Department of Earth & Planetary Science

Alumni Update 2014 - 2015

INSIDE THIS UPDATE

University of California, Berkeley

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Cover photo:
Photo from the recent field campaign of a storm front passing through Oklahoma. Taken by a stereo camera."

Photo by: David Romps

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CHAIR'S LETTER: THE STATE OF THE DEPARTMENT, 2014-2015

Dear Friends and Alumni,

I am pleased to introduce myself as the new chair of the University of California, Berkeley Earth & Planetary Science Department. I cherish this opportunity to write to you as part of our ever-expanding alumni and friends network. I believe that cultivating a line of communication with community members is the best way to carry on the tradition of excellence in EPS, and I hope this Alumni Update provides insight into the recent history and future goals of the department.

I am committed to continuing the productive work of previous chairs in EPS, especially my immediate predecessor Bruce Buffett. Under Bruce's leadership, EPS solidified its standing as a top three graduate program in Earth Sciences and cemented its reputation as the best department in the fields of Geophysics and Seismology, according to the latest ranking by US News & World Report. I aim to build upon Bruce's tenure and continue to make UC Berkeley a world-class destination for graduate studies and faculty research in Earth and Planetary Science.

In our efforts to cultivate EPS' stellar reputation, all of us are working towards the three core tenets of academia: teaching, research, and outreach. In 2015, six individuals were matriculated with a Ph.D. degree in the department: Andrea Chiang, Jesse Alexander Day, Sirine Constance Fakra, Percy Anne Link, Benjamin Albert Nault and Jasper Oshun. At the undergraduate level, the crown jewel of our Undergraduate Majors program is the advanced field course, also known as the summer field camp, EPS 118. Professor Michael Manga co-led the field course in the Long Valley caldera this previous summer, and he provided an informative article on the advancements of the field camp for your reading pleasure.

Over the past year, accolades and awards for our faculty continued to pour in, and I would like to mention a few. At the 2014 Fall Meeting of the American Geophysical Union (AGU), Professor Don DePaolo received the Hess Medal; Professor David Shuster was awarded the Macelwane Medal; and Professor Nick Swanson-Hysell was presented with the William Gilbert Award for excellence in paleomagnetism. Sanne Cottaar, one of our former students and now a research fellow at Pembroke College and a research associate at the University of Cambridge, will receive the Keiiti Aki Young Scientist Award at the 2015 Fall Meeting of AGU. In sum, faculty achievements portray precisely the high caliber of research and teaching we are all committed to in this department.

Last but not least, we are in the process of hiring two positions at the level of Assistant Professor, with an expected start date of July 1, 2016. As always, we are looking for candidates with a strong record in teaching and research, with an emphasis on climate science, biogeochemical cycles, or Earth surface processes. The department is very interested in individuals who may have had non-traditional career paths or those who will contribute to diversity and equal opportunity in higher education.

UC Berkeley's Earth & Planetary Science Department is one of the most highly acclaimed in the nation, yet the department has not attained this elevated stature without the generous support of friends and alumni. We are eternally grateful for your donations as they go directly to expanding the educational opportunities of our undergraduate and graduate students. I humbly request that you consider donating to EPS, particularly in this time of diminishing state funding for our educational mission. The impact of these donations are highlighted throughout this year's Alumni Update.

To conclude, I salute each and every one of you for your continued interest and support of EPS. I invite you to read the following pages that provide a glimpse into some of the accomplishments in the areas of teaching, researching, and outreach of our esteemed faculty. I would like to thank Andrew Jan, Judith Coyote and Valerie Neumark for their efforts in producing this high-quality Alumni Update for your intellectual stimulation and reading enjoyment.

- Richard M. Allen

DEPARTMENT FACULTY RESEARCH ACTIVITIES

Allen, Richard M.,
Professor, Ph.D., 2001, Princeton University. Currently using seismic data from the offshore-onshore Cascadia Initiative to explore the formation, deformation and destruction of the Juan de Fuca plate from the ridge and through the subduction zone.

Bankfield, Jillian F.,
Professor, Ph.D., 1990, Johns Hopkins University. Geomicrobiology, microbial ecology and evolution; nanoparticles in the environment.

Bishop, James K.B.,
Professor, Sc.D., 1977, MIT/WHOI Joint Program in Oceanography. Chemical, physical, and biological controls on the cycles of carbon and related chemical species in the ocean; robotic instruments for ocean exploration.

Boering, Kristie A.,
Professor, Ph.D., 1992, Stanford University. Atmospheric chemistry and climate; field, laboratory, and modeling studies of the stable isotopic compositions of atmospheric trace gases; photochemical isotope effects.

Buffett, Bruce,
Professor, Ph.D., 1991, Harvard University.
Used observations of a 60-year fluctuation in geomagnetic field to reveal stable stratification at the top of the core and constrain the rate of heat flow from the core.

Bürgmann, Roland,
Professor, Ph.D., 1993, Stanford University. Researched active tectonics and used satellite and seafloor data to better understand subduction zone earthquake cycles.

Chiang, Eugene,
Professor, Ph.D., 2000, Caltech.
Planet formation, protoplanetary disks, planetary dynamics.

Cohen, Ronald C.,
Professor, Ph.D., 1991, UC Berkeley. Observing the composition of the atmosphere from the ground, aircraft, and space. Thinking about how rising temperatures combined with declining (U.S.)/ increasing (Asia) Nox emissions affect spatial and temporal patterns.

Collins, Williams D.,
Professor in Residence, Ph.D., 1988, University of Chicago. Dr. Collins' personal research concerns the interactions among sunlight, heat, the coupled climate system, and global environmental change.

Cuffey, Kurt M.,
Professor, Ph.D., 1999, University of Washington. Glacier mechanics; paleoclimatology; environmental isotope geochemistry; river processes.

DePaolo, Donald J.,
Class of 1951 Professor of Geochemistry and LBNL Associate Laboratory Director for Energy Sciences. Ph.D., 1978, Caltech. Continuing work on Tibetan granites, magmatic processes, deep sea sediment diagenesis and carbon sequestration.

de Pater, Imke,
Professor, Ph.D., 1980, University of Leiden. Radio and infrared observations of the Solar System, including giant planet atmospheres and Jupiter's magnetosphere.

Dietrich, William E.,
Professor, Ph.D., 1982, University of Washington. His research group showed experimentally the necessary conditions for sustained river meandering and presented a theory predicting valley spacing.

Dreger, Douglas S.,
Professor, Ph.D., 1992, Caltech.
Wave propagation; earthquake source physics; earthquake hazards; realtime seismology; nuclear monitoring.

Fung, Inez Y.,
Professor, Sc.D., 1977, MIT.
Climate change; global carbon cycle; geophysical fluid dynamics and large-scale numerical modeling; remote sensing of the Earth.

Ingram, B. Lynn,
Professor, Ph.D., 1992, Stanford University. Published *The West without Water*, University of California Press. Recent research includes studies of ancient floods using sediment cores from San Francisco Bay and watershed.

Jeanloz, Raymond,
Professor, Ph.D., 1979, Caltech.
Is using the largest laser in the world to reproduce conditions deep inside Jupiter and super-Earth exoplanets.

Manga, Michael,
Professor, Ph.D., 1994, Harvard University. Studying the Lusi mud eruption in Indonesia to understand why it started, where the fluids come from, and when it will end. Also studying geysers in Chile and Yellowstone to understand how and why they erupt.

Militzer, Burkhard,
Associate Professor, Ph.D., 2000, University of Illinois. Works with scientists on the NASA mission Juno to prepare for the gravity measurements when the spacecraft arrives at Jupiter in 2016.

Pride, Steven R.,
Adjunct Professor, Ph.D., 1991, Texas A&M. Developing theoretical models as constrained by laboratory data, for how Earth properties change when fluid is injected.

Rector, Jamie,
Professor, Ph.D., 1990, Stanford University. Seismic techniques for characterizing reservoir properties and processes; seismic reflection imaging; borehole seismology; near-surface seismology with applications to environmental remediation.

Renne, Paul R.,
Professor in Residence, Ph.D., 1987, UC Berkeley. Research on the Cretaceous-Paleogene boundary with fieldwork; on human evolution and its archeological record (the last 500,000 years); the nature and timing of the Matuyama/Brunhes geomagnetic polarity reversal.

Richards, Mark A.,
Professor, Ph.D., 1986, Caltech. Research has focused on understanding the relationship between Deccan flood basalt volcanism and the K-T extinctions/Chicxulub impact, and also the geological structure and evolution of the Galápagos Islands.

Romanowicz, Barbara A.,
Professor, Doctorat d'Etat, 1979, Université de Paris. From the analysis of information contained in seismic waves bouncing around the earth's interior, we have produced a three-D scan of the earth's deep mantle.

Romps, David M.,
Assistant Professor, Ph.D., 2005, Harvard University. Found that lightning will likely increase by 50% over the U.S. during this century due to global warming, and that increase is due to increases in atmospheric instability.

Self, Stephen,
Adjunct Professor, Ph.D., 1974, Imperial College, London, UK. Co-published papers on the huge flood-basalt province in India, released in both *Science, Geological Society of American Bulletin* and discussed in *Nature Geoscience, Earth and Planetary Science Letters.*

Shuster, David L.,
Associate Professor, Ph.D. 2005, Caltech. Developed a new geochemical paleothermometer based on production and diffusion of cosmogenic noble gases on earth and the moon, and studied timescales of Grand Canyon incision.

Swanson-Hysell, Nicholas L.,
Assistant Professor, Ph.D., 2011, Princeton University. Research projects: the Midcontinent Rift to quantify rapid plate motion; the Tambien Group to constrain global change leading up to Snowball Earth glaciation; the Slate Islands impact structure to probe magnetic effects.

Emeriti

Alvarez, Walter,
Professor, Ph.D., 1967, Princeton University. Research in the Italian Apennine Mountains on Early Cretaceous Earth History and the tectonic origin of this unusual mountain range. Broader research on Big History and ChronoZoom.

Brimhall, George H.,
Professor, Ph.D., 1972, UC Berkeley. Completed geological mapping in the Pioneer Mountains of Montana where a Cretaceous formation bears evidence of early uplift of the Rocky Mountains.

Bukowinski, Mark S.T.,
Professor Emeritus, Ph.D., 1975, UC Los Angeles. Physics and chemistry of planetary interiors; mineralogy; high pressure mineral physics; planetary structure and evolution.

Johnson, Lane R.,
Professor Emeritus, Ph.D., 1966, Caltech. Seismology and physics of the Earth's interior and wave propagation; seismic source theory; applied geophysics.

Kirchner, James,
Professor Emeritus, Ph.D, 1990, UC Berkeley. Showed that stream chemistry time series have a common fractal structure that makes water quality trends difficult to detect and predict.

Morrison, H. Frank,
Professor Emeritus, Ph.D., 1967, UC Berkeley. Applied geophysics: electrical and electromagnetic methods for mapping subsurface conductivity; cross-well electromagnetics for reservoir characterization; numerical modeling and inversion.

Sloan, Doris,
Adjunct Professor Emerita, Ph.D., 1981, UC Berkeley. History of San Francisco Bay, Foraminifers in Bay sediments, biostratigraphy

Wang, Chi-yuen,
Professor Emeritus, Ph.D., 1964, Harvard University. Published a paper in *Nature Communication* on new streams and springs following the 2014 South Napa earthquake.

Wenk, Hans-Rudolf,
Professor Emeritus, Ph.D., 1964, University of Zurich. New edition of the mineralogy book and engaged in a range of synchrotron diffraction projects. Excited to decipher paleostress in rocks and high pressure experiments to add to our understanding of anisotropy of polyphase aggregates in the deep mantle.

WHAT REALLY HAPPENED AT THE CRETACEOUS-PALEOGENE BOUNDARY? GEOCHRONOLOGY SHINES NEW LIGHT ON A CLASSIC PROBLEM

by Paul Renne and Mark Richards

For decades, the cause of the Cretaceous-Paleogene (K-Pg) mass extinction has evoked great interest and heated debate among geoscientists. Two scenarios have emerged as leading contenders for the main culprit, and the debate has largely narrowed down to which of these is correct. Ironically, both of the competing scenarios have been strongly supported by research here at Berkeley. The most popular of these is that an asteroid or comet struck Earth and wrought havoc via severe climatic effects. This theory was proposed by our own Walter Alvarez and his father, Luis in 1980, and became widely accepted following the discovery of a smoking gun, the ~200 km wide Chicxulub impact structure in Mexico. The other leading hypothesis has been that massive flood basalt volcanism (the Deccan Traps) in India was the cause. This scenario is supported circumstantially by studies of Paul Renne and colleagues showing that other major mass extinctions at the Permo-Triassic and Triassic-Jurassic boundaries coincided with major flood basalt eruptions, but not with large impacts – hence by induction the Deccan Traps alone could have killed off *T. rex* and friends. Both mechanisms could produce similar effects through injection of huge volumes of climate-modifying gases into the atmosphere. With such similar fingerprints, distinguishing between the two hypotheses has proven challenging.

We were always perplexed that two such rare events, the Chicxulub impact and the Deccan traps, were essentially synchronous both with each other and with the mass extinctions. Could this really be a coincidence? The odds appear extremely small. Some workers proposed that the impact initiated the volcanism, but this was disproven by clear evidence that the

The Berkeley field team in the Deccan Traps near Mahabeleshwar, India. From left to right, Professors Steve Self, Paul Renne, Mark Richards, and PhD candidate Courtney Sprain. Photo by Loÿc Vandercluysen

Deccan volcanism began before the impact. After years of discomfort with this remarkable coincidence, Mark Richards found himself with time to pursue this topic when he stepped down as a dean in 2013 after 12 years. Interest in the K-Pg boundary was rekindled by a seminar led by Paul, who was working with Ph.D. student Courtney Sprain on the timing and tempo of the extinctions and recovery in the dinosaur-rich Hell Creek area of Montana. Discussions involving Walter Alvarez and volcanologists Michael Manga and Steve Self led us to realize that there was a striking discontinuity evident within the 3 km-thick sequence of lava flows composing the Deccan traps. Although existing age constraints were imprecise, this discontinuity appeared to have occurred within <100,000 years of the K-Pg boundary and the Chicxulub impact! Analysis of existing data led Walter and Mark to conclude that the majority of Deccan lavas- approximately 70% by volume- were erupted immediately after this discontinuity.

This realization led Mark to contemplate whether the Chicxulub impact might have accelerated the existing Deccan magma system via a transient increase in the permeability of the Deccan mantle plume head lurking beneath the Indian subcontinent, similar perhaps to how volcanoes are sometimes triggered remotely by large tectonic earthquakes. However, in this case, Chicxulub was equivalent to a magnitude ~11 earthquake! The case for a Chicxulub trigger for accelerated Deccan volcanism by this general mechanism was proposed in a paper led by Mark in the *Geological Society of America Bulletin* published in 2015. This paper pointed to a critical test of the proposed impact-trigger hypothesis, that of radioisotopic dating of the Deccan transition at much higher precision than had ever been done, to test for synchrony with the K-Pg boundary.

Anxious to test our hypothesis, we traveled to India in March of 2014 with Steve, Courtney, and Loÿc Vanderkluysen of Drexel University, to sample the Deccan Traps for dating by the $^{40}Ar/^{39}Ar$ method. Two weeks and 700 pounds of basalt later, we had a trove of samples from the best exposed Western Ghats region of India that spanned the stratigraphy of the Deccan Traps. After selecting a subset based on petrographic characteristics, weeks of painstaking sample preparation yielded pure plagioclase separates from eight samples, which were sent off to a nuclear reactor at Oregon State University for necessary irradiation. After 3 months of “cooling”, Paul and Courtney began analyzing samples at the Berkeley Geochronology Center.

The painstaking mass spectrometry stretched into 2015. More than a year had elapsed since we initially collected the samples, but our time and effort were rewarded by a much-improved chronology of the Deccan eruptions, which now constrains the timing of the volcanic transition to within only ~50,000 years of the K-Pg boundary—a mere geologic instant. One important implication of our study is that the initial phase of biotic recovery in marine environments, which began about 500,000 years after the impact, may have been suppressed until the envigorated volcanism waned. Our results were just published in an article in the October 2 issue of *Science*. Although not yet conclusive, these conclusions strongly support the impact-triggering hypothesis, and motivate us to further refine the chronology of Deccan volcanic events.

But, already, we are faced with more nuanced questions: Did other flood basalts correlated with mass extinctions also have triggers, but we just have not found the evidence yet? Could strong tectonic earthquakes (i.e., from nearby subduction zones) boost flood basalt volcanism? Could either the impact or the boosted volcanism alone cause such profound ecosystem change, or was it their combined effects that were so potent? Stay tuned....

IN MEMORIUM

Dr Robert M. Douglass
1954 Ph.D Geology
Deceased 2/19/14

Warren Finch
1954 MA Geology
Deceased 7/21/14

Charles Perdue
1958 BA Geology

Paul F. McAndrews
1948 BA Geology

Ralph Strange
1954 BA Geology

Leonard Schombel
1939 MA Geology

Carl Mortensen
1966 BA Geophysics

Marjorie Herkenhan
1946 BA Geology

Marshall Reed
1966 BA Geology
Deceased 3/13/13 He retired from the USGS after 34 years of service in geothermal and high-temperature conductivity.

EPS 118 ADVANCED FIELD COURSE

by Michael Manga

This coming summer, our geology students will once again head for their summertime field camp to the volcanic wonderland of Long Valley caldera and surrounding environs. This capstone course builds on their field mapping course EPS 101, which is now taught by Nick Swanson-Hysell. As they have since Andrew Lawson's first field course in 1892 (arguably the *first* systematic field geology course in North America), students map and decipher the geology of the Berkeley Hills. The neighboring Berkeley Hills remain an excellent field laboratory with their combination of diverse lithologies and complicated, yet tractable, structural and stratigraphic relationships, which are associated with the evolution of California's margin from the Miocene to today. While the bedrock geology has not changed since Cal students first ventured into the hills, our understanding of geological processes has evolved and so too have the interpretations. Thanks to generous gifts from alumni and others, students first map the hills with traditional methods and then use digital technologies in the field and back in the lab, thereby recreating the dramatic developments in technology and concomitant changes in the tools of geologists.

For the past two decades, geology students have done their mapping project in Montana with George Brimhall. In 2014, the field camp moved to eastern California, and students were based at the Sierra Nevada Aquatic Research Lab (SNARL), a University of California field research station. Rather than rely on a single project and instructor, a group of five faculty members guided students through a set of projects. With Paul Renne, students mapped several square miles in the Benton Range where dike swarms and plutons intrude lower Paleozoic metasedimentary rocks. By working out cross-cutting relationships, and inferring the depositional environmental and paleogeographic context of the metasedimentary rocks, students disproved some previous interpretations, including those in a paper published by Renne! Students then jumped into the Holocene and, with Sean Mulcahy, mapped offset moraines in order to determine the slip rate on the Hilton Creek fault.

Although our geology students are not required to take upper division geophysics classes, Doug Dreger and Michael Manga included two geophysical projects in the summer camp. First, students performed a gravity survey across the entire caldera. From their data they modeled the subsurface structure of the caldera. Their data, combined with data from the most recent survey in 1999 was also used to infer the origin of the ongoing uplift in the center of the caldera. Students also set up and performed a seismic refraction survey to study the relationship between the water table and water flowing into the creeks at SNARL. These two geophysical modules combined instrument deployment, data acquisition, reduction of data, and computer modeling.

The field camp ended with Steve Self and Michael Manga helping students with two volcanology projects. The first was to map the stratigraphy of, and hydrothermal features within, the Bishop tuff which is exposed along the shores of Lake Crowley.

The second project was to map the Panum Crater, a small rhyolite dome that erupted approximately 600 years ago. Students used this mapping to integrate observations from microscale texture to dome-scale structures and, eventually, to identify the pathways through which magma, ash and gases were vented as the dome was emplaced.

Field instruction is expensive and time-consuming; vehicles and equipment need to be rented, and students need accommodation and food. And to help ensure "safety first" and maximize learning, the desired ratio of graduate student instructors to students is higher than the University normally supports. Thus, the field camp is not possible without the support of alumni and, more specifically, the Ramsden Fund. Thank you!

Field camp students mapping columns of hydrothermally altered Bishop tuff. Students pictures are Andy Tholt, Sara Beroff, and Izabela Novacka.

Photo by Michael Manga

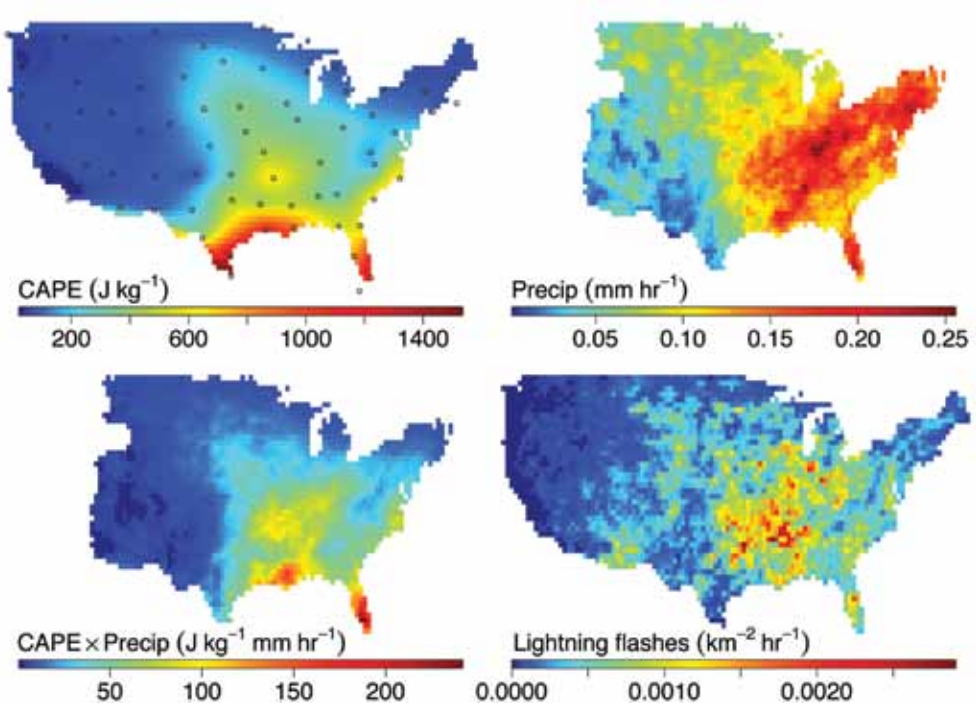
LIGHTNING IN A BOTTLE

by David M. Romps

For hundreds of millions of years, lightning has shaped the evolution of life on Earth through its triggering of wildfires. Today, despite the large number of man-made fires, lightning is still responsible for half of the wildfires triggered in the continental United States. At the time of writing this article, there were eight wildfires actively burning in California, four of which were triggered by lightning. Unfortunately, there has been no reliable way to forecast lightning operationally or to project how lightning rates will change with global warming.

In a paper written with graduate student Jacob Seeley and collaborators at the University of Albany, Assistant Professor David Romps has proposed a novel predictor for lightning that can be used for operational weather forecasting and global-warming projections. Published in the journal *Science* and featured on its cover, this study demonstrates that the lightning strike rate is proportional to the convective available potential energy (CAPE; a measure of potential storm energy) times the precipitation rate (the inches per hour of rain). This predictor for lightning is tested against three observational data sets (one for CAPE, one for precipitation, and one for lightning) that were collected across the United States.

Maps of CAPE (the potential storm energy) are calculated from temperature profiles collected from balloons released at about 70 locations across the United States twice a day, including at the nearby Oakland airport. A combination of ground-based radar and surface rain gauges generated useful maps of the precipitation rate. Maps of the lightning strikes are obtained from the National Lightning Detection Network (NLDN), which is a collection of radio receivers scattered across the United States that "listen" for the electromagnetic pulses emitted by lightning. Those electromagnetic pulses are familiar to anyone who has listened to an AM station during a thunderstorm and heard crackling static. By reporting the precise time that they receive these pulses, the NLDN receivers provide the data needed to triangulate the location of each lightning strike over the entire continental United States.



Lower-right panel shows the distribution of lightning strikes.

When these three independent data sets were combined, Professor Romps was able to show that the product of CAPE and precipitation explains 77% of the variance in the time series of total lightning strikes over the United States, which is much better than any other predictor that was tested.

Spurred on by this success, Professor Romps and colleagues then applied the new predictor to the output from global climate models (GCMs). Working with output from 11 different GCMs, Seeley used the predictor to calculate lightning strikes over the United States during the twenty-first century, during which the GCMs were forced with a business-as-usual scenario for the burning of fossil fuels. During the current century, the GCMs predict an average increase of 50% in the number of annual lightning strikes in the United States. This increase in lightning strikes -- 3 in 2100 for every 2 in 2000 -- was found to be driven primarily by large increases in CAPE, which is the measure of storm energy.

A PT. REYES FIELD TRIP

by Doris Sloan

Kehoe Beach at Pt. Reyes is one of the Bay Area's most dramatic geologic sites, where you can see rocks that have traveled far through time and space to rest temporarily in the Bay Area. A visit takes you from the western edge of the North American plate across the San Andreas Fault to the eastern edge of the Pacific plate.

The granitic bedrock at Point Reyes is part of the Pacific plate's Salinian Block. Transported by the San Andreas Fault System, it has come over 350 miles from Southern California. Along the way, many layers of sediment were deposited onto the granitic rocks. At the trailhead sits Laird Sandstone, the oldest of the sedimentary rocks in this area. (Step carefully up the outcrop to view Native American mortars carved into it.) The rest of the 0.6-mile trail lies on the younger Monterey Formation, which is mostly hidden from view by coastal scrub. As you near the beach, a sand dune turns a seemingly easy stroll into a difficult scramble. The rock at the top of the dune is a fine outcrop of the Monterey Formation, and, here, it is composed mostly of the microscopic silica skeletons of diatoms that accumulated in an offshore ocean basin eight to six million years ago.

Heading north along the beach, you walk back several million years in time to the Laird Sandstone. Fossil barnacles, mollusks and other invertebrates near the base of the formation tell us that the Laird was deposited about 10 million years ago in a nearshore environment. Look at the Laird sand grains; they eroded from granitic rocks similar to those on which they rest. Here the Laird has been faulted and folded into a gentle syncline and is highly fractured, evidence of its long travels with the Pacific plate.

A landslide marks the contact between the Laird Sandstone and the granitic rocks, which were formed about 85 million years ago during the Mesozoic collision between the Farallon and North American plates. The granitics once formed the southernmost end of the Sierra Nevada, about 350 miles south. After subduction ended, they were hijacked by the Pacific plate on its way north.

This Kehoe Beach outcrop is particularly interesting because of its complexity and the variety of features revealed in the rock. Here, half a dozen variations on the granitic theme are jumbled together. In addition to the light-colored granitics, you will find a darker diorite and feldspar white dikes cutting through the rocks. You can also see inclusions of altered 'country rock' into which the magma intruded. These metamorphosed rocks are the oldest on the Peninsula, displaced relatives of Precambrian or Paleozoic rocks found in Southern California. The rocks have been extensively folded and faulted—one might almost say tortured—by their travels with the San Andreas Fault. Many a geology student (and professional) has stood here trying to figure out which rock is the oldest, which the youngest, and how this outcrop was formed.

The Beach

Kehoe lies at the northern end of one of the longest unbroken stretches of sandy beach in the Bay Area, 11-mile-long Point Reyes Beach. Take along a hand lens for a close look at this beautiful sand. The grains consist of sparkling clear quartz, yellowish translucent feldspar, a scattering of dark minerals; all have eroded out of the granitic cliffs, here and further to the north. Occasional reddish chert grains tell you, however, that some of the sands have come from "mainland" North America, across the San Andreas, most likely from the Russian River watershed, which drains to the ocean 20 miles to the north.

The beach after a big winter storm can be a surprise to those who visit only in summer. Last winter during a December storm, which occurred at a time of king tides, waves beat directly against cliffs, washing away dunes and exposing rocks rarely seen in summer. A great quantity of sand was carried off the beach and deposited offshore. A waterfall fell to the beach through a notch in the Laird Sandstone and shallow pools formed in low spots at the base of the cliffs, but this pattern is not atypical of California beaches. The high-energy waves of winter carry sand offshore; summer waves are only strong enough to bring it back onto the beach, not carry it away again, and, ultimately, the beach is built up.



Left: Monterey Shale at Kehoe Beach. Photo by Kirk Ehmsen
Center: Granitics at Kehoe Beach. Photo by John Karachewski
Right: Kehoe Beach on a winter high tide; Bedrock is Laird Sandstone, December 2014. Photo by Kirk Ehmsen

No matter what time of year you visit Kehoe, there will always be surprises and delights from the rocks and the constantly changing sea. A stroll to Kehoe Beach takes you back into a dynamic geologic past and at the same time gives you a fine setting to observe present day geologic processes where land meets sea.

Note: Adapted from "Rocking Out at Kehoe Beach," *Bay Nature*, July-September 2015.

ALUMNI UPDATES

1951
Russell H. Campbell BA Geology
A preliminary revision of the geologic map and description of map units for the Los Angeles 30'x60' quadrangle was posted last summer on the California Geological Survey web site, for review and comment. http://www.consrv.ca.gov/cgs/fwgp/Documents/plate9_los_angeles.pdf
This was a joint CGS-USGS effort. Although my CGS colleagues did not is the heavy lifting, they honored me with lead billing.

1952
Carl Dresselhaus BA Geology
UC Hastings Law 1959
Motto – Geology Students – California with all your faults we love you still.

1953
Giles Wilson Maloof BA Geophysics
Still teaching, emeritus part-time, differential equations & statistics.

1967
Richard T. Buffler Ph.D Geology
I continue to live in Santa Fe, New Mexico. I am still mourning the loss of my wife, Patricia, of 52 years, bay I am starting to move ahead.

1968
James Murray BA Geology
I became emeritus last year which is not the same as retired. I'm just teaching less (40%). I was a visiting professor at UPENN for Fall semester of 2014. On Jan. 1, 2015 I ended my 2 year term as President of the Ocean Science Section of the AGU. Two new research grants keep me busy 1) studying the distribution of particulate trace elements in the Persian Gulf and 2) Ocean acidification and the health of corals in the Persian Gulf around Qatar.

1971
Earl Hart BA , MA Geology
Worked for California Geology Survey for 40 years. Retired in 1994. MA from UC.

1972
Kenneth Howard, Jr. Ph.D Geology
Haven't thrown in the towel yet. Still active in the Faculty Association at Wake Tech. Our Geology Department also constructed outdoor geology labs at two campuses with donated boulders from quarries across the state. You can walk past rocks from the mountains to the coast. We're now writing labs so that the students can identify and learn some basic North Carolina geology.

1975
Charles R. Bacon Ph.D. Geology
I retired in October 2014 and am now an emeritus scientist at USGS. I'm continuing work on projects in Alaska and at Crater Lake National Park.

COMMENCEMENT 2015

Bachelor of Arts

Environmental Earth Science
Areidy Aracely Beltran
Emily Chloe Kim Cheok *
Brittany Morgan Cliffe
Kristina Ann Duncan
Diana Stephanie Espana
Brendan Han Fang
Chris Odeh Habash
Kristen Elizabeth Isom
Sin Yue Kwong
Erik Palomera
Carlos Torres
Christina Vo

Atmospheric Science
Rebecca Elizabeth Bosworth
Isabel Anne Houghton
Mikhail Korotkin
Samuel Rodzwic Pennypacker * †
Pascal Polonik
Steve Daniel Shen
Leif Swenson
Jon Randolph Weiner Jr.

Geology
Grace Margaret Beaudoin *
Alexandra Ariana Chamberlain
Yangyang (Finn) Chen
Katherine Anna Guns *
Colin Reed Holtson
Chihiro Aileen Ishida
Janet Chuiyou Kong
Michael Allen Sorensen
William Werber Zell

Geophysics
Sarah Marie Arveson *
Aaron Christopher Bagnell
Zachary Davies Carango
Michael Brandt Chamberlain * §
William Edward Classon *
Cansu Culha *
Deanna Lucia Gelosi * §
Andres Hernandez
Brenda Luna
Jie Ma
Kyle Thomas Mann
Sanjeevi Nagalingam
Grisanu Matthew Naing
Mason Kyle Davis Perry
Ashley Marie Schoenfeld
Ramanathan Veerappan §

Marine Science
Nathaniel Philip Ashmead
Nicole Louise Ornelas
Seena Tabibi
Doriane Elaine Weiler §
Bryan Nicholas Wong

Planetary Science
Michael Josling Hill
Jonathan Wei-Ting Kao

* with honors
† departmental citation
§ Phi Beta Kappa

Master of Arts

Dylan McHenry Bland
Geologic Applications to Petroleum Systems

Danny Ng
Geophysical Fluid Dynamics

DOCTOR OF PHILOSOPHY

Andrea Chiang
Investigating source processes of isotropic events in Kazakhstan, China, and United States

Jesse Alexander Day
The dynamics of rainfall variability in the Asian summer monsoon

Sirine Constance Fakra
Spectro-microscopic studies of microbial selenium and iron reduction in a metal- contaminated aquifer

Percy Anne Link
Forests, water, and the atmosphere in Northern California: insights from sap-flow data analysis and numerical atmospheric model simulations

Benjamin Albert Nault
Observational constraints on the lifetime and fate of NOx in the upper troposphere

Jasper Oshun
The isotopic evolution of a raindrop through the critical zone

Doctor of Philosophy

Percy Link, Andrea Chiang, Ben Nault, Jesse Day, Jasper Oshun

Atmospheric Science

Back Row (L to R): Steve Shen, Leif Swenson, Mikhail Korotkin, Jon Weiner, Jr.

Front Row (L to R): Pascal Polonik, Isabel Houghton, Rebecca Bosworth, Samuel Pennypacker (departmental citation winner)

Environmental Earth Science

Back row (L to R): Erik Palomera, Carlos Torres, Kristen Isom, Chris Habash, Kristina Duncan, Brendan Fang

Front row (L to R): Christina Vo, Sin Yue Kwong, Brittany Cliffe, Emily Chloe Cheok, Diana Espana

Geology

Back row (L to R): William Zell, Colin Holtson, Michael Sorensen, Grace Beaudoin

Front row (L to R): Chihiro Aileen Ishida, Janet Kong, Yangyang Chen, Alexandra Chamberlain, Katherine Guns

Geophysics

Back Row (L to R): Kyle Mann, Aaron Bagnell, Mason Perry, Andres Hernandez, Michael Chamberlain

Middle Row (L to R): Sanjeevi Nagalingam, Roger Ellicock, Zachary Carango, Ramanathan Veerappan, Sarah Arveson, Matthew Naing, Cansu Culha

Front Row (L to R): William Classon, Jie Ma, Ashley Schoenfeld, Deanna Gelosi, Brenda Luna

Planetary Science & Marine Science

From L to R: (Planetary Sci) Michael Hill, Jonathan Kao. (Marine Sci) Doriane Weiler, Bryan Wong, Nicole Ornelas, Seena Tabibi, Nathaniel Ashmead

DONATIONS TO THE DEPARTMENT

August 2014 through August 2015

Friends of Earth & Planetary Science Fund

Established in 2007 to solicit funds for emergency student aid, collegial activities in support of education and research as well as equipment and facilities upgrades; to help with costs for student activities such as field trips and the yearly Santa Barbara's Day event; to make a monetary award to the winner of the Departmental Citation; to support alumni outreach; to defray the costs of the weekly departmental Speaker's Program in which distinguished speakers from around the country are invited; and to assist in the acquisition of journals for the Earth Sciences Library and Map Collection.

2014-2015:

Abrahamson, Norman & Susan
Bacon, Charles*
Campbell, Russell
Doerschlag, Mark
Galehouse, Jon
Gillerman, Virginia
Hart, Earl
Hirsch, Lee
Irvine, Pamela
Kersting, Annie
Lee, Richard
Liston, James[2]
Maloof, Giles W.*
Marcus, Kim*
McCauley, Sean
Nolan, Julie
Oldlum, James
Odlum, Nicholas
Pellerin, Louise
Romey, Bill
Salter, Dayna*[3]
Savina, Mary
Schwartz, Daniel**
Schwartz, Morgan
Solomon, Sheba
Taylor, Roger[3]

Memorial Funds

PERRY BYERLY FELLOWSHIP FUND

A fund that supports graduate fellowships in the area of Seismology.

2014-2015:

Charleton, John
Gregor, Nicholas
Plumb, Bob[3]
Hough, Susan
Maloof, Giles W*

IAN S. E. CARMICHAEL FUND

A fund that supports outstanding graduate students with a preference given to those researching igneous processes.

2014-2015:

Bacon, Charles
Johnson, Brann
Lee, Cyn-Ty*
Marsh, Bruce & Judith

LOUDERBACK FUND

Supports an annual award to an outstanding student pursuing research in the field, geology, or paleontology.

2014-2015:

Maloof, Giles W.*

THOMAS MCEVILLY FELLOWSHIP FUND

A fund that supports graduate fellowships in the area of Seismology.

2014-2015:

Allen, Mary
Bakun, Bill
Bevc, Dimitri
Boyd, Nicholas
Lee, Richard
Leith, William

MILTON B. SMITH SCHOLARSHIP FUND

A fund that provides financial assistance to undergraduate students.

2014-2015:

Fournier, Thomas[3]
Johnson, Brann
Simpson, Douglas

DON TOCHER MEMORIAL FELLOWSHIP FUND

A fund that supports graduate fellowships in the area of Seismology.

2014-2015:

Bakun, Bill
Gregor, Nicholas

FRANCIS J. TURNER FELLOWSHIP FUND

Funds graduate student fellowships in geology.

2014-2015:

Borg, Iris***
Maloof, Giles W*
Romey, Bill

CHARLES MEYER FELLOWSHIP FUND

Funds graduate student fellowships in the area of integrated field and laboratory studies of ore, mineral, and rock-forming processes.

2014-2015:

Gillerman, Virginia
Howard, Kenneth
McAleer, Joseph
Thacher, Anson
Romey, Bill

* Donation of $1000 or more
** Donation of $10,000 or more
*** Donation of $20,000 or more

Matching funds

[1] Chevron Match
[2] Fluor Corporation
[3] Exxon Mobile Corporation

Endowed Funds

EPS SCHOLARSHIP FUND

Supports outstanding graduate and undergraduate students with fellowships and scholarships.

2014-2015:
Fischer, Fred
Maloof, Giles W.*
Solomon, Ernest
Thacher, Anson
Zaccone, Dana

GRADUATE STUDENT FIELD SUPPORT FUND

Supports field research for earth science graduate students.

2014-2015:
Buffler, Richard
Maloof, Giles*
Campbell, Russell
Thacher, Anson

FIELD GEOLOGY AND DIGITAL MAPPING FUND

To support EPS Summer Field Geology Camp and digital mapping equipment.

2014-2015:
Henshaw, Paul *
Maloof, Giles W.*
Welsh, Tom**

GARNISS CURTIS DISTINGUISHED PROFESSORSHIP

An endowed chair that is used to support faculty research.

2014-2015:
Aldrich, Michele*
Bevc, Dimitri
Cebull, Stanley
Dresselhaus, Carl
Maloof, Giles W*
Moore, Donald
Murray, James*
Ohlmann, John
Schetter, William C.[3]

You can help current students venture on incredible field work!
Donate Online: www.eps.berkeley.edu **Mail:** Using the enclosed envelope.

2014-2015 RAMSDEN AWARDS

Sara Beroff, Geology: Fifth author for research presented at the Geological Society of America.

Jessica Kendall-Bar, Marine Science: Presented summer research at the Society of Integrative and Comparative Biology conference in West Palm Beach, Florida.

Areidy Beltran, Kristina Duncan, Virginia Urzula-Rios - Environmental Earth Science majors: Attended the American Indian Science and Engineering Society conference.

Emily Chloe Cheok, Environmental Earth Science: Research on air pollution for her senior honors thesis in Manilla, Philippines.

Samuel Pennypacker, Atmospheric Science: Poster presentation on cloud-aerosol interactions at the American Meteorological Society Conference in Phoenix, Arizona.

Alexandra Chamberlain, Geology: Worked on a senior thesis that involves determining the metamorphic conditions of blueschist facies metamorphism in the Franciscan subduction complex of California.

Isabel Houghton, Atmospheric Science: Research investigating the behavior of non-spherical particles in turbulence, namely their rotation and slip. Will present research at the American Physical Society Conference in November 2015.

Alexandra Niebergall, Marine Science: Month of field research in Indonesia to investigate the ecosystem interactions and the behavioral function of flashing in Ctenoides ales (disco clams) for her senior honors thesis.

Cansu Culha, Geophysics: Presented her senior honors thesis at the European Geophysical Union meeting in Vienna, Austria.

Katelyn Horton, Marine Science: Completed research on the island of Mo'orea, Tahiti, studying the Geomorphology of Tropical Islands.

Doriane Weiler, Marine Science: Senior honors thesis on the fluid dynamics of Vorticella (a Protozoan) and their predation patterns on choanoflagellates.

Samuel DeNicola, Geophysics: Research on hydrological changes observed after the South Napa M6.0 earthquake.

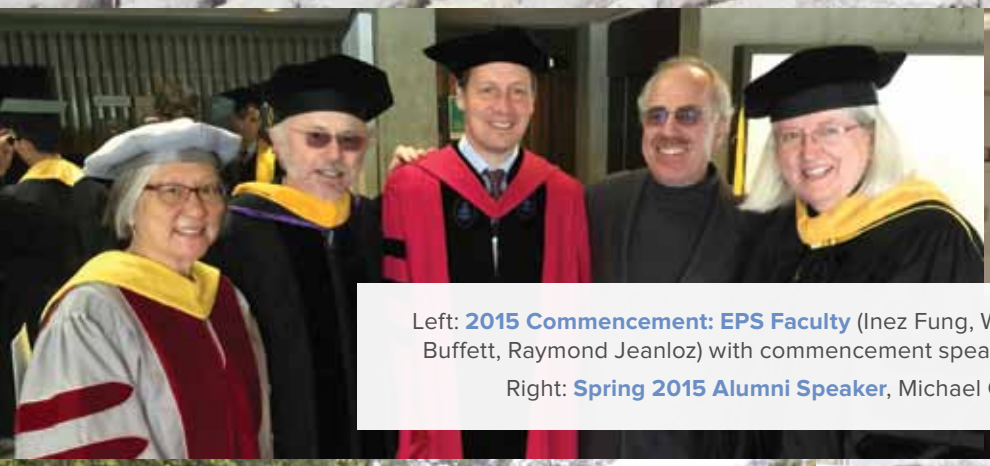
Sarah Arveson, Geophysics: Brillouin studies of cesium idiode at high pressures for her senior honors thesis.

Sydney Minges, Marine Science: Research - Reconstructing seasonal temperature extremes during the last interglacial (~120,000 years ago) in coastal California using bivalve sclerochronology and stable isotope geochemistry.

Daniel Clements, Marine Science: Research studying cephalopods and stomatopods in the ocean with the Roy Caldwell lab.

Chihiro Aileen Ishida and William Zell, Geology majors: Completed their advanced field camp with the South Dakota School of Mines & Technology since we did not offer EPS 118 in summer 2015.

The EPS 39A Freshmen Seminar on Earth Science in the Field Course students had a memorable trip thanks to Prof. Rudy Wenk! Highlights were Telescope Peak, rain in Death Valley and a sandstorm in Eureka Valley, plus the wonderful columnar structures in Bishop tuff.



Left: **2015 Commencement: EPS Faculty** (Inez Fung, William Dietrich, Bruce Buffett, Raymond Jeanloz) with commencement speaker Dr. Priscilla Grew

Right: **Spring 2015 Alumni Speaker**, Michael Gerstein, MD

2015 Department BBQ, Photos by Margie Winn

Left: Hiro, Matsui, Hannah Bourne, Elizabeth Niespolo, Liz Mitnick

Right: Yuem Park, Allison Sharrar, Nadine SpingolaHutton, Jinsol Kim