UC DAVIS
DEPARTMENT OF GEOLOGY
2012 NEWSLETTER VOLUME 9

EXPLORING MARS

in this issue:

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on the cover:
This image taken by NASA's Curiosity shows what lies ahead for the rover -- its main science target, Mount Sharp. The rover's shadow can be seen in the foreground, and the dark bands beyond are dunes. Rising up in the distance is Mount Sharp, whose peak is 3.4 miles (5.5 kilometers) high, taller than Mt. Whitney in California. The actual summit is not visible from this vantage point -- the highest elevation seen in this view is about 2.5 miles (4 kilometers) above the rover. The Curiosity team hopes to drive the rover to the mountain to investigate its lower layers, which scientists think hold clues to past environmental change.

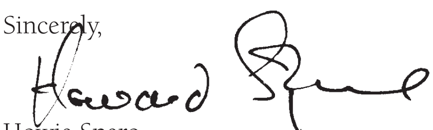
Chair's Welcome

I am excited to introduce geology's completely revised newsletter. This has been a long-time coming and we hope that you enjoy reading through it and catching up on the many activities taking place in the department over this past year. In this inaugural issue, we focus on faculty and graduate research activities to reintroduce everyone to both old and new faces and the exciting breadth of research that is being conducted by our faculty and graduate students. In future newsletters, we will include undergraduate columns, alumni updates and upcoming activities. Also, stay tuned for our new website design which will be active next year.

The past six months have been a period of relative stability in these tumultuous economic times. As you will see inside the newsletter, there have been a lot of exciting activities in the department - both on and off Earth. Our summer field camp is still going strong and providing a capstone experience for our majors. In addition to research in and around California, our students have been traveling far and wide to Antarctica, Iceland, Kyrgyzstan and Kazakhstan, Ukraine, Alaska, and Nevada to work on their projects. These field experiences include exotic scuba diving under the ice in Antarctica to remote research on the Martian surface. The research breadth of the department is truly impressive these days. Finally, I would like to thank you, the alumni, for the support and networking opportunities that you provide to our graduates and for your much-appreciated financial donations to the department.

Please stay in touch and let us hear from you for our next newsletter.

Sincerely,



Howie Spero

Help Support geology@ucdavis.edu

Your charitable, tax-deductible gift to the Department of Geology at UC Davis is greatly needed and appreciated. Your donation will be used to support the highest priority projects in the department: our undergraduate and graduate geology students, departmental programs and facilities.

Donate online by visiting the UC Davis secured giving site at:

http://giving.ucdavis.edu/DeptGeology

The following are just a few of the programs your generous gift to geology@ucdavis can help support. If you'd like to give to a particular fund, please be sure to note your preference with your donation. Unspecified donations to the Department of Geology will be used at our discretion to support our high priority projects. For more information, contact Julia Prather at (530) 752-3668 or *japrather@ucdavis.edu*

Rand Schaal Field Fund - Donations for the Schaal Field Fund may be matched dollar for dollar via the Alumni Challenge! Sponsored by UC Davis geology department Alumni Association President Rand Schaal, the Alumnni Challenge provides funding for department field trips and student field research projects.

Cordell Durrell Funds - The Durrell Funds supports student research projects in both the laboratory and the field.

Everett Dale Jackson Memorial - The Jackson Memorial Scholarship, established in 1980 by family and friends, benefits upper-division students majoring in geology.

Robert Matthews Memorial Fund - The Matthews Memorial Fund was established to help geology students meet their undergraduate academic and geological pursuits.

Professor Dawn Sumner is off on a new adventure – exploring Mars with NASA's Curiosity Rover

Dawn Sumner in the viewing area for the Curiosity test bed at JPL.

The rover in the background is a twin of the one on Mars and is used to test commands before they are implemented on the real Curiosity. In this image, the twin is set up to test scooping activities that will lead to the delivery of wind-blown sediment to the SAM and CheMin instruments. Scoop cleaning started on Mars in early October 2012 and will take a couple of weeks.

Featured Faculty Dawn Sumner writes:

My involvement with Mars exploration began in 2002, when I helped frame the scientific research goals for the search for evidence of life on Mars through the Mars Exploration Program Analysis Group (MEPAG). About that same time, the scientific goals for NASA's Mars Science Laboratory (MSL) were being developed, and they focused on assessing whether or not ancient Mars was habitable. The idea of assessing habitability came directly out of the MEPAG document that I helped rewrite, which included looking for environments with water and a carbon source that persisted through time. A couple of years later, I was a co-investigator on a selected proposal to build and run 4 scientific cameras for MSL. I started planning a two-year field season on Mars!

The next step was deciding where to go. A mission has to land successfully to get any scientific results. For MSL, the engineering team developed an amazing new entry, descent, and landing system that looked terrifying, but could land in a relatively small flat area inside a large crater. This opened up all sorts of interesting landing sites. And the team called on me, among others, to help evaluate the best field areas in which to assess the ancient habitability of Mars. As any geologist knows, thick stratigraphic sections of sedimentary rock preserve lots of information about ancient environments. And strata are best viewed on slopes – just ask any of the dozens of students that line up for Jeff Mount's Grand Canyon trips! But rovers can't land on slopes. Thus, the field area had to be adjacent to a good landing site. After more than 5 years of community discussions, the team settled on my favorite site: Gale Crater, which contains a 5 km-thick stratigraphic section with marker beds, unconformities, an alluvial fan, and canyons that cut down through the strata. It's an exciting place with diverse sedimentary rocks and lots of scientific potential.

In August, when the MSL rover, named Curiosity, landed in Gale Crater, I temporarily moved to the Jet Propulsion Laboratory, where the mission is being run. I am playing a critical role in operating the rover as one of several "Long Term Planners" (LTPs). As an LTP, I am responsible for shaping the overall structure of the mission, including directing where Curiosity should go, prioritizing different science investigations, and encouraging the other 400+ team members to work together to interpret the data coming back. I am also fully immersed in the work of assessing whether the environments recorded in the rock were habitable, using my skills as a sedimentologist to shed light on the environments on early Mars.

My Martian adventures will continue for at least the next two years, which is the prime mission for MSL. However, operations will become distributed late in 2012, and I will return to campus before the start of winter quarter, in time to teach Sediments and Strata. It's a good bet that the class will include new examples from Gale Crater this year!

all photos courtesy Dawn Sumner

Dawn at a JPL press conference with the first large panorama of Mount Sharp in the background. She discussed the team's geological and geomorphic mapping efforts. She is flanked by Mike Malin (left), the PI for the scientific cameras that took the panorama, and Andy Mishkin (right), one of the JPL Mission Managers.

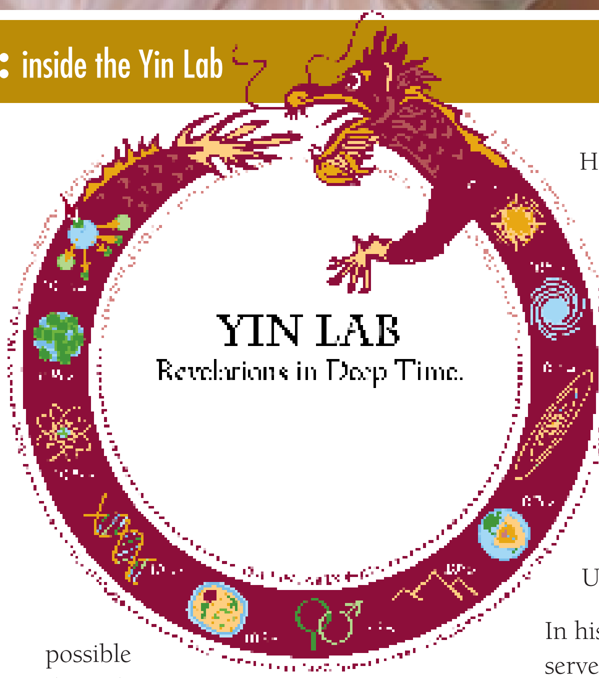
"If confirmed, what we have in hand is perhaps the most primitive materials, preserved in pristine condition in cold storage for 4.567 billion years before it fell to Earth."

– Qing-Zhu Yin

In the photo, Qing-Zhu Yin holds a 5.4-gram meteorite fragment.

credit: ©2012 Gregory Urquiaga/UC Davis

Revelations in Deep Time: inside the Yin Lab



Featured Lab: Yin Lab

Professor Qing-Zhu Yin's research focuses primarily on reconstructing the history of chemical and physical processes involved in the formation of the Sun and the planets. To address these problems, he studies the isotopic compositions of those elements, which were produced during nucleosynthetic processes in stellar outflows, sprinkled into interstellar medium, and subsequently mixed into the solar nebula ~4567 million years (Ma) ago, and locked into a diverse set of planetary materials including the Earth. Some of these newly generated nuclides decay radioactively with relatively short half-lives (t1/2 =0.1-10 Ma). These short-lived radionuclides can therefore be used to obtain high-resolution chronologic constraints on early solar system processes.

His second graduate student, Xiaoyu Shi graduated in August, 2012. He is currently working with three postdoctoral fellows in his new laboratory. A state-of-the-art thermal ionization mass spectrometer, called Triton PLUS, was recently added to his research arms of the ICP Square consists of Neptune PLUS, a multi-collector ICP-MS, Element XR, a high-resolution HR-ICP-MS, and a new generation deep UV 193 nm excimer laser ablation system. The acquisition was made possible through a NASA Planetary Major Equipment grant, as an augmentation to his ongoing research project funded by NASA.

Yin was recently named a Chancellor's Fellow for 2011-2016. He serves as one of the three advisors for the geology graduate program. He is an Associate Editor for *Geochimica et Cosmochimica Acta*, a top tier, premier journal sponsored by the Geochemical Society and the Meteoritical Society (in which he is life member latter).

A recent meteorite fall of a rare type, carbonaceous chondrite, near the California's gold discovery site has made his life even busier. Check out his meteorite search and outreach effort at

http://www.youtube.com/watch?v=OCyORXrBpew

He just came back from attending and chairing a special session dedicated to this meteorite in the 75th Meteoritical Society meeting in Cairns, Australia, in which he and his team co-authored 10 presentations. He has published his first popular science book, *The Earth: Its Birth and Growth*, by Cambridge University Press, co-authored with colleagues at The University of Tokyo and Yale University.

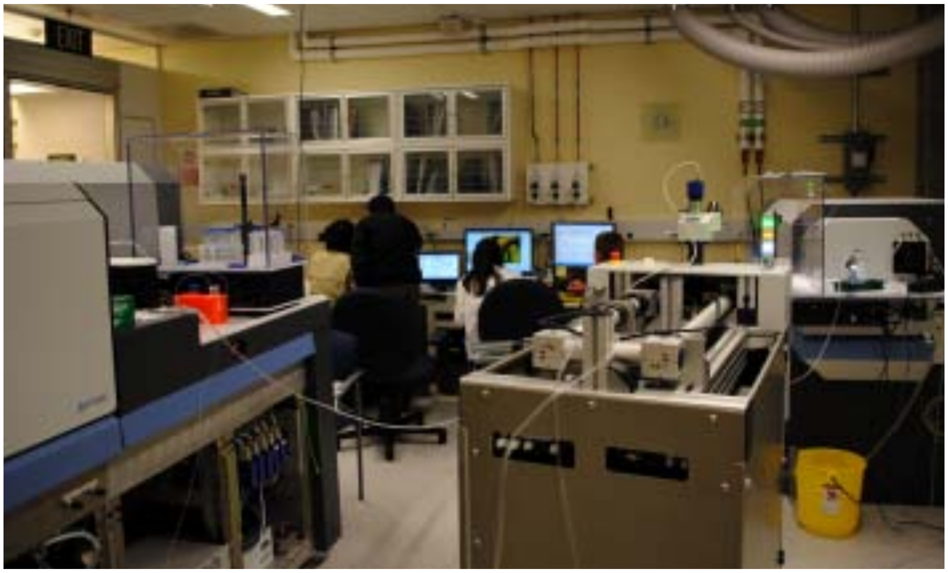
In his spare time, Professor Yin also serves as an Advisory Board Member for the UC Davis East Asian Studies.

credit: ©2012 Gregory Urquiaga/UC Davis

Qing-Zhu and Gregory Jorgensen, a UC Davis alum (shown holding his daughter Abriela), found the meteorite on his driveway and donated it to UC Davis. Yin hopes to find dust grains of pre-solar material from the meteorite.

Yin Lab – ICP²

The ICP² consists of Neptune Plus, a multi-collector inductively coupled plasma mass spectrometer (MC-ICP-MS) (to the left in the image), Element XR, a high resolution magnetic sector ICP-MS (to the right), and a deep UV eximer laser ablation system (center piece). This dream combination enables measurements of isotopic and elemental compositions of terrestrial and extraterrestrial materials from Li (the lightest solid element) to U (the heaviest solid element) in the periodic table in both solution and solid states.



Examples of some recent ongoing projects in the ICP² include:

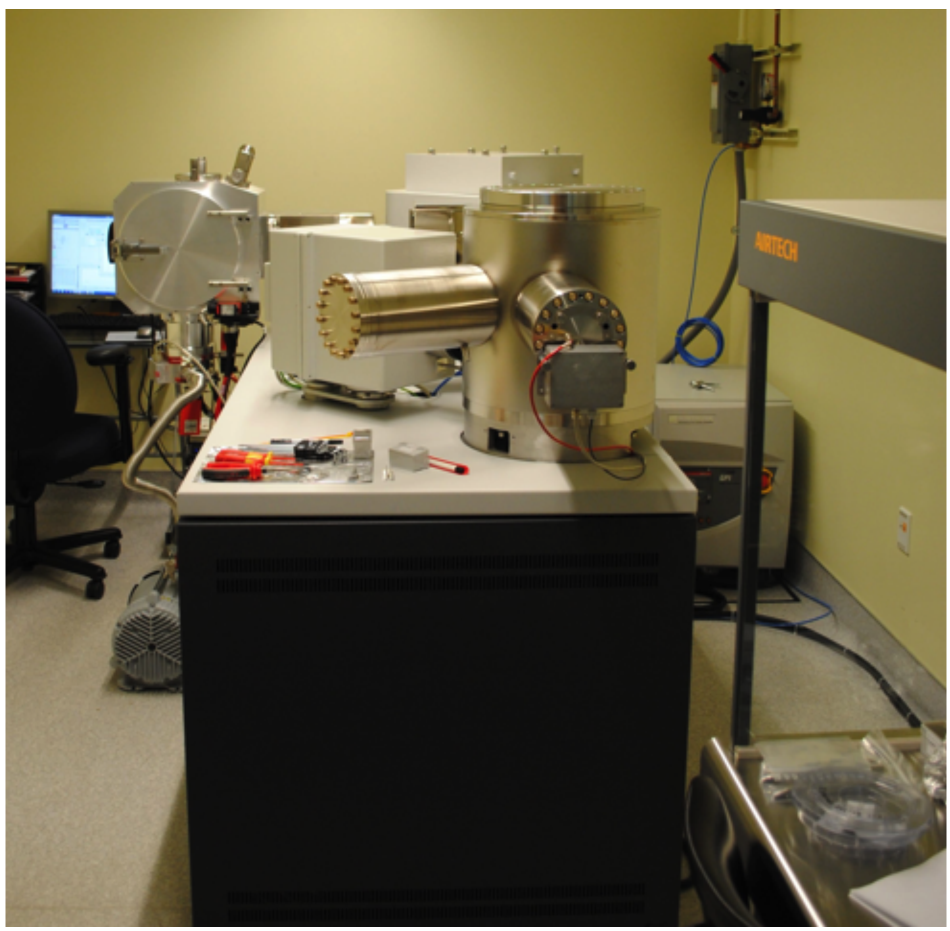
- ^{26}Al-^{26}Mg Isotope Systematics of First Solids in the Solar System (NASA Cosmochemistry Grant).
- Ca Isotope Fractionation between Solution and Solids with Six, Seven or Eight Oxygens Bound to Ca(II) (NASA Exobiology grant)
- Solar wind Mg flux measurement in collaboration with the NASA GENESIS Mission PI and Team
- Tracing changes in the East Asian Monsoon using the Mg isotope record in a loess-paleosol sequence from Luochuan, China.
- Simultaneous U-Pb ages, trace elements and Hf Isotope composition in zircons with application to crust-mantle evolution.
- Rhyolite-rhyolite mixing and the generation of isotopically primitive rhyolites at Yellowstone caldera: Insight from sub-crystal-scale age, trace-element, and Hf-isotopic analyses of zircons and Ba analyses of sanidine (in collaboration with Kari Cooper, supported by NSF grant).

Yin Triton TIMS Lab

A new thermal ionization mass spectrometer, Triton Plus, was added to our arsenal of modern isotope geochemical tools in June 2012.

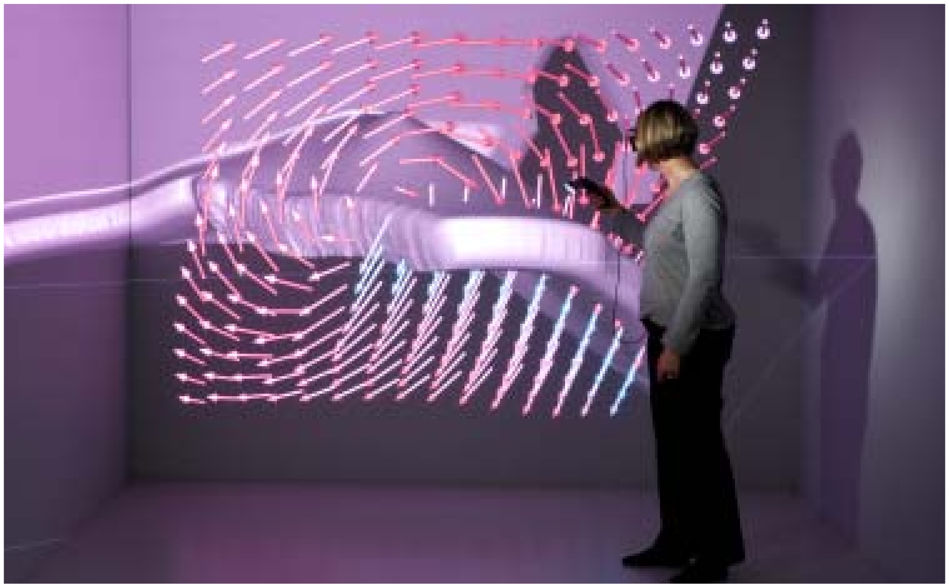
Literally a satellite to our Neptune Plus, the instrument is a state-of-the-art isotope ratio mass spectrometer, capable of measuring isotopic ratios of heavy metals with a precision up to the 7th decimal point.

The very first sample we have measured on the Triton Plus was Sutter's Mill, a recently observed fall of a rare primitive meteorite, carbonaceous chondrite in the foothill of the Sierra Nevada (practically "in our own backyard"!). We were able to constrain its ^{53}Mn-^{53}Cr age to be 4,566.57±0.66 Ma. Future projects enabled by the Triton include the investigation of the primordial differentiation of the Earth, Moon, Mars and Vesta during their magma ocean stage of evolution.



MAGALI BILLEN

Over the last year **Magali Billen**'s research group has been working on numerical models of various aspects of subduction zones from the point at which the oceanic plate starts to bend into the mantle (the outer rise), to point where the subducting slab enters into the lower mantle. Post-doc John Naliboff modeling how faults form in the outer-rise – these faults help to weaken the plate, allowing it to bend into the mantle. Post-doc Pierre-Andre Arrial has shown that the density increase that occurs with the transformation of basalt to eclogite helps intermediate –to-large oceanic plateaus to be subducted, rather than underplated beneath the over-riding plate. Graduate student Katrina Arrendondo is developing new models to explore the effects of multiple phase transitions and a freely-moving trench on slab dynamics. Undergraduate Jessie Saunders is finishing up making movies and data sets that will help students to understand the 3D relationships between topography and structures like synclines and folds. She'll be continuing work on the statistical nature of fault characteristics (length, spacing) in the outer-rise.



credit: ©2010 Robert Durell

Magali Billen explores flow of the mantle (arrows) around the eastern edge of the Alaska slab (isosurface). A strong toroidal (rotational) flow draws material from beneath the slab, around the edge and into the mantle wedge above the slab. These numerical model results are from former Ph.D. student Margarete Jadamec's thesis research as published in Nature (2010).

And, undergraduate Christina Zabalza is starting a new project to examine correlations between subduction zone observables that can be used as constraints on dynamical models. Finally, Magali is focusing her time on helping to develop capabilities of a new geodynamics modeling code, called ASPECT, that promises to make even more realistic models of subduction dynamics possible.

Senator Barbara Boxer and Sandy Carlson

Sandy Carlson represented UC Davis and The Paleontological Society (as President-Elect) at the 5th Geosciences Congressional Visits Day (September 2012) in Washington, D.C., organized by the American Geosciences Institute. She met with Congressional Staff from the offices of Senators Dianne Feinstein and Barbara Boxer, as well as Congressman Mike Thompson, to encourage them to continue to support steady federal funding for geoscience research and STEM-related education.

SANDY CARLSON

Sandy Carlson's research focuses on brachiopod (bivalved marine invertebrates) evolutionary biology and paleobiology: how and why have brachiopods evolved in the ways that they have, and what evidence does the fossil record provide? She recently received NSF funding to test the assumption, widely held among paleontologists, that the shell morphology of living and fossil brachiopods is an accurate source of information on evolutionary relationships. By comparing patterns of morphological evolution with patterns of molecular evolution determined from the roughly 5% of brachiopod species living today, she and post-doc Holly Schreiber will determine which shell characters in extinct species are trustworthy guides to their evolution, and which appear to be related instead to their function and behavior. M.S. student Paige Kercher is determining patterns of seasonality and growth rates in living brachiopods by analyzing closely-spaced samples of shell carbonate for stable oxygen and carbon isotopic composition along ontogenetic trajectories over the lifespan of a brachiopod species common in Monterey Bay (*Laqueus californianus*). Carlson has established phylogenetic definitions for *Brachiopoda* and *Neoarticulata* for the Companion Volume to the PhyloCode, a recently developed system of phylogenetic nomenclature that names clades (systems of common ancestry) that explicitly acknowledge phylogenetic relationships.

KARI COOPER

Kari Cooper's research group has continued to focus primarily on understanding magma reservoir systems beneath volcanoes, with current research focused around Mt. Hood, Oregon, Yellowstone caldera, and Okataina Caldera Complex, New Zealand. Ph.D. students Mark Stelten and Allie Rubin are working on combining in-situ dating of zircon by SIMS with in-situ measurements of Hf isotopic composition by LA-ICP-MS (in collaboration with Qing-zhu Yin and Gry Barfod). The direct linking of age and isotopic composition will allow tracking of different compositions of magma and will provide information on the amalgamation of large bodies of silicic magma between caldera-forming eruptions. Stelten is working on Yellowstone, while Rubin is applying the same approach to recent eruptions in the Okataina Caldera Complex. Mark, Kari and Allie had a productive field season in Yellowstone this summer to collect more samples for Mark's project – it's always great to see the rocks in the field to provide context for the geochemical analyses. Work on setting up U-series dating of carbonates (speleothems and pedogenic carbonates) is ongoing, and initial results relate to provide a chronology for climate proxy records contained in Sierran speleothems (in collaboration with Isabel Montañez and her student). Fine-tuning the chemical and analytical techniques to apply them to carbonates is a work in progress, but will hopefully be routine (or at least as routine as these things get!) by the end of the year.

Kari Cooper leading a discussion about rhyolite dome emplacement at Glass Creek Dome (one of the Mono-Inyo chain), with her latest "field assistant" engrossed in figuring out how to use a hand lens!

ERIC COWGILL

Eric Cowgill's research focuses on quantifying the magnitudes and rates of deformation along major (500-1000 km long) fault systems to understand the deformational processes controlling the first-order structural architecture of continental deformation zones. He integrates field-based structural and neotectonic studies with geochronologic investigations to quantify the deformational behavior of active fault systems, particularly in the poorly understood time interval that lies between the earthquake cycle (~10^2 yr) and the growth of mountain belts (~10^7 yr). In summer 2012 he spent a month doing paleoseismic trenching in NW China with Chinese and US collaborators to determine the timing and magnitude of the last few earthquakes along the central Altyn Tagh fault. Current/recent projects include:

• Investigating strain localization along the southern flank of the Greater Caucasus with student Adam Forte (Ph.D. expected 2012).

• Determining the Holocene slip history of the Altyn Tagh fault in Tibet with student Ryan Gold (Ph.D. 2009) (Cowgill et al., 2009; Gold and Cowgill, 2011; Gold et al., 2011; Gold et al., 2009) and the Mojave section of the San Andreas fault with Tracy Compton (M.S. 2012) and new Ph.D. students Mary Barr and Chad Trexler.

• Investigating the magnitude of surface uplift along the NW margin of the Tibetan Plateau through study of the timing, kinematics, and amount of slip along the North Altyn fault with new Ph.D. student John McDermott.

• Development and application of virtual-reality based terrain visualization as part of the Keck Center for Active Visualization in the Earth Science (KeckCAVES), including development of the virtual-globe application Crusta with student Tony Bernardin (computer science Ph.D. 2011; Bernardin et al., 2011), rapid scientific response to the 2010 Haiti earthquake (Cowgill et al., 2012), and use of lidar to quantify fault slip with student Peter Gold (M.S. 2011; Gold et al., 2012) and identify marine terraces with student Chris Bowles (M.S. 2009; Bowles and Cowgill, 2012).

Eric Cowgill in the Republic of Georgia in the fall of 2011. Rocks in the background are Late Miocene strata exposed in a SW-vergent fold within the Kura fold-thrust belt. View is to the NW on the Georgia-Azerbaijan border.

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HOWARD DAY

Howard Day has continued his interests in high-pressure metamorphism. Following a theoretical study of excess silica in omphacite (Day & Mulcahy, 2007), he recently finished a critical review of thermodynamic and experimental data on the diamond-graphite equilibrium (Day, 2012). He is currently collaborating with Sean Mulcahy on a study of the reactions that control the stability of Ti-phases such as rutile, ilmenite, and titanite in eclogites and peridotites. Graduate student Jesse Starnes is currently working on zircon geochemistry and geochronology in Franciscan eclogite, amphibolite, and blueschist. Day devotes a lot of energy to the Mathematics and Science Teaching program (MAST), of which he has been the founding director since 2005. MAST is part of the UC CalTeach initiative to increase the number, quality, and diversity of math and science teachers trained by UC. It introduces students to the possibilities of careers in teaching and prepares them for entry into credential programs by providing courses that give them structured experiences in K-12 classrooms. The program now serves about 150 students per quarter and has the highest enrollments among the CalTeach programs on the nine UC campuses. The latest addition to the MAST curriculum is a Learning Assistants Program, in which undergraduates support Teaching Assistants in introductory university physics and biological science courses. In addition to their time in the classroom, learning assistants spend 2 hours weekly learning both subject matter and pedagogy that prepares them to work with their students. Enrollment is increasing rapidly, and the program has captured the imagination of other departments that also would like to have Learning Assistants.

Louise Kellogg and a member of the BBC Top Gear production crew inside the KeckCAVES.

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LOUISE KELLOGG

Louise Kellogg is leading two interdisciplinary research projects headquartered at UC Davis: the KeckCAVES, a center for interdisciplinary research on visualization for use in the Earth Sciences, and the Computational Infrastructure for Geodynamics, an NSF-funded consortium of more than 50 universities and laboratories in the US (along with several international institutions), that develops cyberinfrastructure for geophysics simulations. Her own research has two themes: understanding mantle convection (the driving mechanism of plate tectonics) and understanding how forces driving crustal deformation cause earthquakes. One of the major efforts of the KeckCAVES involves developing the capability to respond rapidly to earthquakes and other earth hazards.

CHIP LESHER

My students, post-docs and I continue to use petrology, geochemistry and field geology to investigate the origin and evolution of igneous rocks. Since the last newsletter, we returned to east Greenland to continue field and petrologic studies of the Skaergaard intrusion. Eric Brown (UC Davis Ph.D., 2011) joined the expedition after defending his thesis on the North Atlantic large igneous province. Lots of new discoveries were made, in part due to new bedrock exposures left by retreating glaciers (climate change?). Thankfully, no direct encounters with polar bears this time, but fresh tracks made us acutely aware of their presence. Closer to home we are continuing our experimental investigations of silicate melt properties at high pressure, including viscosity (Lara O'Dwyer Brown, UC Davis Ph.D. 2012), density (Alisha Clark, UC Davis M.S. 2011) and structure (Sarah Gaudio, Ph.D. in progress), using a variety of new tools developed in UC Davis lab and at national synchrotron X-ray facilities. Gry, the boys (Halfdan - 6 yrs old, Herluf - 4

Chip Lesher in the shadow of Bassistoppen peak, Skaergaard intrusion, 2011.

yrs old) and I spent a delightful and productive sabbatical in Denmark during 2010-2011. I am now back to teaching full time after my stint as Faculty Director of UC Davis's Education Abroad Program and sabbatical in Denmark.

credit: ©2009 Karin Higgins/UC Davis

Jim McClain is the Associate Dean for Undergraduate Education and Advising in the College of Letters and Science.

JIM McCLAIN

Jim McClain's field is geophysics, and many aspects of his UC Davis career changed over the last few years. The focus of his research has been the study of the mid-ocean ridges, and in particular the interaction of tectonic, volcanic and hydrothermal processes that result in the formation of the ocean crust. Because of his other obligations, his marine expeditions have been put on hiatus. However, his interest in hydrothermal systems has taken a new turn as he has turned his attention research expeditions closer to home, namely in the geothermal areas in California. These include geophysical research in the Long Valley Caldera with his student Maia Kostlan. This Fall, he is starting a new research effort in the Surprise Valley area of northeastern California, with first-year graduate student Sam Hawkes. These efforts are part of a greater effort to understand the link between hydrothermal circulation and permeability in the earth. In collaboration with Drs. Glassley, Schiffman and Zierenberg, Dr. McClain has been an active participant in the development of new geothermal research center at UC Davis. Dr. McClain is the Associate Dean for Undergraduate Education and Advising in the College of Letters and Science. This occupies a substantial part of his week, but he still has time to teach Physical Oceanography and Geological Oceanography, as well as the geophysics segment of the department's capstone Summer Field courses.

ISABEL MONTAÑEZ

Research in the sedimentary geology and geochemistry lab for those of us who work in paleoclimatology continues to focus on two past periods of extensive glaciation – the last major icehouse of the late Paleozoic and the last glacial maximum and ensuing deglaciation of the past 20,000 years. Our field studies take us from the high elevations of the Altiplano of Bolivia and Argentinean Patagonia, to the coal basins of eastern Ukraine (see photo of this year's field crew) and to the subtropical coastal regions of Brazil while monitoring and studying deposits from caves throughout the foothills of the Sierra Nevada. This past year, Isabel Montañez was on leave as a Guggenheim Fellow spending time at University College London in Dublin, Ireland training with botanists and molecular isotope geochemists in the use of fossil plants as proxies of atmospheric greenhouse gas composition and relative humidity.

Isabel Montañez (center) and her field crew.

JEFF MOUNT

After 32 years of teaching in the Department of Geology, after 11 field camps at Poleta Folds, after 15 major river trips in Ecogeomorphology, after close to 1000 days in the field with great students, after countless hours in the classroom, I have decided to retire at the end of Fall Quarter and move on to another adventure. My time at UC Davis defines my life. Working on great mysteries of the Cambrian radiation event in the first half of my career, I transitioned to working on the great mysteries of rivers in the second half. This second half has been a particular treat, exposing me to amazing places and people, allowing me to work with students from all scientific and technical backgrounds (even economists and lawyers), and affording me the opportunity to join the scrum that is water policy and politics in California. Every day has been different and every day has been a challenge. Most importantly, this second half career would not have been nearly as interesting if it were not for Roy Shlemon, who endowed the Shlemon Chair in Applied Geosciences, the faculty and students in geology, and the many faculty from outside the department I was fortunate enough to work with.

I am way too young to retire from work. For the third half of my career I will be working closely with several foundations. This work will focus on how to manage rivers and the waters that flow through them. It is an opportunity to do something lasting and important. I have spent that last 15 years describing rivers, now I hope to be able to fix some, not just paddle on them.

Thanks UC Davis and the Department of Geology!

Jeff Mount on the Colorado River in the Grand Canyon.

Mike Oskin at a mountain pass near the town of Jiulong (nine dragons), Sichuan Province, May 2012. Anomalously high exhumation rates in this part of the southeast Tibetan Plateau may be driven by glacial erosion.

MIKE OSKIN

Research on active tectonics and earthquake geology in China, Mexico, and the southwest U.S. continue to dominate Mike Oskin's research program. Ph.D. student Scott Bennett is nearing completion of his dissertation on the role of strike-slip faulting in localizing the Gulf of California rift. A growing focus on the role of distributed crustal deformation in orogens and its implications for understanding earthquakes has spawned several projects. One of these is a study of fault slip rates and paleoseismicity in the Aksay Bend of the left-lateral Altyn Tagh fault. This research, led by Ph.D. student Austin Elliott, fuses geologic observations with numerical models of fault rupture to elucidate how fault complexity limits the size of earthquakes. A project to investigate fault slip and distributed deformation in the Mojave Desert region, led by Ph.D. student Jacob Selander, is yielding insights into how strike-slip faults lengthen and link together here via previously undocumented shortening structures. Jacob has just acquired a new high-resolution airborne LiDAR (light distance and ranging) topography data set for one of these fault terminations that we will visit together in the field later in the fall. Research also continues on the differential LiDAR data sets gathered for the 2010 the El Mayor-Cucapah earthquake. A computer science Ph.D. student, Divya Banesh, is working on development of LiDAR point-cloud correlation and new techniques for visualization of the resulting dense 3D vector fields.

DAVID OSLEGER

Dave Osleger is Vice-Chair of the department and is focused on undergraduate geoscience education and the well-being of the geology major. The department is up to 80 majors; we try to facilitate their career development by offering a 'Careers in the Geosciences' seminar where we bring in working professionals to talk about their career arc, the nature of their job, and opportunities for our current majors. It seems to be welcomed by our students and most importantly seems to be getting them to be proactive about developing careers in the geosciences. Dave teaches several large-enrollment classes focused on the geology of national parks, the geology of California, environmental geology and planetary geology. He plans to offer a new course next winter on 'Big History,' exploring the evidence for the Big Bang, the origin of stars and galaxies, the history of life, and the evolution of Earth, culminating in the Anthropocene. Dave was honored by the UC Davis Academic Senate Distinguished Teaching Award in 2012.

HOWIE SPERO

During the past two years, Howie Spero's research group has expanded into a number of new research areas as well as bringing closure to some long-term projects. During the summer of 2011, the planktonic foraminifera culturing group, which included research colleague, Ann Russell, post-doctoral researcher, Jennifer Fehrenbacher, graduate students Lael 'Spider' Vetter, Anthony Menicucci and Brittany Grimm, undergraduate geology major, Jordan Snyder, and a host of international colleagues from China, Australia and France, completed their final summer field season. The culmination of more than 20 years of continuous NSF funding for the Spero lab was captured in two documentaries that can be seen on YouTube titled A Forams Tale - Documentary and -Culturing Process. Exciting research developments in the lab include 1) Anthony Menicucci's successful development of a novel technique to analyze diatom opal and quartz oxygen isotopes using our continuous flow high temperature TCEA system, 2) Brittany Grimm's research on carbon flow change in James River watershed

Dave Osleger spent 16 days on the Colorado in the Grand Canyon this past spring as part of a graduate class on the ecology and geology of the Canyon. Other than taking a cold swim when his boat flipped in one of the rapids, he enjoyed immersing himself in the natural setting of the canyon.

Howie Spero's foram culturing team on Santa Catalina Island in southern California. left to right: Kate Holland (Australia National Univ.), Jennifer Feherenbacher, Spider Vetter, Howie Spero, Bill Wagman, Brittany Grimm and Jordan Snyder.

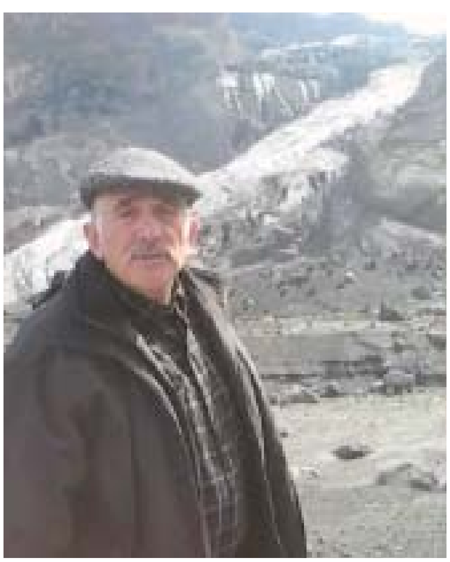
during the 17th and 18th centuries from historical oyster shells collected from the Jamestown colonial site, 3) Spider Vetter's innovative research using our new PhotonMachines Excimer laser/Agilent ICP-MS and SIMS analyses to quantify micron scale variations in elemental and isotope geochemistry in foraminifera shells as well as to reconstruct the oxygen isotope geochemistry of Laurentide Ice Sheet meltwater from foraminifera shells, and 4) Jennifer Fehrenbach's research with our LA-ICPMS system to both optimize the laser for micropaleontological applications and to calibrate the Mg/Ca paleothermometer proxy with thermocline dwelling foraminifera such as *N. dutertrei*.

Rob Zierenberg (back row, far right) and the Spring 2012 GEL 138 Hawaiian Volcanoes class.

KEN VEROSUB

This summer, Ken Verosub continued his globetrotting. In June he attended the AGU Chapman Conference on Volcanic Eruptions and the Atmosphere held in Selfoss, Iceland. At the conference, Ken presented a paper showing how global cooling resulting from a volcanic eruption could have a serious impact on the world's food supply. He also participated in a field trip to the Eyjafjallajokull volcano. An eruption from that volcano two years ago impacted air traffic in Europe for several weeks.

In July Ken participated in a conference on Understanding Risk, sponsored by the World Bank and held in Cape Town, South Africa. The goal of the conference was to help government officials in Africa understand and deal with risk from natural and human-caused events.



Ken Verosub at the base of Eyjafjallajökull.

For the conference, Ken organized a special session entitled: Thinking about the Unthinkable. In that session, Ken and the other participants explored issues related to high-impact, low probability events, such as the Japanese earthquake and tsunami of 2011 and the flooding in Pakistan in 2010 and in Thailand in 2011.

In the same month, Ken was sent to Chile by the State Department and the Office of Naval Research. He was one of several speakers at a conference held at the Geographic Institute of the Chilean military on the use of remote sensing to detect changes in Andean glaciers and in river run-off.

In September, Ken again taught a short course on Earth Science and Natural Disasters in the international Masters Program in Risk and Emergency Management in Pavia, Italy. This year, he had students in the course from Armenia, Bangladesh, Colombia, Ethiopia, Greece, and Pakistan.

Ken was also active on the local Davis lecture circuit. He spoke about the two years he spent in Washington, D.C., at the Phi Kappa Phi Honor Society Initiation and at the Davis Kiwanis International; he gave a lecture on Earthquakes and Earthquake Preparedness for the Osher Lifelone Learning Institute, and he talked about the geology of Yolo and Napa counties for the Davis Bike Club.

ROB ZIERENBERG

Robert Zierenberg continues to offer the physical volcanology class initiated by Peter Schiffman. The field component of the class is taught on the Big Island of Hawaii over spring break and one dozen students were able to participate this year. A portion of the cost of running this program is covered by student scholarships from your donations to the Cord Durrell Fund and the Robert Matthews Fund. Last summer Rob and his graduate student Andrew Fowler participated in the Nordic Volcanology Center – University of Iceland Summer Field School in Geothermal Resources taught in SW Iceland. Work on the Iceland Deep Drilling Project continues and Rob and Andrew recently returned to Iceland to attend a planning meeting for deep drilling on the Reykjanes Peninsula, and to sample geothermal wells.

Recent papers resulting from the Iceland work include:

Elders, W.A., Fridleifsson, G.O., Zierenberg, R.A., Pope, E.C., Mortensen, A.K., Gudmundsson, A., Lowenstern, J.B., Marks, N.E., Owens, L., Bird, D.K., Reed, M., Olsen, N.J., and Schiffman, P.A., 2011, Origin of a rhyolite that intruded a geothermal well while drilling in a basaltic volcano, at Krafla, Iceland. Geology 39(231-234), doi:10.1130/G31393.1.

Marks, N., Schiffman, P., and Zierenberg, R.A., 2011, High-grade contact metamorphism in the Reykjanes geothermal system: Implications of fluid-rock interactions at mid-ocean ridge spreading centers, Geochem. Geophys. Geosyst. 12(8) doi:10.1029/2010GC003569.

R.A. Zierenberg, P. Schiffman, G.H. Barfod, C.E. Lesher, N.E. Marks, J.B. Lowenstern, A.K. Mortensen, E.C. Pope, D.K. Bird, M.H. Reed, G.Ó. Fri›leifsson, and W.A. Elders, 2012, Composition and origin of rhyolite melt intersected by drilling in the Krafla geothermal field, Contributions to Mineralogy and Petrology. DOI 10.1007/s00410-012-0811-z.

RESEARCH SCIENTISTS

OLIVER KREYLOS

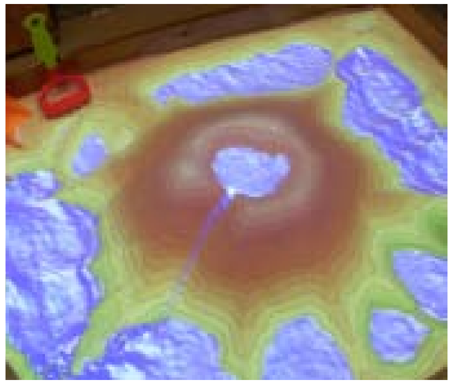
Oliver Kreylos' research and development continues to focus primarily on scientific visualization and data analysis in immersive, or virtual reality, environments such as the W.M. Keck Center for Active Visualization in the Earth Sciences (http://www.keckcaves.org).

Recently, Oliver has been branching out into Augmented Reality (AR) by creating the Augmented Reality Sandbox (http://www.youtube.com/watch?v=j9JXtTj0mzE). Part of an NSF-funded project on informal science education for lake ecosystems (http://www.lakeviz.org), the AR Sandbox is a hands-on exhibit for science museums or classrooms that combines a regular sandbox with a 3D camera (technically a Microsoft Kinect game controller), a digital projector, and a powerful computer.

The 3D camera captures a real-time digital elevation model of the real sand surface, which the computer converts to a topographic map with elevation coloring and contour lines, which the projector then overlays directly back onto the real sand surface. This closed loop ensures that the colors of the sand, and the topographic contour lines, change in real time in response to users' manipulations of the sand surface. The AR Sandbox software also contains a water flow simulation module, which allows users to let it virtually rain from their hands, and observe the water flowing over the real sand surface.

More information can be found on the AR Sandbox's project page, http://idav.ucdavis.edu/~okreylos/ResDev/SARndbox

Together with geology professor Magali Billen and former graduate student (now post-doc at Brown University) Margarete Jadamec, Oliver worked on methods to create initial conditions for, and visualize results of, three-dimensional simulations of geometrically complex Subduction with large viscosity variations. A paper describing this research recently won "Best Science Track Paper" and "Best Paper of Conference" awards at the 2012 XSEDE conference (Jadamec, Billen, Kreylos 2012).



Photograph of Oliver Kreylos' "Augmented Reality (AR) Sandbox," a hands-on teaching tool and science museum exhibit combining a regular sandbox with a 3D camera and a digital projector. The AR sandbox overlays the real sand surface with a virtual topographic map that changes in real time as the sand surface is manipulated. It also simulates the flow of virtual water over the real sand surface.

References:

Jadamec, M.A., Billen, M.I., and Kreylos, O., Three-dimensional Simulations of Geometrically Complex Subduction with Large Viscosity Variations, in: Proc. of the 1st Conference of the Extreme Science and Engineering Discovery Environment Bridging from the Extreme to the Campus and Beyond (XSEDE'12), article no. 31

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POSTDOC NEWS

JOHN NALIBOFF

My broad research interests are the geodynamics of the lithosphere and convecting mantle, with an emphasis on subduction zone kinematics and sources of stress in the lithosphere. Currently, my research focuses on deformation of subducting oceanic lithosphere, which commonly exhibits evidence of extensional deformation in the outer-rise region as it bends beneath the overriding plate. Such evidence includes seismicity and well-preserved normal fault scarps on the sea floor, which have allowed researchers to compile an extensive data set of faulting patterns across multiple subduction zones. As surface deformation patterns inherently reflect the strength of the lithosphere and underlying forces driving deformation, the compiled set of outer-rise faulting patterns presents a unique opportunity to examine the rheology of the oceanic lithosphere with geodynamic modeling. Presently, I am conducting high-resolution numerical subduction simulations that test how the strength of the oceanic lithosphere affects patterns of normal faulting in the outer-rise region. The long-term goal of these simulations is to place further constraints on the strength of the oceanic lithosphere and assess how weakening in the outer-rise region influences plate velocities through decoupling of surface plates and subducted oceanic lithosphere.

GRAD STUDENT NEWS

SCOTT BENNETT

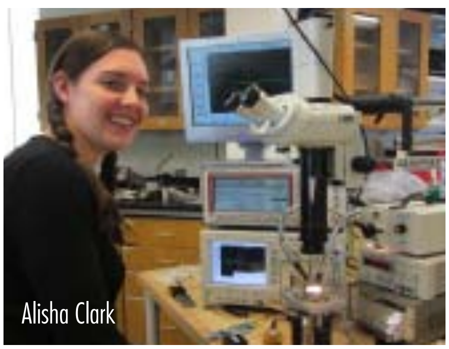
Scott's doctoral research focuses on the role that strike-slip faults play in rupturing continental lithosphere. His field area is located in the Gulf of California rift in northwestern Mexico, where the Baja California peninsula and the Pacific plate are obliquely rifting away from mainland Mexico and the North American plate at ~5 cm/yr. This plate boundary deformation is concentrated on en-echelon, right-lateral, strike-slip faults that are kinematically linked to the San Andreas fault in southern California. Scott works with Professor Michael Oskin to document the earliest strike-slip faults related to the initial formation of the Gulf of California seaway, exposed on its eastern rifted margin, on Tiburon Island, the largest island in the eastern Pacific. Scott conducts 1:10,000-scale geologic mapping of these transform fault zones, integrating results from geochronologic (Ar-Ar) and paleomagnetism of syn-rift volcanic units. Correlative volcanic tuffs are also exposed in north-central Baja California, where Scott conducts mapping and paleomagnetic research to constrain the timing, magnitude, and distribution of clockwise block rotation associated with right-lateral faulting across the Pacific-North American plate boundary. Scott is also involved in a collaborative project compiling detailed

Scott Bennett

palinspastic reconstruction maps of the Pacific-North American plate boundary from Acapulco to the Salton Sea from Miocene time to present. Scott plans to graduate this upcoming year and begin a USGS Mendenhall Postdoctoral Fellowship, working with UC Davis alumni Ryan Gold in Golden, CO.

ALEC BOYD

My name is Alec Boyd and I am a PhD candidate. My research has several goals. My first is to gain a better understanding of how transitions between the aquatic and terrestrial realms effect the evolution of the vertebra in amniotes. I also am working a computer program that will use finite element solvers to remove deformation in fossil material. My final research goal is to understand the functional advantage of the elongated necks in the mesozoic marine reptiles, plesiosaurs.


Alisha Clark

ALICIA CLARK

I am an experimental petrologist studying the physical properties of silicate melts at extreme conditions under Dr. Chip Lesher. In the photo I am using the one and only GHz ultrasonic interferometer to measure the P- and S-wave velocities of frozen silicate melts (glasses) at high pressures in the diamond anvil cell, work done in collaboration with Dr. Steve Jacobsen at Northwestern University. These are the first velocity measurements for silicate melts performed using this instrument. High pressure velocity measurements are critical for the seismic models of the Earth and are also used to determine the elastic properties of silicate melts under mantle conditions. From this we gain insight into the mechanism that accommodate densification in silicate melts.

ANDREW FOWLER

My research is focused on water-rock interaction in active geothermal systems. I am interested in what trace elements in geothermal fluids and alteration mineral assemblages can tell us about geothermal processes in the past and present. Better knowledge of geothermal processes will lead to more efficient exploration and harnessing of geothermal energy for electricity generation.


Andrew Fowler

My primary study area is the Reykjanes Peninsula, Iceland, where the Mid Atlantic Ridge comes onshore. The peninsula hosts a series of geothermal fields that range in salinity from seawater to meteoric water. These characteristics make the area an ideal laboratory to study and understand the influence of fluid composition on water-rock interaction at elevated temperatures.

JULIE GRIFFIN

In this photo I am sitting upon a Carboniferous microbial reef limestone outside of Lugansk, Ukraine. During this trip abroad I collected rocks from one of three sites for my master's thesis. Guided by Isabel Montañez, I am constructing three coeval, high-resolution oxygen isotope records from within cyclothems, repeating packages of sedimentary rocks that represent changes in sea-level. Cyclothems are ubiquitous throughout the Late Paleozoic, illustrating the frequent eustatic variations that resulted from large glaciers located at the south pole. My current research attempts to understand how the fluctuations in size of these ice sheets could have altered tropical seawater chemistry. In order to identify whether these signals are regional or global, I am creating a paleo-equatorial Pangean transect with samples from Arrow Canyon, in southern Nevada and from southeastern Kansas. When I'm not traveling for research, I enjoy working in the lab and conversing with fellow graduate students back at UC Davis!


Julie Griffin

BRITTANY GRIMM

My master's research focuses on estuarine carbon dynamics in the Chesapeake Bay since the first successful European colonization of the James River in 1607. Land use changes dramatically altered the terrestrial component of the watershed, decreasing the residence time of water. Calcium carbonate shells of the Eastern oyster *Crassostrea virginica*, excavated from archaeological deposits that span from before 1607 to the early 1700s, acted as multi-year stationary recorders preserving the changing local environmental chemistry throughout their life. My research will combine $\delta^{13}C$, $\delta^{18}O$, radiocarbon, and trace element measurements to document carbon source changes during the first century of extensive anthropogenic influence in Mid-Atlantic North America.

CARA HARWOOD

My Ph.D. research in geobiology and carbonate sedimentology addresses how organisms have interacted with their environment through time, and how these interactions are preserved in the rock record. In particular, my research on how ancient microbial structures (thrombolites and stromatolites) are influenced by both their environment and the evolution of microbes and animals informs our understanding of how early Earth environments co-evolved with the organisms that inhabited them. My research areas are in southern Nevada and southeastern California in Neoproterozoic and Cambrian carbonates that host abundant microbialites.


Cara Harwood

TYLER MACKEY

Microbes dominate the history of life on Earth, but we understand little about their early behavior and evolution. Unlike larger and more charismatic organisms, the body fossils left behind by microbes are not particularly useful for determining their lifestyles. Fortunately, larger structures formed by whole microbial ecosystems can provide some indication of the behavior of their community members.

In my Ph.D. research with Dawn Sumner, I explore modern microbial communities growing at the bottom of ice-covered lakes in Antarctica that resemble these ancient structures. In these isolated environments, microbial communities form thick mats with complicated geometries such as peaks and webs. My ultimate aim is to develop growth models for these structures that will help us better interpret the behavior and evolution of ancient microbial communities.


Tyler Mackey

JACOB SELANDER

I became a geologist for the field trips. Over time, those trips evolved from weekends with classes as an undergrad to multiple weeks working in foreign countries and remote places in the US. It's hard to be in a landscape and not wonder about the processes shaping it. Why are there mountains here and not there? Why does the landscape look the way it does? These questions and my intense passion for the outdoors led me down a path to studying the Earth's surface. My main interests are the interactions between active tectonics and geomorphology, or put another way- What builds topography? And what brings it back down? And what clues in the landscape can we use to decipher its history? I did my Master's research (while studying at University of North Carolina) examining the growth of the northernmost ranges of the Tian Shan in Kyrgyzstan and Kazakhstan, and for my PhD research I decided to stay a little closer to home and work on fault and topographic evolution in the central Mojave Desert.


Jacob Selander

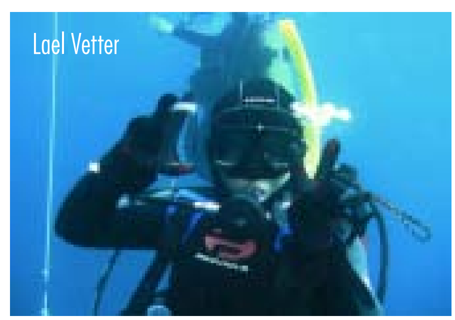
MARK STELTEN

In this picture I am collecting a sample of the Pitchstone Plateau flow, a 70 km3 rhyolite flow that erupted at ~75 ka within Yellowstone caldera. My research is focused on combining 238U-230Th dating with trace-element and isotopic analyses of zircon and sanidine crystals hosted within the several large rhyolite flows from Yellowstone caldera, to understand how compositionally heterogeneous large silicic magma reservoirs are and how they evolve through time. Understanding the heterogeneity of large silicic magma systems will provide insight into how they are constructed, which in turn has important implications for volcanic hazards and the growth of the continental crust. Linking the ages of zircon and sanidine crystals with their trace-element and isotopic compositions provides a means of using the crystals within the rhyolite flows to create a time-constrained record of evolution in the magmatic system.


Mark Stelten

LAEL VETTER

My research interests lie at the intersection between paleoecology and paleoclimate. The calcite shells of planktic foraminifers record environmental conditions and seawater chemistry at the time of shell formation. I am interested in exploring the range of environmental conditions recorded by a population of contemporaneous individual shells from the fossil record, using combined stable isotope and trace element ratio measurements in shell calcite. I use this technique to reconstruct the geochemistry and melting history of the North American Laurentide Ice Sheet across the last deglaciation. I also do experiments with live cultured foraminifers, and I am interested in using intrashell geochemical measurements to quantify shell heterogeneity and gain insight into biomineralization mechanisms.


Lael Vetter

MAYA WILDGOOSE

My name is Maya Wildgoose and I'm a 3rd year Master's student working with

Maya Wildgoose

Dr. Sarah Roeske on the thermochronology of rocks from Alaska. Specifically, I analyze metamorphic minerals in blueschists using a variety of analytical and geochronological techniques, including Lu-Hf dating of garnet and UV laser ablation of mica. I studied Ar-Ar system geochronology on Pleistocene rocks from East Africa while I did my undergraduate degree at UC Berkeley, and that sufficiently whetted my appetite for understanding the age of rocks and how they can illuminate deeper geological history. I'm also very interested in K-12 science education, and have been involved with the MAST (Math And Science Teaching program) on campus, observing and student teaching in earth science classrooms around the Davis area. I have to say that earth education in schools could use some help, but it's great to see kids learning about rocks and earth science systems! I was raised by geologists, so I was lucky to be playing in rocks and fossils at the ripe age of 3 months (and onward).

AMY WILLIAMS

I am a fourth-year Ph.D. student working with Dr. Dawn Sumner. My dissertation explores how microbial life is preserved by mineral growth and how those mineral biosignatures can be detected on Mars with the Curiosity rover instrument suite. I've always had a passionate interest in the origin of life on Earth and possible life in the universe. Now I have the opportunity to feed this passion as a Curiosity rover science team member.

Amy Williams

DEPARTMENT EVENTS

This past spring the geology department held several days of events that coincided with the visit of Professor Roberta Rudnick, the 2012 Moores Distinguished Lecturer. In addition to Dr. Rudnick's talk, our own Dawn Sumner, one of NASA's Chief Scientists on the on-going Mars Curiosity project, gave an account of the program's history and aspirations. Such lectures are important. The new ideas they bring to the department become catalysts for creative thinking and the development of new ideas. While the lectures were great, the best part for me was seeing many former students, especially those who were able to join me on a field trip to the Napa Valley. I am grateful to all who visited the department and all who have contributed to the Moores Distinguished Lecture Fund.

The 21st century may well be known by its handling of the issues of climate change, water availability, hazards, and energy resources. All these issues deeply involve the Earth sciences. In addition, our success as a society depends on an educated populace. Land-grant universities such as UC Davis play an essential role, providing large-scale post secondary education, innovative research, and public service. Future progress in the face of decreased public funding depends more than ever on private contributions. Contributions to the geology department for the Moores Distinguished Speaker Series will help the department to enhance its educational mission and to educate many outstanding new alumni who can help fill society's need for Earth scientists and Earth science. Thanks to everyone for your support. I look forward to seeing you at future departmental Alumni events. **- Eldridge Moores**

Alumni Field Trip 2012
back row (l to r): Nicholas Kent, Eldridge Moores, Maroniae Zatzke, Scott Bennett, Alan Trujillo, Nicholas Leacox, Michael Leacox, Brian Marshall, Bill Newhall
middle row (l to r): Douglas Casebolt (red cap), Kate Davis, Laura Voss, Paula Sime, John Bailey Bobbitt, Clare Marshall, Janice Jacobson (blue baseball cap)
front row: (l to r): Bob Varga (green shirt), Peter Mitchell, Steve Edelman (red shirt), Eureka Casebolt, Judy Moores, Chesshuwa Beckett, Kathryn Stanton, Shari Kawelo, Scott Hector, Dave Osleger; not pictured: Marilyn Sawada, Judy Moores

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(0995)

SUMMER FIELD 2012

Top row - along the back of the porch (l to r): Travis Kroger, Eric Mork, Bao Vang, Kyle DeAnda, Yusuf Pehlivan, Erik Gobbel
2nd row (l to r): Calvin Kuntze, Dave Ocampo, Lindsey Berg, Alicia Noel, Jamie Delano, Kate Lewis, Olga Beketova, Ivan Ferenc-Segedin, Hank Dickey, Kelley Shaw, Peggie Wong, Camille Hackett
3rd row (l to r): Brad Closson, Mary Kaneshiro, Christina Zabalza, Philip Yip, Amanda Kahn, Ivan Carabajal, Chris Halter, Clara Hull, Marrisa Reis, Jane Elliott, Marissa Hartley, Stacey Campbell, Nicole Tanner, Joel Mosebach
4th row: Jordan Snyder and James Collins; not pictured: Christopher Costa and Michael Pantell