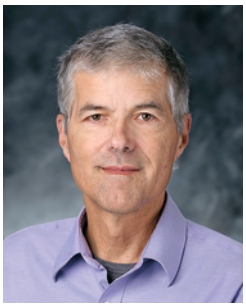
UC Santa Barbara Earth Science



Chair's Letter: Andy Wyss

It's that time of year again when we share with you, members of our Earth Science community, notable events and accomplishments of the past year. We celebrate our faculty, researchers, students and staff, each having a spotlight feature this year. You get a glimpse into a booming field program, our various lab spaces, and the careers of our Distinguished Alumni. Lastly, but most importantly, we introduce you to our newest faculty member, Carolina Martinez-Gutierrez.

As my illustrious predecessor Susannah Porter mentioned last year, we are committed to keeping you connected to our department. One of the ways of advancing this goal is a complete overhaul of our website (**www.geol.ucsb.edu**). We encourage you to take a look and reach out to us to revive connections that have fallen by the wayside. We fervently hope that the vignettes making up this Newsletter provide peeks into the continued vitality and dynamism of the department.

Wishing you all a happy, healthy, and fulfilling new year!

Student and staff operating the Electron Probe Micro Analyser (EPMA) in the **Electron Microscopy facility** to acquire chemical compositions and map the distribution of elements across microscopic areas of a rock sample. Photo: Lee Sharpnack

IN THIS ISSUE | FALL 2024

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Header photo: Summer Field Geology, New Mexico. Credit: Alex Simms

Summer Field Geology

by Alex Simms & John Cottle

Students examining sedimentary structures in the Jurassic Entrada Sandstone near Ghost Ranch, New Mexico. Photo: Alex Simms (left). Summer Field class examining the Miocene Beechers Bay Formation on the south coast of Limuw/Santa Cruz Island. Photo: Ryan Eden (right).

For the first half of Summer Field, 14 undergraduate students and teaching assistants Claire Divola and Trap Puckette went to New Mexico with Professor Alex Simms. During the nearly 3 weeks camping at Ghost Ranch, students had the opportunity to examine the classic Mesozoic stratigraphy of the SE Colorado Plateau. They measured section and mapped many of the faults and folds of the eastern San Juan and Chama Basins. We had good weather by New Mexico standards that included a handful of thunderstorms, which tested our tents. The most memorable experience was probably the spotting of a mountain lion in our last mapping area near Gallina, New Mexico. Nevertheless, the students persevered and became proficient at identifying the Entrada Sandstone and its stratigraphic neighbors, as well as picking parasequence boundaries in some of the classic prograding shorelines of the Cretaceous Interior Seaway. During the second half of the summer field course, students journeyed to Limuw (Santa Cruz Island) with Professor John Cottle and teaching assistants Ryan Eden and Morgan Adamson. This year, the group focused on two projects on the island's western side. Limuw offers a unique and challenging environment for our undergraduates, exposing them to diverse geological features, including metamorphic and plutonic rock exposures, varied volcaniclastic units, and active tectonic processes. By the end of their time on the island, students had significantly enhanced their core field mapping skills and gained experience with digital mapping techniques—preparing them well for their post-UCSB geoscience careers. We extend our gratitude to the National Park Service for their support, Brian Guerrero and Lyndal Laughrin at the UC Santa Cruz Island Reserve for logistical assistance, and The Nature Conservancy for allowing us to use the facilities at Christy Ranch. We thank all the donors whose generosity allowed the students to participate in this capstone field experience.

Paleoclimatic Perspectives

by Syee Weldeab

Methane hydrates constitute a substantial store of greenhouse gas, estimated at 1,500 gigatonnes of carbon. These methane hydrates are found in shallow subsurface and deep marine sediments at the continental margins. Climate warming causes changes in the pressure and temperature in sediments at continental margins, destabilizing methane hydrates and, as a result, releasing methane into the water column and potentially into the atmosphere, amplifying and accelerating climate warming. Of particular interest is the temperature of the intermediate waters (approximately 400 to 1,200 m below sea surface waters) because these waters impinge on sediments that often contain methane hydrates. Current projections of the magnitude of intermediate water warming over the next 50 to 80 years harbor substantial uncertainty. Professor Weldeab's research seeks to provide a paleoclimate perspective on rapid climate warming and associated climatic feedback processes. Initial results of Professor Weldeab's studies reveal that, during the peak warming of the penultimate interglacial, the warming of intermediate waters in the equatorial Atlantic Ocean exceeded the temperature stability limit of methane hydrates and left fingerprints of methane release across the water columns. A major implication of this study is that, under warmer climatic conditions, a diminished Greenland ice sheet produced sufficient meltwater to cause weakening of the Atlantic Meridional Overturning Circulation that, in turn, led to an exceptional warming of the intermediate waters.

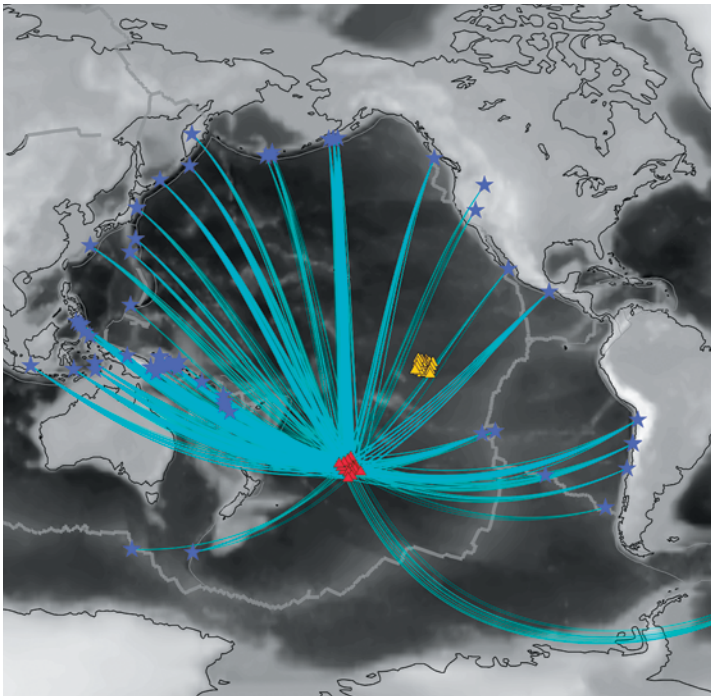
This past summer, Professor Weldeab visited the core repository at the University of Kiel (Germany) and carried out a temporally-resolved sampling of several marine core sediments from the Labrador Sea (North Atlantic) and the Bay of Bengal (tropical Indian Ocean). These samples will allow his research group to map out the spatial extent of the exceptionally strong warming observed in sediments of the Atlantic intermediate water depth. The overall goal of Professor Weldeab's work is to expand and deepen our understanding of climate feedback processes of a rapidly warming climate and provide insights that cannot be gained from a short observational time window.

Syee Weldeab

Fine-grained and coarse methane hydrates (left/right)

Beneath the Waves: Exploring Plate Tectonics with Seismic Imaging

by Anant Hariharan



Map showing, as triangles, the locations of our arrays of seismometers. Stars correspond to the locations of the earthquakes we are using to seismically image the upper mantle. Cyan lines show the surface projection of the paths by which seismic waves generated by these earthquakes may traverse the Earth's interior to be recorded by the seismometers. The underlying grayscale map corresponds to Earth's topography.

Plate tectonics is a core paradigm for the Earth Science community, enabling explanations for diverse processes in the Earth system including the collision and breakup of continents, long-term climatic trends, and the cycling of water between Earth's surface and interior. However, current models of plate tectonics cannot explain all our observations of the solid Earth. In particular, it is well documented that at locations in the ocean associated with older tectonic plates, measurements of heat flow and the depth of the ocean floor are inconsistent with predictions from classical models. Refining models of plate tectonics at these locations, perhaps by accounting for dynamic processes such as small-scale convection in Earth's upper mantle, may allow us to better explain observations of Earth's surface and interior and understand the evolution of our planet.

To gather the data needed to validate such hypotheses, our group, led by Professor Zachary Eilon in collaboration with investigators from Northern Arizona University, Brown University, Syracuse University, and Columbia University, embarked on a series of expeditions to deploy and recover two arrays of 30 ocean-bottom seismometers at sites in the Pacific Ocean. This collaborative effort, part of the international Pacific Array Initiative, also provided new high-resolution maps of the ocean floor and geochemical samples. The data acquired by these seismometers allows us to generate detailed images of Earth's interior, shedding new light on the properties of the oceanic upper mantle and the dynamic processes taking place within it.

To generate these seismic images, we make precise measurements of variations in the times at which certain kinds of seismic waves arrive at our seismometers. We then mathematically solve for models of seismic wavespeeds—how fast certain kinds of seismic waves travel—that best explain these measurements. These images provide constraints on the properties of Earth locally. They can tell us about the temperature variations in Earth's upper mantle, providing snapshots of Earth's dynamic interior. This allows us to infer the forces and dynamics that are involved in the active evolution of Earth's mantle.

The oceans are a challenging environment for this kind of research, however. The background noise in data from seismometers deployed on the ocean floor and the general lack of data across vast swaths of the ocean basins can make it difficult to create large-scale seismic images. Therefore, we are also developing innovative methods to make the most of the valuable data these ocean-bottom seismometers provide, such as observing and modeling the diffraction of surface waves, which is sensitive to smaller-scale features in the mantle. Overall, it is an exciting time to be studying the oceanic upper mantle, and we look forward to the new discoveries that our data will reveal.

Carolina Martinez Gutierrez

by Carolina Martinez Gutierrez

Carolina Martinez Gutierrez

Carolina, an evolutionary microbiologist, joined the Department in the Fall of 2024. She is deeply interested in the history of the interaction between microbes and their environment, particularly in the ocean. Her research interests go from understanding the role that the Great Oxidation Event played on the diversification of microbes, to how bacteria and archaea share genes in contemporary environments. Carolina's scientific journey started as a child when she fell in love with the ocean during family camping trips in the Gulf of California in Mexico. Later on, she became fascinated by microbes when she learned about Cyanobacteria, the first life forms capable of producing oxygen as a byproduct of photosynthesis. These experiences led her to pursue a doctorate in Biological Sciences with a focus on Genomics and Bioinformatics at Virginia Tech in the lab of Prof. Frank Aylward. During her PhD journey, she deepened her knowledge of the evolutionary history of the microbes that dominate the ocean today, and discovered how major geological changes played critical roles in shaping the microbiome of the modern ocean. After finishing her PhD, Carolina joined the lab of Prof. Louis-Marie Bobay at NC State as a Simons Foundation Postdoctoral Fellow, where she studied how gene exchange leads to the maintenance of cohesive species units in marine microbes.

At UC Santa Barbara, the Early Life and Microbial Evolution (ELME) Lab will be focused on four main areas of research. We will develop computational and phylogenomic pipelines to study early microbial life, explore the main processes that drove the diversification of life on Earth, recover unique and high-quality genomic data from novel environments, and study how microbial life continues evolving today. Examples of research questions that our lab will be interested in exploring are: what are the most ancient living microbes and what can they tell us about early life on Earth; and what adaptations allowed marine microbes to prevail after major geological events? Carolina is also excited to contribute to the Department's curriculum by designing and teaching new courses on the application of computational tools to explore biological questions. Besides its scientific goals, the members of the ELME Lab will be interested in generating new collaborations across and beyond campus, and participating in outreach activities that inspire children to become the evolutionary biologists of the future.

Laminated microbial mat from Guerrero Negro, Mexico. Microbial mats are complex communities built by diverse lineages of bacteria and archaea. Microbial mats are key for the study of ancient life because they were prevalent ecosystems during early Earth.

Microbial communities inhabiting an extreme soil environment characterized by a high pH. Cyanobacteria and other anoxygenic lineages can be identified due to their green and red pigments, respectively. Cyanobacteria and anoxygenic microbes are at least 2.4 Ga, and their genomes can inform us about the history of life.

Undergraduate Research

Karla Hernandez Leyva

Karla Hernandez Leyva worked with Robin Matoza. Her research aimed to enhance the detection of volcanic infrasound from Popocatépetl volcano, which generates significant low-frequency pressure waves (below 20 Hz) during eruptions. Given the anthropogenic infrasound produced by large neighboring cities like Puebla and Mexico City, they utilized various array processing techniques to distinguish these volcanic signals from background noise. By evaluating a new signal detection algorithm against other methods using data from a temporary monitoring array, the technique achieved promising results that improve our ability to accurately identify and analyze volcanic activity amidst competing noise sources.

Madeline Huising

Madeline Huising worked with Professor Roberta Rudnick, interpreting halogen (F, Cl, Br, I) concentrations in amphibolite- to granulite-facies metapelites from the Ivrea-Verbano Zone in northern Italy. This section has been suggested to be a tectonically-uplifted cross-section through the deeper regions of the continental crust, providing a natural laboratory to study lower crustal processes. Madi found that the concentrations of most halogens decreased with increasing metamorphic grade, likely due to dehydration melting. The exception was Cl, which remained constant or even increased with grade, possibly reflecting ingress of Cl-rich fluids from the mafic intrusion at the base of the section. Madi presented her results at the Goldschmidt meeting in Chicago in July. Madi is now a Master's student at the University of Michigan.

Ruben Underwood-Aguilar

Ruben Underwood-Aguilar worked with Professor Roberta Rudnick, interpreting halogen concentration data for metapelites in a contact aureole surrounding the Onawa granodorite pluton in Maine in order to determine halogen behavior during medium- to high-grade metamorphism. The metapelites range in grade from regional greenschist facies to the K-feldspar zone adjacent to the pluton. Ruben found that halogen concentrations did not vary across these zones, suggesting the metamorphic dehydration did not significantly affect halogens in these rocks.

We Wish For

Preston Cloud Memorial Fund, which supports student attendance to annual, national meetings of their professional organizations.

Unrestricted funds, which support revitalization of department space; field equipment, essential to our field classes; and microscopes, essential to our lab classes.

Your Ideas Welcome

We truly welcome your thoughts. What lessons did you take away from your time at UCSB? What would benefit the most from improvements? We solicit your input, and greatly value your perspective.

Your Donation Dollars at Work

Summer Field Geology 2024, New Mexico. Photo: Alex Simms

We are deeply grateful to our many alums, colleagues, and friends of the department who have helped us financially this past year!

"The Walrus and the Carpenter
Were walking close at hand;
They wept like anything to see
Such quantities of sand:
If this were only cleared away,'
They said, it *would* be grand!'

If seven maids with seven mops
Swept it for half a year,
Do you suppose,' the Walrus said,
That they could get it clear?'
I doubt it,' said the Carpenter,
And shed a bitter tear."

—The Walrus and the Carpenter by Lewis Carroll, a favorite poem of Ed Keller's, a beloved professor that we lost too soon.

With Appreciation

The Department of Earth Science profoundly thanks the following individuals and institutions for their generous donations between July 2023 and June 2024

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Thank you

This award will help support my future field work, thank you so much for recognizing me and helping me pursue my PhD.

I am deeply grateful for this recognition, and it is incredibly exciting to see my work valued by the community and our donors.

Thank you so much for the generous award and your support in my geologic field studies.

I deeply appreciate this acknowledgement of my abilities as a student and a field scientist.

Undergraduate Student Spotlight

Sabrina Hinz

I am a fourth-year undergraduate student athlete at UCSB, majoring in Earth Science with a Geology emphasis. I have played soccer all throughout college, and as my athletic career comes to an end, I am extremely excited to be able to fully focus on my passion for geology.

Since I was a child, I have always loved being outdoors in nature. I believe that my immersion in our natural world fostered my interests and curiosities in the ways the Earth system functions how it does. The questions I was having about our planet led me to Earth Science where I have discovered more than I could ever imagine; that is when I fell in love with this area of learning.

All these years later, I am still finding new things to love about studying geology: hot Mohave desert field days, hours spent at the microscope, and embarking on my senior thesis project with Alex Simms analyzing coastline sediment cores. There always seems to be something new to discover and learn.

As for the future, I am hoping to go to graduate school so I can obtain my master's and uncover more of the geologic secrets that our Earth holds.

Sabrina Hinz

Alumni News

Francisco Apen (PhD 2022) has taken up a faculty position at Northern Arizona University in Flagstaff, AZ.

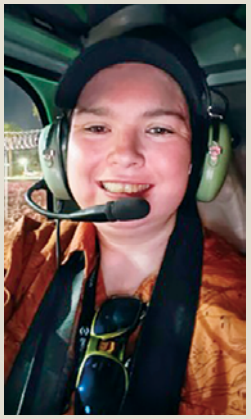
Khalil Droubi (BS 2020) has entered the doctoral program at University of Wisconsin, Madison.

STAFF SPOTLIGHT: KRISTON HYDE

My journey in tech started with an A.S. in computer engineering from Santa Barbara City College, followed by a B.S. in information technology with minors in history and psychology from CSU Channel Islands. My professional experience includes a few years as a system admin and communication security for the Navy at PT Mugu. However, during a decade-long stint as a student/hourly worker at SBCC, I discovered my true passion—helping students succeed.

Outside work, I'm an avid traveler and hiker, always up for an adventure. I'm also a dog lover (even if they can be wild!). I enjoy audiobooks and consider myself a bit of a food nerd, always eager to try new dishes and drinks. I also have a surprising amount of knowledge about cars!

I'm thrilled to be part of the Department and am eager to combine my tech skills with my passion for education to help students thrive. I'm known for my sarcastic sense of humor, which I often use to try and bring a smile to people's faces.



Sunna Harðardóttir

I am a fifth year Ph.D. student with Professor Matt Jackson studying Earth's mantle through the geochemistry of lavas erupted at oceanic hotspots. I earned a BS and MS in Geology from the University of Iceland where I used a geochemical database for Icelandic lavas to study geochemical heterogeneities and melting processes in the Iceland mantle plume. When I started at UCSB my research focus shifted from Iceland to global oceanic hotspots. As a result, my geochemical database expanded to include major element, trace element and isotope data from forty-eight oceanic hotspots. Such a comprehensive database gives me the opportunity to address questions about different mantle domains, how they are spatially distributed and how they are sampled by mantle plumes. My research has also given me the opportunity to complete a research cruise on R/V Kilo Moana, where we dredged Cretaceous rocks from seamounts in the West Pacific. After the cruise, I prepared some of the rocks for geochemical analyses by dissolving them and putting them through column chemistry in the clean lab. The geochemical data obtained on these rocks is then used to evaluate their origin and estimate if these rocks are formed by long-lived hotspots in the Pacific.

Sunna Harðardóttir on the deck of the Kilo Moana

Alexander Pacubas

I think about the ocean a lot. It's fun to imagine what it would be like to be a dolphin and explore the deep expanse of the waters, but researching hydroacoustics would be the next best thing. Being born and raised in Hawaii, it is natural for me to love the ocean and the volcanoes that surround it. My love for volcanoes and geology grew during my undergraduate studies at the University of Washington. After my studies in Seattle, I was commissioned in the U.S. Navy and learned more about oceanography and meteorology.

As I approach my second year of graduate school with Robin Matoza, I can't help but feel that everything in my life so far has been leading to this. My research focuses on hydroacoustic detection of submarine volcanic activity. Additionally, I am using exciting data from the Mobile Earthquake Recorder in Marine Areas by Independent Divers (MERMAIDs) to test its capabilities in detecting submarine volcanoes. The results have been promising, but there is still much work to be done. It's fascinating that we can learn so much from vibrations in the ocean, and I can't wait to see where the water will take me.

Alex at a wedding on Maui

LinkedIn

Seeking to strengthen and enliven our department network, we encourage you to follow our new "UCSB Department of Earth Science" page on LinkedIn. Former students, please follow instructions on the page that will identify you as a department alum. https://lnkd.in/gt3VTTrk

DISTINGUISHED ALUMNI 2024

Annually, the Department honors two of its alumni—one from academia, and one from elsewhere—celebrating their accomplishments and providing our current students exemplary role models.

Dawn Wright

Dawn entered UCSB's doctoral *Geography* program in the middle of the 1990 academic year, having just stepped off the scientific drillship *JOIDES Resolution* for the last time as an Ocean Drilling Program (ODP) marine technician. Under the tutelage of bio-optical-oceanographer-turned-geographer Ray Smith, she was based in Geography's Center for Remote Sensing & Environmental Optics in Girvetz Hall. But with her extensive time at sea with ODP, and a marine geology & geophysics M.S. in hand from Texas A&M, Dawn soon ventured over to Webb Hall, where she was quickly "adopted" by Ken Macdonald and Rachel Haymon. They ignited her interest in the East Pacific Rise, and the possible crucial role of crustal fissuring in the cycling of hydrothermal and magmatic processes. Could new spatial data science workflows as developed in new GIS technology (for that time), and as applied to towed-camera and submersible observations provide some answers? Ray, Ken, Rachel and other faculty encouraged Dawn to complete UCSB's Individual Interdisciplinary Doctoral Program, so established to accommodate research questions not fully answerable in one department.

After completing the dual PhD in 1994, then a short postdoc with NOAA, and then 17 years as a professor of geography and oceanography at Oregon State University, Dawn was appointed Chief Scientist of Esri in 2011. She remains on Oregon State's faculty in a courtesy role. Her current research provides important retrospectives and perspectives on emerging issues in environmental data science, including approaches for international collaborative data sharing, as well as the communication of science for engagement and innovation in various ocean policy-making and industry sectors. She is a GSA Fellow, and an elected member of both the National Academy of Sciences and the National Academy of Engineering.

Wayne Sawka

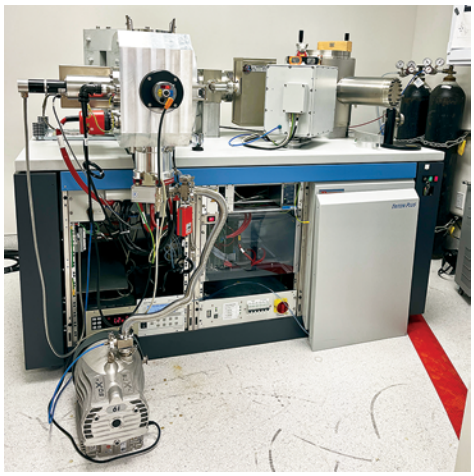
Wayne graduated from UCSB in 1977. He started work at the USGS, mapping in the Sierra Nevada and getting a 3D zoning thesis project in the Palisades. First, Wayne took those granites to UCLA for a 1981 MSc in Geochemistry; then later sent a ton to The Australian National University, earning him a 1985 Geology Ph.D.

Wayne began his professional career as a Physicist at Lawrence Livermore National Lab. He then moved to Aerojet Corporation headquarters where he was Manager of Technology Assessment. Wayne then moved on, working for the World Trade Center and as founding Director of the UC Davis CONNECT entrepreneurship program. Wayne founded DSSP in 2005 with a patent and a new Missile Defense Agency contract. Wayne's electric liquid propellant technology started to get attention from defense, space and even Shell Gamechanger, for "dry fracking." In 2013, Wayne was awarded the "Best Solid Rocketry Paper" by the American Institute Aeronautics and Astronautics. In 2014 DSSP got their first propulsion system into space on NRL's SpinSat and won *Best Debuting Special Effects Product* at the Live Design International Show in Las Vegas. These days, Wayne's passions are spending more time behind the camera on movies, developing studio automation and safer live special effects.

Cardinal Mtn contract, Split Mtn and the rest of the Palisades. Photo: Wayne Sawka

Our Labs in Use





Top, l-r: A student prepares to dissolve rock samples using hydrofluoric acid in the Global Center for Mantle Zoology trace metal clean lab. ; A student loads samples for strontium isotope analysis into the TIMS; The Triton Plus Thermal Ionization Mass Spectrometer (TIMS) housed in the Global Center for Mantle Zoology. Bottom, l-r: Students and staff using the Scanning Electron Microscope (SEM) in the Electron Microscopy facility to image, identify and quantify the proportions of different minerals in a rock sample; Students decide on the locations for geochronology and trace-element geochemistry analyses in the Laser Ablation Split Stream (LASS) Mass Spectrometer facility. Photos: Lee Sharpnack and Ben Byerly

Justice, Equity, Diversity and Inclusion (JEDI)

by Zach Eilon, JEDI Faculty Committee Chair

The Department's JEDI committee continues to promote policies that expand the diversity and accessibility of our academic program at all levels. Our student-led Geoscience Enrichment and Mentoring for Students mentoring group continues to build on its successes. Our 104G course: *Digital Analysis and Interpretation of Field Data* continues to empower undergraduates to major in Earth Science irrespective of physical ability. In light of recent studies that highlight the potential equity barriers associated with field research, three faculty members helped draft a "code of conduct for fieldwork" at a recent UC-wide field-instruction retreat. Applicants to our graduate program are now evaluated through a holistic process that takes into consideration qualities such as resourcefulness, perseverance, experience, and problem solving as much as it does grades and test results. In Spring, postdoc Dr. Alex Phillips offered a new reading seminar on *diversity, equity, and inclusion in geoscience higher education*. We also re-wrote departmental bylaws to make faculty hiring policies as equitable and supportive as possible.. This coming year, look out for a new JEDI lecture series!

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Summer Field Geology: New Mexico. Photo: Trap Puckette

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❑ Including Earth Science at UCSB in my will or living trust

▶ MATCHING GIFTS

I (or my spouse) work for a company that will match my gift.

Company name _____

❑ Form Enclosed ❑ Form Forthcoming

❑ I wish to remain Anonymous

Thank you for your generous gift!