Earth & Planetary Sciences at UC Santa Cruz

Fall 2016

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Chair's Welcome

Dear Alumni and Friends,

It's been a VERY active year in the EPS Department, and the coming year looks to be even more vibrant. Our proposed new environmental sciences undergraduate major (spearheaded by Patrick Chuang and Ocean Sciences' Raphe Kudela) is percolating through the approval system (UC grinds slowly, but it grinds exceedingly fine…) and, as part of this environmental initiative, we are hiring two new faculty this year: in Biogeochemistry and a broad-ranging search for a faculty member who works on the continental side of water's importance in geologic processes (we call it Fresh Water). And, in April, we will have our roughly every 7 year Departmental External Review. So, we've been spending a lot of time preparing our Departmental Self-Study.

On the brighter side, at the forthcoming AGU meeting, our own Susan Schwartz and Rob Coe are being honored: Susan's been elected an AGU Fellow (0.1% of the membership is elected each year) for her outstanding seismologic research, and particularly her work on subduction zones. Rob has won the prestigious John Adam Fleming Medal, which was awarded for his career research and leadership in geomagnetism (during Fleming's career, one of his job titles was "Chief Magnetician," which is certainly how we think of Rob!). The Geological Society of America also showed our faculty some love this year, with Andy Fisher winning the GSA's O.E. Meinzer Award (the father of modern groundwater hydrology) for distinguished contributions to hydrogeology, and especially marine hydrogeology. As part of the award, Andy gets to keep a large silver bowl with his name (and those of past recipients) etched on it for a year—it is truly the Stanley Cup of Hydrology! Congratulations to all…

As a vibrant Department, the cycle of regretted departures and exciting new arrivals continued this last year---on the latter front, we are happy to welcome Nicole Feldl, our new climate dynamicist, who arrived from her post-doc at Caltech. During her time there and in her Ph.D. at U. Washington, she's looked at a broad suite of climatic/atmospheric issues, including the origins and likelihood of extreme rainfall events, and climate sensitivity to, and feedbacks from, regional effects like changes in cloud cover, surface ice cover, and atmospheric water content. Overarching themes of her research are the interplay between regional and global climatic phenomena, and short-term (weather) and long-term (climate) observations. And, we were pleased to recruit Myriam Telus to our faculty in the past year. She's a cosmochemist/meteoriticist whose research focuses on evolutionary and accretionary processes in the first few tens of millions of years of our

Chair's Welcome (con'td)

solar system: a time period in which meteorites are the only witnesses to the dynamic processes occurring as the solar system formed—she utilizes geochemical probes to illuminate this most enigmatic period of solar system history. She is finishing her post-doc at the Department of Terrestrial Magnetism of the Carnegie Institute following her Ph.D. at U. Hawaii, and will join us next academic year. On the departure front, Eli Silver retired this past year—his long-standing presence and standing as a premiere tectonicist in our Department will be much missed (although the plus side is that, as with many of our emeriti, he's still at work from early to late every day, and advises graduate students). And, his mid-career research evolution to being a remote sensing aficionado also represents a major loss for our Department (though we can still fortunately access his expertise). He'll be missed---Thank goodness he's still around! And, we recently lost our long-term Department Manager Judy Van Leuven to a higher-level position in our Arts Division, where she's their new Operations Manager. We're dismayed by the loss, but we wish her well, and really appreciate her many years of service to the EPS Department! And, since one of our strengths is that our Managers tend to stay in our Department for double-digit years, we're working hard to ensure that we have a great replacement.

Now, many of you will (we hope!) recall the lab, field and class experiences that you had while you were with us at UCSC. To continue to maintain this caliber of educational experience, the Department would certainly appreciate any support you can give back: on p. 34, you'll find descriptions of some of our most active donor opportunities within our Department. These include the Weber-Holt Fund, which provides scholarships for students attending field camp and the Casey Moore Fund, for which the first awards were just made to seed graduate student research opportunities in our department. Other opportunities can be found at http://eps.ucsc.edu/support-us/ and in the final pages of this newsletter. Also, if you haven't already, do friend our Department's Facebook page—it's at https://www.facebook.com/UcscEPS , and will give you updates on what's happening on the Departmental home front!

Finally, we all look forward to reconnecting with many of you at our 16th (!) annual alumni/friends/current folks' get-together at the Thirsty Bear ("San Francisco's first and only organic brewery") during AGU! As ever, it's a great time to see old friends and make new ones (and, of course, have snacks with your possibly-hops-bearing beverage of choice). It's Tuesday, December 13th, 6 – 8.30 p.m., 661 Howard Street, San Francisco!!

Quentin Williams, Chair

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Department News


Rob Coe

Rob Coe received the AGU Fleming medal

Susan Schwartz was elected AGU Fellow

Andy Fisher received the Meinzer Award from the GSA and became a GSA Fellow


Susan Schwartz

Adina Paytan became a Fellow of the Association for the Sciences of Limnology and Oceanography

Eli Silver retired from the Department

Nicole Feldl arrive as a new faculty member in climate dynamics


Andy Fisher

Myriam Telus was appointed as a new faculty member in Cosmochemistry

Judy Van Leuven became Operations Manager in the Arts Division


Adina Paytan


Myriam Telus

We hope to see you at the Thirsty Bear Brewing Company for our

16th Annual UCSC EPS Alumni Event at Fall AGU!

When? **Tuesday, December 13, 2016**
from 6:00pm - 8:30pm

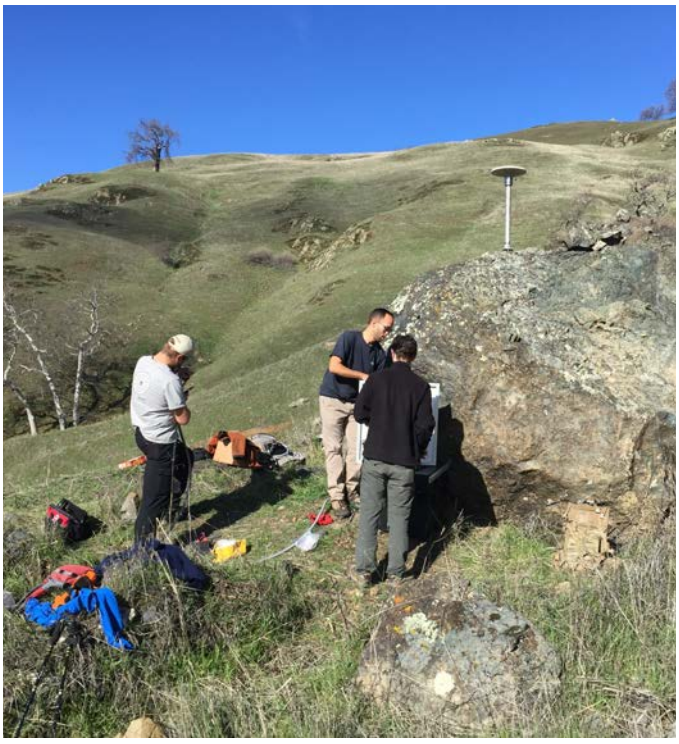
Where? **Thirsty Bear Brewing Company**
661 Howard Street
San Francisco, CA 94105
http://www.thirstybear.com/

Fiat Slug!

Slugs in the Field

Grad student Marci Beitch sampling glacial polish *beneath* a glacier in the Sierra Nevada.

Grad student Dan Killam doing modern carbonate sedimentology in Eilat, Israel



Grad student Alex Nereson and colleagues installing a continuous GPS station on a boulder in the Diablo Range earthflow, northeast of San Jose

EPS graduate student Summer Thresher (left) and Physics undergraduate Jimmy Layne (right) onboard the CIRPAS Twin Otter aircraft during the FASE (Fog and Stratocumulus Experiment), Monterey, CA.

Slugs in the Field

Panoramic view, Invertebrate Paleontology field trip

Grad student Dan Killam, Israel

Department vans, Summer Field camp

Summer Field camp, measuring the Poleta Formation

Jim Zachos coring a section of the Paleocene-Eocean thermal maximum in Maryland

Slugs in the Field

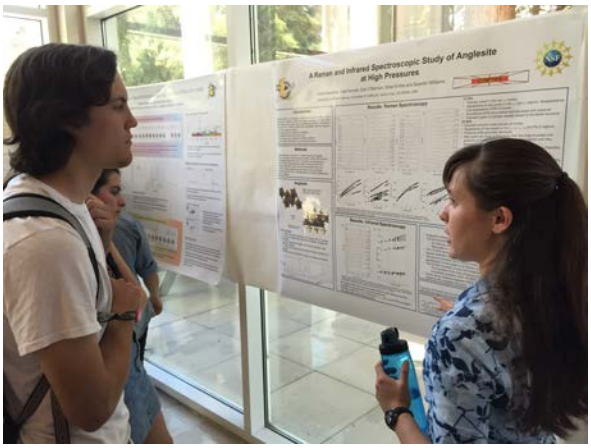
UCSC alum Dr. Lisa White (Ph.D. 1990) stands in front of the cast of a gigantic Late Cretaceous ammonite, *Pachydiscus seppenradensis,* that grew to 8 feet across, recovered from southern Germany. This cast is displayed in Berkeley at the University of California Paleontology Museum, where Lisa serves as Director of Education and Research. *(Photo courtesy of Cal Alumni Association, UC Berkeley).*

Gary Griggs, Coral Beach, Isle of Skye, Scotland

EART102 (Marine Geology) King Tides class field trip, led by Ana Garcia Garcia

Slugs Around Campus

Jennifer and Judy doing their best Thelma & Louise impression on their way to the Thirsty Bear



Inaugural EPS Department Research Symposium

Edible geodes from the Department Picnic, courtesy Claire Masteller

EPS presenters in the UCSC Grad Division Research Symposium

Paul Koch at the Thirsty Bear with former grad students Kena Fox-Dobbs, Katie Snell and Patrick Wheatley.

Slug Science News

Magma body uplifting the Altiplano
Graduate student Jon Perkins and Prof. Noah Finnegan used satellite images, topography and gravity to probe the subsurface structure of the Andean Altiplano, Earth's second highest continental plateau. They concluded that the uplift was driven by a large magma body, also responsible for the volcanic activity of the area.

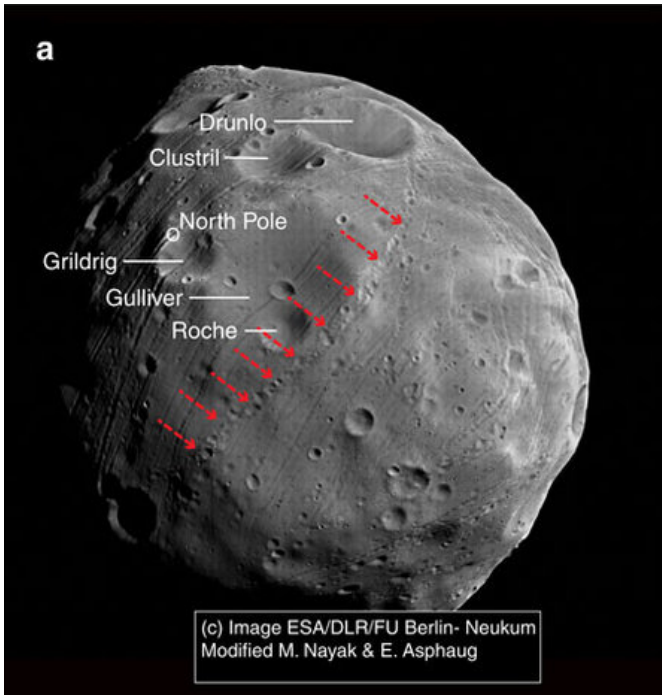
(Perkins et al., *Nature Comm.* 7, 13185, 2016)

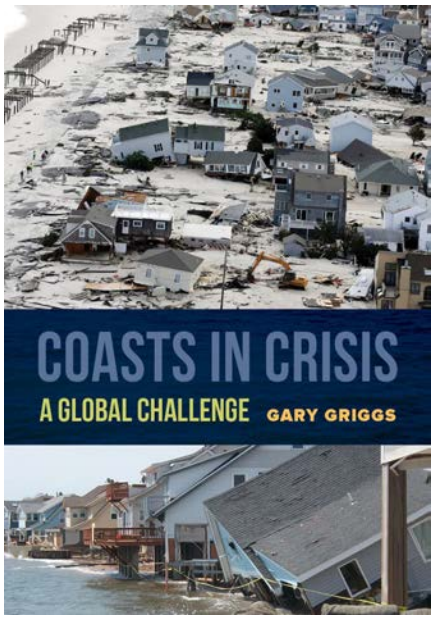
Probing the Dry Valleys of Antarctica
Helicopter-borne electromagnetic sounding has been used by graduate student Neil Foley and Prof. Slawek Tulaczyk to detect salty water beneath the surface of the Antarctic Dry Valleys, one of the least hospitable regions on Earth.

(Foley et al., *Geophysics* 81, WA87-WA89, 2016)

Grooves on Martian moon Phobos
Graduate student Mikey Nayak proposed that the enigmatic grooves on Phobos were caused by debris from a meteorite impact being lofted above the surface and then re-impacting to cause the characteristic "string of pearls" appearance of the grooves.

(Nayak and Asphaug, *Nature Comm.* 7, 12591, 2016)





Gary Griggs' latest book

on coastal retreat is being published by UC Press and will appear next year

GEODES

GEODES was conceived in a car, as a group of EPS graduate students traveled home from an inspiring diversity training workshop at UC Berkeley. Personal conversations among these graduate students about diversity and community in Earth Science have developed into a highly-regarded department organization. Run by graduate students—with support from undergraduates, faculty, and staff—GEODES hosts events that address department needs and interests.

GEODES stands for Geoscientists Encouraging Openness and Diversity in the Earth Sciences. Their mission is threefold:
1. Build community for the entire EPS Department, including faculty, graduate students, undergraduates, researchers, post-docs, and staff.
2. Raise awareness of issues that limit minority participation in EPS and provide strategies to meaningfully address these issues.
3. Provide professional development opportunities for students.

Since spring 2015, GEODES has hosted 18 unique events toward these goals. All department members have had the opportunity to mingle outside the classroom at informal pizza parties. Outside experts have led interactive workshops for students and faculty about topics such as impostor syndrome, growth mindset, and implicit bias. Graduate and undergraduate students presented their impressive research and class projects at the inaugural EPS Department Research Symposium. GEODES events consistently have high turnout and receive positive feedback, and department faculty and staff have expressed gratitude and support for GEODES' dedication.

In recognition of their positive impact on the EPS community, the University awarded GEODES the prestigious Chancellor's Achievement Award for Diversity in June 2016. This award recognizes university programs that promote diversity and inclusion on campus. GEODES leaders also presented an invited talk at the Expanding Potential Meeting at UC Berkeley in January 2016. Other meeting attendees, including diversity officers from local institutions, were impressed at all GEODES had accomplished in its first year.

EPS students and faculty discuss reasons they became interested in Earth Science.

GEODES is always looking for outside participation, be it a guest presentation, event ideas, or donations to support their programming. To learn more, see their website:

www.ucscgeodes.wixsite.com/home

GEODES Founders:

Grace Barcheck
Sarah Beganskas
Claire Masteller
Allison Pfeiffer
Danica Roth
Stephanie Taylor

Current GEODES Leaders:

Grace Barcheck
Sarah Beganskas
Carolyn Branecky
Stephanie Taylor
Victoria "Vicky" Yuan

"[I loved] that faculty, grad students, and undergrads were all gathered together talking about rocks 'n' stuff."

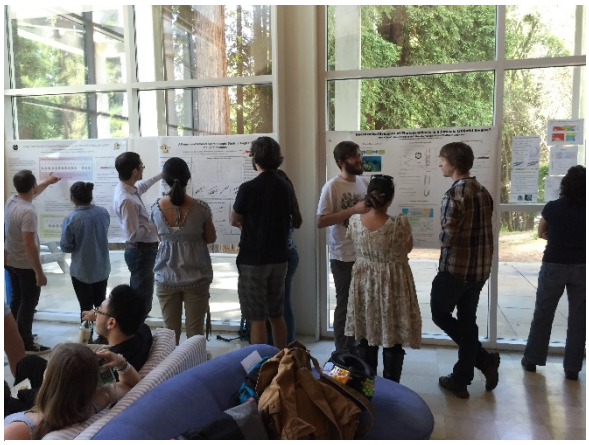
"The [career panel discussion] was an awesome idea … I learned a lot."

What students are saying about GEODES…

"The [science communication workshop] was incredibly well done [and] really helped me think about my AGU presentation."

"Peer discussion produced some interesting exchanges that I will take with me into future teaching and learning."

The EPS department gathers for the 2016 GEODES Fall Dinner.



EPS students present their work at the inaugural EPS Department Research Symposium.

Paleontology field class (Prof. Matthew Clapham, front row, third from left)

Grad/Undergrad degrees & awards

Graduate Degrees, 2015-16

Jonathan Perkins Fall 2015 (PhD)
"Unraveling the magmatic and geomorphic processes recorded in the topography of the Central Andes"

Karla Knudson Fall 2015 (PhD)
"North Pacific Climate, Ocean Circulation, and Productivity Over Millennial and Orbital Timescales"

Kerri Johnson Winter 2016 (PhD)
"Causes and Consequences of Meandering in Bedrock Rivers: How interactions between rock properties and environmental conditions shape landscapes"

David Finn Winter 2016 (PhD)
"Paleomagnetic Correlation of Yellowstone Hotspot Related Rheomorphic Ignimbrite in the Snake River Plain of Southern Idaho, USA"

Danica Roth Spring 2016 (PhD)
"Deciphering the seismic signal of sediment transport in rivers"

Mikael Witte Spring 2016 (PhD)
"Observational and Modeling Studies of Collision-Coalescence in Marine Stratocumulus"

Michael Nayak Spring 2016 (MS)
"Searching for Organics on the Dwarf Planet Ceres"

Sam Landis Spring 2016 (MS)
"Thermal Evolution of the Superior Craton: Accessory Phase U-PB Thermochronometry Constraints on a Diamond-Forming Event Younger Than 1.1GA Near Attawapiskat, Ontario"

Kyle Young Spring 2016 (MS)
"A high-resolution, regional-scale analysis of stormwater runoff in the San Lorenzo River Basin for Managed Aquifer Recharge decision making"

Graduate Awards

ARCS FOUNDATION AWARD:
Claire Masteller

J. CASEY MOORE FUND AWARD:
Dan Killam

ZHEN AND REN WU MEMORIAL FUND AWARD IN GEOPHYSICS:
Stephanie Taylor

WELLS FARGO COASTAL SUSTAINABILITY FELLOWSHIP AT UCSC:
Karla Knudson

CHANCELLOR'S ACHIEVEMENT AWARD FOR DIVERSITY:
GEODES – Geologists Encouraging Openness and Diversity in Earth Sciences (Founding Members: Grace Barcheck, Sarah Beganskas, Claire Masteller, Allison Pfeiffer, Danica Roth, and Stephanie Taylor)

WINNER OF THE UCSC GRAD SLAM ("THREE-MINUTE THESIS CHALLENGE")
Mikey Nayak

PRESIDENT'S DISSERTATION YEAR FELLOWSHIP (1 QUARTER):
Grace Barcheck
Allison Pfeiffer

THE EPS DEPARTMENT AWARD FOR THE BEST PRESENTATION AT THE GRADUATE RESEARCH SYMPOSIUM:
Mikey Nayak

THE CHANCELLOR'S GRADUATE RESEARCH PRIZE AWARD FOR OUTSTANDING PRESENTATION AT THE GRADUATE RESEARCH SYMPOSIUM:
Grace Barcheck

Grad/Undergrad degrees

COTA-ROBLES FELLOWSHIP (5-YEAR TOTAL SUPPORT):
Michele Markowitz

ADVANCED LIGHT SOURCE DOCTORAL FELLOWSHIP IN RESIDENCE FOR 2015-2016:
Earl O'Bannon

NATIONAL SCIENCE FOUNDATION (NSF) GRADUATE RESEARCH FELLOWSHIP PROGRAM (GRFP):
Carver Bierson
Galen Gorski

NATIONAL SCIENCE FOUNDATION (NSF) GRADUATE RESEARCH FELLOWSHIP PROGRAM (GRFP) - HONORABLE MENTION:
Michele Markowitz

NATIONAL SCIENCE FOUNDATION (NSF) EAST ASIA PACIFIC SUMMER INSTITUTE (EAPSI) FELLOWSHIP TO WORK IN TAIWAN:
Kyle Broach

CHAMBERS MEMORIAL SCHOLARSHIP FROM THE NORTHERN CALIFORNIA GEOLOGICAL SOCIETY:
Alex Nereson

NATIONAL DEFENSE SCIENCE AND ENGINEERING GRADUATE (NDSEG) FELLOWSHIP:
Mikey Nayak

AMERICAN MUSEUM OF NATURAL HISTORY (AMNH) LERNER-GRAY GRADUATE MARINE RESEARCH GRANT:
Dan Killam

UC INSTITUTE FOR MEXICO AND THE UNITED STATES (UCMEXUS) RESEARCH GRANT TO EXPLORE FOSSIL ASSEMBLAGES AS PALEOENVIRONMENTAL INDICATORS:
Kyle Broach

SEYMOUR MARINE DISCOVERY CENTER FRIENDS OF LONG MARINE LAB STUDENT RESEARCH AND EDUCATION AWARD:
Ana Martinez Fernandez
Karen Lykkebo Petersen
Michele Markowitz
Esra Mescioglu

BEST POSTER AWARD AT THE 2015 CENTRAL COAST GIS DAY:
Alex Nereson

MYERS OCEANOGRAPHIC AND MARINE TRUST RESEARCH GRANT:
Dan Killam
Ana Martinez Fernandz
Karen Lykkebo Petersen

INTERNATIONAL ASSOCIATION OF GEOCHEMISTRY (IAGC) PHD STUDENT RESEARCH GRANT:
Ana Martinez Fernandez

GEOLOGICAL SOCIETY OF AMERICA RESEARCH GRANT:
Karen Lykkebo Petersen

GEOLOGICAL SOCIETY OF AMERICA TRAVEL GRANT:
Claire Masteller

NSF TRAVEL GRANT TO THE "FEEDBACKS AND COUPLING AMONG CLIMATE, EROSION, AND TECTONICS DURING MOUNTAIN BUILDING" (FACET) WORKSHOP IN TAIWAN:
Kerri Johnson

COMPRES MEETING TRAVEL GRANT:
Earl O'Bannon

POSTDOCTORAL FELLOWSHIP FROM THE NATIONAL CENTER FOR EARTH SURFACE DYNAMICS FOR JOINT APPOINTMENT AT UC SANTA BARBARA AND UNIVERSITY OF NEVADA, RENO:
Kerri Johnson

Grad/Undergrad degrees

NSF POSTDOCTORAL FELLOWSHIP TO STUDY NONLOCAL HILLSLOPE SEDIMENT TRANSPORT AT THE UNIVERISTY OF OREGON:
Danica Roth

CAMPUS-WIDE OUTSTANDING TA AWARD (FACULTY NOMINATED):
David Finn

EPS DEPARTMENTAL OUTSTANDING TA AWARD (STUDENT VOTED):
Dustin Harper – Winner
Joel Edwards – Honorable Mention
Allison Pfeiffer - Honorable Mention
Summer Thresher - Honorable Mention

AARON AND ELIZABETH WATERS GRADUATE RESEARCH AWARD: (1 RECIPIENT THIS YEAR)
Carolyn Branecky

Undergraduate Degrees (BS/BA)
Irita Evelyn Aylward**
Erick Bear
Kalinda Bittner
Genesis L. Briceno
Mason C. Burdick
Elena Butler*
Stuart Camenson
Margaret Champeny
Sami Li Chen*
Alexandra Coblentz
Marshall Danese*
Andria De La Cruz
Steven Dibb*
Sarah Dondelinger
Faisal Fazliat
Mailys Harston
Seana Hood
Daniel Inglese
Ian Jimeno
Sean Justice
Paul Kee
Daniel Kennedy
Alexander Kreile*
Amber Krekorian
Andrew Kruger
Karen Li
Rachelle Lim
Amanda Loveless
Peter Luu
Susana Maltez
Basia Marcks
Kellen Nolen Martin
James Mcguire
Andre Mere
Ellen Mills*
Gary Milne
Devin Minnich
Clark Mizera
Ricardo Munoz
Christine Mylett
John Todd Ohman*
Julie Passantino
Lineda Pineda
Sarah Reuter*
Madeline Richards
Ramon Rivera
Natalie Rizzi**
Gillian Rooker
Aaron Rosenfield
Krista Sawchuk*
Jacqueline She Lin Sinn
Ariel Stavley Parker
Brian Stiebel**
Stephany Subdiaz*
Alexander Swatzell
Jay Tan
Matthew Testo
Sarah Tidwell
Jason Tran
Jeff Venfossen
Kelsey Warkentin
Daniel Williams
Mitchell Williams

* Candidate for Honors
** Candidate for Highest Honors

Grad/Undergrad degrees

Undergraduate Awards

HOLLY DAY BARNETT MEMORIAL SCHOLARSHIP:
Maia Hoffman

KATHRYN D. SULLIVAN AWARD FOR UNDERGRADUATE RESEARCH:
Kristina Okamoto

KENNETH & ANN THIMANN SCHOLARSHIP FOR OUTSTANDING GRADUATES ATTENDING GRADUATE SCHOOL IN THE FALL:
Sami Chen

PBSCI DEAN'S UNDERGRADUATE AWARD FOR OUTSTANDING SENIOR THESIS, ENTITLED: "FROM DIRT TO DIAMONDS: A MINERALOGICAL COMPARISON OF GRANULAR RHEOLOGIES":
Marshall Danse

ASSOCIATION FOR WOMEN GEOSCIENTISTS (SAN FRANCISCO BAY AREA CHAPTER), OUTSTANDING STUDENT AWARD:
Irita Aylward

SANTA CRUZ GEM AND MINERAL SOCIETY SCHOLARSHIP:
Brian Stiebel

SANTA CLARA VALLEY GEM AND MINERALOGICAL SOCIETY SCHOLARSHIP:
Krista Sawchuk

SMITH SOCIETY RESEARCH AWARD:
Kristina Okamoto

SOCIETY FOR THE ADVANCEMENT OF CHICANOS/HISPANICS AND NATIVE AMERICANS IN SCIENCE (SACNAS) AND THE GEOLOGICAL SOCIETY OF AMERICA (GSA) ON TO THE FUTURE (OTF) DUAL TRAVEL SCHOLARSHIP:
Sami Chen

GEOLOGICAL SOCIETY OF AMERICA (GSA) ON TO THE FUTURE (OTF) TRAVEL GRANT:
Kristina Okamoto

SPECIAL MERIT AWARD IN THE PHYSICAL SCIENCES AND ENGINEERING CATEGORY AT THE LOUIS STOKE'S CALIFORNIA ALLIANCE FOR MINORITY PARTICIPATION (CAMP) STATEWIDE SYMPOSIUM AT UC IRVINE:
Sami Chen

WEBER-HOLT GRANTS:
Drew Bogusz
Genesis Briceno
Ian Jimeno
Basia Marcks
Krista Sawchuk
Stephany Subdiaz
Brian Stiebel
Jason Tran

HONORS IN THE MAJOR:
Seana Hood

CANDIDATE FOR HONORS IN THE MAJOR:
Elena Butler
Sami Chen
Marshall Danese
Steven Dibb
Alexander Kreile
Amber Krekorian
Ellen Mills
John Ohman
Sarah Reuter
Krista Sawchuk
Stephany Subdiaz

HIGHEST HONORS IN THE MAJOR:
Sierra Keller

CANDIDATE FOR HIGHEST HONORS IN THE MAJOR:
Irita Aylward
Natalie Rizzi
Brian Stiebel

OUTSTANDING SENIOR AWARD:
Irita Aylward
Natalie Rizzi

My Geophysical Journey from UC Santa Cruz
By Richard G. Gordon

Richard G. Gordon (BA Geophysics 1975) is the Keck Professor of Geophysics at Rice University

It has been a pleasure reading accounts from other UCSC Earth Science Alumni of how they got to where they are now from their years at UCSC to the present. I am grateful for the opportunity to present my account in this newsletter. By way of introduction, I am a native Californian who grew up in the foothills of the Diablo Range in east San Jose, unknowingly living ~100 meters from the Hayward fault.

At the time of my graduation from UCSC, my ambition was to emulate Isaac Asimov, whose popular accounts of science inspired me through middle and high school and whose work in science fiction I also admired. He had received a Ph.D. in biochemistry and it made sense for me to get a Ph.D. in my chosen field of Earth Science. When I discovered Earth Science in my junior year at UCSC, Rob Coe was already on the faculty, Eli Silver joined the faculty that year, and Al Smith joined the following year, so it may have been the first opportunity for a UCSC undergraduate to get a broad education in geophysics. I immersed myself in the subject matter of the courses that all of them taught, and I have in my career published papers rooted in what I learned from all those courses (and from other UCSC Earth Science courses as well). At the time, the department did not yet have an official pathway to concentrate in geophysics, but my petition for an individual major in Geophysics, which included about ten courses in Earth Science and nine in Physics, was accepted by the administration. Besides geophysics, my course work included oceanography, mineralogy, stratigraphy and sedimentation, and the department's first offering of field camp in the Marin Headlands for which I did a small and successful paleomagnetic investigation of Franciscan Formation cherts (under Rob Coe's supervision with help from Joe Liddicoat).
From UCSC, I crossed the San Andreas fault to continue my education at Stanford University under the supervision of Allan Cox, whose work on establishing the reality of geomagnetic reversals and their chronology was essential to elucidating seafloor spreading and plate tectonics. In the summer of 1975 I was the field and laboratory assistant to another graduate student, Bob Simpson, who was using paleomagnetism to investigate the possible clockwise rotation of the Oregon Coast Range. After we spent a few weeks along and near the Oregon coast collecting paleomagnetic samples, Bob went away for a couple of months to do an internship at the USGS in Denver while I measured and demagnetized his samples and obtained promising results from both the Tyee Formation and the Fluornoy formation. I seemed on the path to pursue a Ph.D. in a similar endeavor. After two years of field and lab work on a project based in the Santa Ynez Range, however, Allan told me that it really didn't look I had any useful data and I had to start all over on a new Ph.D. project.

I thought, after two unproductive years, that to finish a Ph.D. in a reasonable amount of time, I needed a project that did not involve collecting any new data, and set out accordingly. One theme of my new dissertation plan was to investigate the motion of the plates relative to the deep mantle, a.k.a. "absolute" plate motions. From one of our geomagnetism research seminars, a fellow graduate student (Clay Harter) and I developed a new method for estimating absolute plate velocities from the torques applied at the edges of plates by ridge push or slab pull. We applied this to the problem of the origin of the bend in the

My Geophysical Journey from UC Santa Cruz (cont'd)

Hawaiian-Emperor island and seamount chain, a problem to which I was introduced in Eli Silver's course at UCSC and to which I have recently returned. We assumed that the bend reflected a change in the motion of the Pacific plate relative to a Hawaiian plume approximately fixed with respect to the deep mantle. We hypothesized that the change in plate motion was caused by the formation of new trenches subducting the Pacific plate in the west, southwest, and south Pacific.

A second theme of my dissertation was the determination of apparent polar wander paths, especially for the Pacific plate. The oceanic plates, including the Pacific plate, present a special challenge to traditional paleomagnetism because fully oriented subaerial paleomagnetic samples can be collected only on young volcanic islands—everything else is under water. Instead one must use other sources of paleomagnetic information: paleo-inclinations from azimuthally unoriented vertical cores, seamount poles (from analyzing the magnetic anomaly that they produced at the sea surface), equatorial sediment facies, and skewness (asymmetry) analysis of marine magnetic anomalies due to seafloor spreading (which I first learned about in Eli's class, and have recently returned to investigating).

I had heard Allan give a talk on paleomagnetic methods for oceanic plates at AGU during my senior year at UCSC. I knew that he had not been able to follow up on it and was not likely to do so with his new duties as Dean of Earth Science at Stanford. So, one day I went to his office and told him that he should have me take over the project. He seemed surprised but pleased. He gave me his notes and I went to work. I was able to make several improvements on his initial methodology and unify the formulation for some of the data types that initially seemed disparate. Then I went to work sifting through the large and diverse data set for Pacific plate apparent polar wander. I applied the results to tests of global plate motion circuits and the implications for the Hawaiian-Emperor bend and absolute plate velocities. Thus, I was able to tie together the different projects I had been working on and present them as a dissertation with a unified theme.

Part of this work did not make it into my dissertation but was published soon after. I had enjoyed Casey Moore's class in Sedimentation and Stratigraphy so much that at Stanford I followed it up with a course in Stratigraphy and Paleoecology taught by Jim Ingle. Somewhere in these courses, I learned about equatorial sediment facies, which record the passage of sites on the Pacific plate as they cross from the southern hemisphere to the northern hemisphere. A talented Stanford geophysics undergraduate, Cheryl Cape, and I used our interpretation of the age and distribution of these crossings to show that the Hawaiian hotspot used to lie farther north than its present latitude (marked by Kilauea volcano) and that this distance increased with age. Paleomagnetic data obtained from deep sea drilling had recently indicated a similar latitudinal shift, but our work provided more detail and demonstrated that the paleomagnetic results were not an artifact of non-dipole components of the paleomagnetic field.

Around this time I started to realize that I really liked research and that I had some aptitude for it. I began to think that perhaps I wanted the same sort of job as the professors with whom I interacted at UCSC and Stanford. I had spent a summer as a research seismologist at ARCO, and I liked it a lot, but I liked research in paleomagnetism and tectonics even more. So my idea of being a science (plus science fiction) writer began to morph into someone who wrote papers on their original research on science while also teaching.

My last year as a graduate student at Stanford, Seth Stein arrived as a postdoc working with Bob Geller, a new Assistant Professor. With Emile Okal,

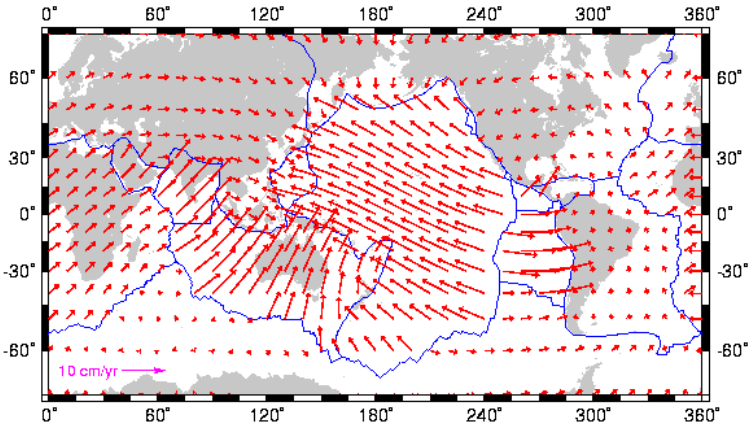
My Geophysical Journey from UC Santa Cruz

Seth had just published an interesting paper on the seismo-tectonics of the equatorial Indian Ocean, which suggested surprisingly high rates of deformation for a supposed plate interior. About the same time, Bernard Minster and Tom Jordan had just published a paper featuring RM2, which was their new global set of relative plate angular velocities. I began working with Seth on the subject of global plate motions. I coded up Minster's algorithm for plate motion inversion and wrote some new code for trying to find "diffuse plate boundaries" from plate motion data. Not long after, Seth accepted a faculty position at Northwestern University and a year later I did as well, which facilitated our continued collaboration. After some trials and tribulations, our work on plate motions, including NUVEL-1, our global set of relative plate angular velocities, became a big success. As part of the effort, two talented graduate students (Chuck DeMets and Donald Argus) and I re-analyzed all available magnetic profiles available across mid-ocean ridges in a self-consistent way that led to major revision to spreading rates around the globe, with especially large revisions to those in the Pacific Ocean. With Doug Wiens, who had recently finished his Ph.D. at Northwestern, we soon recognized two major diffuse oceanic plate boundaries and eventually recognized many others.

After 15 years at Northwestern University I moved to my present position at Rice University where I have been since 1995. Since leaving UCSC, I've had the privilege to work on tectonic problems from many angles including collecting new marine geophysical data in the Pacific and Indian Oceans, paleomagnetic field work in the western interior of the U.S., analog laboratory experiments, analytical models, numerical models and a lot of time spent on data analysis: paleomagnetic, marine geophysical, and space geodetic.

Despite being far from my native California, I have been able to do research relevant to California tectonics and seismic hazards with my favorite project probably being a holistic analysis (conducted with Donald Argus) of displacement and straining distributed across the San Andreas fault and coast ranges using boundary conditions determined from geodetic data from very long baseline interferometry. We showed that the rates of convergence (perpendicular to the San Andreas and other related strike slip faults) across the coast ranges, including the Diablo Range, is only a few millimeters per year, much smaller than many others believed at the time.

I've also had the privilege of working on many problems on global tectonics, which continue to inspire me. Today I am actively pursuing research on Pacific plate apparent polar wander, the hotspot reference frame, the processes by which "rigid" plates slowly deform, and the rheology of, and processes deforming, oceanic lithosphere in diffuse plate boundaries. For me, being a Professor of Earth Science is the best job in the world.



NUVEL-1 plate velocities in the no-net-rotation reference frame

Sami Chen graduated in 2016 and is now doing a PhD at Stanford. Here she writes about her experiences at UCSC.

While I was at UC Santa Cruz, the Earth Science and Ocean Science departments opened the door to numerous opportunities in the classroom and through research for me to explore the ocean and ongoing climate change. I developed my profound love for the ocean at an early age through numerous tide pooling, boogey boarding, and surfing adventures. During my undergraduate studies as an Earth Science major with an Ocean Science concentration, I found my love for science. I conducted research in three laboratories that explored marine microbiology, marine geochemistry, and paleoceanography and continued to chase after a remote sensing project started as a final class project. Each of these experiences gave me a better understanding of my course material and shaped the way I see the world around me today.

As a surfer, I naturally gravitated towards marine science course work. In Dr. Matt McCarthy's introductory oceanography course, I learned about how ocean acidification is negatively impacting marine ecosystems. In the summer after my freshman year, I met Dr. Eric H. De Carlo, who studies ocean acidification at the University of Hawai'i at Manoa. When I shared with Dr. De Carlo that I had written about ocean acidification for my final paper in Dr. McCarthy's course, he offered me a position in his laboratory for the following summer. In preparation for my research in Dr. De Carlo's lab, I obtained my scientific SCUBA diving license through UCSC's diving program. Dr. De Carlo additionally suggested that I look into undergraduate research opportunities at UCSC.

I started research focusing on how marine bacteria influences growth and toxicity of *Pseudo-nitzschia* with Dr. Sison-Mangus the fall of my sophomore year. *Pseudo-nitzschia* is a marine diatom that produces a neurotoxin called domoic acid (DA). *Pseudo-nitzshia* produces domoic acid as a stress response to multiple factors including light, nutrients, and bacterial symbionts. In recent years, there has been an increase in the toxicity and frequency of bloom events, which may be linked to

Sami receiving a California Alliance for Minority Participation award at UC Irvine

altered microbial community structure associated with anthropogenic stressors. In the process of identifying bacteria that elevated *Pseudo-nitzschia multiseries* growth and toxicity, I learned to conduct genomic identification of bacterial communities (as well as how to count 11, 637 *Pseudo-nitzschia* cells under a light microscope). This experience taught me the importance of focusing in on smaller scale processes.

During the summer after my sophomore year, I worked with Dr. De Carlo to address how ocean acidification is influenced by variations in coral reef environments around coastal Oahu. I used my scientific diving license to work on oceanographic instruments and collect pore water and surface water samples from three different coastal sites. Kaneohe Bay is a protected embayment with large freshwater inputs and long seawater residence times while Kilo Nalu and the Ala Wai are nearshore open ocean sites on the south shore of Oahu. In the laboratory, I analyzed total alkalinity (A_T), an important component of the marine inorganic carbon system. A_T can be used to calculate the entire CO_2-carbonic acid system when

Sami Chen (cont'd)

one other parameter is known (i.e., pH, dissolved inorganic carbon-C_T, or pCO_2). A long-term record of the CO_2-carbonic acid system allows for comparison between Hawaiian reef waters and other tropical marine ecosystems. I learned how the different geochemical conditions between Kaneohe Bay, Kilo Nalu and the Ala Wai influence how the coral reefs respond to increasing threat of ocean acidification. Following my summer research, I presented my results at the American Geophysical Union (AGU) Fall Meeting in December 2014. AGU opened my eyes to the diverse spectrum of ongoing geoscience research and made me eager to continue my own research.

I became intrigued by the application of stable isotopes in paleoceanography to address the mechanisms of climate change while taking Dr. Christina Ravelo's Marine Geology course. For my senior thesis, with Dr. Ravelo, I used marine sediment core samples from the Axial Seamount, Juan de Fuca Ridge, to explore how global climate change affects regional upwelling in the California Current from Marine Isotope Stage 3 through the Last Glacial Maximum and Holocene. In waters above the Axial Seamount, cool nutrient-rich upwelling within the California Current results in dynamic interactions between circulation and biological productivity. This research opportunity taught me about how changes in sea surface temperature and nutrient utilization are linked to larger scale cycles that influence our climate. Changes in the size of Cordilleran, Innuitian, and Laurentide ice sheets influence placement and strength of the Aleutian Low and North Pacific High pressure systems, which in turn impact precipitation patterns and upwelling strength in the NE Pacific Ocean. These insights on past climate change lay the foundation for understanding complex ocean and climate dynamics. My experience in Dr. Ravelo's lab allowed me to better understand paleoceanography. Dr. Ravelo's support as an advisor and incredible role model helped pave the way for my graduate studies.

Picking forams in Christina Ravelo's lab

Aside from coursework and research, I participated in MESH (Mixed Ethnicities Student Headquarters), SANAI (Student Alliance of North American Indians) and the UCSC STEM Diversity Program. Each organization provided a space for me to explore my identity and form a deeper sense of community. When I attended the Society for the Advancement of Chicanos/ Hispanics and Native Americans in Science (SACNAS) and Geological Society of America (GSA) National Conferences during the Fall of 2015 on a dual conference travel scholarship, I was exposed to speaker sessions that connected my passions for community, identity, and science together. At SACNAS, I was really inspired by Dr. Margaret Hiza Redsteer's talk about connecting traditional oral knowledge of climate change with current climate change studies.

Following the conferences, I looking at changes in snowpack in the Chuska Mountains of Navajo Nation for as a final project for Dr. Eli Silver's Remote Sensing course. The Chuska Mountains, located along the northern border between Arizona and New Mexico, attract more annual precipitation than any other part Navajo Nation and contribute substantially to fresh water supply in the Navajo Nation. (1) Multiyear long droughts and warming temperatures lead to significant declines in water supply. 25-40% of people in Navajo Nation currently do not have access to running water and instead rely on hauled domestic water. (1-3) Changes in annual snowpack

Sami Chen (cont'd)

may further impact cost and access to drinking water as snow acts as a significant form of water storage. I used Landsat 4-5 TM and Landsat 7 scenes of the Chuska Mountains and ENvironment for Visualizing Images (ENVI) software to analyze changes in snow deposition. In order to separate snow and ice pixels from non-snow and non-ice pixels, I used Normalized Difference Snow and Ice Index (NDSII). NDSII uses red and infrared spectral bands to distinguish snow and ice pixels from surrounding vegetation, clouds, and soil. To quantify snowpack cover, I used density slices to separate snow/ice pixels from non-snow/ non-ice pixels and then calculated the total snow cover area by multiplying the number of pixels defined as snow/ ice by pixel size. The density slice thresholds were adjusted to account for three types of snow cover scenes: low snow, medium snow, and high snow to minimize overestimates and underestimates of snow cover. Since taking Dr. Silver's course, I have continued this project working in the computer labs at UCSC and now at Stanford. I collaborate with Dr. Redsteer over the phone and email and recently presented a poster on this project at the SACNAS 2016 National Conference.

Each of my research experiences supplemented what I learned in the classroom and gave me a deeper understanding of how the Earth and Ocean function. I learned through my course work how much I appreciate the questions addressed by Earth Science research and chose to move to terrestrial systems for my graduate studies. The EPS department allowed me to transform my passions/interests from a love for the ocean into a deeper appreciation for all of Earth's intricate processes and a strong desire to pursue a research career in Earth Science. Since graduating in June 2016, I have been fortunate to continue my studies as a PhD student in the Geological Sciences department at Stanford under the advisement of Dr. Kate Maher. For my graduate studies, I will be working with local farms in Pescadero, CA to study the soil geochemistry and groundwater dynamics. This builds off the tools in my course work and undergraduate research experiences. The project will examine water and land use, hopefully leading to a model of how the water moves through the farms. Additionally, I intend on additionally advancing the Chuska Mountain snow project as I continue to learn more about remote sensing. Ultimately, I want to combine geochemistry and hydrogeology analyses with remote sensing techniques in order to better understand growing water issues.

Diving in the Kelp Forest Tank at the Monterey Bay Aquarium for Scientific Diving Class
Photo credit: Donna Linda

I am grateful for the many opportunities I had while at UC Santa Cruz and would like to acknowledge the tremendous support I had from the Earth and Planetary Sciences department, Ocean Sciences Department, Ravelo lab group, Sison-Mangus lab group, Dr. Eli Silver, Yulianna Ortega, Malika Bell, Xingci Situ, Zia Isola, STEM Diversity Program, Disability Resource Center, MESH, SANAI, SACNAS, and my wonderful fellow Earth Science classmates and instructors. Wherever my research takes me, I know that I will always be a banana slug at heart.

A "finer scale" for Geochronology: Measuring fine-particle production timing in ice, rivers, faults and extraterrestrial bodies

By Terry Blackburn

Terry Blackburn is an Assistant Professor in EPS

The field of Earth Planetary Sciences has undergone a massive change in the last 20 years, with an ever-expanding catalog of "geo-" sub disciplines and the increasing specialization within long-established fields. Through this change, geologic time and the ability to measure it using radioisotopic techniques has remained the common thread linking these fields. Indeed, as a historical science, we all rely in some way on "dates and rates" to study our environment. Because of this central role, Earth Science has benefitted from several massive leaps in knowledge that have been largely driven by method development in radioisotopic dating. One dramatic example is Claire Patterson's determination of our Solar System's ~4.5 billion year old age. Beyond fueling imaginations as to what could has occurred over such an expansive amount of time, these first meteorite ^{207}Pb-^{206}Pb age determinations triggered a cascade of investigations into the health and environmental effects of human-sourced Pb that is arguably the most significant contribution our field has given to human society.

First year PhD students Graham Edwards (left) and Gavin Piccione (right) dig a trench to collect the Mono Basin moraine found at Bloody Canyon, a location just north of Tioga pass that preserves at least 3 discrete glacial advances. Undergraduate Dylan Tasker in background. Photo credit Brian Dreyer (UCSC)

Such methodological advancements continue. Within the last 30 years, the rates of magmatic processes, global sea level and climate change have been dated, in part by use of the "U-series" isotopic systems. Going back to the late 80's Isotope Geochemistry at UCSC played a central role in developing U-series analytical techniques, with a focus on dating Earth's most active magmatic systems. Much of UCSC's infrastructure for these studies remains today –to the benefit of my group as we work to develop a new application with U-series isotope geochemistry.

The U-series describes the decay chain of radionuclides that exist as "intermediate nuclides" during the transformation of parent ^{238}U to the stable daughter ^{206}Pb, for example ^{234}U, ^{230}Th and ^{226}Ra. And because each member is radioactively unstable, the relative abundance of any two nuclides is usually fixed in a state of equilibrium by

The well-dated Bishop tuff (760 ka) anchors the age of the underlying Sherwin Till, where cosmogenic dates indicate exposure of 50 Ka prior to eruption—tight bounds with which to hone comminution-dating techniques.

their decay constants. The use of these isotopes as a clock only arises when a nuclide is thrown out of equilibrium. Most geologic applications of the U-decay chain exploit the *chemical* separation among the decay chain members, for example, the loss in ^{230}Th which occurs in natural forming ocean coral permit direct dating of their formation.

One additional source of disequilibrium can arise from the physical ejection of intermediate daughter products of the U-series decay chain by the "recoil" experienced during high-energy decay. In short, the radioactive decay is so energetic that the resulting daughter moves up to 0.03 microns or more within the crystal lattice—movement that can result in the loss of nuclides at the crystal edge. And while this *physical* disequilibrium occurs in all particles, it is only in very fine particles, with a relatively high surface area relative to grain volume, that our mass spectrometers can detect their loss. So called "comminution dating", this system can place time constrains on when particles are reduced from a large particles in equilibrium, to fine particles that lose more intermediate daughters as time progresses.

This sensitivity to particle size makes this a unique geochronologic system, one that can be used to date the timing of glacial action, as ice breaks bedrock down to glacial flour. Just a few hours drive from Santa Cruz, the Sierra Nevada preserves record of at least 3 major glaciations over the last 800 thousand years. First year graduate Gavin Piccione is working along the Eastern Sierran front, and Yosemite National Park (collaborating with park geologist Greg Stock, PhD UCSC) to test and improve the accuracy of this chronometer. While not only scenic, this field area is ideal due to the near-continuous volcanism that stratigraphically brackets glacial moraines and thus provides independent time constraints on deposits of glacial till. In one example, the 760 ka bishop tuff lies above the Sherwin till in what has to be a recognizable outcrop for many of who attended

UCSC Isotope Laboratory upgrades include a new NSF-funded TIMS.

UCSC field camp in the region. Samples from these locations have proven invaluable as Gavin works to develop laboratory protocols, improve age accuracy and construct a revised glacial timeline for the region.

Such exploratory work is rather harmonious in our lab group as our facilities have expanded and improved over the last 2 years. Our clean lab facilities, located in the W.M Keck Isotope lab completed a massive refurbishment in 2015. Just this summer we've installed a brand new NSF-funded Thermal Ionization Mass

Spectrometer (TIMS) and thanks to the hard work and expertise of UCSC EPS technical staff members Daniel Sampson, Brian Dreyer and Rob Franks, the Neptune Multi-Collector Induced Plasma Mass spectrometry has emerged from a multi year "rest". Having all of these tools in-house is not only essential to training students but for this experimental work

Development of this tool has allowed us to take inspiration from and work collaboratively with other UCSC faculty, researchers and alumni as we pursue dating fine-particle production in a variety of environments. Working with Graniterock geologist John Erksine, (UCSC MS), UCSC Professor Emily Brodsky and postdoctoral scholar Shalev Siman Tov, undergraduate Dylan Tasker ('16) has collected comminuted granite samples from gauge zones within the San Andreas fault system, exposed within the Logan quarry, Aromas, CA. Tasker is working to date the timing of past fault motion and hopes this could provide a new tool aiding in seismic hazard assessment. In a collaboration with UCSC Professor Ian Garrick-Bethell we are looking towards dating the production of fine particles that occurs on the lunar surface. Our Moon is entirely covered with a meters thick "regolith" of comminuted rock that to this day is evolving due to meteorite impacts both big (rare) and small (common). It is our hope that this study will inform the rate of meteorite impacts and the age of lunar surfaces. Finally, in another glacial application, first year PhD student Graham Edwards, Professor Slawek Tulaczyk and myself are investigating the past glacial history of Taylor Valley, one of the McMurdo Dry Valleys located within the Transantarctic Mountains, Antarctica. With field work schedule for late fall of 2017, we'll be collecting samples from glacial features deposited over the last few million year, a time over which polar conditions are though to have limited active glacial erosion. Dating silt production within the Valley will test whether any recent erosion of the valley floor has occurred, a process thought to drive isostatic uplift of Transantarctic peaks.

Ongoing and future projects include dating fine particle production: in Santa Cruz, including rivers, beaches and within the Marine terraces (highlighted in red left); along fault surfaces (middle left); within the Antarctic Dry Valleys (middle right); and on the lunar surface (right)

Salmon, sediment supply and the fine rivers of the West Coast

By Allison Pfeiffer

In 2012, I came to Santa Cruz to work on a Master's project with Noah Finnegan comparing the spatial distribution of salmon spawning habitat to geomorphic predictions of riverbed surface grain size. The project was a collaboration with the National Marine Fisheries Service (NMFS). Using high resolution LiDAR-derived Digital Elevation Models (DEMs) and basic geomorphic principles, I made a map of predicted riverbed surface grain size throughout Scott Creek, a local drainage that meets the ocean just north of Davenport. The goal was to compare the distribution of suitably sized spawning gravel to steelhead trout (*Oncorhynchus mykiss*) and coho salmon (*O. kisutch*) spawning data collected by NMFS. When salmon return to their natal streams to spawn, they excavate depressions in the gravel in which they lay their eggs. Coarse grained, cobble- and boulder-covered reaches make for sub-optimal spawning habitat because most particles on the bed surface are simply too large for a salmon to move. In this way, modeled bed surface grain size should be a good predictor of salmon habitat suitability.

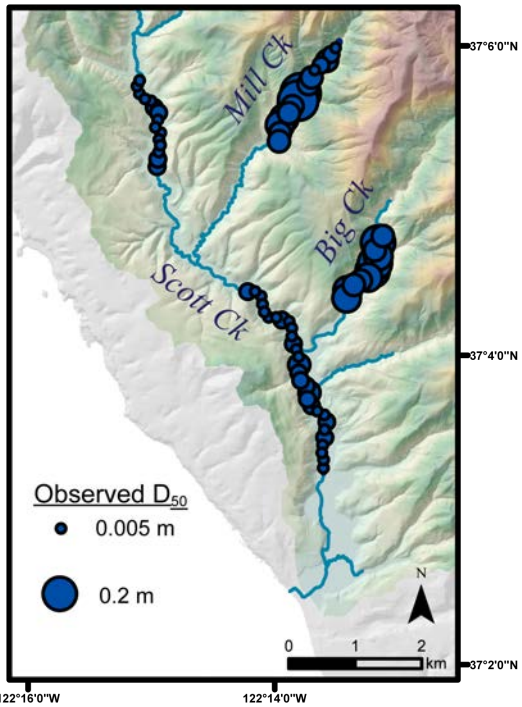


Figure 1. Scott Creek drainage. Blue circles are sized by the median measured bed surface grain size (D_{50}).

Allison Pfeiffer is a final-year graduate student in EPS

Leveraging the bright-eyed enthusiasm of UCSC EPS undergraduates, I gathered field measurements of grain size at sites throughout the drainage **(Figure 1)** to check our grain size predictions. After a summer of collecting field data, we compared our measurements to predictions and ran into a problem: the predicted grain sizes in Scott Creek were off—systematically **(Figure 2)**. Predicted median grain size was more than three times higher than the grain sizes we measured in the field. The consistency was convenient, and the mismatch could be solved

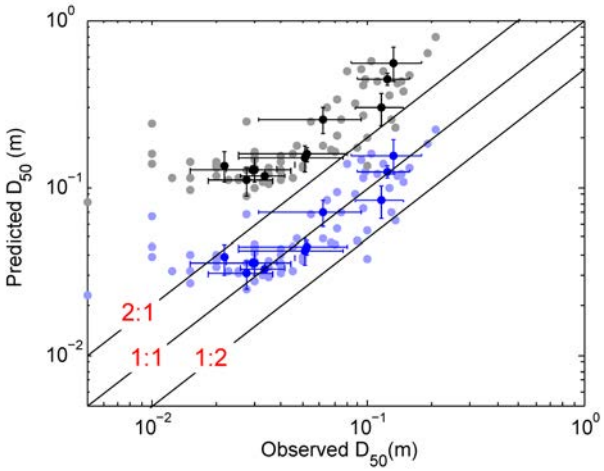


Figure 2. Comparison of field-measured and predicted river bed surface grain size, assuming a threshold channel (grey dots, black dots show reach averages), and using an empirically calibrated partitioning coefficient (light blue dots, reach averages in dark blue).

using a single calibration coefficient (blue points, Figure 2), but the underlying process was vexing. Commonly used geomorphic principles were failing us.

Compiling data from elsewhere in the region I found a similar phenomenon: river bed grain size was systematically smaller than the standard predictions would suggest. A key assumption underlying our predictions was that California coastal creeks fit the 'threshold channel' model. Threshold channels are ones in which the median sized grains on the river bed surface begin to move when flood levels reach the top of the channel banks. Geomorphologists tend to assume that all gravel bedded rivers are threshold channels. This assumption is supported by theory and decades of field data from a diverse range of places including Alberta, the UK, Colorado, and Maryland. Why, then, don't the local rivers conform to the standard model?

Inspired by the quandary, I switched from a MS to a PhD and dove in to the question: *why are the rivers of the West Coast so exceptionally fine grained?*

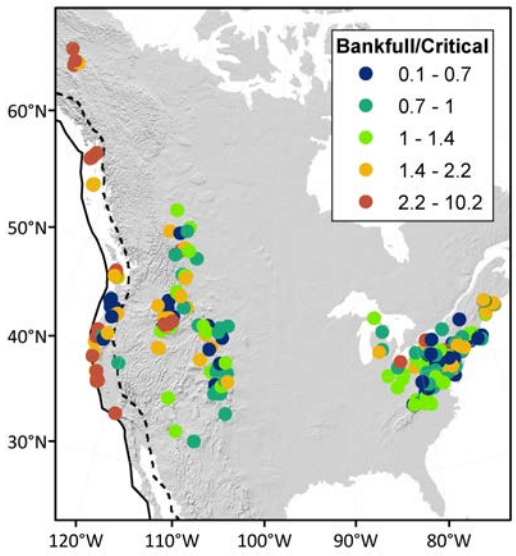


Figure 3. Compilation of gravel-bedded river data. Sites are colored by the ratio of bankfull Shields stress to critical Shields stress. 'Threshold channels' ($1< \tau^*_{bf}/\tau^*_c <1.4$) are colored in grass green. Note that a) most channels aren't threshold channels(!), and b) that τ^*_{bf}/τ^*_c is high across most of the West Coast.

Suspecting that sediment supply might be the culprit we worked with collaborator Professor Jane Willenbring, a professor at UCSD, to compile two continent-wide datasets: one of >300 gravel-bedded rivers, and the other of >600 basin-wide erosion rates, which we use as a proxy for sediment supply. Normalizing to compare across rivers of many sizes, we find that bed surface grain size is significantly smaller in West Coast river reaches than in river reaches across the rest of the continent **(Figure 3)**. As you might expect, erosion rates are also significantly higher along the tectonically active West Coast. The data we compiled show that normalized bed surface grain size decreases as a function of sediment supply. These finding suggest that the seeming ubiquity of 'threshold channels' may simply reflect the fact that the sediment supply to most rivers is quite low. Our California coastal rivers, on the other hand, are bombarded with high sediment supply, making their beds exceptionally fine grained. While many researchers have recognized effects of sediment supply on riverbeds, the link to equilibrium channel geometry is a new addition. We are excited to see this work spur further conversations in the geomorphology community about the complexity of equilibrium channel

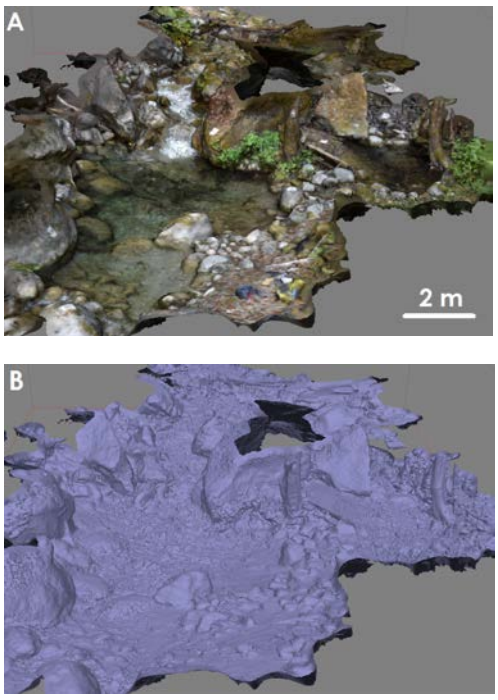


Figure 4. Structure-from-motion 3D modeled surface of a reach in Big Creek, Big Sur. a) colored model, b) shaded relief model.

geometry.

With a year or so left at UCSC, I am taking advantage of my time in coastal California by squeezing in a last bit of local field work. The final chapter of my dissertation has me studying riverbed grain size in the stunningly beautiful Landels-Hill Big Creek Reserve in Big Sur. There, I'm exploring the controls on gravel patch distribution in an otherwise cobble- and boulder-bedded river. The project in Big Sur brings me full circle: the creek I'm studying is home to endangered steelhead trout, which may be using these scarce gravel patches to spawn.
Instead of mapping clusters of gravel by hand in the field, I'm experimenting with structure-from-motion photogrammetry to build extremely high resolution (~5 cm x 5 cm) DEMs. This involves photographing the bed of the creek from many angles, in this case using a camera mounted on a 3 m pole. I call it the 'Giant Selfie Stick for Science'. Back on campus, I run these photos through a program that finds common points in multiple photographs to build a 3D model of the surface **(Figure 4)**. Moving forward, I'll use this 3D model to automatically identify patches of gravel.

While many graduate students do exotic, far-flung field work as a part of their dissertations, I am happy to have stayed local, working primarily in the gravel bedded rivers of the California Coast Ranges. Two of my projects have taken place on research reserves, Cal Poly Swanton Pacific Ranch (home of Scott Creek) and the UC Landels-Hill Big Creek Reserve. I feel lucky to have had ongoing access to these protected lands— as anyone who has struggled with skeptical land owners may understand. The local field work has also made it easy to involve UCSC EPS undergraduates. In addition to ~15 short-term assistants, I've had the fortune of working with three undergraduates on their senior theses: Neal Hetzel (2014) explored the relationship between large in-channel wood and riffle spacing; Madeline Richards (2016) investigated channel morphology and sediment supply in the Santa Cruz Mountains; and Sarah Reuter is currently working on the relationship between immobile boulder protrusion and sediment supply. These collaborations have been a great way to get me out of the office more often. You can't ever see too many rivers, you know?

We hope to see you at the Thirsty Bear Brewing Company for our

16th Annual UCSC Earth & Planetary Sciences Alumni Event at Fall AGU!

When? **Tuesday, December 13, 2016**
from 6:00pm - 8:30pm

Where? **Thirsty Bear Brewing Company**
661 Howard Street
San Francisco, CA 94105
http://www.thirstybear.com/ *Fiat Slug!*

Alumni Notes

1974

Robert Aston, MS: I have been working in the area of underwater video monitoring for the last 10+ years. If you think our work would be of interest, you could use any of the information from our website (www.oceanpresence.com).

1978

Ken Johnson, BS: Ken Johnson is currently a Senior Technical Principal Geological Engineer at WSP|Parsons Brinckerhoff in San Francisco where I am working on a variety of infrastructure projects with diverse geological issues. From leading the geological and geotechnical design of the Central Subway project in SF (yes the one that still snarls traffic around Union Square and Moscone Center!) I am working on some deep combined sewer outfall tunnels in limestone in St. Louis, Mo.; Instrumenting and stabilizing a perennial landslide on Many Glacier Road in Glacier National Park; and working on extending BART into downtown San Jose and Santa Clara from the soon to open Warm Springs and Beryessa Stations. The work I am currently doing for the Central Subway project during construction involves mapping all the tunnel faces as the excavation of the Chinatown Station is being excavated beneath Stockton Street - up close and personal with the Colma Formation and the Franciscan Melange! (See attached photo).

1982

Ray Wells, PhD: Welcome to the golden years! It has been an eventful year for us. Sally and I sold our house in La Honda and moved to Portland, OR to help take care of her elderly parents. I retired July 2nd to an Emeritus position with the USGS in the Portland office. I'm still working on convergent margin tectonics, most recently with fellow grad student Rob McCaffrey, who lives down the road in Hood River. I'm still mapping in the Columbia River Gorge as part of a large USGS Columbia Corridor project. However, I have taken the year off from field work to recover from surgery on my cervical spine (must have been that old motorcycle crash in the 60s..). Sally and I look forward to spending some time fishing for steelhead on the Deschutes this fall.

Linda Angeloni, BS: After 24 years in Montana, it's time for a change. For the past two years, I've been a full-time ski instructor for VailResorts. But I miss geology and scientific endeavors. I want to get back to my other passion. If anyone needs a research assistant, I'm ready.

John Childs, PhD: Childs Geoscience is still providing geologic, database and resource assessment consulting services to the exploration and mining industries from our offices in Bozeman, Montana. I am still trying to ease myself out of the business so if there are people out there who would be interested in taking over please get in touch. In the last few years we have had projects in BC, Quebec, Newfoundland, Mexico, Honduras, New Zealand, the Western US, and Alaska. It has been a great ride.

1983

Rich Gunderson, MS: After 32 years of working in the geothermal business for Unocal and Chevron, I've retired also. Of those 32 years, my family and I lived in Indonesia for 9 years where I worked on development of the Salak geothermal

field, and was exploration manager for the discovery and appraisal of 2 Sarulla fields in North Sumatra. Those fields will be coming into production in 2017. In my time in Indonesia I got to travel to most parts of the archipelago, both for work and for pleasure, staying in hotels ranging from -1 star (an actual rat's nest beneath the pillow) to 5 star Bali resorts. The rest of my career I lived Santa Rosa, CA and worked on development of The Geysers field, and exploration of geothermal areas mostly around the Pacific Rim. My most recent project before retiring was the study of the fracture systems in 4 large developed geothermal fields. Imagine all the fun that can be had studying over a million feet of fractured volcanic rocks with actively circulating hydrothermal fluids! Most recently I've worn out one of the knees that I was born with, and so I had it replaced a week ago. I'll be hobbling around in rehab through the end of the year, and then after that I'll be hiking, kayaking, gardening, traveling, occasionally working, and otherwise keeping busy in retirement.

1985 &1990

Ahmed El-Shishtawy, MS 1985 & Ph.D 1990: Having been awarded a coveted Camp David Peace Fellowship in the early 1980s, Ahmed chose to come to UCSC from Egypt and in 1985 completed a MS thesis on the diagenesis of Tertiary carbonates in Egypt. One year later he returned to Santa Cruz to expand this research to diagenetic studies of siliceous rocks in his Ph.D. thesis, after which he joined the faculty of the Dept. of Geology at Tanta University, one of the largest universities in Egypt with around 100,000 students and located in the central part of the Nile Delta. Following retirement a year ago, he continues teaching and research in Tanta as an Emeritus Professor. His research over the past few decades has continued to focus on the stratigraphy and sedimentology of Tertiary units in Egypt. More recently he has been involved in several projects dealing with ground water and environmental issues. This includes studies of dissolved metals in Nile Delta aquifers with researchers from the University of Texas at Austin; and, collaborating with researchers from Penn State Univ., investigations of groundwater and soil corrosion at the Hierakonolis Temple site near Idfu, one of the oldest Egyptian temples containing structural remnants as old as 3500 BCE. His most recent work is on the therapeutic thermal brines in oasis regions of the Western Egyptian desert. Over the years he has supervised more than 30 MSc and PhD theses, was the Head of the Educational Technology Department at the Faculty of Specific Education (Tanta University), served as the Executive Director of the Information and Communication Technology Project (ICTP) at Tanta University and now is the Vice Executive Director for Tanta University's Management Projects. In 2010 he received a diplomatic appointment as Cultural Attaché in the Egyptian Embassy in Muscat, Oman where he served for three years.

George Williams, **BS**: Eli was the first Earth Science professor I met at UC Santa Cruz, due to my interest in Marine Geophysics. I live and work in the Greater Seattle area with my wife, two children, and our Australian Kelpie dog, named Chrissy. I continue to work and grow in the areas of Data Analysis & Data Management (*Business Intelligence & Geographic Information Systems [GIS]*) and Project Management *(certified PM – CompTIA's PROJECT+*) consistent with my MBA degree in Information Technology Management (*emphasizing Relational Database Technology & Quantitative Analysis*) earned in 2002. Professionally, I most recently worked as a Data Program Manager for The Hacker Agency in downtown Seattle from early 2015 into early 2016, managing Business Intelligence and Marketing Campaign Data for direct marketing campaigns on a few projects for Insurance Industry and Cellular Phone Industry clients. Unfortunately I was laid off in February 2016 when Hacker lost a major client and needed to downsize staff accordingly. I continue to provide freelance IT & Business services under the business name of Applied GeoData LLC (www.appgeodata.com). I recently produced and co-authored an online training program on

the subject of ***using GIS to build Location Intelligence*** for a firm named, E-Learning Curve (ELC). The ELC course has been available since June 2016 at http://ecm.elearningcurve.com/Location_Intelligence_p/ba-04-a.htm. I write a blog (http://appliedgeodata.blogspot.com/) on the merits of Location Intelligence and advocate for the use of Geographic Information Systems (GIS) for business purposes, and I continue to serve on the board of The Data Warehousing Institute's (TDWI) NW Chapter as their Membership Coordinator (https://tdwi.org/pages/chapters/seattle/home.aspx). And finally I remain academically active, I am always taking continuing education courses and seminars in various technical subjects – Agile/Scrum Project Management, Business Intelligence, Data Mining, Programming, Database Technologies, GIS, Open Source Tech, and Big Data – as technology is constantly changing and evolving. I am always glad to connect with fellow Banana Slugs on LinkedIn (https://www.linkedin.com/in/geowill2) George Williams, MBA, CPM

1987

David Smeeth, BA: David continues to enjoy teaching at Verde Valley School, a small boarding international high school in Sedona, Arizona. This year he is teaching physics for the first time and taking a project based approach with students building rockets, firing projectiles, trapping the flow of heat, and other fun stuff.

1989

Lisa D. White, Ph.D.: Born in San Francisco, the Bay Area has been the center of her life and career. She came to UCSC in 1984 after graduating from San Francisco State Univ. and completed a thesis that utilized her expertise in diatom micropaleontology to advance understanding of the paleoceanography of the Monterey Formation as well as diatom-rich sediments recovered by ODP Legs 127 (Japan Sea) and 170 (Costa Rica Margin) both of which she participated as a shipboard scientist. She then joined the faculty of her alma mater, SFSU, where over a 23 year career she advanced to Full Professor and along the way served as Dept. of Geosciences Chair, and Associate Dean of Graduate Studies and of the College of Science & Engineering. From the beginning of her career, Lisa has maintained a strong interest in promoting diversity in the geosciences. While at SFSU she combined ongoing research on diatom biostratigraphy with geoscience diversity efforts, including four government-funded programs, such as the NSF-supported "Minority Education through Traveling and Learning in the Sciences: METALS" and "Reaching Out to Communities and Kids with Science in San Francisco (SF-ROCKS). These innovative projects gained national recognition, resulting in her appointments to several National Research Council committees on geosciences and workplace diversity and to the Geological Society of America Committee on Diversity. Awards recognizing these efforts include the GSA's first Bromery Award for Minorities (2008), an honor bestowed upon a geoscientist who has been instrumental in opening the geoscience field to other minorities; and election as Chair, President's Advisory Committee for University Relations, University Corporation for University Relations Atmospheric Research (UCAR). In 2012 she was appointed as the Director of Education and Outreach at the University of California Museum of Paleontology in Berkeley. Among other responsibilities, in addition to continuing her outreach efforts on a national scale, she coordinates a major initiative funded by the Moore Foundation aimed at synthesizing the complexities of global change (*Understanding Global Change*) in a comprehensive web resource for educators and others. Recognition of her continued paleontologic research combined with her educational initiatives led to her appointment as a Member of the Ocean Science Board, National Academy of Sciences, and election as Councilor of the GSA and as a Fellow of both the GSA and the California Academy of Sciences. In the fall of 2015, Lisa was featured in two episodes (Origins and Human) of a 3-part NOVA Series, *Making North America*, narrated by the Director of the Smithsonian Kirk Johnson, with highlights of the San Andreas Fault and a Sierra Nevada gold mine.

1990

Patricia Thompson, BS: Patricia is a management consultant in the Bay Area. She has been married to fellow slug and physicist (Jacob Wilbrink '88) since the start of the Anthropocene. Prior gigs include: water sampling and rig minding, CU Law student Editor-in-Chief of international environmental law journal, energy start-up, Board member international behavior change nonprofit, regulatory advisor and researcher with North American Energy Utilities, TA for MOOC on behavioral economics, SAHM and UCSC beer czar.

1992

Lisa Campbell, MS: I came to Boulder, Colorado in '92 to work on a PhD in Isotope Geochemistry with Dr. Lang Farmer (Precambrian crustal genesis in northern Labrador and west Greenland). I was awarded a Fulbright Scholarship to work with David Bridgwater at the University of Copenhagen in 1994-95. I completed my PhD from University of Colorado, Boulder in 1997. In 1998 I went to work with Conoco oil company (now ConocoPhillips), in Midland, then Houston, Tx. I stayed with Conoco through 2012, when we moved back to Boulder Colorado. I now work at Anschutz Exploration Company in Denver, CO. In 1993 I married Dr. Flemming Mengel (a geologist from Denmark). We have 2 kids, Karsten Mengel (18), and Kristine Mengel (15).
Eli, I am happy to say that I get updates on you and on the department from Lon Abbott, who lives a 5 minute walk from us. I also frequently see Nan Rosenbloom and Al Bol, who also live just minutes from us. As you probably know, all are doing well. I am sorry that I will miss this reunion.

Richard (Rick) Behl. Ph.D.: After leaving UCSC, Rick was a post-doc at UCSB (1992-1995) focusing on marine sedimentology related to climate-ocean variations. In 1995 he joined the faculty at California State University Long Beach where he has advanced to Professor and, starting this year, became Chair of the Dept. of Geological Sciences, with ~70 undergrads and 50 grad students. CSULB is the third largest campus in Calif. (37,000+ students), among the most selective (102,800 applicants this year), and has been judged as the top university on the West Coast in terms of student body racial diversity. Although carrying the heavy teaching responsibilities of all CSU faculty, he has established and funded significant research programs centered on reconstructing the tectonic, climatic, and oceanographic evolution of the California Margin and the Pacific Ocean, along with integrated studies of the sedimentology, diagenesis and structural deformation of siliceous and other sediments associated with organic-rich deposits of the Monterey Formation and other units. Recognition of this research has included election as Fellow of the Geol. Soc. of America, election as President and Honorary Member of the Pacific Section-Society of Sedimentary Geology, and selection as Distinguished Lecturer of the AAPG. Likewise, several awards including CSULB's Distinguished Faculty Teaching Award and the Pacific Section AAPG Distinguished Educator Award honor the high quality of his teaching. Rick served as principal advisor for 25 Masters students in their thesis research and, happily, is still friends with every last one.

1994

Todd Greene, BS: Following his graduation from UCSC, Todd studied at Stanford where he received his Ph.D. in 2000 after completing a thesis on the tectonics, basin analysis and organic geochemistry of Permian through Mesozoic deposits in the Turpan-Hami Basin of northwestern China. This was followed by six years as a Senior Geologist focusing on clastic sedimentology and stratigraphy with the Anadarko Petroleum Corp., based in Houston but involving international exploration projects and field work in the Republic of Georgia, Indonesia, Algeria, Canada and West Africa. This work also included participation in training programs, whetting his appetite for teaching and leading him in 2007 to join the faculty at California State University-Chico, where he now serves as Associate Professor. He continues his focus on clastic sedimentology along with new research interests in volcaniclastic sedimentation, the characterization of clastic aquifers, and ground water processes. Todd serves as Science Director

in CSU-Chico's Center for Water and the Environment. From 2014 through 2016, he has been President of the Pacific Section-SEPM (Society of Sedimentary Geology), chosen by the West Coast community of sedimentary geologists, and an elected position also held earlier by UCSC alum Rick Behl (Ph.D. 1992) in 2005-2007.

1998

Katie Castelli, BS: I'm writing to pass on an update. My husband **Chris Castelli** (also a UCSC Earth Science Alum, BS, 1998) and I have been living in Oregon for 15 years now. I'm currently a Sr. Engineering Geologist with the Oregon Department of Transportation and Chris is a Sr. Policy Analyst for the Oregon Department of State Lands. We have a 2yr old son William who keeps us on our toes! Hope retirement treats you well!

2000

Aaron Reyes, PhD: I obtained my PhD in geochemistry specializing in low temperature groundwater geochemistry in December of 2000 working under the mentorship of James B. Gill. I am currently working at Westfield State University a 4 year liberal arts public University in Massachusetts where I am currently a Tenured Associate Professor. I recently attended the GSA meeting in Denver where I presented results from work performed by my first intern student. My student's work consists of analysis of major chemistry and bacterial content of the Westfield River during varying flow conditions.

Brenda Bowen, MS: I am now the Director of the Global Change and Sustainability Center at the University of Utah (http://environment.utah.edu/). I am also a tenured associate prof in Geology and Geophysics and was recently awarded a $1.5M grant from NSF to study the coupled natural – human system of the Bonneville Salt Flats (https://www.nsf.gov/awardsearch/showAward?AWD_ID=1617473&HistoricalAwards=false).

2003

Eric Peterson, BS: Presently a Petroleum Geophysicist at BHP Billiton Petroleum in Houston, Texas assisting in exploration and development of prospects both domestic and international

2005

Ben Melosh, BS: After finishing my PhD (2015) in mid-crustal fault rheology with Christie Rowe (PhD UCSC 2006) at McGill University, I moved back west to start a 4-yr term position at the USGS in Menlo Park. I am working on making a new geologic map of part of the northern California coast ranges along the Bartlett Springs fault system and surrounding area, with a focus on active tectonics in the region. I am excited to be back in California and looking forward to many more rafting trips and hopefully at least one with Gerry Weber (no introduction necessary).

2008

Brina Mocsny, BS: It's my 7th year living the dream and working full time in Yosemite National Park! During the summer and fall season I work as a physical scientist for Yosemite National Park in the division of Resource Management and Science. Recently I've been working on a collaborative project with the California Department of Water Resources to upgrade Yosemite's snow tower sites so park managers can have real time snow data for the Tuolumne and Merced watersheds. Also in my branch for the park are two fellow slug alumni- Greg Stock, park geologist and Keenan Takahaski, air quality technician. From late fall to late spring, I am a lead environmental science educator for NatureBridge in Yosemite. I teach students who come with their schools from all over California about climate change, hydrology, geology, and the beauty of the outdoor world. I'm outside for my job 90% of the time so I know I'm doing something right.

2009

Katharine Turkle, BA: I am living in Mountain View with my husband and dog. I got married

this spring (http://www.sandiegouniontribune.com/news/2016/jul/11/wedding-katharine-turkle-aaron-nutten-safari/) and run my earthquake safety company, Quake Plan Consulting (www.myquakeplan.com). I opened a school in Menlo Park for aerial acrobatics in 2013 and it is doing very well (http://www.almanacnews.com/morguepdf/2013/2013_12_04.alm.section2.pdf)

Devon Orme, BS: Glad to hear you are putting together another news letter! I have a few updates to share. I was awarded my PhD in 2015 from the University of Arizona and began as a postdoctoral scholar at Stanford University in Fall 2015. In January 2017, I will start a faculty position at the University of Nevada Las Vegas. On a personal note, Dr. Andrew Laskowski and I were married on October 24, 2015, in a ceremony officiated by Dr. Jeremy Hourigan.

2012

Timothy Lambert, MS: After working for a couple years at the Illinois Natural History Survey, I've started a PhD in Ecology & Evolutionary Biology at Cornell. Thanks for your work on the Newsletter, and best wishes to everyone there.

2013

Jessica Johnson, BS: Thanks for reaching out to EPS alums. I regret not being more active with the department while I was studying at UCSC and I've been bad at keeping in contact with the department since. I do hope to change that. First I'll give you an update on what I've been up to since graduation. I graduated in 2013 with a BS in the Environmental Geology concentration. I went on to get a masters in Environmental Assesment from American University in Washington, DC. I interned for non-profit conservation groups and nature preserves, did a stint with the US Forest Service, and recently started working with Teichert, a private construction and mining company located in Sacramento. I work with their Land Management division. We are responsible for restoring all of Teichert's reclaimed aggregate mine sites following completion of mining. Let me know if you want any other info! As I said before, I am interested in reconnecting with the department and other alumni. What are some ways you recommend doing this?

Priya Ganguli, PhD (1998 MS): I started my UC Irvine postdoc about 10 months ago and have been mentoring 6 incredibly motivated undergrads. We conducted 2-day phytoplankton incubation experiment in San Diego last August. I can assemble some field pics and write a brief paragraph if that sounds like a good fit for what you're looking for.

2014

Matt Farrell, BS: Doing great working for ENGEO, we are hiring if you'd like to pass that on to others.

Alex Mitchell, BS: I just wanted to share that I have started a Masters program at the University of British Columbia, Vancouver, Canada. I am joining a fluvial geomorphology research group, but I haven't pinned down an exact project yet as I arrived in the country a few weeks ago.

David Mason, BS: Still working for the Navy as a civilian by preventing the spread of radioactivity to the environment. The newest development is that I will be going to Japan for a few months to help out with work out there. Super excited about that.

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Your contribution can help build an endowment that will have lasting benefit for future generations of EPS students, or you can support ongoing needs in teaching, research and service.

On the next page we describe current high-priority EPS development goals.

(1) Please Give Online
Please visit the EPS web site for information on current funds/endowments and EPS Department priorities: http://eps.ucsc.edu/support-us/index.html

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This is the easiest way to support the EPS Department!

(2) Please Give by Check or Credit Card
Please use the form on the next page to prepare your donation. We list the four highest EPS development priorities: more information for each of these can be found at the website noted above.

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We are glad to discuss your interest in supporting EPS at UCSC, and to provide information that may be helpful in directing your contribution to be consistent with your goals.

Please contact:
Quentin Williams (Department Chair): 831-459-3132, qwilliam@ucsc.edu
Andy Fisher (EPS Development Coordinator): 831-459-5598, afisher@ucsc.edu

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Four highest EPS Development Priorities (Fall 2016):

Casey Moore Fund

The Casey Moore Fund supports current EPS graduate students as they conduct thesis-related research. *Match alert!* Contributions up to $5000 for the current calendar year will be matched 1:1 by a generous alumnus.

Double the impact of your contribution by donating before the end of 2016

Gerald Weber and Suzanne Holt Fund

The Weber-Holt Fund supports EPS majors while they participate in summer field camp, an iconic experience that satisfies the "capstone course" requirement applied to all undergraduates at the University of California.

Zhen and Ren Wu Memorial Award Fund

The Wu Fund supports EPS graduate students in geophysics as they conduct thesis-related research, with an emphasis on students seeking careers in exploration industries.

Earth's Environment Fund

The Earth's Environment Fund supports EPS graduate and undergraduate students as they conduct thesis-related research involving topics such as water resources, climate change, and the evolution of landscapes and aquatic systems. *Match alert!* Contributions up to $5000 for the current calendar year will be matched 1:1 by a generous alumnus.

Double the impact of your contribution by donating before the end of 2016

For all of the above funds, our goal is to build endowments that will assure benefit for years to come. If you would prefer to provide support that can be used immediately, it should come as no surprise that the department welcomes these gifts as well:

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This unrestricted fund supports immediate EPS research, education, and development needs.

Please see http://eps.ucsc.edu/support-us/index.html for more development options

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Name(s): _____

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Degree: _____ Year: _____ ☐ New address

News about myself and other classmates

Please use space below and continue on facing page. Let us know where you are and what you are up to!

May we publish your comments on the Earth and Planetary Sciences website under Alumni? ☐ yes ☐ no

☐ I would prefer my comments to appear only in the Earth and Planetary Sciences newsletter

We hope to see you at the Thirsty Bear Brewing Company for our *16th Annual UC Santa Cruz Earth and Planetary Sciences Alumni Reception at Fall AGU!*

When: **Tuesday December 13, 2016**
6:00pm - 8:30pm

Where? **Thirsty Bear Brewing Company**
661 Howard Street
San Francisco, CA 94105
http://www.thirstybear.com

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