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Department of Earth and Planetary Sciences Washington University in St. Louis St. Louis, MO 63130

2013 Majestic Field Trips

This year has been an exciting year for field trips. During spring break, twelve undergraduate students, accompanied by Profs. Skemer and Fike, Dean Jen Smith, and Fossett post-doctoral fellow Catherine Rose, visited Scotland. In June, Bob Dymek, Paul Carpenter and grad student Michael Zanetti shepherded twenty department members and guests throughout southeastern and central Arizona. Both trips were quite educational and many geologic formations were examined and discussed.



Siccar Point in Scotland.

The Scotland trip got off to a rough start as uncooperative weather stranded the group in St. Louis but once in Scotland, the class hit the ground running. They viewed some of the oldest rocks on Earth including the three billion year old Lewisian gneiss that creates the knobby terrain typical of the Scottish highlands. During the following days, students studied volcanic rocks across the Isle of Skye and visited the Great Glen Fault, Loch Ness (no monsters found), and Glen Roy's ancient lake terraces. However, the highlight for many was visiting Siccar Point on the Scottish-English border. This

outcrop is where James Hutton developed his ideas about the age of the Earth, realizing there was "no vestige of a beginning, and no prospect of an end" to geologic time. The locality is widely considered the birthplace of modern geology. The trip was, "a life-changing experience," according to Dan Johnson, a senior EPS and Pathfinder student. With the success of the Scotland trip, Prof. Skemer hopes the excursion will become an annual event, providing junior and senior undergraduates with invaluable field skills and serving as a comprehensive capstone to their educational experience in Earth & Planetary Sciences. This field trip was made possible due to a generous gift from H. Matsen Smith. In spring 2014, undergraduates will head to Italy to learn about the Apennine Orogeny and visit famous outcrops such as the K-T boundary at Gubbio.



Pinnacles at Chiricahua National Monument.

The Arizona trip examined geologic formations and biological plant life in the southwest deserts and canyons. Prof Dymek and company began their trek in Phoenix, drove to Organ Pipe Cactus National Monument, and went east to Saguaro National Park and Chiricahua National Monument. They viewed the Porphyry Copper mines, the Petrified Forest,

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Overview *by Slava Solomatov*

Greetings everyone! It is a pleasure to give you an overview of the past year. First I would like to thank Professor Doug Wiens, the outgoing Chair of EPS, for his selfless service to the Department from 2008 to 2013. He is now on sabbatical, conducting research in seismology in Washington D.C., Japan and Antarctica. We are pleased by the return of our Research Professor Katharina Lodders who was away for three years serving as a Program Director at the National Science Foundation in Arlington, Virginia. A new Assistant Professor, Mike Krawczynski will arrive next summer. His expertise in experimental petrology and his new lab, which is currently being built on the first floor of Rudolph Hall, will greatly expand our research and teaching capabilities. Alian Wang has been promoted to Research Professor and Fred Moynier and Jeff Catalano have been promoted to Associate Professor with tenure. Fred Moynier established a unique record by collecting all possible prestigious awards that a junior geochemist can win. Sadly for us, he will be moving to France to take a

Professor position and a Chair of Excellence at the Institut de Physique du Globe de Paris. We are also very proud of our students. All our recent doctoral graduates accepted positions in academia or industry. Most of our undergraduate majors have gone on to pursue careers in Earth and Planetary Sciences. They are now in graduate programs at Brown, Berkeley, Stony Brook and other universities. Exciting news for our undergraduates is that we will now be able to offer annual field trips abroad, thanks to a generous gift from H. Matson Smith. In spring 2013, his contribution supported a very successful field trip to Scotland, led by Assistant Professors David Fike and Phil Skemer, and Fossett Postdoctoral Fellow Catherine Rose. I must say that the high quality of education that we are able to offer to our undergraduate and graduate students would not be possible without support of our donors. This year we will again hold a reception for our alumni and friends at the Fall AGU meeting in San Francisco. We look forward to seeing you there!

Solomatov Appointed New Chairman

After five years of leading Earth & Planetary Sciences, Doug Wiens is taking a well-deserved sabbatical and focusing on his seismology research. Regarding his experience as Chairman, Doug replied, “I think we’ve made some good improvements in these five years and that the department’s future looks bright. This progress has only come as a result of the hard work of many people and I’ve enjoyed working with all the department members.” The new Chair, Slava Solomatov, held a June celebratory luncheon in Doug’s honor and thanked him for his tenure as chairman. Professor Solomatov then presented Doug with a plaque mounted on a red granite stone, the same rock that was used in the construction of Rudolph Hall in 2004. Professor Solomatov was appointed as Chair of the Department of Earth and Planetary Sciences effective July 1, 2013. Slava is a theoretical geophysicist who develops models of planetary evolution using analytical and computational techniques. He is from Sochi, Russia, the site of the 2014 Winter Olympics. He completed his undergraduate and graduate work at the Moscow Institute of Physics and Technology. After receiving his Ph.D. in 1990, he came to the United States



and worked as a Research Fellow in the Seismological Laboratory at the California Institute of Technology. In 1996 Slava accepted an Assistant Professor position in the Department of Physics at New Mexico State University in Las Cruces where he received tenure in 2000. In 2004 he came to Washington University in St. Louis to start the Computational Geodynamics lab. He was promoted to Full Professor in 2008. Slava held visiting professor positions at Kyushu University (1995-1996) and University of Tokyo (2011), and summer research fellowships at the University of Cambridge (1998) and the Woods Hole Oceanographic Institution (2003). Slava is an author or co-author of over 50 publications. In 1997 he was selected as an Alfred Sloan Fellow.

ALUMNI UPDATE!

Let us know what you are doing now.

Either send an email to mueller@wunder.wustl.edu or mail an update to: Washington University in St. Louis, Department of Earth & Planetary Sciences, Margo Mueller, Campus Box 1169, One Brookings Drive, St. Louis, MO 63130.

Michael Krawczynski to join department in 2014

Dr. Michael Krawczynski, currently at Case Western Reserve University, will join our department as Assistant Professor in the area of experimental geochemistry and planetary petrology starting July 1, 2014. Prof. Krawczynski grew up in Northampton, MA. He received his undergraduate degree in Geological Sciences from Brown University and a Ph.D. in Geochemistry from the MIT/Woods Hole Oceanographic Institute Joint Program in 2011. His dissertation topic was “Experimental Studies of melting and Crystallization Processes in Planetary Interiors.” Mike moved to Case Western Reserve University in Cleveland for a postdoctoral position under Prof. James Van Orman. Mike uses an experimental approach to study dynamic igneous processes on Earth and other bodies in the inner solar system. His research focuses on time scales and conditions of magmatic differentiation and isotopic and trace element redistribution during planetary differentiation. He has received numerous awards and honors and is a member of the American Geophysical Union and Mineralogical Society of America. Mike will add to the excellent experimental capabilities and reputation of E&PS at Washington University. He and his cattle dog (Kila) look forward to teaching and life in St. Louis, although he will join fellow assistant professor, Alex Bradley, in remaining an unabashed Red Sox fan.



Field Trips continued from page 1.

Meteor crater, Sunset Crater and finished their grand tour with two days in the Grand Canyon. They also viewed the massive pinnacles in Chiricahua, walked the circumference of Meteor Crater, treaded precariously through lava flows at Sunset Crater, hiked gingerly around multiple cacti in Organ Pipe NM, and a few brave souls even hiked up and down the Grand Canyon in one day. They camped in various campgrounds and cooked their own mouth-watering meals every night. By the time the trip concluded, everyone was an expert on cacti and could identify at least five different species of cholla as well as barrel cactus, saguaro, ocotillo, brittle bush, prickly pear, palo verde, and organ pipe plants. Gratefully they did not experience any close encounters with diamondback rattlesnakes or javelina.



The crew pictured at Petrified Forest.

PHD's Awarded 2013

Garrett Euler

Seismic array analysis of core-diffracted waves and microseisms.

Yang Liu

Spectral identification and analyses of hydrous mineral deposits: Implications for the aqueous history of Aram Chaos and Melas Chasma, Mars.

Kelsi Singer

Icy satellite tectonic, geodynamic and mass wasting surface features: constraints on interior processes and evolution.

Credits

Editors

Margo Mueller • Slava Solomatov

Contributors

David Fike • Abigail Fraeman
Stephen Seddio • Bob Dymek
Catherine Rose • Slava Solomatov

For more information about the department and a listing of our faculty go to eps.wustl.edu

Isotope biogeochemistry: Using modern systems to decipher Earth history

by David Fike

I seek to understand biogeochemical cycling in modern environments and how it has changed throughout Earth history; particularly in association with the rise of oxygen in the oceans, atmosphere and the evolution of animals as well as subsequent mass extinctions and climatic events (e.g., glaciations). My research focuses on determining the stable isotopic composition of carbon- and sulfur-bearing phases (e.g., calcite, organic matter, gypsum, pyrite) preserved in marine sediments and ancient sedimentary rocks. Global biogeochemical cycling is mediated through microbial metabolic activity on land, in the oceans, and in sediments. Our lab focuses on stable isotopic analysis because this metabolic activity imparts diagnostic stable isotopic signatures into biomass and geochemical phases in the environment. As such, the lab can use these isotopic data to reconstruct the presence and activity of specific metabolic pathways and processes in natural environments and the long-term evolution of biogeochemical cycling. Specifically, these measurements are used to probe (micro)-biological activity and its dependence on the ambient geochemical environment to address: 1) what controls the rates and types of metabolic activity; 2) how this activity impacts the ambient geochemical environment; 3) how the resulting chemical signatures get preserved over geologic time; and 4) how to optimally extract information from ancient sediments to best reconstruct paleoenvironmental conditions. I am particularly interested in microbial sulfate reduction and sulfide oxidation (both biotic and abiotic), and how the



David Fike at Siccar Point.

spatial and temporal scales on which these are coupled in marine environments. The isotopic signature for these processes is strongly dependent on both the rates of metabolic activity and the particular types of microbial metabolisms present, which allows the lab to extract paleoecological information. In addition, we have been discovering there are strong sedimentological controls on the expression of these isotopic signatures as well, particularly as a function of the depositional environment (quiescent, deep-water settings vs. shallow, high-energy, storm-reworked settings). This provides new tools to investigate depositional conditions in ancient sedimentary strata. The lab combines measurements collected across a range of spatial scales (from individual micrometer-sized minerals to sedimentary basins hundreds of km in extent) and temporal scales (from day-night changes in marine sediments to glaciations

lasting millions of years) to understand the evolution of organism-environment interactions in natural systems over Earth history. For much of the research the lab makes use of a technique called secondary ionization mass spectrometry (SIMS) and is delighted at the upcoming installation (November 2013) of a new Cameca ims 7f-geo instrument in the basement of Rudolph Hall. This instrument will enable high-precision, high-resolution isotopic and geochemical analyses of a variety of geological and biological materials and represents a major advancement in the analytical facilities available here at Washington University.

Mapping Minerals at High Resolution in Mt. Sharp

by Abigail Fraeman

On the evening of August 5, 2012, the Mars Science Laboratory rover Curiosity executed a series of Rube Goldberg-like maneuvers to land on the floor in Gale Crater, a ~150 km diameter impact crater located near the Martian equator. Curiosity was sent to Mars on a mission to seek out evidence that the planet, which is cold and barren today, may once have had environments that were hospitable for life. Now a little over halfway through its two-year primary mission, the rover has already made many exciting discoveries. Curiosity has imaged conglomerates with rounded pebbles that were shaped by fast moving, knee-deep streams, examined the chemistry of gypsum-rich veins that formed after water flowed through fractures in rock, and drilled into a clay-rich mudstone that was deposited at the bottom of a lake which all evidence suggests had the potential to sustain life.

Gale Crater was selected as a landing site for Curiosity because of a ~5 km high stack of material, dubbed Mt. Sharp, lying in the center of the crater (Fig. 1). While all of Curiosity's discoveries to date have been made on the plains of the floor of Gale Crater, the most exciting discoveries still await on Mt. Sharp, currently some 5 km away from Curiosity. Orbital and rover-based images show that Mt. Sharp is comprised of a series of layers, some of which tantalizingly look like they could have been deposited in watery environments (Fig. 2). Initial analyses of spectral information from the Compact Reconnaissance Imaging Spectrometer for Mars (CRISM), an instrument on the Mars Reconnaissance Orbiter spacecraft, also showed these layers contain clay, sulfate, and nanophase iron oxide minerals. This diverse mineralogy suggests the rocks of Mt. Sharp preserve times of dramatic environmental changes on Mars.

Researchers in the Earth and Planetary Remote Sensing Lab are supporting Curiosity's mission as science team members and participate in daily tactical operations. We are also strategically looking ahead towards Mt. Sharp, and are developing a new way to collect and analyze orbital spectral data from CRISM that allows us to map the locations of minerals in Mt. Sharp at spatial resolutions up to 3x better than previously available (Fig. 1). These high-resolution mineral maps will be used to guide Curiosity to the most scientifically important locations with precision, and will provide a broader geologic context for the rocks Curiosity examines in detail on the surface. To generate these new data products, we have been working closely with members of the CRISM science operations team at The Johns Hopkins Applied Physics Laboratory to command CRISM in such a way that it collects data

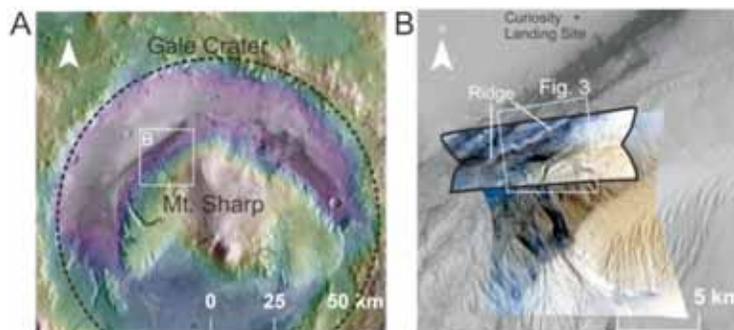


Figure 1: (A) Elevation map showing the context of Gale Crater. (B) Context mosaic showing the area from the white box in (A) and oversampled CRISM observation (outlined in black). For comparison, a normal CRISM observation is also shown (no outline). Both observations contain the same number of pixels in the along-track direction, but the oversampled image covers a smaller spatial area in the along-track direction due to oversampling. The hematite-bearing ridge is located at the base of a large trough descending from the top of Mt. Sharp.



Figure 2: Curiosity Mastcam mosaic showing the layers in Mt. Sharp from ~5 km away. The white box highlights a boulder that is about the size of the Curiosity rover. Image credit: NASA/JPL-Caltech/MSSS (available online at http://www.nasa.gov/mission_pages/msl/multimedia/pia16105.html).

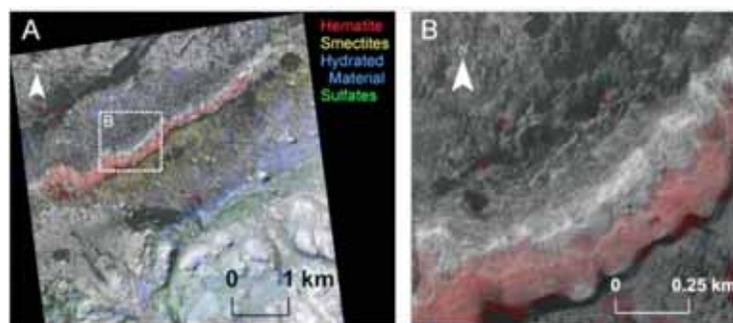


Figure 3. (A) HiRISE image showing mapped locations of hematite (red), smectite clay minerals (yellow), hydrated material (blue) and sulfate minerals (green). (B) Zoom in on hematite bearing ridge. The CRISM detections follow the uppermost stratum on the southern end of the finely layered ridge.

points which overlap in the along-track (approximately north-south) direction. We take advantage of this overlap through pixel regularization and projections in order to create spectral datasets with enhanced resolution in the along-track direction.

One of the first discoveries we made from this new method of oversampling data is that the mineral hematite (Fe_2O_3) is closely associated with one of the lower layers in Mt. Sharp (Fig. 1, 3). This hematite-bearing layer is relatively resistant to erosion and forms a ridge that rises a few meters above the surrounding strata. We hypothesize the hematite acts a cementing agent in the ridge, explaining its relative erosive resistance. This hematite signature is different than the hematite signature that lead Opportunity to land in Meridiani Planum in that it is localized to a single layer, and its relative resistance suggests the hematite is present as pore-filling or capping unit, rather than individual spherules like in Meridiani.

We proposed two possible ways for the hematite to have formed in such a localized manner along the ridge, both of which will be testable from ground measurements made using Curiosity's powerful scientific payload. In the first scenario, anoxic water traveling through Mt. Sharp carrying dissolved Fe^{2+} became exposed either to the atmosphere or another relatively oxidizing body of water, which caused the

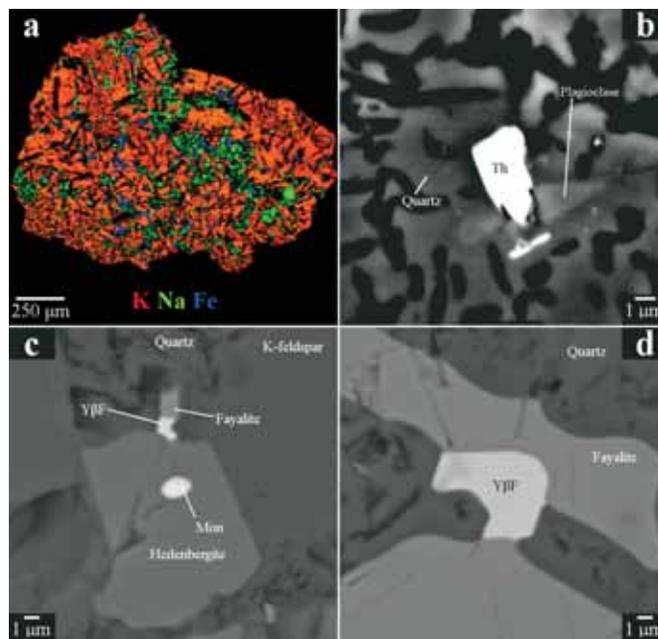
Fe^{2+} to oxidize to Fe^{3+} . While Fe^{2+} can dissolve under a wide range of conditions, Fe^{3+} only remains soluble under extremely acidic conditions, and would therefore precipitate out of solution as soon as it becomes oxidized, forming the hematite (or more likely a precursor mineral which eventually transforms to the thermodynamically stable hematite). In the second scenario, Fe^{2+} is leached directly from local materials by neutral to slightly acidic waters and quickly oxidizes to Fe^{3+} , where it again precipitates out to form hematite or a precursor.

In either of these scenarios, the oxidization of Fe^{2+} and formation of hematite have important implications for habitability. On Earth, iron oxidation at chemical interfaces is almost exclusively mediated by microorganisms that obtain energy through the oxidation process. While many locations on Mars provide potential chemical energy for life to conduct similar processes, this hematite-bearing ridge represents a specific site that is accessible for detailed study by a rover where concentrated and localized iron oxidation occurred, and will be an exciting place for Curiosity to search for signs of past habitability once it reaches Mt. Sharp. Curiosity will hopefully reach the base of Mt. Sharp in the next few months, so stay tuned!

Analysis of Moon Rocks *by Steve Seddio*

Although forty-one years have passed since the last of the Apollo collection was brought to Earth, the Apollo sample suite is still revealing exciting new discoveries elucidating the somewhat cryptic petrologic and geologic history of the Moon. Many of these discoveries are made by the Planetary Materials Research Group of the Earth and Planetary Sciences Department of Washington University. Using the JEOL JXA-8200 electron microprobe in the Earth and Planetary Sciences Microanalysis Facility, we can analyze mineral phases in polished rock samples that are as small as $\sim 1 \mu\text{m}$ using high-resolution secondary and backscattered electron imaging, qualitative and quantitative X-ray mapping (Fig. a), and qualitative and quantitative spot chemical analysis.

Unlike the red Missouri granite that envelopes Scott Rudolph Hall and most of the buildings of the Danforth Campus, granite is one of the rarest of the known rock types on the Moon. Lunar granite is of particular interest to the Planetary Materials Research group because it represents the end stages of lunar fractional crystallization and, given its paucity, little is known regarding the timing and nature of its formation. Recently, we did the first quantitative mineral chemical analysis of a mineral grain of thorite ($[\text{Th},\text{U}]\text{SiO}_4$; Fig. b) in a lunar sample using the electron



microprobe in the EPS Microanalysis Facility. The thorite grain is hosted in a $\sim 1 \text{ mm}$ diameter fragment of lunar granite from the Apollo 12 site and coexists with another pair of rare lunar minerals called monazite ($[\text{La},\text{Ce},\text{Pr},\text{Nd},\text{Th},\text{U}][\text{P},\text{Si}]\text{O}_4$; Fig. c) and yttrite ($[\text{Y},\text{Ca},\text{Fe},\text{Th},\text{U},\text{REE}]_2[\text{Nb},\text{Ti},\text{W}]_2\text{O}_7$; REE = rare earth elements; Fig. d). Our analyses of thorite, yttrite, and monazite in this

Continued on page 11.

Moynier chosen for the Hisashi Kuno Award

This past summer, Frederic Moynier was announced as the 2013 Kuno Award recipient from the American Geophysical Union. The Kuno award (named in honor of Hisashi Kuno, a Professor of Petrology at the University of Tokyo and an outstanding volcanologist and petrologist of the mid-20th Century) is given annually by AGU to recognize the scientific accomplishments of junior scientists who make outstanding contributions to the fields of volcanology, geochemistry and petrology. Moynier was cited for his “prolific and creative studies on the use of non-traditional isotopes in geochemistry and cosmochemistry.” The award will be bestowed on Moynier at a reception for the Volcanology, Geochemistry and Petrology section of the AGU at their fall meeting held annually in San Francisco. Moynier will also deliver a Kuno lecture at the European Geophysical Meeting in Vienna in 2014.

Emeritus Professor Hal Levin finishes 10th edition

Hal Levin completed the tenth edition of his historical geology text, *The Earth Through Time* and his part of the 10th edition of the historical geology laboratory book, *Laboratory Studies in Earth History*. Hal’s co-author for the laboratory book is alumnus Michael S. Smith. Michael is a professor at the University of North Carolina, Wilmington.

Alex Bradley part of Symposium on Astrobiology

Department geochemist Alex Bradley participated in the minisymposium on Astrobiology held at Green Hall’s Rodin Auditorium in April of 2013. The symposium was sponsored by the Departments of Biology, Earth & Planetary Sciences, NASA Virtual Planetary Laboratory, I-CARES and the McDonnell Center for the Space Sciences.

Student wins Dean’s Award for teaching excellence

Graduate student Margaret Anne G. Hinkle was chosen as one of the winners of the Dean’s Award for Teaching Excellence. This award recognizes superb performance by a graduate teaching assistant in the instruction of Arts & Sciences undergraduates. Margaret Anne was the TA for EPS 444 Environmental Geochemistry taught by Jeff Catalano.

Fegley part of new Science grant

Professor Bruce Fegley and team members Professors Mike Reed (PI) and Dave Cornelison at Missouri State University, Springfield, MO and Dr. Nathan Jacobson at the NASA Glenn Space Center, Cleveland, OH were awarded the first NASA-

EPSCOR science grant for the state of Missouri. The grant is titled “Understanding the Atmospheres of Hot Earths and the Impact on Solar System Formation” and is about experimental, observational, and theoretical studies of atmospheres on hot rocky extra solar planets such as Kepler 10b and CoRoT-7b.

Alian Wang and Planetary Spectroscopy Group awarded grant

Research Professor Alian Wang was awarded a new three million dollar grant from NASA entitled, “A Compact Integrated Raman Spectrometer (CIRS).” Her project was selected by NASA’s MatISSE program (Maturation of Instruments for Solar System Exploration) in order to expand the science applications of laser Raman spectroscopy and to raise the technical readiness level for the explorations to a broad range of planetary bodies in our solar system, e.g., Mars, Moon, Venus, icy satellites, asteroids, and comets.

Professors promoted

Jeff Catalano and Frederic Moynier were promoted to Associate Professor with tenure effective July of 2013. Alian Wang was also promoted to full Research Professor in recognition of her strong record of research accomplishments.

Katharina Lodders returns from NSF

Katharina Lodders, Research Professor in EPS has returned from a three year rotation at the National Science Foundation (NSF) in Washington DC. Katharina worked as Program Director in the Division of Astronomical Sciences. She advised and informed researchers about proposal outcomes, active award matters, and possible funding opportunities. She managed proposals in Galactic Astronomy, which is one theme in the major individual research grants program for Astronomy and Astrophysics at NSF. She conducted panel meetings for proposal review, and coordinated the collaboration of program directors in the division for a timely and efficient merit review process for assigned research, education, or infrastructure proposals. She read many proposals and science reports, which was fun; and many federal agency regulations, which was like learning a new language, she says. Delivering the news of a declined proposal was a frustrating part of the job, but she found that delivering good news and seeing exciting research projects moving ahead in this funding climate is worth all efforts.

David Fike receives MRI grant from NSF

David Fike and his co-Investigators, Jeff Catalano, Christine Floss, Phil Skemer and Ernst Zinner have received a \$2,071,491 grant from the Major Research Instrumentation program of the National Science Foundation. It is for the acquisition of a SIMS Instrument (Secondary Ionization Mass Spectrometry) which will enable high-precision, high-resolution isotopic and geochemical analyses.



Kathryn Connor
Research Laboratory Technician

Kathryn Connor was born and raised right here in the Lou. She attended Missouri State University in Springfield, MO where she majored in geology and minored in biology. Kathryn started working for Alian Wang in the Raman Spectroscopy lab in July, 2013. She especially enjoys working in her field at a highly-ranked research university and conducting Mars research. Being the expert on St. Louis, she has remarked that St. Louis has so much of the life of a huge city, but it is all easily within reach and the city is definitely under rated. When she is not occupied in the lab you might find her setting up Star Wars costumes and participating in the local Rebel Legion Chapter events. Kathryn also has a passion for video games and likes to practice archery, a skill she learned with the medieval reenactment societies.



Steven Chemtob
Postdoctoral Research Scholar

Steven is an NSF Postdoctoral Fellow working in Prof. Jeff Catalano's aqueous geochemistry and mineralogy group since January of this year. He originally hails from Silver Spring, Maryland. Steven is an alumnus of this department (B.A. 2006), and returns to Washington University after having earned his Ph.D. in geochemistry in 2012 from the California Institute of Technology. Steven likes the great sense of camaraderie within his lab group and he is definitely excited about his research, using experiments to understand the origin of low-temperature mineral assemblages on early Earth and early Mars. In his off-time, he enjoys rock climbing, running, and exploring St. Louis' many great neighborhoods and restaurants. He is also an avid singer and recently joined the St. Louis Symphony Chorus, with whom he will perform in Carnegie Hall in November 2013.



Clive Jones
SIMS Research Scientist

Clive Jones spent his childhood in Bakewell, Derbyshire, which is located on the banks of the River Wye in England. He received his undergraduate and graduate degrees in physics from nearby Sheffield University. Clive completed postdocs in cosmochemistry at the Max Planck Institute for Nuclear Physics in Heidelberg, Germany and the department of Physics at Berkeley, California. Before coming to St. Louis, Clive worked with the

Cameca Instruments Atom Probe Center in Madison, Wisconsin. Clive, an expert in mass spectrometry specializing in SIMS, started working in David Fike's SIMS lab in July, 2013 and is currently overseeing the installation of the IMS 7f-GEO instrument, only the third of its kind in the US. He and his wife, Christabelle, are looking forward to enjoying the Missouri Botanical Gardens when they have time to sightsee. In his spare time Clive is an occasional rock climber and guitarist. He loves the jazz and blues music for which St. Louis is renowned.



Kelsi Singer
Postdoctoral Research Associate

Kelsi Singer spent her childhood in Colorado, California and Kansas. She graduated with bachelor's degrees in astronomy and archaeology from the University of Colorado. Kelsi completed her graduate education here with Bill McKinnon in April of 2013 and started researching craters on the moon with the "totally amazing!" high resolution images from the Lunar Reconnaissance Orbiter Camera (LROC) as a post doc for Dr. Brad Jolliff in June. Kelsi's favorite things about St. Louis include the Arch and all of the great restaurants in town (especially those that offer chocolate in any form). When she is not pouring over images of the moon, she volunteers for various organizations and dances Argentine Tango.



Mike Brasher
Research Laboratory Technician

Mike Brasher spent his childhood here in St. Louis, with the exception of 4 years in London, Ontario. He completed his undergraduate studies in environmental studies at Maryville University. Mike joined David Fike's lab in May of 2011 as an intern. When the opportunity for a fulltime position was available, Mike jumped at it because he loves science. He is particularly enjoying working with the great people in the lab to solve problems. When asked about his favorite things about St. Louis, Mike referred to the good-natured Midwestern philosophy evidenced by most people. He said, "St. Louisans work hard and look out for each other." He also likes the change of seasons, weather that changes from very cold in the winter to almost unbearably hot in the summer. The things he likes most are spending time with his wife, Emily, and the best dog in the whole world, Rusty. Mike also spends time in his workshop, building and fixing things. He also likes to read, watch movies and cheer on his favorite St. Louis sports teams.



Melanie Suess
Laboratory Manager

Melanie Suess is from Evansville, Indiana. She received her bachelor's degree in biology from the University of Southern Indiana and her master's degree in biology from Washington University in St. Louis. She joined Alex Bradley's lab in November of 2012. When asked about her job, she said that she enjoys the variety of disciplines, projects and techniques utilized in the lab. She frequently switches from chemistry projects to biology disciplines and back again. Melanie and her husband, Ryan, enjoy exploring the various neighborhoods, festivals and live music options the city has to offer. When she is not in the lab or at a festival, Melanie is probably running long distances. Currently, she also administers a running club in the Metro East.



Vicki Ferrari
Administrative Assistant

After growing up in a small town in southern Illinois, Vicki relocated to St. Charles, MO with her husband Mike, and son, Brian. She is a Washington University graduate with a degree in English literature. Vicki's career with Washington University began in 1991 in the School of Architecture. Her university experience includes 11 years with the Office of Sponsored Research Services and recently the Department of Surgery at the Medical School. In April of 2013, Vicki became the administrative assistant in Earth and Planetary Sciences where she enjoys constant interaction with students, faculty and staff as well as other departments. Regarding St. Louis, Vicki is fond of the theatres such as the Fox, the Muny and Edison Theatre as well as the many food venues in our fair city. Vicki belongs to a book club as well as a wine-tasting club and positively enjoys exploring both regional and national parks.



Garrett Euler
Research Scientist

Garrett Euler hales from mid-Missouri as he grew up in the Lake of the Ozarks region. He attended Missouri University of Science and Technology in Rolla, MO and was awarded his BS degree in geology and geophysics. He completed his doctoral degree at Washington University in St. Louis last December and started working for Doug Wiens in January of this year. He is an avid hiker and outdoor enthusiast who especially likes

the trails in Forest Park and the gardens surrounding the trails. He and his wife, Lisa, have a six-month-old child, Alexander. When he is not looking at seismic arrays in the lab, he often works in his raised vegetable garden or builds projects at their home in Maplewood such as a patio and more gardens. They will be moving near the end of this year to Los Alamos, New Mexico where Garrett has a postdoctoral position at the Los Alamos National Lab.



Hélène Couvy
Research Scientist

Hélène is from Guitres, France in the Bordeaux region. She completed her undergraduate degree in the geosciences at the University of Bordeaux and her graduate degree in mineral physics at the Universities of Lille and Bayreuth. Most recently she was working for the National Nanotechnology Infrastructure Network at the University of Michigan site. While Hélène liked Ann Arbor, she is glad to move a little further south to avoid the lengthy winters and the skunks. Hélène started Oct. 1, in Phil Skemer's rock deformation lab and will also work for Michael Krawczynski when he arrives in 2014. Helene and her artist husband, Lonnie Craigg, are avid salsa dancers when the time permits.



Jie Wei
Research Scientist

JieWei spent his childhood in the Anhui province of China. He received his doctoral degree from the Anhui Institute of Optics and Fine Mechanics, Chinese Academy of Sciences (CAS), established in 1970, which is located at the "Science Island" on Lake Dongpu in western Hefei, Anhui. He is working in Alian Wang's lab investigating planetary applications of optical spectroscopy, particularly Raman Spectroscopy. He enjoys that his research involves mineralogy, spectroscopy, engineering and world-wide cooperation. When asked what he likes about St. Louis, he replied that he likes the public recreation areas, specifically Forest Park, the Zoo and the Science Center. He and his wife, Liandi Zhang, have two sons, Zhizhang (Jim), age 13, and Thomas, age 6. When he has some time at home, Jie likes to play with his sons, or read. The family also likes table tennis and badminton.

Maurry Tamarkin (PhD '61) has retired from Clark University where he has been on the Finance faculty since 1981. Best to all who remember me from the late 50s.

Ernie Anderson (PhD '62) is currently on Elba Island, Italy where he is doing field research on the Zuccale fault, a world-class example of that kind of extensional fault structure. Along with colleagues from Pisa, they are fashioning a reinterpretation of the relationship between faulting and iron-ore formation. Elba has been a source of iron since the iron age though all is shut down since the early 1980's, so this is a post mortem, albeit an important one in terms of processes. In other news, he has a Geological Society of America book (Special Paper 499) coming out in early November summarizing some research in the eastern Basin and Range over the past 20 years.

Max Reams (PhD '68) has finally completed a long term project designed to help laypersons appreciate the geology of their state (IL) through visiting its state parks: "Geology of Illinois State Parks," available from Amazon.com. His goal is to convince those without geological background to see the great geological variety available in Illinois. (It is not all flat!!!)

Wei Luo (PhD '85) received Northern Illinois University's presidential research professorship award earlier this year. He is now working on two projects: (1) building a new "web-based interactive landform simulation model" (WILSIM) to simulate the evolution of the Grand Canyon (funded by NSF-TUES program); (2) estimating volume of excavation by fluvial processes on Mars (funded by NASA-MDAP program).

Susanne Borchert (AB '86) is a senior hydrologist and Remediation Strategist with CH2MHill in the northern Illinois area.

Glen Green (PhD '88) is an Associate Professor at the University of San Carlos, Cebu Philippines. He and Cynthia live in Pulang Bato, Cebu if anyone is ever in that part of the world.

Carla Koretsky (AB '92) recently took on a new position as the Dean of the Lee Honors College at Western Michigan University. She also had a daughter, River Rose Reich on July 31, 2013.

Michael Rockow (PhD '95) is still teaching at Leslie Middle School - working with 7th and 8th graders. He is still sponsoring the research club, the rocket club and

the dissection club. He will also be co-sponsoring their chapter of the National Junior Honor Society this year. He directed a Camp Invention session (hands on science and engineering program for elementary students) and he looks forward to doing it again. Last December, he presented at the NSTA-Phoenix conference and this fall, he will be presenting at the NSTA-Portland conference.

Brian Yanites (AB '03) started a new position as an assistant professor in Geological Sciences at the University of Idaho in Moscow, Idaho. His research is studying river evolution in mountainous environments.

Laurel Griggs Larsen (AB, MA '03) is an Assistant Professor in the Department of Geography at the University of California, Berkeley.

Crystal Gammon (AB '06) recently started as the web editor for Yale Environment 360 (e360.yale.edu), an independent environmental news magazine published by the Yale School of Forestry and Environmental Studies.

Nikki Lovenduski (AB '06) and her husband welcomed a baby girl, Jade, on March 15, 2013. Nikki is an Assistant Professor in the Department of Atmospheric and Oceanic Sciences, Institute of Arctic and Alpine Research, University of Colorado at Boulder.

Karyn Rogers (PhD '06) has accepted an assistant professorship in Earth and Environmental Sciences at Rensselaer Polytechnic Institute, Troy NY.

Steven Chemtob (AB '06) finished his doctorate at California Institute of Technology and accepted a post-doctoral research position with Jeff Catalano, here at the Department of Earth and Planetary Sciences. Welcome back, Steven.

Ian Orland (AB '06) finished his Ph.D. in Geochemistry at the University of Wisconsin-Madison under Prof. John Valley in December, 2012. Currently he is an NSF post-doctoral fellow working with Prof. Larry Edwards at the University of Minnesota. He and his wife, Kate, welcomed their first child, Alistair, in August, 2013.

Aine Steiner (AB '07) is still in Portland, and working for Cornforth Consultants as a staff engineer. She and Greg Mines, another Wash. U alum, were married October 5th, 2013. Her work revolves around helping develop slope stabilization mitigation for a particularly nasty stretch of highway in Oregon with multiple large landslides.

Maggie Osburn (AB '07) received her doctorate from California Institute of Technology and has accepted a one year post-doc position with Jan Amend at the University of Southern California. After she completes that she will accept an Assistant Professorship at Northwestern University in Chicago in September, 2014.

Kimberly Wallis (AB '08) finished her Master of Environmental Management at Duke University last year, and just started a new job in Tulsa, OK. She is the project coordinator for a utility's energy efficiency incentive program and is very excited about her new occupation!

Brittany Huhmann (AB '10) earned an MS in Civil and Environmental Engineering from the University of Iowa in May, 2013. In the summer of 2013, she spent 3 months in the Washington, D.C. area as a Geoscience Policy Intern with the American Geosciences Institute. This fall she began work toward a Ph.D. in Civil and Environmental Engineering at MIT, where her research will focus on arsenic mobility in groundwater in Bangladesh.

Elizabeth Hasenmueller (PhD '11) is currently a post-doctoral scholar with the Earth and Environmental Systems Institute at Penn State, but will be starting as an Assistant Professor of Environmental Science at St. Louis University in the spring, 2014 semester.

Merrill Rudd (AB '11) finished her MS at the University of Florida and is currently in Seattle at the University of Washington (School of Aquatic and Fishery Sciences). She has an IGERT fellowship in their Program on Ocean Change.

Christopher Orth (PhD '12) decided to stay in St. Louis. After defending his dissertation, he initially worked for GeoEye, a commercial satellite imagery company and is now a software engineer at UrtheCast. This company develops software for the first high-definition streaming video cameras that are being installed on the International Space Station.

Amy Shaw (PhD '12) is in the second year of her post-doctoral fellowship in the Department of Earth and Space Science and Engineering at York University in Toronto. She is continuing her work on the reflectance of asteroid analogs using the newly built goniometer facility at the Planetary Exploration and Instrumentation Lab in preparation for the OSIRIS-REx asteroid sample return mission. She also enjoys being a member of the York University Observatory.

ALUMNI, VISIT US THIS DECEMBER

**Fall AGU Meeting
San Francisco
Department and Alumni Reception
Jillian's@Metreon**

101 Fourth Street
San Francisco
Monday
Dec. 9, 2013
7:00–10:00 PM

Moon Rocks continued from page 6.

Apollo sample revealed several wt% of Th, U, and radiogenic Pb, that is, Pb produced by the natural radioactive decay of U and Th. Assuming that all Pb present in our analyses is radiogenic, because common Pb does not fit readily into the crystal structures of thorite, monazite, and yttrite, we calculated the age of crystallization of the thorite-bearing granite from the concentrations of Th, U, and Pb present in our analyses of these minerals. Our calculations reveal that the thorite-bearing granite is 3.87 ± 0.03 billion years old.

This age corresponds to the ages of several other lunar granite samples obtained by radioisotopic techniques, but is several hundred million years younger than some of the other occurrences of this rock type on the Moon. This age is just a few tens of millions of years after the formation of the nearby giant Imbrium impact basin, and we infer that the granite in this case has an origin related to magmatic activity that was at least in part related to the giant Imbrium impact event. Findings such as this are contributing to a more precise knowledge of impact and magmatic events at this time long ago when the Moon was geologically active and undergoing the late-heavy impact bombardment that affected the entire inner Solar System.



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