Earth and Planetary Sciences at UC Santa Cruz

Fall 2014

2014 Field Methods Class

http://eps.ucsc.edu

Earth and Planetary Sciences at UC Santa Cruz

Fall 2014

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Chair's Welcome

Dear Alumni and Friends,

Overall, it's been a pretty good year for the Earth and Planetary Sciences Department. Our faculty continue to sweep up awards, we have new faces appearing, our students and alumni continue to make us proud, and new curricular efforts are emerging.

Our Honors list for the year includes: a Sloan Foundation Fellowship was awarded to planetary scientist Ian Garrick-Bethell; emeritus faculty Jim Gill was named an AGU Fellow; AGU's John Adam Fleming Medal was awarded to Gary Glatzmaier; and finally, our illustrious seismic colleague Thorne Lay collected hardware like a crazed home-repairperson, being elected to the National Academy of Sciences (that's a biggy…), winning the Inge Lehmann Medal of the AGU, and winning the Harry Fielding Reid Medal of the Seismological Society of America.

As part of the natural evolution of a vibrant Department, we've had some transitions in the last year. We were pleased to hire Xi Zhang, a Caltech Ph.D. who will arrive in the summer of 2015: he's an expert on planetary atmospheres. Isotope geochemist Terry Blackburn, hired last year, finished up his post-doc at the Carnegie Institute and arrived this past summer. In the other direction, Gary Glatzmaier shifted to emeritus status in order to (wait for it…) spend more time with his research. And, recent graduates can congratulate staff person Jenna Scarpelli, who moved up and out of our Department, becoming the Departmental Manager of Astronomy.

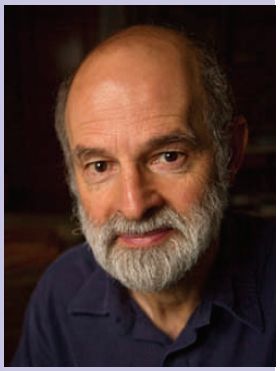
On the curricular front, Patrick Chuang and Ocean Scientist Raphe Kudela worked up a formidable proposal to establish a new, multi-departmental (but EPS and OS-dominated) undergraduate degree program in Environmental Sciences---a notable lack on our campus. We're proceeding gradually, since a few additional faculty are likely required to offer such a major well, while maintaining the quality of our existing majors and concentrations (but, stay tuned…).

As many of you are aware, the campus is celebrating its 50th birthday over the next couple of years. We will have a 50th anniversary celebration of the EPS Department on **Friday to Sunday 5/8-5/10/15**. It will include a mix of field trips, tours, and faculty/alum presentations (not too many…). And food. And favorite beverages, some likely in keg form. More details will follow, but do mark it on your calendar. The 50th is accompanied by our campus' first Capital Campaign ($300 million goal); our Department is working on expanding our fundraising and alumni outreach in conjunction with this campus goal. And it's in this arena that we would truly appreciate any support you can give to enhance and maintain the educational experiences that our students can access. Please see information on p. 34-36 describing current EPS Development priorities. Contributions are most welcome for endowments that support graduate and undergraduate research and education activities. Two of these endowments currently have a 1:1 match opportunity, thanks to the generosity of several alumni (double your gift!). We also welcome contributions to the Earth and Planetary Sciences Fund, which provides discretionary resources for immediate needs, including support for alumni activities.

Speaking of social events, we'll have our annual alumni gathering at AGU for alumni/friends/current folks at the Thirsty Bear. Come join us, see old friends, make new ones, have snacks (the stuffed mushrooms are to die for . . .). And, you can congratulate Thorne and Gary on their newly acquired AGU hardware. It's Tuesday, December 16th, 6 – 8:30 p.m., 661 Howard Street, San Francisco—Hope to see you there!

Quentin Williams, Chair

Thorne Lay



Gary Glatzmaier

Ian Garrick-Bethell

Slug Web Corner

We are now on Facebook! Like us at **www.facebook.com/UcscEPS**

Department News

Thorne Lay was elected to the National Academy of Sciences and received the Inge Lehmann medal from the American Geophysical Union and the Harry Reid medal of the Seismological Society of America.

Gary Glatzmaier was awarded the John Adam Fleming medal of the AGU.

Jim Gill was made a Fellow of the AGU.

Xi Zhang was appointed as the newest member of faculty in the EPS department. Xi is an expert in planetary climatology and is currently finishing a post-doc at the Lunar and Planetary Laboratory at the University of Arizona.

Xi Zhang

Ian Garrick-Bethell was awarded a Sloan Fellowship to pursue spacecraft exploration of the Moon

Patrick Fulton (researcher) won an Early Career Award from the Tectonics section of the AGU.

Patrick Fulton

Alumni Awards

Sam Hansen (PhD '07) won a Presidential Early Career Award.

Ray Wells (PhD '82) was awarded the Department of Interior's Distinguished Service Award.

Cruz Ortiz (BS '11) and **Christina Richardson** (BS '12) were both awarded NSF graduate research fellowships.

Ray Wells with Secretary of the Interior Sally Jewell

Arrivals/Departures

Gary Glatzmaier retired - in order to devote all his energies to research.

Jenna Scarpelli left her current position to become Department Manager in Astronomy. We are sad to see her leave.

Slug Science Round-up

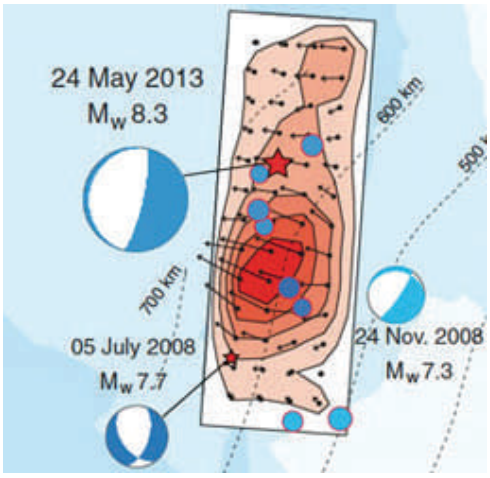
Carved rows of animals cover both sides of the ivory handle of a ritual knife from the Predynastic Period in Egypt .

Ecological collapse in Egypt over 6000 years

Researchers have used depictions of animals in ancient Egyptian artifacts to identify extinctions in large mammal populations over 6000 years. Drying climate and the growing human population were responsible. The study was led by former grad student **Justin Yeakel** and also involved Prof. **Paul Koch**.

Largest deep earthquake recorded

An analysis of a deep earthquake off the coast of Kamchatka by graduate student **Lingling Ye** and Prof. **Thorne Lay** revealed that it was the strongest such earthquake ever recorded. How such a rapid rupture could have occurred at such great depths and pressures is currently an unsolved mystery.



Tidal forces gave the Moon its shape

A new analysis of the Moon's shape suggests that it was mostly generated by early tidal heating while still partly molten. The study was led by Prof. **Ian Garrick-Bethell** with grad student **Viranga Perera** and Prof. **Francis Nimmo** also contributing.

We hope to see you at the Thirsty Bear Brewing Company for our *14th Annual UCSC Earth & Planetary Sciences Alumni Event at Fall AGU!*

When? **Tuesday, December 16th, 2014**
from 6:00pm - 8:30pm

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

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Slugs in the Field

Danica Roth, installing fluvial seismometers at the Erdbach Falls (Switzerland).

Paul Koch taking time off from being Dean to examine seal carcasses in Antarctica.

Chia-Te Chien on a Taiwan Ocean Research cruise to collect seawater and aerosol samples in the Philippine Sea.

Slawek Tulaczyk (center), Susan Schwartz (right) and Dan Sampson (left) spooling 800 meters of cable for instrument deployment in a deep borehole on Whillans Ice Stream, Antarctica.

Slugs in the Field: Undergraduate Field Trips

Mark your calendars for the
EPS 50th Anniversary Weekend!

When? **Fri-Sun, May 8-10th, 2015**

Where? **UCSC Earth & Planetary Sciences Department**

What? **A celebration, field trips, alumni lectures and more . . .**

Graduate Degrees, 2013-14

Ken Mankoff, Fall 2013 (PhD)
"Multi-scale investigations of subglacial and sub-ice shelf conduit hydrology"

Lucas Beem, Fall 2013 (PhD)
"Changes in the flow of the Whillans Ice Stream West Antarctica: Insights into Basal Processes"

Priya Ganguli, Fall 2013 (PhD)
"Mercury Speciation and Transport at the Land-Sea Margin"

Megan Avants, Fall 2013 (PhD)
"Effects of Near-source Heterogeneity on Wave Fields Emanating from Explosive Sources Observed at Regional and Teleseismic distances"

Nadine Quintana-Krupinski, Fall 2013 (PhD)
"Calibration and application of the planktic foraminifera B/Ca carbonate system proxy in the Pacific Ocean"

Jude Viranga Perera, Winter 2014 (MS)
"Lunar Geophysics: the Moon's Fundamental Shape and Paleomagnetism Studies"

Stephen Hernandez, Winter 2014 (MS)
"The Magnitude Distribution of Dynamically Triggered Earthquakes"

Han Yue, Spring 2014 (PhD)
"Toward Resolving Stable and High Resolution Kinematic Rupture Model of Large Earthquake from Joint Inversion of Seismic, Geodetic and Tsunami observations"

Marci Beitch, Spring 2014 (MS)
"Greenland Ice Sheet Retreat Since The Little Ice Age"

Brian Coggan, Spring 2014 (MS)
"Shoreline change in southern California during the 2009/2010 El Niño Modoki"

Andrew Racz, Spring 2014 (MS)
"Spatial and Temporal Infiltration Dynamics During Managed Aquifer Recharge "

Rachel Brown Reid, Summer 2014 (PhD)
"Dietary Ecology of Coastal Coyotes (Canis latrans): Marine-Terrestrial Linkages from the Holocene to Present "

Nicole Russell, Summer 2014 (PhD)
"Sea-Level Rise, El Niño, and the Future of the California Coastline "

Tina Dwyer Wasem, Summer 2014 (PhD)
"Terrestrial Planets and Galilean Satellites: Giant Impacts, Composition, and Formation"

Rhiannon Bezore, Summer 2014 (MS)
"A Comparative Study of Passive versus Dynamic Sea Level Rise Inundation Models for the Island of Kauai"

Graduate Awards

CAMPUS-WIDE OUTSTANDING TA:
Karla Knudson

DEPARTMENTAL OUTSTANDING TA:
David Finn (Winner)

HONORABLE MENTION DEPT OUTSTANDING TA:
Marci Beitch
Doug Hemingway
Lesley Petrie
David Santaniello
Alex Steely

WATERS' AWARD:
Delphine Defforey
Erin Todd
Sarah White

DISSERTATION QUARTER FELLOWSHIP:
Heidi Stauffer

ARCS FOUNDATION AWARD:
Erin K. Todd

Graduate Awards (cont'd)

LAWSON HYDROLOGY AWARD:
Ana Martinez-Fernandez

J. CASEY MOORE FUND AWARD:
Alex Steely

ZEN AND REN WU MEMORIAL FUND AWARD IN GEOPHYSICS:
Lian Xue

MYERS TRUST FUND GRANT:
Delphine Defforey

CHANCELLOR'S DISSERTATION-YEAR FELLOWSHIP:
Lingling Ye

PBSCI DEAN'S AWARD:
Danica Roth

NATIONAL DEFENSE SCIENCE & ENGINEERING GRADUATE FELLOWSHIP:
Mikey Nayak

GEOL. SOC. AMERICA GRAD STUDENT RESEARCH GRANT:
Tracey Conrad and Delphine Defforey

CENTER FOR DARK ENERGY BIOSPHERE FELLOWSHIP:
Delphine Defforey

2013 UC MEXUS STUDENT RESEARCH SMALL GRANT:
Ana Martinez Fernandez

GROUNDWATER RESOURCES ASSOC. OF CALIF. BEST STUDENT PRESENTATION:
Sarah Beganskas

14TH BIENNIAL SYMPOSIUM ON MANAGED AQUIFER RECHARGE, BEST STUDENT PRESENTATION:
Sarah Beganskas

GEO-PRISMS EXTERRA FIELD INSTITUTE SCHOLARSHIP:
Alex Steely

FRIENDS OF LONG MARINE LAB STUDENT RESEARCH AWARD:
Chia-Te Chien and Sarah White

Undergraduate Degrees (BS/BA)

Christine Baba
Matthew Rodney Beck
Joshua Brown
Christine Brownfield*
Lawrence Bush*
Cheryl Cary*
Benjamin James Cassady
Marissa Christine Castillo
Ren Chao
Alexandria Fontana*
Sean Fender*
Lauren Fowler**
Melissa Govaerts**+
Arianna Hall-Reinhard*
Kevin Halpin
Ryan Harmon*+
Afghana Sultana Khan
Rachael Klier
Nicolette Lawler
Eric Lujan
Roya Maghzi
Patrick McCarthy*
Melissa Misao Mendiola
Daniel Mendoza
Paul Morgan**+
Paul Orona
Benjamin Osias
Marcel Peliks*
Georgia Peterson*+
Chris Porter
Diana Rattanasith
Grant Rea-Downing*+
Sina Mirmohammad Sadeghi
Corinne Selvin*
Joseph Schools
Tyler Sproule

Undergraduate Degrees (cont'd)

Cory Steinmetz*
Keenan Takahashi
Julius Velas
Hannah Waiters
Anna Weisenberger
Taylor Whitehill
Charles Alexander Wilson
Aidas Worthington
Natalie Zimdahl**

* Honors
** Highest Honors
+ Thesis honors

Undergraduate Awards

HOLLY DAY BARNETT MEMORIAL GRANT:

Faisal Fazilat

KATHRYN SULLIVAN SCHOLARSHIP:

Alex Mitchell

UCSC UNDERGRADUATE RESEARCH AWARD:

Paul Morgan
Georgia Peterson

Undergraduate Awards (cont'd)

HITACHI SCHOLARSHIP (CALTEACH):

Thooba Samimi

THOMAS WALSH SCHOLARSHIP:

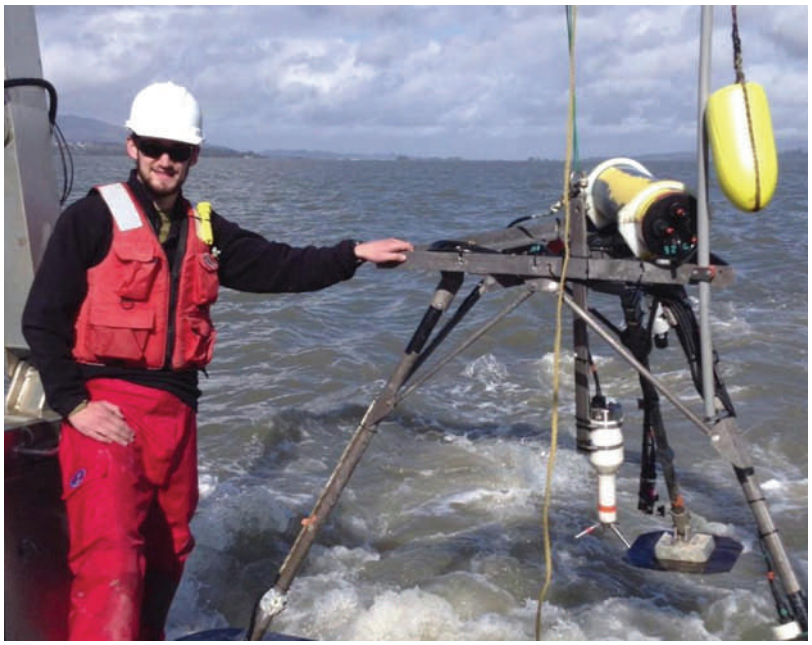
Diana Rattanasith

CALIFORNIA FEDERATION OF MINERALOGICAL SOCIETIES SCHOLARSHIP:

Diana Rattanashith

WEBER-HOLT GRANTS:

Ethan Brown
Christine Brownfield
Lauren Fowler
Jacqueline Hyman
Alex Mitchell
Paul Morgan
Diego Osnaya
Marcel Peliks
Grant Rhea-Downing
Madeline Richards
Taylor Whitehill



Forty-one Years Later

Chuck Lawson (BS 1973)

Earlier this year, I had the honor of being invited to address the 2014 EPS graduating class at its June 2014 graduation ceremony. I thought a lot about what I could possibly say to inspire the class or what sage advice I might impart that hadn't already been said by others - and said much more cleverly and eloquently than I could ever say. The answer I came up with was, unfortunately - not much. In the end, I decided that all that I could really offer was to talk a little bit about me - what I did when I left Santa Cruz 41 years ago and how I ended up where I am today. I anticipated that some might take my experience as a cautionary tale of what the seniors would not want to happen to them. For others, I hoped that my experience might resonate with them. I summarize here some of what I said in June.

At the end of my senior year at Santa Cruz, the big question on my mind was - what now? My answer to that question in 1973 was - I have no clue (photo #1 shows a typical UCSC student in 1973). I noted to the graduating class that, in my opinion, in the long run it does not matter if you currently have no clue.

A couple of months after I graduated, I was fortunate to get a job in the geology group at Bechtel Corporation. While the Bechtel job was interesting, I learned something about myself. I learned that I didn't like working a 9-to-5 job. So, I applied to graduate school.

I ended up entering the PhD program in the geology department at Princeton. I liked graduate school so much, it took me seven years to get my PhD. Part of the reason it took me so long was that I still did not have an answer to the question - What now? I had no idea what I wanted to do after I got my PhD. What I did know was that I liked research. So, I applied for postdoctoral fellowships and ended up at the Johnson Space Center doing research in the geology department on terrestrial analogues to Martian soils. From the Space Center, I got a research position at the USGS in Reston, Virginia. When I started at the Survey, I thought I had found the perfect job. I was doing research and collaborating with great geologists at the Survey and elsewhere. After a few years, though, I started to question whether or not I wanted to do research for the rest of my professional life. I began looking around for jobs where I could use my scientific background, but in a context that would have a broader impact than my research might have.

I ended up receiving a AAAS fellowship to work in the State Department on foreign policy issues related to science. What started as a one-year fellowship ended up as a 21-year stint working in the foreign policy realm. For most of my time at State, I worked on water issues related to the Middle East peace process. I spent a lot of time and energy bringing Israeli, Palestinian, and Jordanian water officials and experts together to work collaboratively on water projects. An interesting outcome of our efforts was that the Israeli, Palestinian, and Jordanian participants built such strong working relationships that even when the political elements of the peace process hits the skids and the politicians had stopped talking to one another, the water officials continued to work together.

As satisfying as it was to work on an aspect of the peace process that was consistently positive and was providing benefit to people in the Middle East, ultimately, the work became frustrating because the overall political situation in the region was so bad for so many years.

Six years ago, I landed the job that I currently have as the Secretary of the U.S. Section of the International Joint Commission. The IJC was created in 1909 by the U.S. and Canada to assist the two countries in managing the water resources they share along the boundary. I have been able to continue to work on water issues, just a little closer to home.

I ended my remarks to the graduating class by noting the following:

1) I hoped my experience had demonstrated that it is possible to have an interesting, fun, and fulfilling life, even if you have absolutely no idea right now what you want to do after you leave UCSC.

2) The professors and the EPS department at UCSC had inspired my love for geology. In my case, Aaron Waters, who founded UCSC's earth sciences department, was one of my biggest inspirations (photo #2). I urged the students to thank those professors who have inspired them.

For all the EPS alumni and alumnae out there who were similarly inspired by your experience in the department, I urge you to join me and give something back to the department. You can check out the variety of opportunities to make donations on the department's website at: http://eps.ucsc.edu/support-us/index.html. Thanks.

The author, circa 1973

Aaron Waters, Department Founder

Loma Prieta 25 years on

Prof Susan Schwarz

On October 17, 2014 we commemorated the 25th Anniversary of the Loma Prieta earthquake. This milestone garnered more attention from the media than any previous anniversary and the interviews I participated in with local TV and journalists from the Sentinel and the UCSC Review (there's an article in Fall Review magazine) caused me to reflect on this event more deeply as well. At the time of the earthquake, I was a postdoc at UCSC studying earthquakes in far away places like Japan and the Kurile Islands. Although I knew a lot about earthquakes before that day, experiencing the Loma Prieta event was a profound experience for me and provided a completely new kind of education. The town that I just recently started to call home lay in ruins. While first responders started search and rescues in downtown Santa Cruz, colleagues and I set out into the Santa Cruz Mountains with seismic instruments to record the inevitable aftershock sequence and learn more about how and why this earthquake occurred. This was my first encounter with the devastating aftermath of an earthquake. Many houses were completely destroyed and thousands of people were left homeless and had to stay in shelters. Bottled water and other supplies ran out quickly and people were scared. I was involved with the aftershock deployment and analysis of the data collected for months after the event and this experience turned out to be my initiation into "aftershock chasing". I got involved in several more aftershock deployments following significant earthquakes in California and Costa Rica in the following years. More earthquakes, more data to study and more to learn, however, my first hand experience with the Loma Prieta event infused the science I was pursuing with a very human element.

The Loma Prieta earthquake was a somber event, but I also have some lighter, funnier memories of the day it occurred. If you have seen the Department T-shirt that the undergrads designed a few years ago with the slogan "Its Okay I'm a Geologist", and wondered where this saying came from, I think I might know the answer and its connected to the Loma Prieta earthquake. When the earthquake hit I was running on the trails behind the former Earth Sciences Department (now Baskin Engineering I) with graduate student Barrie Bernstein (PhD, 1991, now Barrie Taylor). We just reached Marshall Field when we heard what sounded like a freight train barreling towards us. We stopped, looked at each other and the ground started to shift violently beneath us. Like acrobats on a tightrope we regained our balance, confirmed that we just experienced a "large" earthquake and decided that we best get back to the department to find out where and how bad the earthquake was. As we made our way back to the campus we ran into a group of students huddled together under a tree looking terrified. I walked over to them and exactly what I said is a point of contention between Barrie and me. She heard "Don't worry, I'm a seismologist" and imagined me lifting off the ground, twirling my super hero cape and carrying the girls to safety. I don't remember what I said, but I do remember my intention to comfort those girls, to explain to them what they just experienced. I think Barrie's recollection of my words might have gotten passed down, amended, and immortalized on that T-shirt. Although, I do believe that it is Hilde Schwartz's likeness on that shirt.

Twenty-five years is a long time in human experience and in that time our campus, town, county and state have pretty much recovered from the Loma Prieta earthquake. However, 25 years is nothing in geologic time and many may think that we already had our earthquake and much more time is required to reload for another event. The latest earthquake probabilities report tells us that this is not so. This report assigns the Santa Cruz Mountain segment of the San Andreas Fault a 15% probability of experiencing a magnitude>6.7 earthquake within the next 30 years. I would therefore be remiss in an article commemo-

rating the Loma Prieta earthquake if I did not remind those living in Santa Cruz County and everyone who lives in reach of an earthquake to take some simple measures to assure that they are prepared for the next earthquake.

E&PS faculty Susan Schwartz (talking) and Thorne Lay (shoveling) deploying seismometers in the Santa Cruz Mountains following the 1989 Loma Prieta earthquake. Heidi Houston (UCSC researcher 1988-1992), Ornella Bonamassa (Ph.D 1995) and former IRIS President David Simpson are assisting.

The T-shirt!

An Interview with Jerry Weber about the Weber-Holt Fund

__Jerry Weber and Sue Holt__ are two of the top contributors to the UCSC Earth and Planetary Sciences Department. We interviewed Jerry to get his input on the Weber-Holt Fund, his reasons for developing the fund, and his thoughts on the future.

Eli: Who would you like to see as beneficiaries of the fund?
Jerry: Both grad students and undergrads.

Eli: What is the main purpose of the fund?
Jerry: The main purposes are to cover field or research expenses for grad students and to help defray the costs of Summer Field and University Fees for undergraduates. However, we don't want to tightly constrain the use of the fund. We want the fund to be flexible enough so that it can be useful for the department well into the future, as both the field and the department evolve.

Eli: What do you see are the values of a geology degree in today's world?
Geology offers students a fantastic starting point for a wide variety of careers. I couldn't have imagined as a young student owning my own company and testifying in court for a living, but that turned out to be a very rewarding and satisfying career. Even though different from what I originally imagined, this work utilized my geological skills and field observational abilities in a great way.

Eli: What funding level are you hoping to attain?
Jerry: At present the fund has about $160K, and we contributed $20K this year. We're hoping to see it grow to over $1M eventually.

Eli: What do you see as the key benefits of field geology for students today, realizing that many of them will not become field geologists in the future?
Jerry: Field work helps to develop thinking in three and four dimensions, which is very useful in many different fields. It also tends to integrate and solidify what students have learned during their undergraduate Earth Science courses, so it's value goes far beyond simply training to be a field geologist.

Eli: Given that you could do a number of things with your resources, what made you decide to focus strongly on this fund?
Jerry: A good education for students is the most important need that the country has. I can't think of a better use for money than to further the education of our students.

Eli: What do you see as the future of the field?
Jerry: Geology is rapidly expanding and now consists of a large number of subfields and specialties. I dabbled in a number of areas through my career, and I see people taking a much narrower focus now as each sub-area grows. Of course, having a large number of specialties opens up the possibilities for branching across these different specialties to make new discoveries.

The Department of Earth & Planetary Sciences at UC Santa Cruz would like to thank and acknowledge Jerry and Sue for ensuring support for students in the field by including a "Planned Gift" to the Weber-Holt Fund as part of their estate plans. Planned giving can allow you make an impact beyond what you might have thought possible without requiring an outright donation; other Planned Gifts make it possible to support EPS, enjoy a tax deduction, and receive a lifetime income at the same time. For more information about Planned Giving options, visit plannedgifts.ucsc.edu, or contact JJ Mack in the Sciences Development at 831.459.5238 or jjmack@ucsc.edu

The Art of Field Rheology

Christie Rowe, Tim Sherry and Ben Melosh

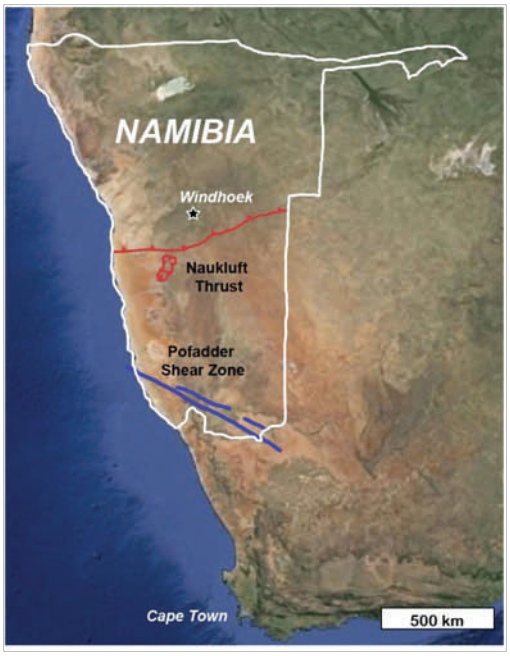
***Prologue**: After my Santa Cruz PhD with Casey Moore, a stint at University of Cape Town and a postdoc back at UCSC with Emily Brodsky, I started working at McGill University in Montréal in the summer of 2011. What follows here are first-hand accounts of the adventures of two of my first graduate students, Ben Melosh (UCSC '05) and Tim Sherry (UCSC '11). Before you accuse me of nepotistic recruiting (fairly) let me just say that the field program at UCSC does a fantastic job of preparing graduates for hard(rock) -core field research. - CR*

Tim Sherry '11: The only question a geologist can *really* ask of any rock is "Why are you so destroyed?" Christie Rowe sought to build a team, eager to undertake the quest of fault rocks far and wide. Answering the call was two UC Santa Cruz geologists, Ben Melosh and myself, Tim Sherry, and a University of Cape Town geologist, Nils Backeberg. Together we formed the Field Rheology team at McGill University in Montreal.

Christie, acting in her usual mindset as future "Director of All Things" dreamed up a geo-cultural exchange plan. She assigned Ben and I, the two North American geologists to projects in Africa and gave Nils, the South African geologist, a project in North America. The goal of this exchange was to give each of us the opportunity to see more rocks, and to apply and adapt what we already knew to new and exciting terranes. Ben and I would find ourselves in Africa twice.

A bumpy plane ride from Cape Town with sights of the Skeleton Coast dropped us in Windhoek. We gathered supplies and made our way to the "town" (read: gas station and bakery) of Solitaire to swap vehicles with colleagues from Stellenbosch. Clint Isaacs, an undergrad at Stellenbosch, joined us to assist and gain valuable mapping experience. Once in our double tank diesel, we took aim for the Naukluft.

The Naukluft Mountains represent the farthest southern reaches of the Cambrian Damara Orogen. Exposed in a klippe of the foreland fold and thrust belt, the Naukluft Thrust rings the mountains for approxi-



mately 200 km. Across this extent the Naukluft Thrust changes orientation, geometry, and lithologic expression. Above the Naukluft Thrust lies several nappes, which themselves contain near countless minor thrust faults and repeating sequences. This area was first mapped by two German geologists in the 1930s who would later hide from British forces in the Namib Desert for two years during World War II, mapping all the while. Various mapping expeditions over the years have expanded the detail and structural expression of nappes, although current topo contours are at too small a resolution to capture the subtle fault geometries. My mission was to map the Naukluft Thrust using a high resolution differential GPS to capture these changes in fault geometry.

The 200 km fault outcrop was too long to walk out in the short time we had, so two end member field sites were selected: Naukluft-9 and Tsams Ost. In Naukluft-9 the thrust fault emplaced sequences of dolostone, shale, and quartzite upon blue limestone footwall. The fault zone itself is composed of a 2 - 10 m thick carbonate granular fault rock known as “gritty dolomite”. Gritty dolomite was fluidized during coseismic slip. Frictional heating during slip dissociated the carbonates and reinforced pressurization by adding CO2 to the system.

The granular nature of gritty dolomite led to some fascinating structures and textures within the fault. Gritty dolomite may be massive, but will also exhibit laminae which are typically parallel to the walls of the fault plane, and are locally flow folded. We also found evidence of multiple coseismic slip events shown by crosscutting relationships of microfaults and breccias within the fault rocks.

By far the most fascinating gritty dolomite structures are the injectites formed when the gritty dolomite flowed into fractures in the wall rock. The largest injectite is ~70 m tall and 8 - 10 m wide at the base, indicating that massive fluid pressures drove the injected gouge.

Mapping didn’t always go smoothly. One morning Ben said to me: “If my hand isn’t better tomorrow, I’m going to go to the medical clinic.” He showed me his hand, which was the size of an elephant’s paw. In the middle was a zit larger than a brunton **[PHOTOS REDACTED]**. I sent him to the clinic, 50 km away. Clint and I carried on mapping.

Often we found ourselves stalked by the tribe of baboons that lived in the park. Once, when we were low on food, we turned our back on our bakkie for two seconds. A baboon snuck up and stole our good crackers. I hate baboons.

In total, we walked out about 25 km of the trace of the Naukluft Thrust. At other localities, we found similar injectites cutting down into the footwall, or connecting between the Naukluft Thrust and hanging wall faults. We believe that the changes in wall rock lithology had a dominant control on the morphology of fault injectites.

Being in the field is all about exposure. Old lessons are applied to new terranes. The field is a melting pot for new ideas, just waiting to become science. Namibia gave us the opportunity to experience almost all types of exposure: new rocks, new structures, great outcrop, shear cliffs, new friends, new meats, new adventures, and bacon sandwiches.

Ben Melosh '05: It was either 2 or 3 months, I forget, but I was dirty and ragged with a huge beard, smelling great in a backcountry sort of way. A steady diet of cowboy coffee, rusks (dried breakfast biscuit), biltong (dried meat) and Windhoek Lager had purified my soul. My mind was full of broken rocks as I stumbled toward the Geology Department at University of Stellenbosch. The 208 rock samples I had collected with my field partner were waiting patiently to be dissected in the cold isolated saw room at the back of the department.

The cop was not so patient however, he slowly crept up behind me on his motor bike and looked skeptically into my distant eyes.

"Why are you so destroyed? Have you slept in the bush?"

I thought about that for a while. I mean what could I say? He nailed that one.

"Yes" I replied.

Months prior I had been driving north into the desert with a dread-locked, Capetonian, climber geologist named Louis Smit. Our bakkie (pickup truck) we had named Natalie the Nissan and loaded her full of weeks worth of gear and supplies. It was winter in the Namib desert, the only time for fieldwork, with cold nights but daytime temperatures that stay below REALLY REALLY HOT. We drove until the pavement turned to dirt, until the dirt turned to rock, and until the rock turned to cliff. Then we got out of the bakkie, opened a beer and watched the moon rise into the ecliptic, which was shining above the granulite klippes on the deep blue northern horizon.

When we woke we found ourselves on the edge of the Pofadder Shear Zone, a 500 km long, dextral, strike slip fault which formed about a billion years ago when two cratons smashed into each other. Or so they say. The shear zone is so long that half of it is missing, probably buried under sediments in Paraguay, but that is a story for another day. Today we were mapping.

What does a field rheologist do you might wonder? We perform fault autopsies. One of the interesting things about the Pofadder Shear Zone is that it has been exhumed from about 15 - 18 km depth. This is a part of the crust where quartz flows like silly putty when you stretch it. Of course when you take silly putty and stretch it as fast as you can it breaks. The same sort of thing happens in this part of the crust during earthquakes, which can leave lasting imprints on the rocks they destroy. As field rheologists we try to decipher these signals from the rock record through detailed mapping and description to learn about the evolution of deformation processes during the seismic cycle. This helps us understand what is happening during earthquakes which occur every day on faults like the San Andreas.

We mapped the core of the Pofadder Shear Zone in detailed transects down to a 1:10 scale. The best exposure of the shear zone core occurs on the banks of the orange river where the flood water has polished the rocks (on left). Mapping at this scale is a challenge because there are no topos detailed enough yet it is too big to map on a photograph. Instead we used a measuring tape and sticks. After breaking the outcrop down into 5m grids we mapped directly on to a gridded mylar sheet. As things started to come together we could see relationships between brittle and plastic deformation textures, folding, lithology and shear zone geometry develop right before our eyes.

Perhaps one of the most unique features we found were a series of dilational crackle breccias, with very closely spaced tensile fractures, almost identical to those produced during dynamic rupture simulations in the lab. These fractures branch off the mylonitic foliation which serves as a brittle slip surface during earthquake events. A wise professor once told me “let the rocks talk to you”, and these rocks spoke: “Snap, Crackle, Pop!”

With the nose of Natalie pointed toward the sky, the bed filled with hundreds of pounds of rock and the beautiful Boesmanland wild flowers flying past the window, we headed back to Cape Town with dirty smiles and rocks to cut.

***Epilogue**: Three years on, and Tim has finished his MS and gone off to make his fortune as a petroleum-seeking rock climber on the artsy side of Houston. Ben and Nils have wallpapered their office with surf magazines against the frigid Montréal winter and both are just one chapter away from PhDs and following Tim out of the nest. Ben’s hand made a full recovery. As for me… I’m on the hunt for the next generation of graduate students to feel the rheology in Namibia or anywhere else majestic ancient faults are slumbering beneath minimal sedimentary cover. For more details about our work (which, inspite of the stories you just read, sometimes results in publications) check out our website at eps.mcgill.ca/~crowe. Tim can be found blogging about rocks at upsection.com or on instagram @tsherrygeo.*

From UCSC to the National Labs

Wes Myers (PhD 1973)

Congratulations to Earth and Planetary Sciences at UCSC for an impressive 50-year record of education and research. I've enjoyed following the growth and success of EPS since the early 1970s when I was a graduate student. Special memories include experiences shared with fellow graduate students, the enthusiasm of the faculty, the dissertation process, being a teaching assistant, and the field trips.

The author on the Mendenhall Glacier

I arrived at UCSC in the fall of 1970 after a BS and MS (University of Georgia) and two years as a petroleum geologist (Chevron Oil). Over the next three years I completed my coursework and dissertation, which was a borehole-based stratigraphic study of flood basalts in the deep subsurface of south-central Washington. I received my Ph.D. in June, 1973, completed a post doc at SUNY Stony Brook, and spent two years as an assistant professor at Appalachian State University. After that I came full circle by returning to Washington for a job studying the flood basalts, some of which were candidate host rocks for a geologic repository for high-level nuclear waste. My career to that point had been both enjoyable and technically interesting---and relatively traditional in the sense of being a mix of teaching and basic and applied geosciences research, for which my UCSC experience had definitely helped to prepare me.

Then things changed. The changes began in 1981 when at the suggestion of A. C. Waters, my UCSC graduate supervisor, I applied for and was offered the job of leader of the geology group at Los Alamos National Laboratory. I accepted, moved myself and family to New Mexico, and entered the career path of becoming a research manager. In so doing I found myself immersed in the fascinating scientific culture at Los Alamos: quasi-academic, mission-oriented, and with a strong national security focus. In 1989 I became director of the newly created Earth and Environmental Sciences Division (EES). EES at that time was a 350-person mix of scientists (mostly atmospheric, solid earth and environmental), engineers (chemical, civil, mechanical, mining, and environmental), post-docs, students, and others. Projects spanned several national security, energy and environmental topics.

My UCSC experiences helped me as a research manager in surprising ways. Of course, the academic training was invaluable, but other experiences turned out to be useful too. Examples: 1. The manner in which the UCSC earth sciences faculty handled staffing, space and new equipment matters provided a frame of reference as I struggled with similar matters for EES division. 2. During my last summer at UCSC I was TA for the UC Berkeley field camp; the importance of field safety was permanently imprinted on me at that time when a student suffered a serious accident at a remote location in the Sierras. 3. The UCSC TA experience helped me improve how I structured and explained EES science and technology to non-technical audiences.

Being the EES division leader turned out to be professionally satisfying and also great fun. This was especially so on those occasions when we achieved what I like to think of as a research project trifecta: the simultaneous creation of multidisciplinary project teams that produced results pleasing to the funding agency, plus refereed-journal publications that enhanced the professional stature of the EES scientists working on the project, and also new technology that was transferred to and valued by U.S. industry.

I retired from Los Alamos in 2005. Now I promote new uses for underground space, with current attention on deep bedrock siting of advanced nuclear power systems. I continue to live in Los Alamos and spend several months each year in the southern Blue Ridge of northern Georgia.

My memories of UCSC earth sciences are wonderful. Keep up the special milieu of educational and research experiences. I'm sure it will help your graduates in both expected and unexpected ways.

What lies beneath? – Investigating shallow subduction environments in New Zealand

Erin K. Todd (PhD student)

R/V Tangaroa in Wellington Harbor, New Zealand, and the author

Way down in the far southwest corner of the Pacific, two tectonic plates are engaged in a struggle of epic proportions. The Pacific and Australian Plates are continuously fighting for dominance, catching New Zealand in what some have called a 'subduction sandwich' (Figure 1). In the south, the Pacific plate wins the battle, with the Australian Plate subducting beneath the bottom of the South Island along the Puysegur Trench. Moving northward, the battle reaches a stalemate as neither plate wins dominance over the other. Instead, we have the transpressional Alpine Fault, a strike-slip fault not unlike our own San Andreas. Here, the plates force themselves past one another with the occasional skirmish in the form of an earthquake (up to magnitude 8) and a longer-term compressional battle that pushes the Southern Alps higher and higher. In the north, the Australian Plate is the clear winner with the Pacific Plate subducting beneath the North Island along the Hikurangi Margin. With the North Island sitting as little as 12-15 km above the subduction interface, the Hikurangi Margin is especially well-suited to investigating subduction zone processes.

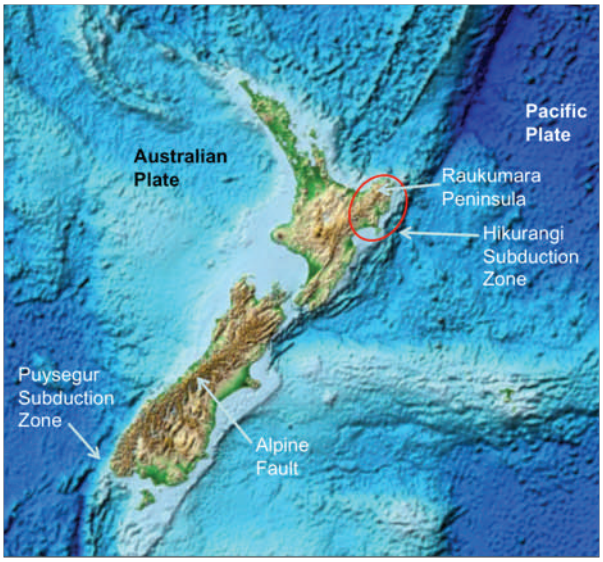


Figure 1: New Zealand tectonic setting

The Raukumara Peninsula (Figure 1), situated along the east coast of the North Island, sits 12-40 km above the plate interface and is well instrumented with continuous GPS (cGPS) and seismic arrays. Here, the plate interface hosts earthquakes of varying size and duration. There are numerous small earthquakes each year (M<5) and the occasional moderate to large (most recently, there were two M~7 earthquakes in 1947) tsunami-earthquakes, earthquakes that generate larger tsunamis than expected for the magnitude. In addition to traditional earthquakes, studies from the last 10 years, primarily led by former Slug Laura Wallace (PhD, 2002), have shown the existence of shallow (<15 km depth) slow earthquakes just off shore.

What Lies Beneath (cont'd)

These slow earthquakes are equivalent to magnitude 7 events but slip over days to weeks rather than seconds, occur at relatively regular time intervals, and do not show up on seismometers. Rather, they are detected by cGPS stations monitoring the motion of the upper plate. Susan Schwartz and I, along with US and New Zealand colleagues, are looking at the relationships between these different types of earthquakes on the shallow plate interface to understand how slow earthquakes can trigger large, hazardous earthquakes.

Most slow earthquakes detected around the world occur at depths of 30-50 km. New Zealand is special because in the north, slow earthquakes occur at depths of less than 15 km, close enough to the well-instrumented landmass to warrant in-depth investigations. One important question is: *do slow earthquakes slip to the trench?* If so, that greatly impacts the way we think about the seismogenic zone (or lack thereof), where large interplate earthquakes nucleate. Perhaps slow earthquakes in this area are relieving nearly all the stress on the plate interface within the slip patch and are loading the surrounding region enough to trigger earthquakes. We are using a 3-D finite-element model to address this question (Figure 2).

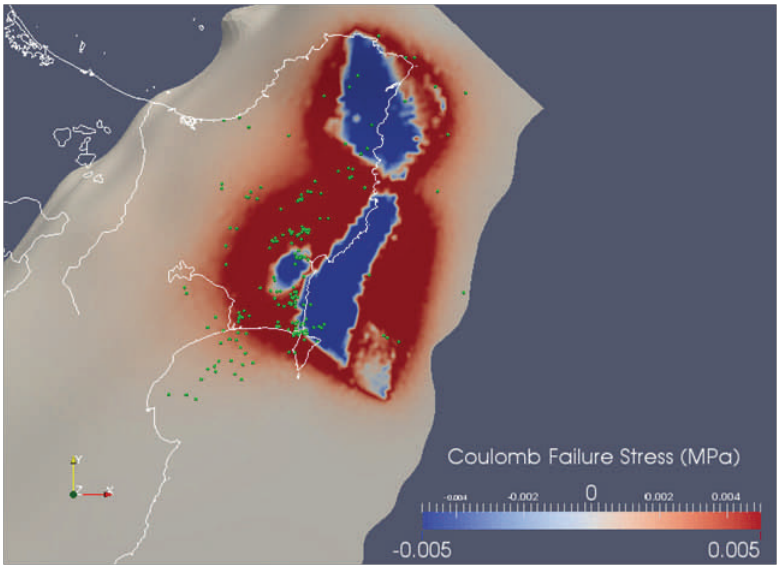


Figure 2: Coulomb stress change and relocated seismicity
Stress changes on the megathrust from a simulated slow earthquake shown in red (stress increase) and blue (stress decrease). Relocated seismicity from the GeoNet catalog within 5 km above or below plate interface shown in green. Much of the seismicity locates at the down dip edge of the slip patch in regions of increased Coulomb stress.

In our model, we simulate slip based on prior slow earthquakes on the interface (March 2010 shown in Figure 2) and calculate the resulting Coulomb stress change. We are finding that the largest slow earthquakes in this region increase Coulomb stress enough to trigger seismicity, and in fact, many of the small earthquakes on or near the subduction interface are located at the fringes of the simulated slip patch.

Despite the extensive coverage of the cGPS and seismic network on land, it is still difficult to resolve what's happening in the offshore environment with much certainty. To address this shortcoming, a team of scientists from the US, Japan, and New Zealand deployed 35 instruments on the ocean floor between the Raukumara Peninsula and the trench (Figure 3). The cleverly named Hikurangi Ocean Bottom Investigation into Tremor and Slow Slip, better known as the HOBITSS experiment (coined by our own Susan Schwartz), will collect seismic, absolute pressure, temperature, and EM data for 1 year with the hope of catching one of these slow earthquakes. While I'm writing this, GPS data from the land stations indicate that a slow earthquake likely started 7-10 days ago and shows no sign of stopping! By combining offshore and onshore data, we will be able to get a clearer picture of the spatial extent of these shallow slow earthquakes and have the opportunity to gain further insight into the seismic hazards in this tectonically complex corner of the world.

Figure 3: Ocean-bottom pressure gauges and seismometers awaiting deployment

Recent Research in Groundwater Recharge
Prof. Andy Fisher

Students, researchers, and colleagues in the UCSC Hydrogeology lab have collaborated on a variety of projects in the last few years, including several that seek to improve groundwater resources. This work is timely given the last three years of dry conditions, increasing use of groundwater, and new legislation that will regulate groundwater across California. A brief summary follows, and you can find links to related papers and presentations at **www.rechargeinitiative.org**.

We have been collaborating with the Pajaro Valley Water Management Agency (PVWMA), which manages fresh water resources in southern Santa Cruz County and northern Monterey County, in the agriculturally productive region that surrounds Watsonville. In one set of studies, we applied tools and data processing techniques developed at UCSC to measure rates of surface water infiltration during managed aquifer recharge, with instruments deployed across a 7.5-acre percolation (recharge) basin near Harkins Slough. These studies showed enormous variability in location and through time in rates of infiltration. Contemporaneous fluid sampling at multiple depths below the basin, and isotopic analyses of nitrate (NO_3) in recovered fluids, demonstrated that there is a functional dependence between fluid flow rate and the rate of NO_3 removal through denitrification, resulting in permanent removal of this common contaminant from the aquatic system. Faster infiltration led to faster rates of denitification, until a threshold was exceeded (0.6-0.8 m/day), above which infiltrated water remained too oxic, and denitrification did not occur. We plan to examine these processes in other areas.

We have been exploring how the hydrologic cycle has changed over the last 120 years, with an emphasis on extreme precipitation. Data from across the San Francisco Bay area show that, although there has been only a small change in mean annual precipitation during this time, in later years a significantly larger fraction of precipitation falls during a smaller number of increasingly intense precipitation events. For example, what used to be a 3-day, 50-yr event is now a 3-day, 10-yr event. With more precipitation falling during fewer events,

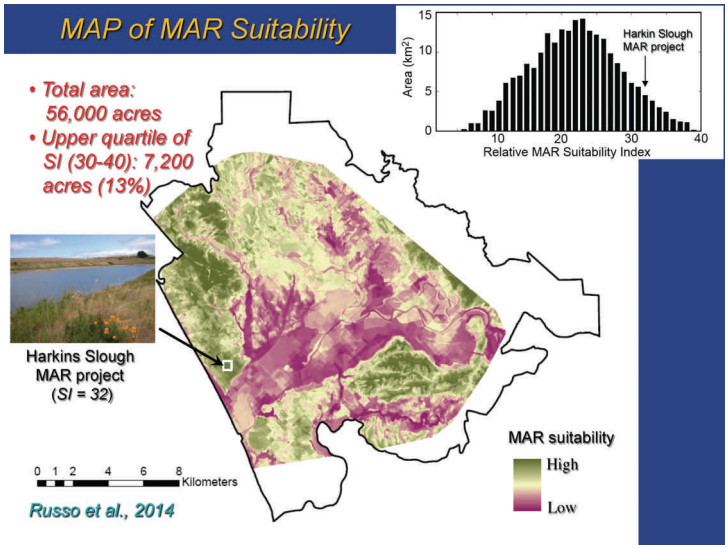


Figure 1. Map showing relatively suitability for managed aquifer recharge (MAR) in the Pajaro Valley. Insets show a histogram of relative values for the basin, and a photo of conditions at one MAR site operated by the PVWMA.

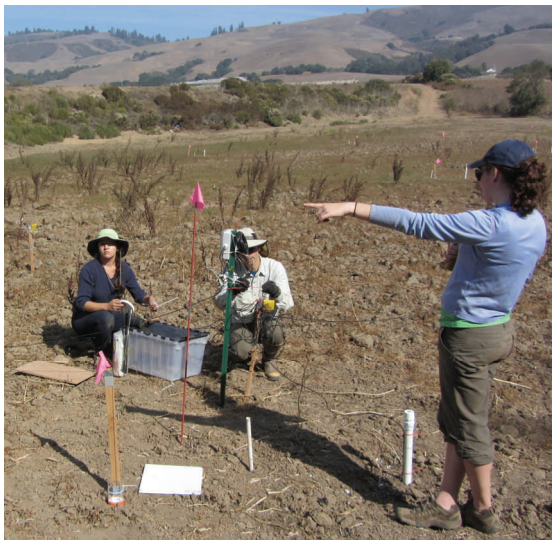


Figure 2. Deploying instrumentation for sampling and real-time measurement at a field site where stormwater is captured for MAR. Left to right: Christina Hill, Andy Fisher, and Sarah Beganskas (current EPS graduate student).

Recent Research in Groundwater Recharge (cont'd)

there is likely to be more flooding and less opportunity for water to recharge aquifers before it runs off the landscape. We are also developing tools and methods that will facilitate stormwater capture linked to managed aquifer recharge. In one study of the Pajaro Valley, we combined eleven sets of surface and subsurface soil, land-use, geologic, and hydrogeologic data and calculated which areas might be most amenable to managed recharge (Fig. 1). We are now extending this analysis to all of Santa Cruz County (and the Elkhorn Slough drainage basin), and linking recharge suitability to runoff models. And we are identifying and establishing field sites to implement this approach, measure flows, determine how to operate these systems more effectively, and put more water into overdrafted aquifers (Fig. 2).

If you would like to know more about these and related projects, please contact me (afisher@ucsc.edu).

Mark your calendars for the
EPS 50th Anniversary Weekend!

When? **Fri-Sun, May 8-10th, 2015**

Where? **UCSC Earth & Planetary Sciences Department**

What? **A celebration, field trips, alumni lectures and more . . .**

AGU FALL MEETING

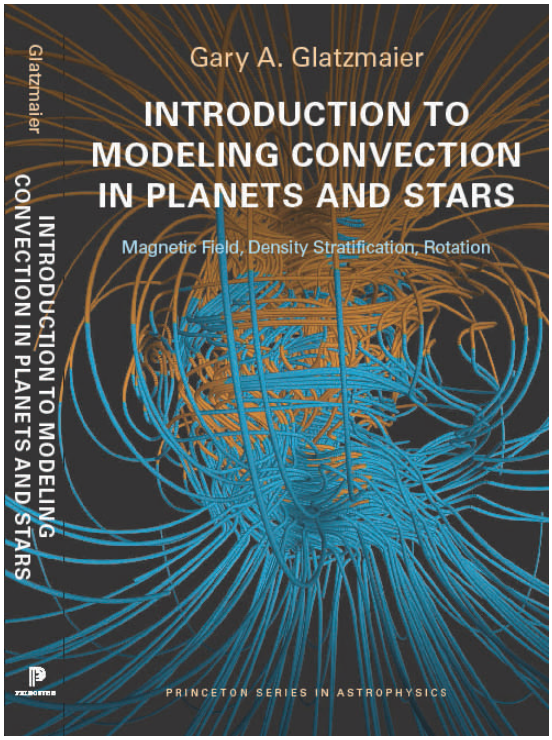
We hope to see you at the Thirsty Bear Brewing Company for our *14th Annual UCSC Earth & Planetary Sciences Alumni Event at Fall AGU!*

When? **Tuesday, December 16th, 2014**
from 6:00pm - 8:30pm

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

Slug Books

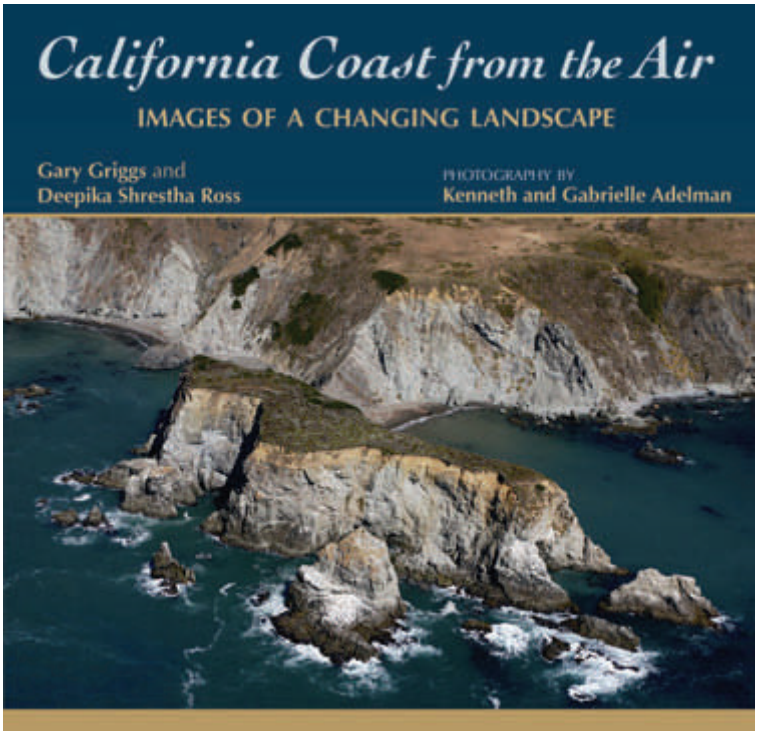
Introduction to Modeling Convection in Planets and Stars
By Gary Glatzmaier



This book is an outgrowth of Gary's numerical modeling class. In it, he provides readers with the skills they need to write computer codes that simulate convection, internal gravity waves, and magnetic field generation in the interiors and atmospheres of rotating planets and stars. He begins by offering a step-by-step guide on how to design codes for simulating nonlinear time-dependent thermal convection in a two-dimensional box using Fourier expansions in the horizontal direction and finite differences in the vertical direction. He then describes how to implement more efficient and accurate numerical methods and more realistic geometries in two and three dimensions. In the third part of the book, Glatzmaier demonstrates how to incorporate more sophisticated physics, including the effects of magnetic field, density stratification, and rotation.

(from Princeton University Press)

California Coast from the Air: Images of a changing landscape
By Gary Griggs and Deepika Ross



This book features 150 of the best photographs from a collection of more than 80,000 images spanning more than a century assembled by the California Coastal Records Project. Steep coastal cliffs gradually sliding into the ocean, an isolated sandy beach that cannot be reached by road, or sand dunes marching inland under the force of the wind are just a few of the scenes portrayed in the book's photos. Oceanographer Gary Griggs and architect Deepika Shrestha Ross provide insightful captions, describing the natural features, their changes over time, and human efforts to tame them. The photographs are organized by county, from north to south, and shaded-relief maps locate features described in the text.

(from Amazon.com)

Alumni Notes

1974

Nancy Brewster Budden, BS: Nancy Ann recently received the Exceptional Civilian Service Medal from the Secretary of Defense, for work in experimental foliage penetrating LIDAR missions over Afghanistan and Africa. She remains after nine years with the Office of the Secretary of Defense as Director for Special Operations Technology, in the Rapid Reaction Technology Office in the Pentagon. Her tasks include identifying and integrating classified and unclassified advanced concepts and emerging technologies, field experimentation, and operational demonstrations, supporting Special Operations commands. She links new tools and capabilities to the various operational military commands while partnering with the intelligence, military, laboratory, and academic agencies and communities.

She is a member of the Research Faculty in the Defense Analysis Department of the Naval Postgraduate School in Monterey California, and also a member of their Space Science Academic Group. With ten years of previous work for NASA at Johnson Space Center as science manager for the Lunar and Mars Exploration Office, she sits on the NASA Headquarters Advisory Council.

OPERATION-BUDDLIGHT 2011-2013

1976

Rebecca Lawton, BS: I'm in Canada as a 2014 Fulbright Visiting Research Chair in Humanities, Social Sciences, and Fine Arts at the University of Alberta. This has more to do with my Earth Sciences degree from UCSC than one might think—decades of research as a Fluvial Geologist (my thesis advisors in taphonomy in NE Utah were Kay Behrensmeyer and Leo LaPorte) and my life as a Colorado River guide led to a parallel career writing about water and water resources. While in Alberta I'm visiting potential settings for my second novel, speculatively about megadrought, mapping, and indigenous masks. Would love for any old friends and colleagues to get in touch (www [dot] beccalawton [dot] com).

1977

Frank Perry, BA: In 2013 I took over as curator of the Capitola Historical Museum. I respond to inquiries, build exhibits, manage collections, give tours and lectures, and so forth. When not busy with Capitola matters, I serve as president of the Friends of the Cowell Lime Works Historic District at UCSC. I helped put together a special exhibit on the local lime industry titled "Crystals, Caves, and Kilns," which was at the San Lorenzo Valley Museum and the Santa Cruz Museum of Natural History this past year.

Marc Bond, BA: It has been almost 40 years since I graduated from UCSC with a degree in Earth Sciences. I remember those years fondly, and I believe they helped set me up for a successful career and life. I even remember the course I took from Eli (Marine Geology). I still live in the United Kingdom with my wife. We have been here since 1991, and thoroughly enjoy being here. We have two daughters (ages 29 and 25). Regarding career, I have had a fabulous one filled with many challenges and excitements and I am always learning. My roles have allowed me the opportunity to travel all over the world, seeing cultures, people and geology I would not normally have been exposed to. My current assignment is the role that I always aspired to ever since I started my career, Chief Geophysicist. My prior two assignments - Subsurface Assurance Manager and Exploration Manager Bolivia - were two further highlights. The Assurance role allowed me to influence and improve all of the subsurface projects and the Bolivia role exposed me to some of the most fascinating geology with some great field work.

Lisa Wright, BS: About a year ago, I retired after 15 years with ConocoPhillips (and an earlier spell with BP, among others). I spent my last year working in our Aberdeen, Scotland, business unit on development geology (drilling long reach wells in a HPHT gas field) and building geocellular models. Although I loved living in Scotland, I find retirement more congenial and lower stress than ops geology! My husband and I then spent a year in Cape Coral, Florida, where he found a teaching job. SW Florida was not a good fit for us culturally or climatically. We are now living in wonderful Anacortes WA, where my husband is teaching high school. I am presently looking around for contract geology work, likely playing to my Alaskan petroleum development experience. Unlike so many fellow Slugs, I have received no major awards, although I am proud of my co-writing of a US patent on gas log analysis. Shades of Mark Twain!

Brian Gobran, BS: MS Petroleum Engineering Stanford 1978
PhD Petroleum Engineering Stanford 1981
ARCO Oil and Gas in Plano TX in various senior research engineer positions 1981 - 1999
EDS, Plano, TX, Oracle Database Administrator 2000 - 2008
DeGolyer and MacNaughton, Dallas (oil consulting company) 2008 - 2013
Denbury Resources, Inc. 2013 - present
Reservoir Engineering Advisor
Denbury is an Oil and Gas company specializing in CO2 floods
2 daughters: Stephanie (22) and Catherine (20)

1978

Kenneth Johnson, BS: I am currently working on a number of engineering geology and hydrogeology projects associated with tunnel and pipeline construction. In my capacity as a Senior Supervising Geological Engineer at Parsons Brinckerhoff in San Francisco I led the geotechnical design for the Central Subway project for the San Francisco Municipal Transportation Agency. Project milestones this year included completion of twin 20-ft diameter tunnels and beginning of construction for the three underground stations. The underground stations include the Yerba Buena/Moscone Station at 4th and Folsom; Union Square Station beneath Stockton Street; and the Chinatown Station at Stockton and Washington Street. My apologies to all the AGU folks for the bad traffic this project is causing around Moscone

during constructions! Geology was key to the success of this project from characterizing the unconsolidated quaternary sediments, to the Franciscan formation forming Nob Hill, to the excavation dewatering of excavations that will be 70 to 100 feet deep.
This year I also began similar work on a new subway line in Baltimore, MD where a 14-mile long Baltimore Red Line light rail line will be constructed that includes about 5 miles of tunnels through downtown Baltimore. It is pretty fascinating to deal with the older amphibolites and granite along the eastern seaboard as well as Cretaceous-age soils overlain by more recent geology as well. The Red Line tunnels and underground stations through downtown will also skirt Camden Yards, the Convention Center, Little Italy and other points adjacent to the Inner Harbor area where the technical challenges will be significant.
I am fortunate to be well prepared (thanks to UCSC) to interpret, and explain the geologic characteristics that in many cases are integral to successful tunnel and underground excavation design and construction.

1979

Fred(rika) Moser, BA is very much enjoying her position as Director for the Maryland Sea Grant College Program and looking forward to many more years working to support research, education and outreach efforts to restore and sustain the Chesapeake and Coastal Bays and their watersheds.

Sue Gilchrist, BS: Upon graduation with a BS I joined the Santa Cruz County Planning Department as the "staff geologist". I worked with Gerry Weber and Gary Griggs on a variety of land use issues relating to geologic hazards. I eventually expanded my area of responsibility to include the full range of environmental issues including mining reclamation, erosion control, agricultural preservation and CEQA compliance. I then moved to the Redevelopment Department where I was able to build community facilities rather than regulate private ones. I worked on several affordable housing projects and became interested in the people we served. My last decade in public service was spent in social services working on a number of issues including homeless services. My ES studies prepared me very well for a career in public services - an appreciation of geologic time is very useful if you work in government. In addition, the writing and presentation skills, as well as the research and problem solving skills that I learned at UCSC served me so well I every part of my varied career. I was so lucky to have a great education at UCSC in the ES department. When our children were young I worked part time in the oil and gas industry for a small consulting firm. As consultants never say 'no' to work opportunities I also started learning the environmental side of the geology business. I helped to permit a hazardous waste disposal site - now called Clean Harbors, worked on a gold mine, gravel quarry, gas station clean-ups, and continued subsurface work in the oil industry. While dodging the ups and downs in the oil industry we followed Jerry's career to Saudi Arabia, Indonesia and Kuwait for a total of 15 years overseas. We loved the travel and the great friends we made along the way. Our daughter, Sarah McNaboe graduated from high school in Kuwait and then attended UCSC earning a BA in Earth Science (2006); a second generation UCSC Geo-Slug! It was interesting to see that she had many of the same professors as I had. Our son Christopher also attended UCSC but studied political science and languages. Our youngest son just graduated from Carroll College in Montana with a degree in International Studies. We are now in Bakersfield, California where I work for a consulting firm, EnviroTech Consultants. I am involved with permitting exploration oil wells (CEQA documents), underground injection wells, hydraulic fracturing, aquifer exemptions, site characterization, Phase I site assessments for oil field properties, and occasional clean-up and remediation. I have been involved with AAPG as a board member for the Division of Environmental Geosciences.
Jerry and I just purchased a 41-foot sailboat and hope to be exploring the world by boat sometime soon.

1982

John Childs, PhD: I am entering my third year of trying to retire. We continue doing surface and underground mine geology. We explore for and evaluation metal and industrial mineral deposits. If anyone would like to take over a consultancy in Bozeman, Montana I would be happy to hear from him or her. PS- We do not need employees or interns at the moment but would be happy to hear from students next spring.

Ray Wells, PhD: The Distinguished Service Award is the highest honorary recognition an employee can receive within the Department of the Interior. It is granted for an outstanding contribution to science, outstanding skill or ability in the performance of duty, outstanding contribution made during an eminent career in the Department. **Awarded to Ray E. Wells** – for scientific leadership and expertise in developing geologic and tectonic models of the Northwest U.S. that provided the essential framework for earthquake hazard assessments and mitigation in this seismically and volcanically active region.

1983

Victoria Pease, BA: 1) A bit of an update. I am concentrating on Arctic tectonics right now, leading a collective of c. 35 geologists and geophysicists to develope an integrated model for the tectonic development of the Circum-Arctic region and running a geochem/geochron lab (XRF and LA-ICPMS). 2) Internships. Self-funded interns are very welcome (acknowledging that getting to Sweden and finding housing is not cheap/easy, but perhaps there are dept grants students can apply for, or they are willing to pay for the opportunity to study abroad). Co-funded interns are more complicated, but can still be developed. From our end this would involve a low hourly wage in conjunction with course credits (its called 'practical experience' and is limited to a 5 week or a 10 week period). Due to obtaining student visas, this requires some advance planning, typically c. 6-4 months. If this is of interest, I can ask around the dept to see what kind of subjects/projects we would have and get back to you - let me know what you think... 3) A different matter, but I have been promoting PhD studies at Stockholm University because they are FULLY FUNDED! No loans, no student debt, no part time working... If you have particularly good applicants, but not enough positions/funds to offer them all a project, please direct them to us. All of our PhD projects are internationally advertised on our web page under positions (www.geo.su.se).

1984

Michael Ort, BS: I have no recollection when I last updated you on what I am doing! Anyway, this year, I am on sabbatical. We are living in Wicklow, Ireland, as my wife has some projects here in Ireland and I did not want to live in Dublin. I am mostly sitting at the table and writing (well, I do get out for runs along the stony beach and rides in the Wicklow hills), with occasional trips for field and lab work for projects on Reunion Island and the Colli Albani, Campi Flegrei, and Ischia volcanoes in Italy.

1985

Will Osborn, BS: I'm seeing tectonics in action this week, working on the Momotombo geothermal field and power plant sitting next next to the smoking, subduction-fueled Volcan Momotombo on Lake Managua, Nicaragua. This is my 3rd year as VP at Geothermal Resource Group in Palm Desert, The geother-

mal business was 'sluggish' the last couple years, but busy now. We have geothermal projects in California, Nevada, Hawaii, Idaho, Commonwealth of Dominica, Nicaragua, Kenya, Indonesia, and elsewhere. We are interested in interns with interest in geothermal and studies in geosciences and exploration drilling. Slugs receive special consideration.

1986

David Pais, BS: David, MS, CSP, is an EHS Director, Operations Support at Seagate Technology. David earned his Earth Science B.S. from University of California, Santa Cruz and an Environmental Management M.S. from the University of San Francisco. He has managed environment, health and safety programs for over 26 years within the electronics industry. Mr. Pais is an instructor for the University of California, Santa Cruz Extension's Environmental Health and Safety program. David serves on Ecology Action's board of directors while previously serving on the Santa Cruz County Hazardous Materials Advisory Committee and City of Santa Cruz Water Commission. David still lives in Santa Cruz with his wife Deena, two daughters Zoe and Hannah and their doodle dog, NachoCheese. We do have student internships available from time to time and sometimes have projects for students through the UCSC Extension Courses. This work would be more Environmental Geology/Studies focused.

1987

Mark Reagan, PhD: I am currently *(9/20/14)* on-board the JOIDES Resolution as one of the co-chief scientists for IODP Expedition 352. I stepped down as chair of the Department of Earth and Environmental Sciences at the University of Iowa last July, and I am looking forward to a full year of conducting research on the cores from this expedition, and working on other projects.

Lisa Dierauf, BA: Lisa Dierauf, Lon Abbot and Terri Cook were in the field right after the Colorado floods hit last year, brainstorming on how the City of Boulder's Open Space and Mountain Parks department could teach the public about this momentous event. In the first year, staff and volunteers offered over 130 public hikes! Also, Suzanne and Bob Anderson have students in the field studying some of the debris flows created by the flood.

1988

Jim Robinson, MS: At the end of the year I will be leaving my position as a water planner for the Montana Department of Natural Resources and Conservation, a position I've held for 17 years. Nearly all that time has been spent working on water-related projects in the Yellowstone River basin and I feel fortunate to have had this opportunity. Now is a good time to sever my ties with the Department as we have nearly completed the most recent version of Montana's state water plan (see dnrc.mt.gov/mwsi). At this point, I'm not sure what my encore will be, but I have some time to figure it out. For now I plan to divide my time between the Rocky Mountains of Montana and the Andes of Ecuador. Hardly a day goes by that I don't think about my time at the UCSC Board of Earth Sciences.

1992

Kirk McIntosh, PhD: When I think about what I have been doing lately, I have to laugh a little bit—at the surface, I am doing now what I was doing 20 + years ago—I am still at the University of Texas Institute for Geophysics, I am still working on the tectonics and structure of the Costa Rica convergent margin, and I am still trying to document how arc-continent collision works in Taiwan. Fortunately, I think that we are making great progress in these areas, and I have enjoyed many exciting discoveries. I expect to continue this work and hopefully expand to some new areas in the near future.

Jonathan Stock, BS: I recently became the hood ornament for the USGS Innovation Center for Earth Sciences, here in Menlo Park. The Center's mission is to identify national scientific problems where USGS core interests are aligned with those of our external partners, and to pursue innovative technological solutions together, using scarce dollars to best serve the public. We hold annual workshops to bring together scientists with technologists and engineers to do this. The workshop often leads to proposals to the Innovation Fund, a resource for fueling these ideas. It occurred to me that it might be fun if folks from UCSC Earth Sciences joined us for our hazards workshop December 12, the Friday before AGU. We are currently collaborating with UCSC engineers on some projects, ironically next to the old Earth Sciences home in Appl. Sci. There is more information about this opportunity, and previously funded proposals at: http://geography.wr.usgs.gov/ICES/events.html

1995

Eric Thor Egland, BS: In 2000, I completed my Master's thesis with Prof. Bruce Luyendyk at UCSB estimating flux of natural hydrocarbon seep gas to the atmosphere above the Santa Barbara Channel just offshore of the university. I also participated in SF6 tracer surveys of water infiltration in southern California and of currents deep in Mono Lake. I enjoyed another 2 years as a post-grad research assistant, helping with sonar survey navigation in the SB Channel, and designing a research website: http://seeps.geol.ucsb.edu. After UCSB, in 2004, I joined L-3 Communications California Tube Laboratory as an environmental engineer. During that time, I greatly improved productivity by designing a product cooling flow tester, using equilibrium geochemistry to treat calcium buildup in microwave cooker tubes. I survived colon cancer, my father passed, and the facility closed in 2012. In 2013, I joined Dr. Ira Leifer, a UCSB thesis advisor, at Bubbleology Research Intl., Inc., for a couple months to participate in a cross-country RV trip sampling greenhouse gasses in specific areas of interest to corroborate satellite data. During the survey, we stopped at LUMCON in Cocodrie, LA to participate in a benthic lander sonar survey of seep gas bubble plumes on Mississippi Channel Site 118 aboard the R/V Pelican. I'm currently cleaning up the family ranch in San Juan Bautista, and am actively on the job hunt again. I'm also seeking PhD opportunities in environmental or physical oceanography. I'm interested in monitoring global warming and all of its effects on the ocean using chemical and geophysical methods. I would recommend to any prospective undergrad, that they complete a dual degree program in Earth Science and Engineering, Chemistry, Marine Biology, or Business/Economics. Many current jobs have requirements that fit a dual degree.

2002

Stefano Mazzoni, MS: Still continuing work at Oxy (now California Resources Corporation) as a geologist developing oilfields in the southwestern San Joaquin Basin. Family life has been incredible since the arrival of baby Emilia in August 2013! Heidi and I are overjoyed. We've taken her camping, to NYC, Italy, and West Virginia as well as road-trips to the SF Bay Area, San Diego, Central Coast, and many trips to Mammoth. Looking forward to bringing her to UCSC and the annual geo-slug camping trips.

Mark Clementz (PhD) received a Humboldt Research Fellowship and is spending the year in Berlin studying fossil whales.

2003

Lisé Whitfield, MS. I continue to work as the lead curriculum designer for the University of Washington, College of Education research project, Knowledge in Action (http://www.edutopia.org/knowledge-in-action-PBL-research), which is studying how project-based learning impacts students in advanced high school level science courses. In this capacity, I lead a team of scientists, education researchers, and high school science teachers in designing and testing a project-based curriculum for AP Environmental Science and AP Physics. In more personal news, we now have a delightful 1.5 year-old son, Élan, and have recently moved from Seattle to Abu Dhabi where my husband has accepted a faculty position in physics and astronomy at NYU Abu Dhabi. I'll continue my work at UW from Abu Dhabi - a fortunate but challenging telecommute of 11-12 hours.
My background in physics and earth science at UCSC combined with continued education in the field of science education has helped me to develop a career designing and researching innovative ways of teaching science, with a particular emphasis on reaching poverty-impacted students . Over the years I've worked developing curriculum and training teachers at the middle school, high school, and introductory college level for earth science, astronomy, physics, and chemistry. We don't really have internships per se (other than doc students in science ed!), but I'd be more than happy to chat with any GeoSlugs with an interest in science education (teaching, curriculum design, or research).

2006

Greg Stemler (M.S. 2006), **Mari Gilmore** (B.S. 2003), and **Alex Rosenthal** (M.S. 2012) are all living the dream in Oakland. We all work together as environmental consultants at AMEC, where we investigate and remediate contaminated sites. The work is diverse and challenging, but being part of a great team makes it really rewarding. Recently, Khalil Abusaba (also a slug M.S. Marine Science 1994, PhD Chemistry 1998) joined our team as department manager and we are hoping to add some more slugs soon.

S. Tyler Boss, BS: I have one of the best jobs in the world. I work for Western Geco on seismic surveys all around the world. Currently I'm working in Equatorial Guinea. Next will be Angola. In the last two years with the company I've been to about 18 countries plus a few more on my personal travels. I work 5 weeks onboard and then I get 5 weeks off. I spend the majority of my time off traveling the world. Onboard I work in the data acquisition department and I also drive the small workboats, the FRC (Fast Rescue Craft) and the crane.

2008

Mike Swirsky, MS: For the last five years or so I've been working as a Petroleum Geologist for Aera Energy in Bakersfield, working in 3D reservoir modeling. Our company has paid graduate internships every summer, which is a great way to make some extra money and to get experience in industry, if they are trying to decide to head in that direction. Backgrounds are quite varied; many of my fellow new hires out of college have non-petroleum degrees, specializing in structure, geochemistry, and the like. Please let me know if there is any interest; I know several of Casey Moore's grad students got internships in oil (that's how I got the idea myself).

Jennifer Small Griswold, PhD: I'm starting my third year as faculty in the newly named "Atmospheric Sciences" Department at the University of Hawaii … we just changed from Meteorology to modernize our image and better relate to our diverse faculty interests. I'm an integral part of our Curriculum Committee re-doing our undergraduate program, developing new courses and degree options (a BA and a

coursework masters very similar to and guided by UCSCs program). I've just finished developing a class that talks about how weather and climate shaped the cultures of the Pacific Islands, it's first of its kind and should be a great option for our students. I started the first every Expanding Your Horizons young women's conference getting girls involved in STEM field here at UH and will be hosting it annually. I have two Graduate Students of my own which is scary and awesome and we're waiting to hear about a field project opportunity. My current Master's student will be graduating in summer 2015 and I'll be looking for a new Master's Student interested in doing aircraft cloud stuff next year. So, if there are any outstanding undergrads thinking about graduate programs in atmospheric sciences spread the word.

Ryan Haupt, BS: I'm currently pursuing a PhD at the University of Wyoming in the Department of Geology & Geophysics under Mark Clementz, who did his PhD with Paul Koch at UCSC. My research involves using proxies such as dental microwear or stable isotope geochemistry to better understand the paleoecology of ground sloths and other Xenarthrans, including their living descendents. For fun and as an outreach project, I also co-host a podcast called *Science... sort of* with fellow department alums Patrick Wheatley and Charlie Barnhart. It's a really great way to promote science to a diverse audience around the world.

Brooke Crowley, PhD: I spent two years living in Toronto. Now I am in Cincinnati Ohio starting up my fourth year as an Assistant Professor. I have a joint appointment in Geology and Anthropology, which means I have a fair amount of freedom in the research I conduct and the courses I teach, but that I have a lot of meetings to attend. I have a small but bustling lab and I like my colleagues. Cincinnati is a nice place to live. I am fond of the combination of urban and green space and I love being able to walk to work. I think of Santa Cruz frequently. I won't be at AGU this year but hope to attend in 2015.

2010

Charles Barnhart, PhD: I will be teaching my first class this Wednesday, 'energy and the environment', as a tenure-track assistant professor at Huxley's College of the Environment at Western Washington University. I am one of 4 campus-wide hires in the Institute for Energy Studies: https://energy.wwu.edu/users/barnhac2. My role is to study earth system – societal energy system interactions… net energy analysis and life cycle assessment will be my principal techniques. I'm new so I don't have much more to report other than I'm really excited to execute my dream of becoming a professor. And, I'm excited to be back in the northwest surrounded by family, friends, mountains, forests and hoppy beer.

Alex Morgan, BS: After graduating with a B.S. from UCSC, I worked at NASA Ames for a year where I researched alluvial fans on Mars. I am currently in the fourth year of my PhD at the University of Virginia. My work is focused on martian fluvial geomorphology, but I have been able to get into the field at a number of terrestrial analogue sites, including Death Valley, Hawaii, and the Atacama Desert.

Sora Kim , PhD is a Chamberlain Postdoctoral Fellow in the Geophysics Dept. at the Univ. of Chicago.

2011

Katie Snell, PhD accepted a position as an Assistant Professor in the Department of Geological Sciences, University of Colorado Boulder.

2012

Aviel Stern, BS is working on a Master's at UMass Amherst investigating the stress and energy budgets of strike-slip faults.

Update on EPS Development

Prof. Andy Fisher, EPS Development Coordinator

The last year has been busy for EPS Development, with establishment of a standing EPS Advisory Committee (EPS-AC), setting of development priorities for the department, revision to the EPS website to simplify giving, and developing a plan to celebrate our upcoming 50th anniversary.

Most top-15 departments like EPS (and many others that are not ranked as highly) have long histories of alumni networking and development. EPS (formerly ES) at UCSC remains relatively young, and in the past we have not had a faculty member who would focus on alumni development. My role as EPS Development Coordinator is to be my primary department job for the next several years, and I'll be aided by Quentin Williams (department chair), Francis Nimmo, Patrick Chuang, Judy Van Leuven (department manager), and JJ Mack (PBSci division). JJ (and Anne Hayes before him) has been an essential partner in launching this effort, and we are coordinating our activities carefully and getting strong support from the PBSci division.

Our EPS-AC is being lead by Mike Underwood (BS, 1976) and Peter Vrolijk (PhD, 1987), in collaboration with Gerry Weber (PhD, 1980), Chuck Lawson (BS, 1973), Greg Beroza (BS, 1982), Robert Koeppen (BS, 1972; MS, 1977), Bill Connelly (PhD, 1976), Laura Stupi (BA, 1997; MS, 2000), Richard Gordon (BA, 1975), and Shengwen Jin (Postdoc, 2000). Mike and Peter can be reached at: underwoodm@missouri.edu and pvrolijk@comcast.net. The EPS-AC will meet at least once annually, and is assisting in planning and holding events at UCSC and around the country. Please contact the EPS-AC leadership if you have ideas or suggestions for events and for our alumni network more broadly.

We have revised the part of the EPS website dedicated to fund-raising, including an explicit listing of priorities. Please see the new layout and content here:
http://eps.ucsc.edu/support-us/index.html

Scroll down to see development priorities and links to get more information and/or make contributions. **Please note:** two of our highest priorities have an active match opportunity: donations to the J. Casey Moore Fund and the Earth's Environment Fund will both be matched 1:1, ***doubling the impact*** of your generosity in support of EPS students.

Mark your calendars! We are planning for the **EPS 50th Anniversary** weekend, to be held **8-10 May 2015**. Details are forthcoming, but we currently plan to include one or more half-day field trips; presentations and posters by faculty, researchers, students, and/or alums; an update on EPS activities and plans; and plenty of time for socializing while enjoying local libations. Please watch your email and the EPS website for more information. Events will likely begin afternoon of Friday 5/8/15 and extend to morning of Sunday 5/10/15.

I am glad for the opportunity to get to know many of you, and welcome your suggestions and ideas for ways to be more effective in nurturing the EPS community. Please stay in touch, Andy Fisher (afisher@ucsc.edu).

Earth and Planetary Sciences Department
University of California, Santa Cruz
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Santa Cruz, CA 95064
http://eps.ucsc.edu

Ways to Give to the Earth and Planetary Sciences Department at UCSC

Your contribution can help to 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/`

We recently updated this part of the EPS website. You can read about current development priorities, and after choosing the fund/endowment of your interest, you will be transferred directly to a page where you can enter the amount of your gift and credit card information.

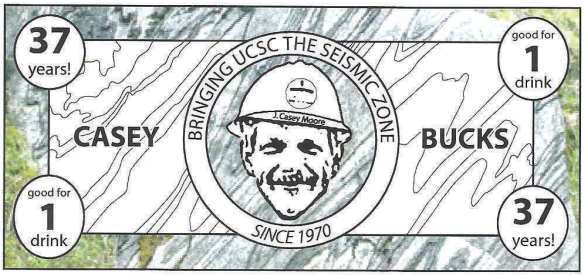
This is the easiest way to support the EPS Department!

(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 above.

(3) Please Call or Email for Information
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:
- Judy Van Leuven (Department Manager): 831-459-4478, judy@ucsc.edu
- Quentin Williams (Department Chair): 831-459-3132, qwilliams@pmc.ucsc.edu
- Andy Fisher (EPS Development Coordinator): 831-459-5598, afisher@ucsc.edu

(4) Please check with your employer to see if they will match your donation!



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Please attach a check payable to the UC Santa Cruz Foundation (with fund/endowment designation written under "Memo"), or enter credit card information:

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My company will match my gift (company name): _____

Please mail to:UC Santa Cruz, MS: PBSci Development, 1156 High St, Santa Cruz CA 95064

Or donate online at http://eps.ucsc.edu/support-us/index.html

Four highest EPS Development Priorities (Fall 2014):

☐ **Casey Moore Fund** (current value: $94k)
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 2014.

☐ **Gerald Weber and Suzanne Holt Fund** (current value: $159k)
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** (current value: $36k)
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 $10,000 for the current calendar year will be matched 1:1 by a generous alumnus and family.
Double the impact of your contribution by donating before the end of 2014.

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:

☐ **Earth and Planetary Sciences Fund**
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**

UC Santa Cruz

Earth & Planetary Sciences

1156 High Street
Santa Cruz, CA 95064
http://eps.ucsc.edu

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Name _____ **Telephone** _____ **E-Mail** _____

Year _____ **Degree** _____ **Is This A New Address?** ☐

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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.

Mark your calendars for the
EPS 50th Anniversary Weekend!

When? **Fri-Sun, May 8-10th, 2015**

Where? **UCSC Earth & Planetary Sciences Department**

What? **A celebration, field trips, alumni lectures and more . . .**

The Earth and Planetary Sciences Department and Institute for Geophysics and Planetary Physics proudly acknowledge their many advocates and supporters. The following people and organizations have made gifts to the department in 2014. Thank you one and all!

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Naohiko and Kathleen Noguchi

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Jacob Ogilvie Sewall
Everett and Allison Shock
Rich Schouboe and Judith Fierstein
Christopher and Kathy Snyder (PG&E Corporate Foundation)
Melissa Simcox
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