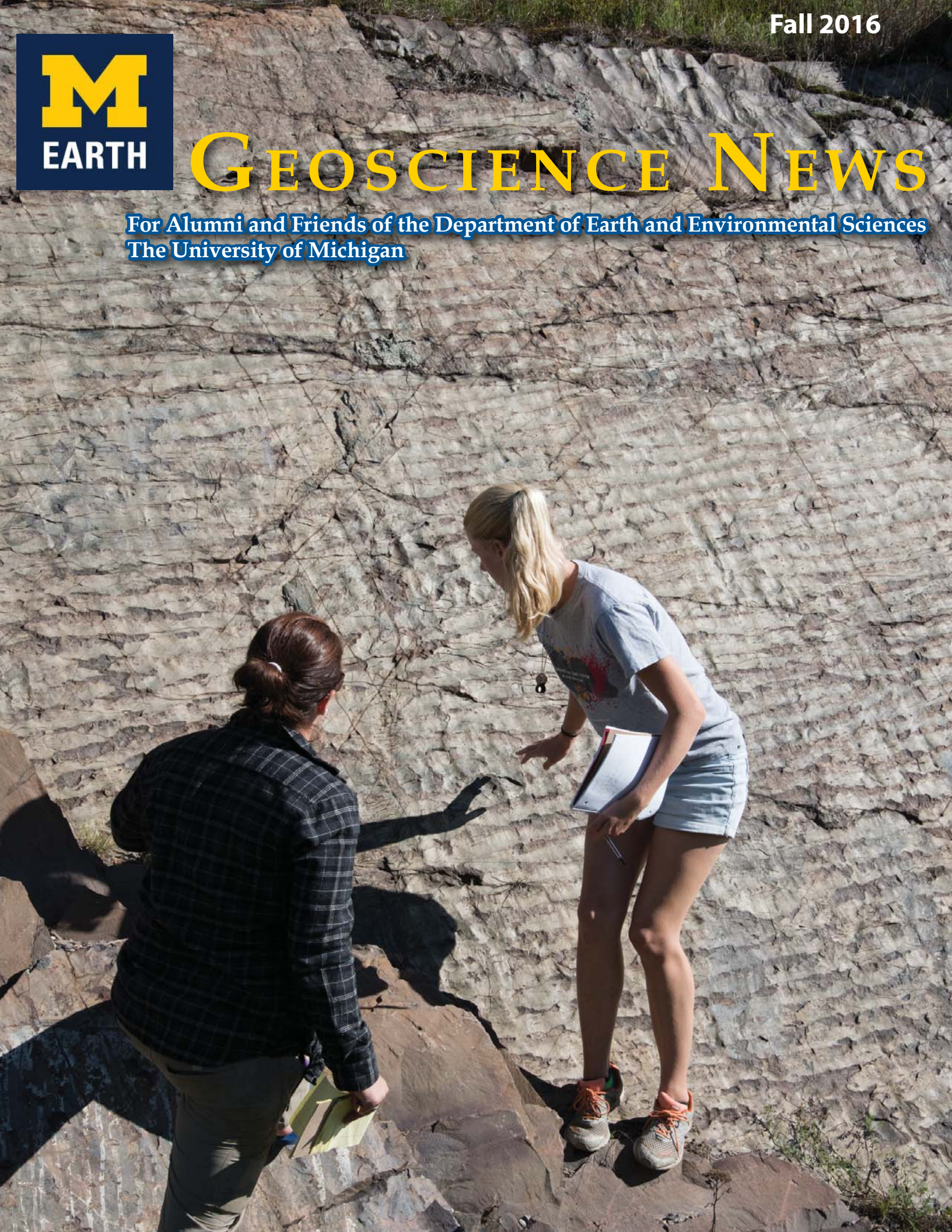
Fall 2016

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,

The leaves have turned and are falling, my morning stroll to C.C. Little is in darkness, and only a few student holdouts are sporting shorts and short-sleeves. It must be time to write the annual newsletter!

There's much to report this year. Most notably, we had a tremendous year of recruitment. This fall we welcomed 22 new graduate students, four new faculty members, and one new staff member to our department. They join our 155 declared majors, 66 minors and 73 graduate students.

Our four new faculty members include **Professors Matt Friedman, Yihe Huang, Naomi Levin, and Ben Passey.** Naomi and Ben join us from Johns Hopkins University and were hired through a search in the area of climate/water. Naomi is a geologist, stratigrapher, and geochemist, who uses the sedimentary record to reconstruct the history and response of terrestrial environmental and ecosystems to past climate change. She is especially well known for documenting environmental conditions in Africa over the last 20 million years and its impact on hominid and mammalian evolution. Ben is an isotope geochemist and develops and applies novel geochemical approaches to learn about the evolution of the Earth system. He is highly regarded for his contributions to understanding the clumped isotope thermometer, which uses the ordering of carbon and oxygen isotopes within a carbonate crystal structure as a measure of temperature.

Yihe was hired through a search in geology/geophysics. Yihe is a geophysicist and studies earthquake dynamics and characteristics using a combination of seismic observations, numerical simulation, and theory. She is currently investigating earthquakes in the central United States induced by fluid injection during hydrocarbon exploration. I announced the hire of Matt Friedman, a paleoichthyologist from Oxford University, in last year's Chair's letter. We are thrilled to have these folks on campus and look forward to their contributions to the Department.

There's more! As part of our geology/geophysics search we also hired Dr. Diego Melgar, a geophysicist who studies earthquakes and the hazards associated with them. Diego is currently a post-doctoral fellow at the University of California Berkeley and will join us next fall.

Our faculty are among the most talented and accomplished Earth scientists in the nation and excel in many extraordinary ways—including by earning recognition through honors and awards. This year I am absolutely delighted to report that Professor Becky Lange was named the Alex N. Halliday Collegiate Professor. This is a tremendous honor—collegiate professorships are one of the highest awards the College can bestow on a faculty member. Among other notable accomplishments, Professor Marin Clark was named a GSA Fellow, Emeritus Professor Phil Meyers was elected an ASLO Fellow, and Professor Jackie Li was promoted to Professor.

It is with bittersweet feelings that I announce that Bill Wilcox and Nancy Kingsbury will both be leaving the department this fall. Bill is retiring after 38 years of remarkable service with UM and 33 years as the Department's facilities coordinator. Nancy will be moving to the LSA Procurement Office after 20 years of service. Though she will no longer reside in our office, Nancy will continue to work with our department in her new role. We will miss them both and wish them the very best. On a cheerier note, we are happy to welcome Paula Frank to our staff as a student services assistant.

The annual Alumni Advisory Board (AAB) meeting was held in late October. As always, it was a productive and fun event. As part of the festivities, the Department presented its third annual Distinguished Alumnus Award to **John Greene (BS '63, MS '70).** John's wonderful acceptance speech described how the connections

he made at UM shaped and enriched his life, a message that was especially well received by our students. In other news, **Dr. Steve Henry (BS'73, MS' 78, PhD'81)** has stepped down as AAB Chair after three very productive years and is replaced by **Larry Davis (MS '79)**. We thank Steve for his exceptional service and look forward to working closely with Larry.

Last year I reported that giving to academic programs was down both in our department and across the nation. I asked for your support in reversing the trend in our department. I am delighted and thankful to report that you did! The total amount of gifts to the Department and Camp Davis increased by over 100%. These gifts came in different types and amounts—as expendable funds, endowed assets, pledges and bequests ranging from $5 to more than $50,000—from departmental alumni, friends, students, staff and faculty. On behalf of the Department, thank you.

Your gifts are critical to the opportunities that we are able to offer our students. The monies to the department from student tuition keep the lights on, the floors swept, the faculty and staff paid. All of the opportunities that make our program extraordinary—the need-based student scholarships to attend Camp Davis, the support to run fall and spring field trips, the awards for a student to conduct a research project, graduate student fellowships, the funds that support summer outreach activities to expose underrepresented students to the Earth sciences, travel funds for guest lecturers, monies that help our new faculty build their labs—these come from you.

Please consider giving again this year. For the second year, the Department will again participate in Giving Blue Day on Tuesday, November 29th. Last year, we set the standard in the College for participation and total amount of donations!

In closing, let me 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 influenced your life.

Warmest regards,
Chris

COVER PAGE PHOTO

Students Megan Hendrick and Samantha Nemkin examining Ripple Rock near Elliot Lake, Ontario during a recent Shell-sponsored field excursion. Photo by Kacey Lohmann

FUND RAISING

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MATT FRIEDMAN

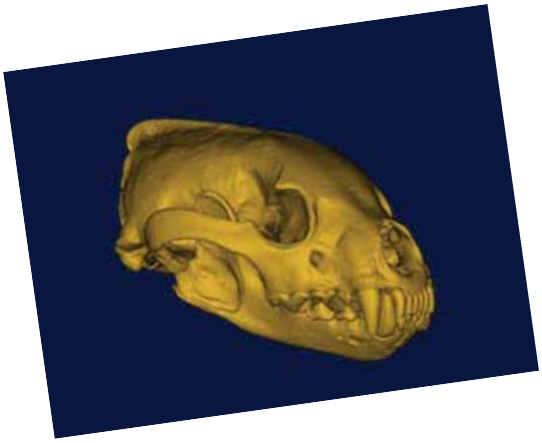
NEW FACULTY
PALEONTOLOGY

By joining the Department of Earth and Environmental Science and the Museum of Paleontology at U-M, I'm returning home in more ways than one. I grew up in the western suburbs of Cleveland, near Devonian outcrops that yield the remains of giant extinct fishes including that perennial favorite at the U-M Museum of Natural History, Dunkelosteus. That's where my interest in earth science and paleontology began. My wife is an alumna of U-M, and I gave my first seminar here in Ann Arbor when I was a PhD student. It is an exciting time for paleontology at the University. The Museum of Paleontology will be leaving its old home in the Ruthven Museums Building, with researchers, students, and geological exhibits headed to the new Biological Sciences Building currently under construction, while our world-class collections will join those of the Herbarium and Museums of Zoology and Anthropology at the new Research Museums Center. By consolidating the University's incredible biodiversity archives under one roof, I am hopeful that this move will ignite a series of cross-departmental collaborations that will lead to new lines of inquiry.

I started my academic career by majoring in biology and geology at the University of Rochester, and I have been back and forth between biology and geology departments—and both sides of the Atlantic—ever since. My next step was the University of Cambridge, where I completed a MPhil in the Department of Zoology. It was back stateside for my PhD in evolutionary biology at the University of Chicago, followed by appointment at the University of Oxford where I was on the faculty of the Department of Earth Sciences and a fellow of St. Hugh's College for seven years.

Put simply, I am a vertebrate paleontologist focused on using fossils to inform our understanding of the evolution of modern biological diversity. My own studies target the paleontological record of fishes, which spans the better part of half a billion years and is represented in a variety of depositional settings by relatively complete fossils rich in anatomical data with a bearing in ecology and evolutionary relationships. Current research spans this long history, with projects in the Paleozoic, Mesozoic and Cenozoic that are complemented by molecular genetic studies of the living relatives of the fossil groups under study. My studies of fossil anatomy draw heavily on recent advances in computed tomography and so-called 'virtual anatomy', and along with fellow U-M paleontologist Selena Smith, I've set up a high-resolution microtomography lab in Earth and Environmental Sciences for the study of geological samples. – Matt Friedman

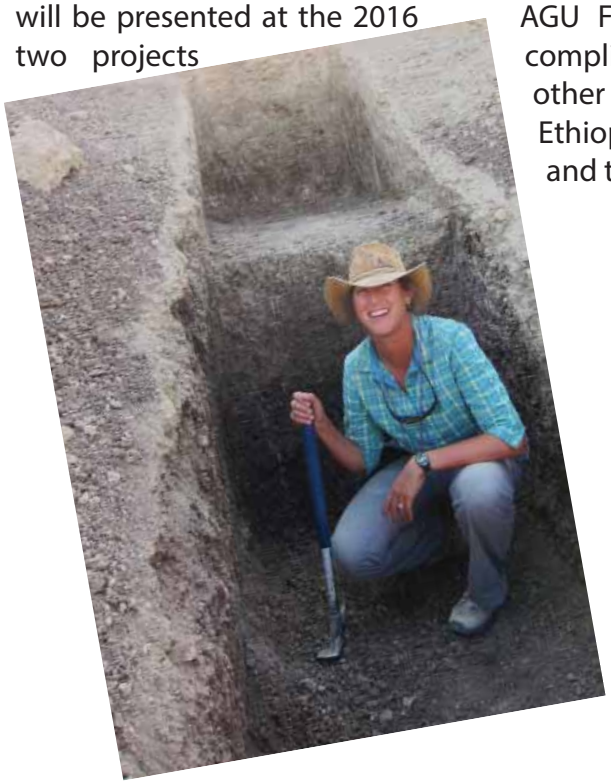
Right: *Prof. Friedman is performing a CT-Scan of a Michigan Wolverine skull in the newly commissioned laboratory. The COMPUTED-TOMOGRAPHY FACILITY is jointly run by Profs. Selena Smith and Matt Friedman in conjunction with their paleontologic research.* ***Below:*** *The Result -- now you know why Wolverines are so tough!!*



NEW FACULTY
GEOCHEMISTRY AND PALEOCLIMATE

NAOMI LEVIN

Naomi Levin comes to us from Johns Hopkins where she was an Assistant Professor in the Department of Earth and Planetary Sciences. Originally from Brooklyn, NY, Naomi was an undergraduate at Stanford (BS Geological Sciences, BA Anthropological Sciences, 2000), completed her graduate studies at the University of Arizona (MS Geology 2002) and the University of Utah (PhD Geology 2008), and did a brief postdoc at Caltech in geochemistry (2008-2009) before starting at Hopkins. Naomi studies interactions between climate, landscapes and organisms using a combination of isotope geochemistry and good old fashioned field geology. The majority of her research has focused on understanding the dynamics between mammals, vegetation and climate in Africa since the Miocene and within this, establishing the climatic and ecological context for early human evolution. Recently, Naomi has delved into the field of high-precision triple oxygen isotope geochemistry, which she initially pursued to expand the toolkit for terrestrial paleoclimate research but it's clear that it will facilitate work on a range of problems in the Earth system – anything with oxygen in it is fair game. Initial applications include work on drill cores from Lake Junin in the Peruvian Andes and the Kora Basin in the southern Kenyan Rift to constrain Quaternary terrestrial hydroclimate. The results from Lake Junin provide a terrific example of how triple oxygen isotopes can be used to test hypotheses about the degree of evaporative water loss in lakes. NSF-AGS postdoctoral fellow Jessica Moerman is taking the lead on the southern Kenya project and is showing how this expanded toolkit can be used to extend the amount of climate information that can be gleaned from terrestrial carbonates, which can otherwise be difficult to interpret. The results from the southern Kenya project are geared to understanding the climate and environmental context of human evolution (the cores were drilled adjacent to fossil and archaeological sites at Olorgesailie) and they will tie into a series of other cores that have been drilled near hominin sites in eastern Africa. Preliminary results from both projects will be presented at the 2016 AGU Fall Meeting. These two projects compliment Naomi's other work ongoing in Ethiopia, South Africa and the U.S.



Left: *Trenching into a carbonate-rich paleosol in the Olorgesailie Fm. in southern Kenya.* ***Above:*** *Typical outcrops in eastern Africa. Here late Pleistocene fluvial red-beds are incised into white diatomite of the Olorgesialie Fm. with the flanks of the southern Kenyan Rift visible in the background.*

BEN PASSEY

NEW FACULTY
GEOCHEMISTRY AND PALEOCLIMATE

Ben Passey grew up near Salt Lake City, where he spent much of his youth playing in the Wasatch Mountains and building things in his father's workshop. As an undergraduate at the University of Utah, he found that geology and geochemistry were the perfect match for these interests. Through his graduate career at Utah, postdoc career at Caltech, and faculty careers at Johns Hopkins and now Michigan, he has become increasingly focused on the 'workshop' aspect, specializing in stable isotope geochemistry, and developing a penchant for technical innovation in the laboratory setting. Some of his contributions include minimizing sample size requirements for carbon isotope analysis using a laser-ablation technique; automating lengthy and error-prone laboratory procedures using robots, pneumatics, and computers; and developing chemical techniques that transform "impossible" isotope analyses into a matter of routine. Of course, real science has always motivated these innovations. For instance, high resolution laser ablation (Fig. 1) has been used to quantify carbon-isotope variation to understand the diets of 2-million-year-old hominids; the automation has contributed to our knowledge of ocean temperatures during the Phanerozoic; and the chemical techniques open the door to oxygen-17 isotope geochemistry of carbonates (Fig. 2), with its myriad of potential applications.

At Michigan, Ben is excited to pursue one of these new oxygen-17 isotope applications, the reconstruction of past carbon cycles and vertebrate physiology based on oxygen-17 analysis of fossil bones, teeth and eggshells. The premise is that animals inhale atmospheric oxygen, biominerals such as teeth record its isotopic composition, and this composition is related to past CO2 levels and the 'vigor' of the global biosphere (= primary productivity). Although complex, the potential reward of this work is high: a detailed record of carbon dioxide levels deep into Earth's past, and unprecedented insight into the physiologies and behaviors of extinct animals, including early mammals and dinosaurs. With its top students and deep faculty expertise in paleontology, ecology, Earth systems history, and stable isotope geochemistry, there is no better opportunity to undertake this research than at Michigan.

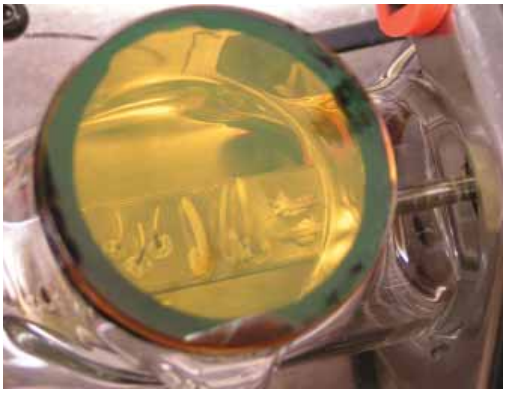


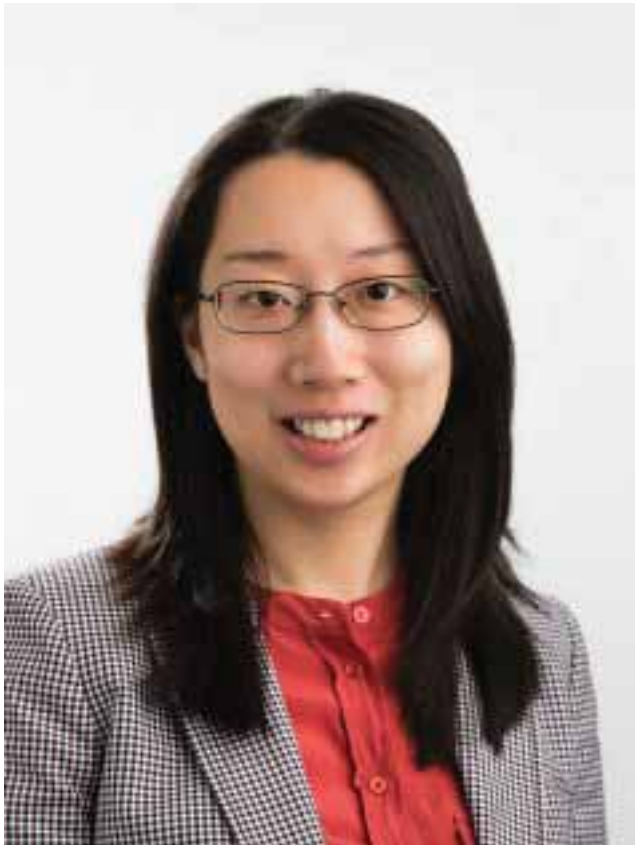
Figure 1: Rodent teeth loaded in a laser ablation chamber, ready for isotopic analysis. The yellow window is composed of zinc selenide, which is transparent to the infrared radiation used to zap the teeth.

Figure 2: The apparatus for triple oxygen isotope analysis of carbonates, as developed at Johns Hopkins. Looks fun, eh? The system will be streamlined and automated in Passey and Levin's new lab at Michigan.

YIHE HUANG

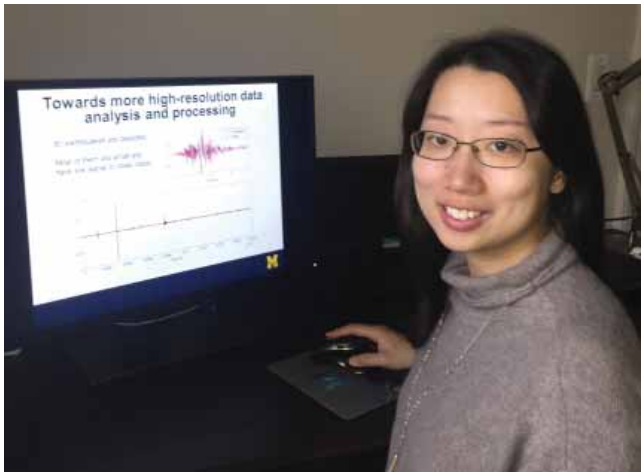
As an undergraduate in civil engineering, I always found topics about earthquake engineering fascinating. I decided to pursue a PhD in geophysics and seismology at Caltech (2009-2014). After two years as a postdoc at Stanford, I became an assistant professor in geophysics at U-M where I'm surrounded by spectacular trees, vibrant cultures and great people. I'm enjoying the color of the fall season in Ann Arbor, and am looking forward to the winter snow that I saw a lot when growing up near Beijing.

Motivated by the potential hazards of earthquakes, my research group studies the physical mechanisms of earthquakes and faulting processes using both observational methods (e.g., seismic data analysis) and numerical tools (e.g., earthquake rupture simulation). We're particularly interested in how fluid flow, fault zone structure and fault geometry can affect the nucleation, propagation and arrest of earthquakes and how earthquakes contribute to the strain budget and structural evolution of fault zones and plate boundaries. We also have a broad interest in developing physical tools for bridging earthquake science and engineering applications.



A great example of our current research projects is to detect and monitor injection-induced earthquakes. Recently, more moderate-size earthquakes in the central U.S. that can be felt and sometimes are even frightening, appear to be related to fluid injection in unconventional hydrocarbon development, which poses an urgent need to understand the mechanism of induced earthquakes. Using an innovative technique called template matching, we are able to detect small induced earthquakes that are otherwise missing in the traditional earthquake catalog. High-resolution analysis of earthquake source properties such as magnitude-frequency distribution and stress drop also provide more physical insights into the inherent similarity and difference between natural and induced earthquakes.

– Yihe Huang



In the laboratory, Professor Huang works on increasing the resolution of her data for evaluating induced earthquakes related to hydro-fracking.

SHELL OIL COMPANY SUMMER FIELD TRIP
Ontario Canada and Upper Peninsula, Michigan

Kacey Lohmann and Adam Simon spent their last week of summer leading undergraduate and graduate students on a field trip through Ontario and Michigan's Upper Peninsula. The group drove through Port Huron and spent the first day on the Bruce Peninsula, where we stopped to examine the concretions at Kettle Point, Devonian fossils in the Rock Glen Conservation Area. Day two included a beautiful ferry ride from Tobermory to Manitoulin Island. The group spent a day in the Sudbury Basin examining evidence for Earth's second largest preserved comet impact that penetrated to a depth of 20 kilometers and excavated a crater of at least 250 kilometers in diameter. Geologic reorganization of the crust after the impact resulted in the formation of ore deposits rich with copper, nickel and platinum group metals. The Sudbury area is one of the most prolific producers of these metals, which are embedded throughout the fabric of modern society. Copper allows us to turn the lights on. Nickel makes stainless steel stainless, and a copper-nickel alloy is used to desalinate salt water, an increasingly important source of drinking water throughout the world. Platinum helps our catalytic converter scrub pollutants from internal combustion vehicles, and is the base for synthesizing the chemotherapy drug Cisplatin, which is used to fight a wide variety of sarcomas, carcinomas, lymphomas, bladder cancer, cervical cancer and germ cell tumors.

Megan Hendrick *and* ***Youxue Zhang*** *examine coarse impact breccia in the Sudbury Basin.*

We spent time north of Elliot Lake examining diamictites and stromatolites that record oxygenation of Earth's atmosphere. Moving up the stratigraphic section in these Paleoproterozic rocks, students examined outcrops of granite clasts with white and grey feldspars, then beautifully preserved dolomitized stromatolites, and then granite clasts with pink-stained feldpars. Students also visited outcrops of fluvially deposited uraninite and pyrite bearing quartz pebble conglomerates and sandstones, which are also hallmark indicators of low atmospheric oxygen levels. Before departing Canada, a stop at the locks on the Canadian side of the border in Sault Ste. Marie allowed us to discuss the relationship between geologic features and international trade.

Samantha Nemkin touches her first stromatolite. These structures are formed in cap carbonates associated with Paleoproterozoic episodes of glaciation.

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

The group at the Banded Iron Formation at Jasper Knob, Ishpeming, Michigan.

Two days in the Upper Peninsula were spent exploring banded iron formations, the role of mining in local economies, and the sedimentary structures along Pictured Rocks National Lakeshore. Throughout the trip, students were encouraged to look at the rocks and develop their best scenarios for their field observations. Students also learned how to pack up camp really quickly in the dark to avoid a thunderstorm, how to make wonderfully delicious shish kabobs over a camp fire, and spent a lot of time discussing life and career paths with the faculty. The trip provided a wonderful opportunity to connect the students to the geologic events that make humans possible and enrich the fabric of modern society.

Spectacular lithologic features of the Paleoproterozoic sequence in the Elliot Lake region of Ontario.

Above Left: Excellent example of the Gowganda Tillite in outcrop.

Above Right: Large Dropstone in laminated glacial sequence in the Gowganda Fm.

On the outcrop in Elliott Lake region , Lohmann treats the students to a spectacular outcrop replete with mudcracks and evaporite pseudomorphs. These outcrops of Paleoproterozoic-aged sediments record dramatic variations in global climate patterns and depositional environments.

Victors for Michigan

National and International Field Excursions

UPCOMING INTERNATIONAL EXCURSION
NEW ZEALAND 2017

Dr. Tim Stahl (NSF Postdoctoral Fellow) and **Associate Professor Nathan Niemi** will lead a field trip to New Zealand in May 2017. New Zealand is host to a range of geologic phenomena that are actively shaping the natural and sociopolitical landscape. The focus of the trip is active tectonics and geohazards of the North and South Islands. Planned activities include visits to multiple active volcanoes, uplifted marine terraces, glaciers, and active faults with prehistoric and historical earthquakes. In addition to field exercises, participants will take guided tours of Wairakei Geothermal Power Station, White Island, the site of the 1953 Tangiwai lahar and train disaster, and Christchurch's 'Red Zone' (from the 2010-2011 Canterbury earthquake sequence). Guest lectures by world experts on landslides and Maori perspectives on Earth science are planned.

A large sackung landslide complex that looms over glacially-carved Lake Hawea, posing a modern tsunami hazard. Southern Alps in the distance.

The Department views our international trips as a unique opportunity for students to experience a combination of classic geological features and delve into the cultural aspects of our world's communities. We receive partial support for these excursions by the University International Institute which helps keep the costs for student participation at an reasonable level. This is also possible because of the generous support that has been provided by the Department's endowments for field excursions that were initiated by an anonymous donor and continues to receive the support of many of our alumni and friends.

THANK YOU FOR KEEPING FIELD OPPORTUNITIES ALIVE FOR OUR STUDENTS

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

The 2016 Alumni Advisory Board during their recent meeting in Ann Arbor. From Left to Right: Dan Core, David Mogk, Tina Nielsen, Steve Henry, Larry Davis, Bob Klein, Bill Zempolich, Dexter Perkins and Dan Wiitala.

The Alumni Advisory Board

The Alumni Advisory Board had its annual meeting in October 2016 during Homecoming week. This year marked the transition from Steve Henry as Chair, to Larry Davis who will carry on the excellent work of advising and guiding the Department. We thank Steve for his many years of service to this Board. We will certainly miss his energy and dedicated efforts. The Board continues to develop a career workshop and mechanisms for mentoring our students. These efforts are welcomed by our students who are joining an increasingly competitive workplace. If you would like to contribute to this important effort contact the Department and we will keep you informed of the activities and opportunities available on the Board.

DISTINGUISHED ALUMNI AWARD 2016 JOHN F. GREENE

John Greene (BS '63, MS '70) was honored this year during Alumni Advisory Board weekend festivities for his generous contributions to industry and the Department. John received his BS in Geology in 1963. Following 5 years of naval service he returned to UM where he completed his MS under the tutelage of Dr. Ike Smith. Subsequently, Jon has worked in the Petroleum industry for Conoco, Milestone Petroleum (Burlington Resources) and the Louisiana Land and Exploration Company. His industry career began as a geoscientist in exploration and progressed into management with increasing responsibilities in both domestic and international business arenas. John has served as a corporate director for El Paso Exploration Company, Louisiana Land and Exploration Company, Basin Exploration, Mariner Enerand Resources Institute, the Rocky Mountain Oil and Gas Association, the AAPG, and the American Petroleum Institute.

John and a handful of dedicated alums formed the first Department of Geosciences Alumni Advisory Board and he has served as its Chair in the early developing years. He was instrumental in promoting the Department's capital campaign which established a well funded, and sustainable endowment that serves to perpetuate the excellence of Michigan today and into the future.

We are honored and blessed to have John Greene as an alumnus of the Department of Earth and Environmental Sciences. He serves as an example of the excellence of those who have come before and after to the University of Michigan and exemplifies what it means to be a WOLVERINE. GO BLUE!!!

UPDATE YOUR ALUMNI PROFILE AND EMAIL

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

LARRY DAVIS: ADVISORY BOARD CHAIR 2017

Before I introduce myself I would like on behalf of the entire Alumni Advisory Board (AAB) to say thank you to Steve Henry for a highly productive term as the chair of the AAB. Job well done! Steve did an amazing job of moving the AAB forward as an invaluable resource for the Department of Earth and Environmental Sciences. A few highlights of Steve's tenure as chair include: the introduction of a career panel program, the formation of subcommittees to increase the effectiveness of the AAB, a Distinguished Alumni Award, the establishment of an Emeritus Board, and the renaissance of the Michigan Wolverine football team. Steve is truly a hard act to follow. This year's highly productive annual AAB meeting took place took place in mid-October (20th to 22nd). It started on Thursday evening with a standing room only Career Panel Pprogram with over 75 undergraduate and graduate students in attendance. I believe the career panel is one of the highest value AAB contributions and will be organized in the future by the AAB Sub-Committee on Professional Employment.

Friday's agenda included an excellent presentation by department chair, Chris Poulsen, on the State of the Department, reviews of the undergraduate and graduate programs, an introduction and short presentation by the new faculty members as well as a catered lunch with graduate students. All this was accompanied by well-reasoned input and related discussion from the AAB. It was a very productive and I believe highly valuable meeting. I was particularly impressed by the new faculty members. Their research which includes everything from CT-derived 3D images of fossil fishes to plio-pleistocene environment reconstruction using O_{17} isotope data to explanations of human caused seismic activity is really exciting to hear about.

Friday's programming also included a wonderful talk by **John Greene (BS '63, MS '70)** who was the recipient of this year's Distinguished Alumni Award. John, by the way, was one of the original eight AAB members and served as its first chair. It was refreshing to hear a talk without the need for PowerPoint slides. Something like an extended TED talk where John reviewed the remarkable Michigan connections that he continuously found along his long and distinguished career. All who had the pleasure of being there understood John's message of the depth of Michigan connections one encounters throughout their career everywhere in the world.

During the next year the AAB will focus on three main areas: Fundraising with an emphasis on Camp Davis; assisting the Department review curriculum paths for finding employment or for entry into graduate school; and increasing the AAB's diversity. To this end anybody wishing to serve on the AAB or has a recommendation of someone else they feel would enjoy and contribute to the AAB, please contact me at: ldavis@maproyalty.com.

And as I promised, I am **Lawrence (Larry) H. Davis (MS '79)** and am much honored to serve as the new AAB chair. I have resided in Oklahoma City ever since leaving Ann Arbor. My wife, Ronna, is also a Michigan grad (AB '73, AM '80) and an Ann Arbor native. For the past 25 years I have worked at MAP Royalty, Inc. based in Palo Alto, Ca. making investments on behalf of individual and institutional investors in owning the assets that form the future of electrical production – namely natural gas and renewable energy. I look forward to continuing the tradition of the AAB chairs that have preceded me in guiding the AAB to be a useful asset to the Department.

– Lawrence (Larry) H. Davis

IRONING OUT THE ARCTIC CARBON CYCLE

Prof Rose Cory and her group returned from a summer field season in the Alaskan Arctic where they are studying the role of iron in greenhouse gas emissions from permafrost soils. For this work, Rose Cory and her PhD student **Adrianna Trusiak** (right) sampled soils and rivers across the North Slope of Alaska. Weathering of shales in the Brooks Range of Alaska can lead to high iron in the soils. Rain and snow flush iron from soils into small streams, turning them red due to the formation of iron (oxy)hydroxides (pictured above). Trusiak and Cory find that iron is a "key ingredient" in a reaction where soil organic matter is converted to carbon dioxide (a greenhouse gas) in the Arctic. As the Arctic continues to warm, the thawing of permafrost soils will likely increase opportunities for weathering and release of iron where it can convert more soil organic carbon to carbon dioxide, part of a "feedback" cycle that reinforces more warming on Earth.

Faculty News

The **Geophysics Laboratory** is currently shared by several faculty, **Eric Hetland (Assoc Prof), Yihe Huang (Asst Prof),** and **Jeroen Ritsema (Prof)** For this lab, Summer is the most productive time of the year for their theoretical research. Indeed, we do not go outside very much. The geophysics students and postdocs have made great progress. Below a short description on what has been accomplished in the north wing on the 4th floor of the CC Little building.

Meredith Calogero (PhD Cand) has been working on developing numerical models to simulate the thermal evolution of the lithosphere in volcanic regions over million year time-scales, initially focused on Long Valley caldera, in California. Meredith is being co-advised by Prof. Lange. One of the challenges of her project is to resolve the vastly different scales, from several tens of kilometers spatial-scale of the lithosphere and several million year time-scales, down to sub-meter and sub-weekly scales over which transient partial melting of the crust occurs. And all with computationally tractable code! Meredith is currently resolving these scales in simulations that take about a day of computation time on a common desktop workstation, but we hope the next iteration of the algorithms will get these simulations down to just a few hours. Over the next few years of her dissertation research, she plans to include mechanics of magma transport and evolution of petrology in the simulations. **Sam Haugland (PhD Cand)** has worked together with our regular summer visitor Professor Kaneshima from Kyushu University in Japan on the mapping of kilometer-scale heterogeneity in the deep mantle. Using hundreds of seismograms recorded by USArray in the United States, Sam and Professor Kaneshima have observed a tiny but coherent seismic wave reflection from a depth of 1700 km beneath South America. The traveltime move-out, polarity, and amplitude of this reflection suggest that it was generated by a fragment of mid-ocean ridge basalt which has been subducted into the lower mantle. We will soon submit this work to Geophysical Research Letters. **Trever Hines (PhD Cand)** developed a novel method to directly invert geodetic data for viscoelastic properties of the lithosphere. His application of this "geodetic tomography" to the postseismic deformation following the 2010 Baja California earthquake was recently published in the Journal of Geophysical Research. Trever is now developing a statistically robust technique to extract coherent signal from dense GPS data, providing estimates of the variation of crustal strain-rates over the past decade, or more. Trever is focusing on fault slip behavior of the Cascadia megathrust, and we anticipate some exciting new results. **Ross Maguire (PhD Cand)** is continuing his work in computational seismology. He is making numerical simulations of the ascent of plumes from the core-mantle boundary into the upper mantle and calculating how, in 3D, seismic waves interact with plumes. His paper in Geophysical Journal International shows that plumes cause traveltime delays of less than a half second, short to what may be observable in data. Ultimately, Ross hopes to understand how narrow plume upwellings can be imaged most effectively. Using a Turner Award, Ross has traveled to Nantes, France to work with experts on regional-scale seismic tomography of mantle plumes. His results will be shown at the AGU and soon submitted to Earth and Planetary Science Letters. **Jamie Neely** is using seismic observations to understand the fundamental process of lithosphere tearing and the formation of a new transform plate boundary in the Solomon Islands-Vanuatu region. He is analyzing the source properties of two large earthquake sequences that migrated from east to west along the transform fault. The idea is that earthquake properties can reflect the available strain budget and the maturation process of this new plate boundary. He will integrate both the seismic and geodynamic tools to provide insights into the Australia plate tearing process. First-year PhD student **Russel Wilcox-Cline** has just begun working on his first two projects. Russel will analyze shear wave amplitudes to understand wave attenuation and wave focusing in the mantle and use statistical methods to infer crustal stress from earthquake focal mechanisms and finite slip models.

Postdoctoral researcher **Carlos Chaves** has worked on simulations of shear wave reflections from mineral phase-transitions in the upper mantle transition zone. Carlos's research is aimed at making accurate estimates of the depths of these seismic discontinuities and to estimate the variations of temperature and composition in the upper mantle. Visiting scholar **Ping He** has been imaging the fault slip in the M 7.8 Ecuador and M 6.4 Taiwan earthquakes, both in 2016. Ping's expertise is in satellite-based radar interferometry, and he is on a year-long leave from his faculty position at the China University of Geosciences, Wuhan. Ping is also working on constraining the ongoing postseismic fault creep following the 2015 M 6.4 Pishan earthquake in western Tibet, China. Ping's primary objective is to use estimates of fault slip to inform continuing seismic hazard near recent earthquakes.

Undergraduate students work with us, using global catalogs of earthquake focal mechanism solutions. **Wardah Mohammad Fadil** is testing the hypothesis that the plate collision along the Himalayan Front causes compression and strike-slip faulting in the interior of the Indo-Australian Plate. **Graham Gerdes** is measuring the reflection coefficient

of P waves reflecting off the outer core to determine whether it can be affected by the post-perovskite phase transition, a thin layer of silicate melt, and other complex structures at the base of the mantle. Several undergraduate students continue to assist with a project to calculate exposure in past natural hazards, in order to develop mathematical vulnerability models: **Emily Gargulinsky** implemented tropical cyclone wind models; **Larissa Lu** implemented ground motion prediction equations for earthquake shaking, focusing on their uncertainty; **Erica Lucas** explored a cluster analysis of focal mechanisms, focusing on the region around Istanbul, Turkey; **Raven O'Rourke** developed statistical population models constrained using census data from a variety of sources; and **Rachel Willis** investigated changes in US tornado loss over the past 55 years, and its relation to changing vulnerability. Rachel continued working in the geophysics lab for most of the summer, delving into global earthquake loss over the past five decades. Larissa also stayed on in the lab this summer, but shifted her focus to developing algorithms to do random-walk sampling on high dimensional spheres, a needed ingredient in our stress inversion work. At least four more undergraduate students are joining the geophysics lab in 2016/2017. Among them, **Alex London** is a sophomore studying Geology with a minor in Physics and a member of the Undergraduate Research Opportunity Program. He is using a cutting-edge technique called template matching to detect small earthquakes that may be related to unconventional oil and gas operations in the central States. The goal is to understand whether a spatial-temporal correlation between earthquake occurrence and hydraulic fracturing exists and to develop a more feasible framework to monitor the hazards of induced seismicity.

Youxue Zhang's group had a fruitful year in 2015-2016. **Katheryn Clark** graduated with her MS degree at yearend of 2015. She wrote up her MS research and the paper is being published, a high achievement for a Masters student. **Yi Yu** graduated with PhD degree in 2016. A new student (**Sha Chen**; from USTC) joined the group. **Peng Ni** (current PhD student) is working hard on 3 projects simultaneously. **Chenghuan Guo** (current PhD student) published his first paper this year. Summer travel brought Youxue to China, Japan, and Canada. In China, Youxue visited several institutions and his former students, **Huaiwei Ni (PhD 2009)** in USTC, and **Hejiu Hui (PhD 2008)** in Nanjing University. Both Huaiwei and Hejiu are highly successful in China. They have larger laboratories and research groups than Youxue. They have also received prestigious young scientist awards this year: Hejiu received the Shensu Sun Award, and both Hejiu and Huaiwei received the Hou Defeng Award. Hejiu is also founding the Institute for Lunar and Planetary Sciences in Nanjing University, which opened with fanfare in May of 2016. In Japan, Youxue and Chenghuan presented their research at the Goldschmidt Conference. In Canada, Youxue joined the field trip led by **Adam Simon** and **Kacey Lohmann** to Sudbury impact crater and ore deposits.

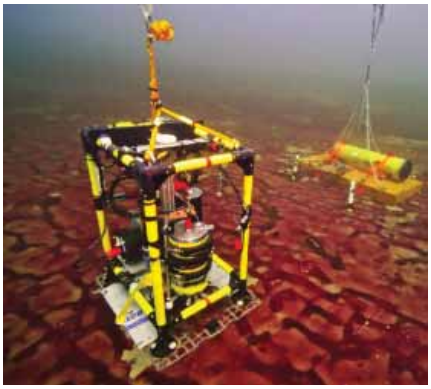
Ben Passey (Assoc Prof) joined the Department during the Summer 2016. As part of his group, he recently hired **Ian Winkelstern (PhD 2016)** as an EES postdoctoral fellow. Below, Ian and graduate student **Becca Dzombak (BS '16)** can be seen in their kayak sampling water and carbonate oncolites from nearby Ore Lake as part of a broader study of oxygen-17 systematics of natural waters and sedimentary carbonates. Ian stumbled on a classic 1978 Journal of Sedimentary Petrology paper by U-M's very own **Frances Jones** and **Bruce Wilkinson** describing these oncolites, which feature concentric banding represent seasonal cycles of algal growth and carbonate mineralization. Ian and Becca, are working with Ben to apply the new oxygen-17 method to paleo-lake hydrology and the aridity / humidity aspect of past climates.

Jeff Wilson (Assoc Prof) spent February exploring Cretaceous deposits in central India (Maharashtra and Madhya Pradesh States). He and colleagues found some exciting new land vertebrates, including a small "side-necked" turtle. This and other discoveries indicate that India's continental vertebrate fauna is similar to those from other southern landmasses, like Madagascar and South America, implying biotic connections between these landmasses that persisted until the end of the Cretaceous.

Researchers including Matthew Medina and Judith Klatt (right) on the R/V Storm of Middle Island in Lake Huron.

The Geomicrobiology lab led a large interdisciplinary group of scientists investigating living analogues of Precambrian microbial mats in Lake Huron. Associate Professor **Greg Dick (Assoc Prof), Judith Klatt (Postdoc)**, and PhD students **Sharon Grim, Matthew Medina,** and **Katy Rico** (working with **Nathan Sheldon**), and **Chien Tan (BS 2017)**, together with colleagues from the University of Southern California, Harvard, Washington University, the NOAA Thunder Bay National Marine Sanctuary, and the Max Plank Institute in Germany, spent two weeks studying the mats in a sinkhole just off Middle Island in Lake Huron, near Alpena, Michigan. Here, mats of cyanobacteria thrive under low-O_2, sulfidic conditions reminiscent of coastal environments of the Proterozoic. The team is trying to understand how microbiological and geochemical processes in cyanobacterial mats control the production of O_2, and how such ecosystems might be detected in the geological record. Ultimately this research is aimed at understanding the pattern and processes of Earth's oxygenation. A short summary on NPR's All Things Considered can be heard here: http://www.npr.org/2016/09/05/492727566/scientists-explore-purple-microbial-mats-in-the-depths-of-lake-huron.

Purple microbial mats of cyanobacteria thrive under Proterozoic-like conditions of high sulfide and low-O_2.



Instruments deployed on the bottom of the Middle Island sinkhole take in situ measurements of geochemistry in purple microbial mats of cyanobacteria that thrive under Proterozoic-like conditions of high sulfide and low-O_2

Life and work at home and in the Department took on the aspect of a *"Big Five-Oh"* in the last two years, reflecting the celebrations of **Rob Van der Voo's (Emeritus Prof)** early years at the University. After two years as visiting Assistant Professor and having persuaded the Department in 1972 to offer him a tenure-track assistant professorship, Rob turned down (how could he not?) the efforts of the Ohio State University to recruit him. Combined with the milestone of Rob's 75th birthday, a celebration of Rob's retirement from the University was organized in the form of a two-day scientific symposium and a couple of appropriate parties in late August 2015. Some 25 colleague-paleomagnetists from institutions elsewhere presented their research, including former PhD students working with Rob. But more parties were yet to come! The 50th wedding anniversary of Tanja and Rob was celebrated by the Van der Voo family (sons Serge and Björn, daughters in law Kirsten and Lee, and grandson Jens), in February 2016. An 18-day tour of Barcelona and Andalucia's famous cities, such as Granada and Sevilla, with luxurious Airbnb accommodations, will be in our memories of this most enjoyable occasion for years to come.

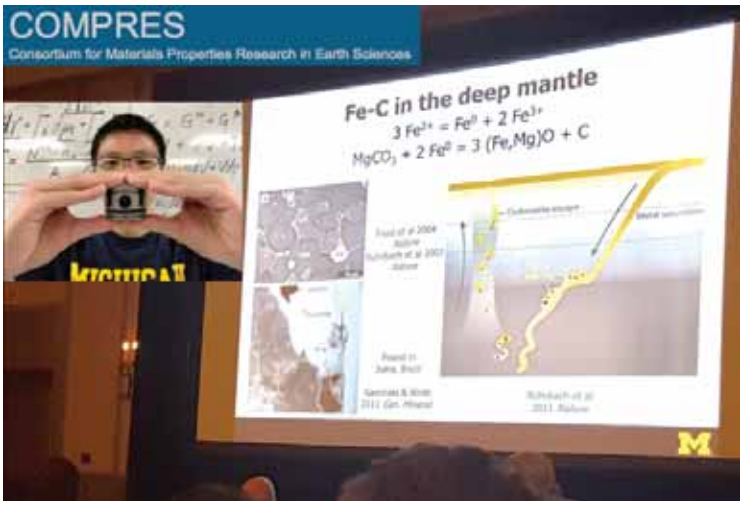
Over the last several years, **Valerie Syverson (PhD 2014)**, **Meg Veitch (PhD Cand)** and **Tom Baumiller (Prof)** have been studying the biology and ecology of extant deep-sea crinoids. Some of this work is aimed at understanding why today's stalked crinoids are restricted to depths greater than 100 m, whereas throughout much of the Paleozoic and Mesozoic they were associated with much shallower waters.

To study deep-water crinoids, we have been using a manned submersible, Idabel, based on Roatán, a small island in the Caribbean, ~60 km off the north coast of Honduras. This is an ideal place for studying deep-sea crinoids as they are abundant and diverse at depths from 150-700 m and can be reached within a half-hour of shore. Relative ease of access allows Idabel to operate without a tender ship dramatically lowering costs. Between 2012 and 2016 we have visited Roatán on 6 occasions, setting up several study sites at various depths and revisiting the same sites (and the same individuals) over time to gather data on crinoid behavior, functional morphology, population dynamics, growth, and injury rates.

To date, the results indicate that stalked crinoids in deep water experience much lower predation pressure than do stalkless crinoids in shallow water. This is consistent with the hypothesis that predation pressure restricts stalked crinoids to deep-sea refugia, and that stalkless crinoids are better able to cope with predation because of a variety of physiological and behavioral strategies. In the future, we plan to move from deep water to deep time, to explore the fossil record for temporal changes in predation pressure.

Ted Moore (Emeritus Prof) has rambled through a couple of projects. First was the dating of siliceous marine sediments to determine the youngest marine deposits in the Himalayas. These data, when combined with the U-Pb age of zircons in Asian turbidites, gave a consistent estimate of 59 +/- 1 Ma for the youngest marine sediments in the Sangdanlin section of the central Himalayas. Together with a coincidental shift in the source of turbidites from India to Asia, the data give an estimate of the initial collision between India and Asia. This study has been followed by the opportunity to act as an informal advisor on an undergraduate's project to model the global impact on marine sections of the tsunami generated by the Cretaceous – Tertiary bolide that landed off the Yucatan Peninsula. **Molly Range (BS 2017)** under the tutelage of Brian Arbic, has made a good start on this effort, which will continue into 2017.

During the fall break, **Jackie Li (Prof)** took the Earth 315 students to the Greater Detroit Gem, Mineral, and Fossil Show in Warren, Michigan. The group posed for a photo with the dinosaur teratophoneus (monstrous murderer). Students acquired mineral samples for class projects, including jasper, ruby, malachite, vanadinite, calcite on pyrite, labradorite, and spectrolite. They also interviewed vendors about career options and mineral market.



In June 2016, undergraduate student **Junjie (J-J) Dong** gave an excellent talk on "Is the core still growing? Assessing the fate of molten iron-carbon alloy by investigating its wetting of mantle silicates" at the COMPRES annual meeting at the Hyatt Regency Tamaya Resort & Spa in the Santa Ana Pueblo, New Mexico. J-J was the only undergraduate student selected to speak at the meeting.

Professor Jie (Jackie) Li received a Sloan Foundation grant to lead a Deep Carbon Observatory Synthesis project on "Earth in Five Reactions". She will be working together with Prof. Simon Redfern at Cambridge University and the Synthesis Task Force to identify and use the five most important reactions as the central themes to synthesize and disseminate deep carbon knowledge and findings, and to provide a new and integrative perspective for scientists to understand and advance deep carbon science.

Associate Professor Nathan Niemi's research group had a busy year of international research in tectonics and structural geology. In March and April, Nathan went on a three week expedition to the northern portion of the Tibetan Plateau, near the border between Qinghai and Xinjiang provinces. Near the 6860 m peak of Bukadaban Feng, a large normal fault system disrupts the low-relief plateau surface. Tectonism and volcanism associated with this fault system offer potential insights into the timing of creation of high topography in Tibet, the petrologic processes that are acting within the crust of Tibet, as well as seismic hazards associated in this largely unstudied part of the Tibetan Plateau.

Basecamp in northern Tibet, with the high peak of Bukadaban Feng in the distance at left. This range is roughly the same size, and relief, as the Grand Tetons, but elevations in the valley in front of the range are ~5000 m, with the peaks exceeding 6000 m.

Dr. Tim Stahl logging a paleoseismic trench in the Drum Mts., western Utah. The two exposed faults displace Lake Bonneville-aged (~18 ka) white marl and alluvial fan sediments that G.K. Gilbert first mapped in the 1890s. Surveying and combined luminescence and radiocarbon dating constrain the timing of a single > MW 7 earthquake to ~1 ka. Photo by Gregg Beukelman, Utah Geological Survey.

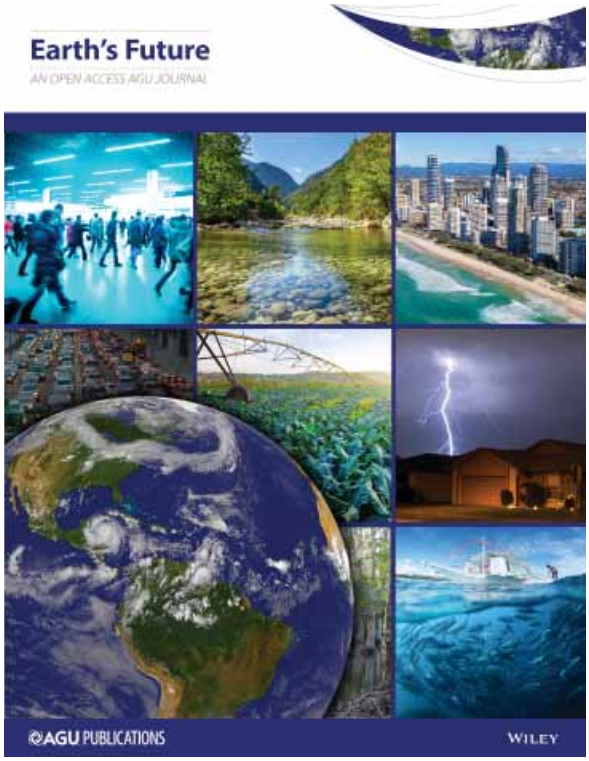
Alyssa Abbey collecting a vertical sample transect for thermochronology analysis up the flank of Mt. Belford, CO.

In May, Nathan joined NSF Postdoctoral Fellow **Tim Stahl** in the deserts of western Utah, to look at fault scarps and other neotectonic features associated with Basin and Range extension in the western United States, where he is studying the seismic hazard of this region, and it's relationship to seismic and volcanic hazards.

Alyssa Abbey (PhD Cand) continues her work on low-temperature thermochronology in the Colorado Front Range, and Nathan and **Alex Tye (PhD Cand)** spent time in Azerbaijan, where Alex is working on unraveling the geologic record of subduction cessation and the initiation of continental collision.

When not traveling for field work, the group has been presenting work this year at conferences in Brazil and Colorado. With new research group members, including graduate students **Nikolas Midttun** and **Kevin Ortiz**, and new postdoctoral scholars **Kendra Murray** and **Eric Portenga (BS '08),** we see a lot more great science ahead.

Alex Tye creating a geologic strip map of the Greater Caucasus Mountains along the Girdiman River in the former Soviet republic of Azerbaijan.



Ben van der Pluijm (Prof) usually writes about geo-research or teaching in this annual update, but he has a parallel interest area in sustainability and resilience. Since 2014 he has been editor-in-chief of the AGU's fledgling journal Earth's Future (see cover image). A transdisciplinary, open-access science journal, Earth's Future examines the state of the planet and its inhabitants, and the predictions of our collective future. The journal assesses the challenges and opportunities associated with regional and global change in an era where humans dominate Earth's environment, resources and ecosystems. It publishes peer-reviewed articles, reviews and (short and long-form) commentaries in areas that include water, air, food, energy, hazards, climate, ecosystems, human health and demographics, among others. Contributions focus on Earth as an interconnected, evolving system to inform researchers, policy makers and the public on the science of the Anthropocene.
One novel element is the use of authoritative commentaries that critically examine a topic (like geo-engineering) using a solid science foundation. Those interested in the yes/no debate about an Anthropocene Epoch will also find several key papers there, with a couple examples recently highlighted in my Editors' Vox (https://eos.org/editors-vox/here-comes-the-anthropocene). Have a look at the journal, at http://agupubs.onlinelibrary.wiley.com/agu/journal/10.1002/(ISSN)2328-4277/, where you will likely find stimulating and informative contributions on our (=Earth's) Future.

Transformative Learning for Undergraduate Students – Arbic & Simon

Adam Simon (Assoc Prof) and **Brian Arbic (Assoc Prof)** mentored six undergraduate students who worked full-time during the summer on three separate sustainability themed research projects. Simon wrote three proposals to the Michigan Sustainability Cases program, which is part of the Provost-funded Third Century Initiative program that seeks to develop transformative teaching methodology to improve student learning outcomes across the curriculum. Students worked in teams of two on the following case studies. Undergraduates **Mark Finlay** and **Elizabeth Oliphant** investigated the potential for the flowering plant *Jatropha curcas* to be grown and harvested for production of biodiesel. Undergraduates **Jessica Hicks** and **Erich Eberhard** investigated the environmental land and water use impacts of cultivation of *Theobroma cacoa*, better known as the cocoa tree that provides society with the incredible food group chocolate. Undergraduates **Anne Canavati** and **Jayson Toweh** investigated the end-of-life fate of electronic products, specifically focusing on the export of electronic waste (E-waste) to emerging economies where they end up having significant negative environmental consequences. The commonality among all three projects is the country Ghana, where biodiesel production, cocoa cultivation and E-waste imports are having real-time negative impacts on the environment. The six students traveled to Ghana with faculty members Simon and Arbic where they interviewed local citizens, government officials, and members of non-government organizations about these topics. This transformative experience allowed the students to go far beyond what they learned from published studies, photographs and videos posted on the internet. The students got to see with their own eyes the environments of biodiesel production, cocoa cultivation and the E-waste graveyard Agbogbloshie. All three case studies are freely available and designed to be teaching tools for high school (great for AP Environmental Science) and college courses (land use, water use, life cycle analyses).

Toweh, Eberhard, Hicks, Canavati, Simon, Arbic, Finlay and Oliphant at the Cape Coast Castle, one of the forty slave trading locations along the Ghana's coast.

COASTAL OCEAN ENVIRONMENT SUMMER SCHOOL GHANA 2016

Brian Arbic (Assoc Prof) and **Adam Simon (Assoc Prof)** along with **Joseph Ansong (Asst Res Sci)** and undergraduates Mark Finlay, Jessica Hicks, Elizabeth Oliphant, Erich Eberhard, Jayson Toweh and Anne Canavati organized and taught parts of the Coastal Ocean Environment Summer School at the University of Ghana in Accra, Ghana during August. Approximately 100 faculty, government officials, private sector employees, and students from various universities and institutions in Ghana participated in the school. The school featured lectures, discussions, and labs on oceanography, oil and gas development, fisheries management, maritime affairs, research funding, and applying to graduate programs. There was also a field trip to Sakumono Beach. The 2016 school built upon a 2015 school held at Regional Maritime University, also in Accra. Arbic, Simon, and Ansong will return to Ghana in 2017, along with many colleagues and students, to hold another summer school. Marine issues of great importance to Ghana include: fisheries, piracy, pollution, shipping and port management, and the recent advent of offshore oil drilling along Ghana's coastline. Long-term goals for the group include securing funding to continue the school on an annual basis, building links with institutions in other African countries, and incorporating research partnerships into the school. More information can be found at: *https://coessing.org/*

Right: Student participants in the laboratory titrating for water chemistry.

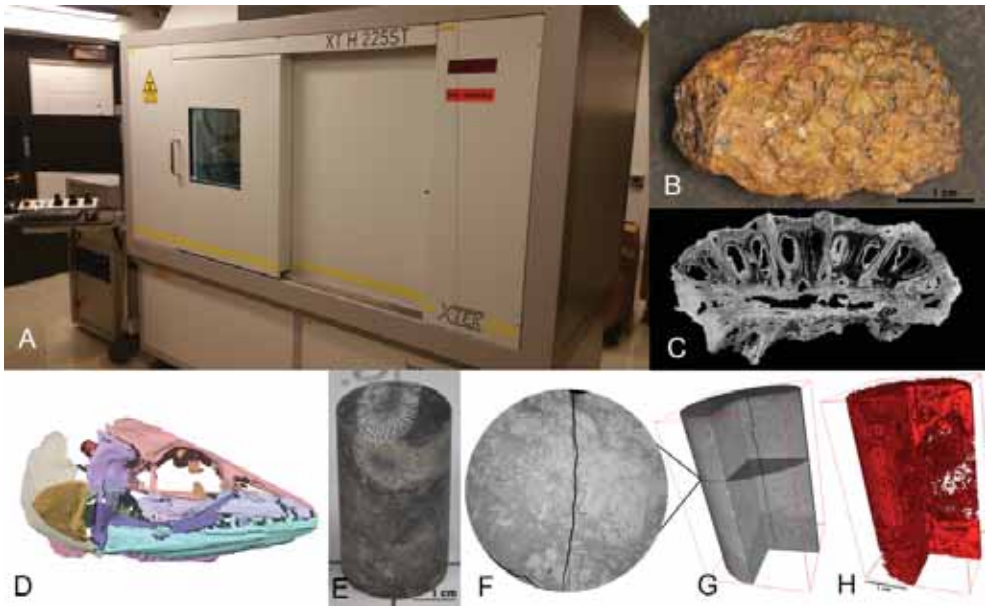
Below: Dr. Drew Lucas, of Scripps Institution of Oceanography who was part of the instructional staff, discusses coastal dynamics during field trip to Sakumono Beach.

COMPUTED TOMOGRAPHY LABORATORY

New and Exciting Facility

Selena Smith (Asst Prof) and **Matt Friedman (Assoc Prof)**, coordinated the purchase and installation of a Micro CT instrument that will form a new CT (computed tomography) facility that they will run on central campus, based in CC Little (Fig A). CT is becoming a widely used tool in geosciences, as well as other fields such as biology, and having this instrument in-house will support student research by providing an opportunity for students to learn hands-on how to gather and analyze CT data. There is much that can be done with the data, including morphological analyses (e.g., structure of fossil plants and animals (Fig B–D); microscopic cracks in rocks (Fig E–G), 3D visualization and printing of objects for teaching or museum displays and quantitative analyses (e.g., volumetric data: what is the pore space in a rock sample? How much of a certain mineral is there? (Fig E–H)). Department Alumnus **Brian Ellis (BS 2009)** now an Assistant Professor in the Department of Civil & Environmental Engineering at UM is serving as a third member overseeing the facility and will add exciting 4D experimental capabilities to better characterize multi-phase flow dynamics and reactive transport processes in rock cores, with applications to subsurface energy development.

The Nikon XT H 225ST is a behemoth of an instrument at 9,000 lbs and very nearly didn't make it into the building! It will be able to handle samples from a few millimeters to ~30 cm in size, with resolutions up to 3 µm. The machine is also relatively easy to use, which was important for our goal of supporting student research. We anticipate that having this machine in the department will greatly enhance numerous different research programs in the department including paleontology, hard rocks, and economic geology, as well as other fields including environmental science, biology, and anthropology. While the facility is currently in a development phase, we foresee scanning samples commercially in the future. The new CTEES (Computed Tomography in Earth & Environmental Sciences) facility will strengthen research and student training in EARTH. Stay tuned for some exciting research results!



A, *The Nikon XT H 225ST industrial micro-CT scanner in its new home in CC Little.* ***B–C,*** *A fossil fruit from the Cretaceous of Mexico being studied by* ***Kelly Matsunaga (PhD Cand)*** *as part of her dissertation research, and one of the first samples scanned on the new instrument.* ***B,*** *Overview of the fossil fruit.* ***C,*** *Digital longitudinal section through the fruit showing multiple fruitlets with several seeds each.* ***D,*** *CT-scanned head of a fossil fish from the Cretaceous, showing how these data can be digitally segmented to study individual elements such as bones (image by M. Beckett).* ***E–H,*** *rock core (images by B. Ellis.)* ***E,*** *raw core.* ***F****, CT slice through core.* ***G****, 3D volume of XCT data.* ***H****, calcite segmented out of core.*

Camp Davis Gazette

We had another busy (and for some of us, quite exciting!) Summer at Camp Davis. Course enrollments have held steady the past few years, and we enrolled 135 students in eight courses, with four course offerings at the 100-300 level for introductory level students and non-science majors, and four additional courses (two sections each of 440 and 450!) to meet the needs of the undergraduate majors in our Department and in the Program in the Environment. Two UM professors **Jeroen Ritsema** and **Jackie Li**, taught at Camp for the first time this summer, in Earth 116, continuing to expand the proportion of Department faculty engaged in Camp teaching.

Those of us at Camp Davis in late July were treated to the excitement of the Cliff Creek Fire, which initiated from a lightning strike near the mouth of Cliff Creek, and which burned over 30,000 acres from Granite and Cliff Creeks eastward to Bondurant. Highway 189 was closed for almost a week, and thick smoke enveloped Camp from late night until noon each day. A rain storm in early August tempered the fire, and our fears of an evacuation, but the remnants are continuing to burn, with containment expected in late fall. If you pass through between Pinedale and Jackson, you'll be stunned by the dramatic changes to the forest from this event.

Dinner for 24, in the Beartooth Mountains, Montana, is always a great end to a long day of geology in the field.

Above: Students at Golden Gate, Yellowstone National Park.

Major Donation for Camp Renovation!

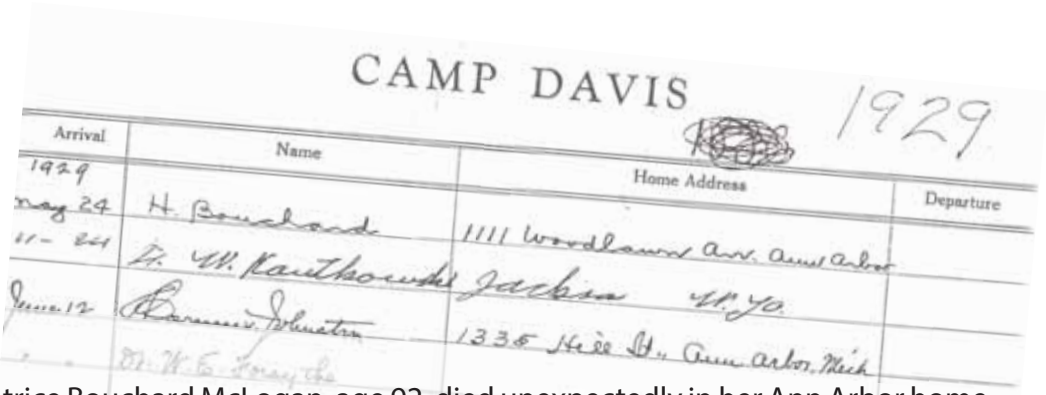
This summer, the Department received an anonymous $1 million bequest from one of our alumni to support our plans to renovate Camp Davis! This incredibly generous contribution, in combination with donations from many of you, puts the renovation of the student cabins nearly within our reach. We're still short of the funds needed to break ground and are trying to raise these funds in time to start construction in the Fall of 2017. To learn more about the need for this renovation project, our timeline for starting construction, and how you can help, either immediately, or with long-term planned gifts, please visit the Camp Davis Renovation webpage, http://lsa.umich.edu/earth/camp-davis/camp-renovations.html.

We continue to plan for a renovation of the student cabins in the near-term, and we are grateful for the generous gifts from alumni, and for the tireless work of the Alumni Advisory Board, in helping us in the major capital project. A tremendous bequest from one of our alumni (see box above) has put us on the path towards completion of this project. In the meantime, we continue to upgrade the existing facilities. A new kitchen floor and walls were the main project for this summer, and the difference in the kitchen is dramatic.

The modern world continues to creep toward Camp Davis. Fiber optic cable has made it as far as Hoback Junction, and it is expected to be strung from Hoback to Bondurant within the coming year. When that happens, we might be able to Skype with all of you from Camp Davis. Until then, cell phones don't work and the student phone line is usually busy. But, we're around from June through August, and if you're in the area, please stop by and say hello.

– **Nathan Niemi**
Camp Davis Director

In Memoriam



Beatrice Bouchard McLogan, age 92, died unexpectedly in her Ann Arbor home on Tuesday, February 23, surrounded by her seven loving children.
Bea's lust for life knew no bounds. Her insatiable curiosity, thirst for knowledge, and intellectual zest were contagious.

Bea was born in Ann Arbor on July 27, 1923 to Harry and Vernona Hutton Bouchard, the youngest of three daughters. Her father taught civil engineering in Tientsin, returning in 1928 to Ann Arbor where Bea attended Tappan School and University High School. She spent many summers at University of Michigan's Camp Davis near Jackson, Wyoming, which her father helped establish and where he taught surveying. Harry Bouchard was the first director of Camp Davis (see his entry as the first to be added to the Camp Registry). Bea entered University of Michigan in 1940 and pledged the Collegiate Sorosis sorority. She met her future husband, Edward (Ted) A. McLogan, of Flint, who was in the class of 1942. Bea's greatest accomplishment and joy was her marriage to her beloved Teddy, who predeceased her in 2013 after 67 years of marriage.

Bea leaves behind seven children: Deborah Nelson of Salinas CA; Matthew (Jane Brierley) of Grand Rapids; Martha Morrow of Melbourne, Australia; Jennifer (Daniel Gurskis) of Garden City, NY; Mary (Daniel) Ziegeler of Omena, MI; Elizabeth (Robert) Sugar of Salinas, CA and Ann Arbor, MI; Helen (Carl) Chamberlain of Prairie Village, KS.

Memorial donations may be made to University of Michigan Camp Davis Renovation/Harry Bouchard Memorial Fund or St. Mary's Student Parish, Capuchin Soup Kitchen (Detroit).

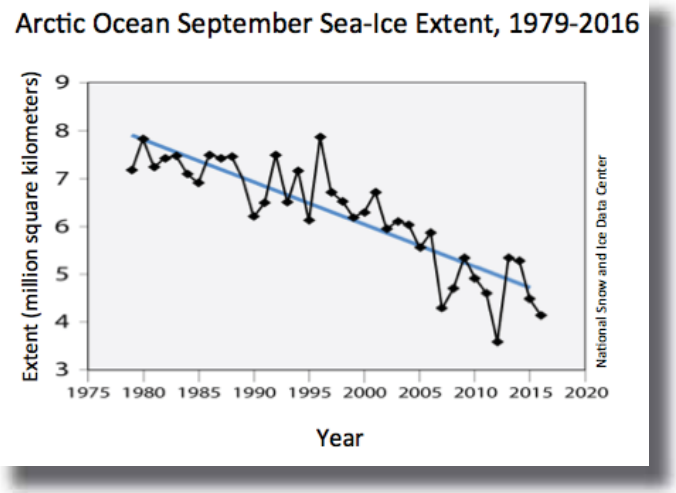
Bill Wilcox Retires

I think that for most of us, as far as we can remember, **Bill Wilcox** has been there: organizing our departures for Camp Davis, finding that special desk that you think you need, knowing how and where everything you thought you might ever need could be found. Some of us remember before the time when our Department did not operate with such ease and liquidity. As Departmental Facilities Coordinator, Bill had the responsibility of dealing with the changing bureaucratic oversight of the University, where every roll of toilet tissue, every square foot of lab and office space needed to be accounted and justified. Bill has mastered the tasks, generally thinking ahead of the faculty when field trips needed to provide tents and protective gear and keeping the students in mind when he put equipment in the vans that he knew would be needed. Bill has always known what we want and what we don't know that we need. Thank you Bill for taking such care of our Department for the last 32 years! It will be hard to find a person with the skills and perspicacity that have made you a valuable and irreplaceable member of the EARTH FAMILY.

THE NORTHWEST PASSAGE --2016

Henry Pollack (Emeritus Professor) was part of an expedition team that accompanied the cruise ship Crystal Serenity through the fabled Northwest Passage across the high Arctic this past August and September. The ship departed Anchorage on August 13 and finally docked in New York City on September 16 alongside the USS Intrepid in the Hudson River. Intermediate stops included Dutch Harbor and Nome in Alaska, Ulukhaktok, Cambridge Bay, and Pond Inlet in Canada, and Ilulissat, Sisimiut and Nuuk in Greenland, before returning to the USA. Most of the route was well north of the Arctic Circle, with the furthest north registered at about 75 N in Lancaster Sound north of Baffin Island. Through the Canada and Greenland segments of the passage the Serenity was accompanied by the RRV Ernest Shackleton, a British Antarctic Survey icebreaker usually found in the southern high latitudes.

The route followed (in reverse) the pathway of the first successful transit of the Northwest Passage by Roald Amundsen, the famous Norwegian explorer, in the interval 1903-1906. But there was little else in common between these two voyages a century so apart. Whereas it took Amundsen and his crew three years to make the journey, it took Serenity only three weeks!



The difference? The Serenity encountered absolutely no sea ice along the route. Although the Shackleton was available for ice-breaking if necessary, in effect it was on summer vacation. For millennia sea ice has continued to block the channel-ways of the Canadian Arctic archipelago even at the end of summer. But for the past half century, sea ice extent and thickness have been on a downward trend which, if it continues, will lead to a completely open Arctic ocean at the end of summer before mid-21st century, probably for the first time in human history.

The west coast of Greenland was telling the same story of a warming Arctic, but in a different way. The fjord at Ilulissat was so full of ice discharged from the Greenland ice sheet that the Serenity could not even approach the harbor at the mouth of the fjord. Similarly at Nuuk, the capital of Greenland further south, one can view fast-retreating glaciers and meltwater waterfalls that appeared only in the past few decades. If we need a 'canary-in-the coal mine' to advise us that climate change is real and serious, the Arctic region is certainly singing loudly.

Victors for Michigan

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

Making a big contribution to an NSF-funded research project to **Gordon Moore (Res Sci),** undergraduate **Jack Touran (BS 2016)** has been directly involved in synthesizing high temperature and high pressure experiments in Becky Lange's lab. He has also had the opportunity to analyze the resulting run products using XANES, EPMA, and SEM. Since graduating last fall, Jack continues to work in the lab with Gordon as a research assistant, and is currently getting his applications ready for PhD programs.

Recent undergraduate **Tom West (BS 2016)** wrote a senior thesis wherein he investigated Emissions Trading, which is proposed as a government-mandated and business-oriented partial solution to reduce emissions from fossil-fuel-based electricity production technologies.

Undergraduate **Emily Kopas (BS 2018)** spent the summer investigating the effects of hydrocarbons on coral reef systems to determine their survival rates. A Florida native, Emily's interest in this field was driven by the after effects of the Deepwater Horizon oil spill.

Alyssa Abbey (PhD Cand): This year I had a very interesting and different field season compared to what I normally do. I was back in Colorado but instead of spending my time in the heart of the Rockies, me and my field assistant **Megan Hendrick (BS 2017)** spent almost all of our time in the High Plains in eastern Colorado. Megan is now a senior and doing her thesis with me. It was a lot of fun/frustrating thinking of new ways to target and find samples in a landscape with very little exposure and a lot of private land owners to convince to give us access. They were worried we were working for oil/gas companies and that we were going to okay their land for drilling. After research fieldwork, I taught EARTH 440 for the second time at Camp Davis. And this new semester has had a great start with two back to back conferences: 1) International Thermochronology conference in Maresias Brazil, where I presented a poster on apatite He results from the lower Arkansas River valley in the southwest Front Range of Colorado; and 2) GSA in Denver where I had an oral presentation on near Recent exhumation in the northern part of the Rio Grande Rift. Both were very well received and I made some amazing connections.

Tristan Childress (PhD Cand) published a paper in the Journal of Economic Geology on the evolution of the Pea Ridge and Pilot Knob magnetite – apatite deposits in Missouri, USA. These deposits were historically mined for iron, and are now being investigated for their rare earth metal resources as part of a federally funded initiative being led by the United States Geological Survey. The United States currently imports nearly one hundred percent of the rare earths embedded in every technology product used by society – from smartphones to wind turbines to hybrid and electric vehicles. We proposed a new genetic model for these deposits that will hopefully improve exploration strategies for these important resources. Tristan also continued his investigation of the Mantoverde iron oxide – copper – gold system in Chile, in collaboration with **Martin Reich (PhD 2006)** at the University of Chile, and the mining company Compañia Minera del Pacifico.

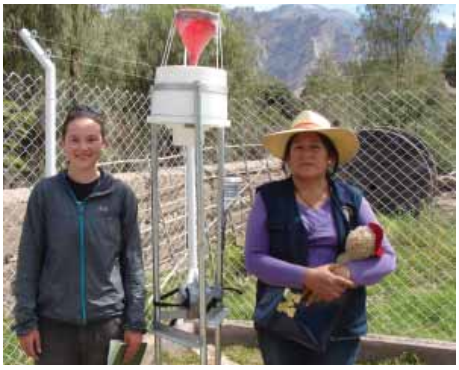
2nd year PhD student **Nikita La Cruz** is investigating the chemistry of apatite in iron oxide – apatite ore deposits to determine if chemical variations within apatite hold clues about the genesis of this important class of ore deposits. Nikita focused this year on apatite from the Los Colorados deposit in Chile, which served as the basis for a new ore deposit model our group published in 2015. Apatite grains are systematically zoned with respect to halogen and trace element concentrations, and Nikita is working out what the zonation reveals about the genesis of apatite and the ore body.

Brian Konecke (PhD Cand) published a paper in American Mineralogist that reports data (for the very first time) that demonstrate the mineral apatite structurally incorporates three different oxidation states of sulfur – sulfide, sulfite and sulfate. These experimental data were produced across a large range of oxygen fugacities and measurement of sulfur oxidation states was accomplished by using in situ synchrotron X-ray absorption near edge structure (XANES). The systematic change in the proportion of reduced to oxidized sulfur in the apatite structure as a function of the oxidation state of the system suggests that sulfur in apatite may be used as an oxybarometer. This would provide a new, powerful tool for unraveling the role that oxidation state plays in moderating the mobility of ore metals in magmatic systems.

1st year PhD student **Gephen Sadove** comes to us from George Washington University where she earned dual degrees in Geology and International Affairs, and was a four-year member of their Division I Rowing team. Gephen is working to help us assess the applicability of our new experimental knowledge about sulfur in apatite to natural systems. She is investigating the oxidation state of sulfur in natural samples from volcanic environments such as Mt. Pinatubo, and several iron oxide ore deposits.

Daniel Korfeh (MS 2017) is completing his thesis wherein he is investigating the trace element chemistry of magnetite from the Pea Ridge magnetite – apatite ore deposit, Missouri, U.S.A. Several recently published papers propose that the trace element chemistry of magnetite can be used for provenance studies and to fingerprint the type of ore deposit in which detrital magnetite formed. Daniel's data for the Pea Ridge system indicate that moderate to low temperature hydrothermal alteration of magnetite changes the trace element compositions by local dissolution and reprecipitation. The alteration essentially eliminates the primary chemical signature of magnetite and suggests that the use of magnetite trace element chemistry should be done with extreme caution.

Phoebe Aron (PhD Cand) spent three weeks this past summer in southern Peru setting up a network of precipitation collection stations to study hydrology and climate in the Central Andes. One of the stations built for this purpose is deployed in Ayo, a small town on the western flank of the Andes. The woman on the right is a Peruvian helper who maintains the station and collects biweekly precipitation samples.



Molly Ng (PhD Cand): About 60 million years ago, *Taxodium distichum*, the bald cypress, was widespread throughout the Northern Hemisphere reaching to the Arctic Circle. Today, its natural range has contracted and is restricted to the swamps of southeastern United States. This summer, I collected leaf samples from across their range to investigate whether leaf anatomy and physiology is controlled by climatic niche, and through mechanistic niche modelling see how they will respond to global change.

DEPARTMENT OUTREACH: EARTH CAMP 2016

We had a very successful expansion of Earth Camp – our summer outreach program for high-school students. All 20 Earth Camp students from last summer returned for a one-week, Upper Peninsula experience. We started the week on Mackinac Island learning about the sedimentary rocks of the Michigan Basin. A 10-mile bike ride allowed us to explore the shoreline bedrock features such as terraces, stacks, arches, sea cliffs, and caves of glacial lakes Nipissing and Algonquin. We traveled north to Tahquamenon Falls State Park to examine Cambrian-aged rocks of the Munising Formation and examples of cross-bedding and ripple marks. The conglomerates here were also a great contrast to the Mackinac breccia – they were able to identify that the clasts were differently-shaped and work out the differences in their formation histories on their own. At Pictured Rocks, we started on a lakeshore cruise to see the cliffs from the water. It was the first time for many of the students and staff seeing Pictured Rocks and everyone was in awe. The boat ride allowed us to see the different color stains on the rock and identify what was causing the different colors (iron =red/orange, copper = green, limonite = yellow and white, and black = manganese). It was also a great opportunity to see current Lake Superior shoreline features being formed to help better understand how the ancient ones they saw on Mackinac Island were formed. We explored Precambrian rocks at Presque Island State Park, where students learned about unconformities when they found the nonconformity between serpentinized peridotite and the overlying Jacobsville Sandstone. A stop at Jasper Knob in Ishpeming was a highlight for the staff and students. The exposure there of banded iron formation was a great place to start connecting the history and economy of Michigan to its resources "up north" as we made our way to the Quincy Copper mine in Houghton the next day.

The students loved this stop – on the tour they got to ride the cog-rail tram car down the hill to the mine entrance and then ride by a tractor-pulled wagon into the mine – seven levels underground! They finished the day at the Seaman Mineral Museum with a tour from the curator and Michigan alum, **Chris Stefano (PhD 2010)**. It was an incredibly successful expansion of our Earth Camp program that we hope to continue to expand next year. We would like to bring the same group of students back for another experience in the Jackson Hole/Yellowstone region. If you are interested in financially supporting these high-school outreach efforts, please contact Jenna Munson -- jennamun@umich.edu.

A few of the thank you notes of how Earth Camp impacted the students:

"I would like to say thank you for organizing and bringing this group back together for an amazing earth camp experience in the U.P. and Mackinac. I enjoyed every part of the trip from the long van rides, to bike riding on Mackinac Island, to swimming in Lakes Huron and Superior, to learning about the glaciers shaping Michigan and how it's a basin with layers of rocks everywhere. From limestone, to shale, to sandstone, and Mackinac breccia, with headways, arches, and the occasional ephemeral bar, I learned more about Michigan and geology than I ever had in my whole educational career. I loved all the little drops of knowledge dropped upon me from you and the counselors along the course of last week." –LR

"Thank you for two amazing Earth Camps. I have thoroughly enjoying exploring and learning about Michigan's natural beauty – during this past week it was easy to forget I was still in-state. My favorite experience this year was Pictured Rocks, during the boat tour and exploring the beach, but a close second experience was the mine tour. I have also formed great friendships with people I will continue to keep in touch with. I hope that I can have another Earth Camp Experience again next summer." -CM

"I just wanted to thank you again for another great trip this year! It was the definitely the highlight of my summer. It was so great to be with all these amazing people again, you and the counselors included! I already miss being there and I can't wait for Wyoming next year! I hope everything works out for next year as well, because I had such a fun and educational experience and I think I could learn a lot more. Earth science and UofM have become things I'm really interested in! I already learned a lot and I'm excited to learn more – especially in the Earth Science class I'm taking this year and hopefully next summer." -ND

Generous Supporters of the Department 2016

The Department would like to acknowledge the generous corporate, foundation, and individual gifts it has received over the last year (July 1, 2015– June 30, 2016). 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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THANK YOU!

Kyle Meyer collecting Upper Cretaceous samples on Anthracite Ridge in Alaska.

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Shell Oil Company Fellowship Fund: J. El Adli

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Stewart R. Wallace Fellowship: M. Cherney, K. Matsunaga, S. Nedrich, H. Shen, Y. Wang

HONORS AND AWARDS

Research Grant Recipients 2016

Alyssa Abbey (PhD Cand) received a student research grant from the Geological Society of America and an NSF Earthscope AGes Gechronology Grant.

Tristan Childress (PhD Cand) received a Hugh E. McKinstry research award from the Society of Economic Geologists.

Brian Konecke (PhD Cand) received a Rackham International Research Award.

Nikita La Cruz (PhD Cand) received a Hugh E. McKinstry research award from the Society of Economic Geologists.

Alex Tye (PhD Cand) received a Rackham International Research Grant.

ANNUAL AWARDS – 2016

Eugene and Elizabeth Singer Award for Academic Excellence in Geology:
Molly Moroz
Noah Attal

Camp Davis Field Geologist Award:
Jeffrey Bennett
Sarah Washabaugh
Ryan Graham

Alumni Undergraduate Award:
Jessica Hicks

Undergraduate Academic Excellence Award:
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John Dorr Graduate Academic Achievement Award:
Sae Yun Kwon

FELLOW OF AMERICAN SOCIETY OF LIMNOLOGY AND OCEANOGRAPHY

Phil Meyers (Professor Emeritus) continues to be recognized for the scientific contributions that he has made during his career. He has been elected a 2016 Fellow of the American Society of Limnology and Oceanography, an organization that he joined in 1970 while still a PhD candidate at the Graduate School of Oceanography at the University of Rhode Island. This honor joins his earlier elections as a fellow of the GSA, the AGU, the Geochemical Society, and the AAAS.

2016 HARRY HESS MEDAL
America Geophysical Union

Alex Halliday (Former Faculty 1986-98) was awarded the prestigious 2016 Harry Hess Medal of the American Geophysical Union.

2016 LUNA B. LEOPOLD AWARD

Alison Duvall (PhD 2011) received the Luna B. Leopod Award from AGU for an early career scientist who has made a significant and outstanding contribution that advances the field of Earth and Planetary surface processes.

RALPH W. MARSDEN AWARD
SOCIETY OF ECONOMIC GEOLOGY

Steve Kesler (Emeritus Prof) was the recipient of the Ralph W. Marsden Award, bestowed annually by the Society of Economic Geology to one member for exceptional stewardship and contributions to Society affairs. Steve's record of volunteer service to SEG over more than four decades is incredibly impressive when one considers his prolific research accomplishments and his strong commitment to teaching and mentoring undergraduate and graduate students, and junior faculty. The award was presented at the SEG annual meeting in Turkey.

MEDAL OF EXCELLENCE IN MINERALOGICAL RESEARCH INTERNATIONAL MINERALOGICAL ASSOCIATION

Rod Ewing (Emeritus Prof) was honored with this award for his important contributions to the safe mineralogic disposal of high-level nuclear waste.

GSA FELLOWS 2016

Marin Clark (Assoc Prof), Andrea Dutton (MS 2000, PhD 2003), Gabe Bowen (BS '99), Peter Wilf (MI Fellow '99), and Anna Martini (PhD '97) were elected GSAF ellows in 2016.

AGU FELLOW 2016

Susan Schwartz (MS '83, PhD '86) was elected an AGU Fellow in 2016.

Antonio Arribas (PhD '92 and Visiting Scholar, 2012-2015) recently moved to Akita University in NW Honshu, Japan as a Professor with the International School of Mineral and Energy Resources, which teaches (in English): a) geology and mineral deposits, b) metallurgy and mining engineering, and c) mineral economics and policy. Akita University formed several decades ago from the merger of several technical, medical and engineering schools, including the Akita School of Mines. Metal mining in Akita prefecture was on-going until the 1980's at the famous Kuroko massive sulfide deposits. Antonio's main role is as a member of an institute that focuses on research and training on mineral deposits with graduate students and professionals from resource-rich countries in the developing world. "Our classes and seminars are akin to a geosciences UN, with students from over 15 countries in Asia and the Pacific Rim. This, together with traveling to many of these countries and working with students in the field is what I found quite attractive. Until a few decades ago, it was geologists from the first world doing the heavy lifting at the mines worldwide; it's time now to help ensure these countries have their own well trained technical human resources", said Antonio .

Antonio Arribas with colleagues from Japan.

Tom Hudgins (PhD 2015) is in his second year as a tenure-track assistant professor at the University of Puerto Rico Mayagüez. Tom is spending lots of time in the field, taking advantage of the incredible geology of Puerto Rico, as well as co-leading a department trip to Cuba to see exposed Caribbean arc segments from mantle to crust and examine the carbonate sequences and exposed arc sections of Western Cuba, and to the British Virgin Islands to investigate the origin of continental crust in the Caribbean. On campus, Tom is in the process of setting up a laboratory equipped with a fusion system and a pressed pellet system for XRF analyses and is working with undergraduates to provide them hands-on research experience in sample preparation and analysis. The lab also has a high-resolution thin section scanner for detailed thin section analysis. With assistance from other faculty I have repaired our thin section laboratory to the point where it is accessible to students and faculty. I've incorporated these facilities into my petrology class to provide them with an experience that takes them from whole-rock samples to thin sections to chemical analyses.

Petrology field trip examining a dike with multiple chill-margins that is cut by a river. We used a small rock drill to collect samples of the dike and I had the class make thin sections to look at the textures in the lab.

In La Bodeguita del Medio in Havana, Cuba, known as the birthplace of the Mojito and frequented by Hemingway. This was near the end of our trip to look at the carbonate sequences and exposed arc sections of Western Cuba.

THE TEAM! THE TEAM! THE TEAM!!! *As Bo Schembechler would say, it takes all of us as a team, as a Department to make the difference. We discover and learn together.*

Recipients of Earth and Environmental Science Undergraduate Degrees

BACHELOR OF SCIENCE HONORS THESES

Christian Banner	*Thermochronology Analysis of the Caucasus*
Aaron Kurz	*Investigation of mercury deposition in three US lakes: the effect of catchment size on mercury isotopes*
Joshua Miller	*Measurements of seismic wave attenuation using multiple ScS waves*
Kevin Roback	*Coseismic Landsliding associated with the April-May 2015 Gorkha Earthquake Sequence, Nepal*
David Vander Weele	*Limb bone geometry of the sauropod dinosaur Jobaria tiguidensis: A photogrammetric approach*

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Allyson Tessin	*Organic carbon burial under greenhouse climate conditions: The regional expression of the Late Cretaceous OAE-3 within the Western Interior Seaway*
Ian Winkelstern	*Diagenetic and Mineralogical Effects in Clumped Isotope Thermometry and Application to Last Interglacial Climate*
Yi Yu	*Kinetics of Anorthite and Quartz Dissolution in Silicate Melts*

Recent Masters Theses

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Opposite Page: *Erosional wave cut Glacial Stage 5e beach exposure on Bermuda. Sierra Petersen and Ian Winkelstern continue research on anomalous ocean temperatures during the last major interglacial. Photo by Kacey Lohmann*

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