIVE Generously to help define the future of Michigan