

# UCLA

# Earth, Planetary, and Space Sciences

Fall 2018 Newsletter



# Greetings from the Chair

The Department of Earth, Planetary, and Space Sciences (EPSS) had another impressive year of accomplishments, which I am thrilled to highlight in this newsletter. We welcomed three new faculty members: Mackenzie Day (Fall 2017 newsletter), Carolina Lithgow-Bertelloni (page 6), and Lars Stixrude (page 6). To accommodate our new faculty and other departmental needs, we renovated 15 spaces in our building in the past two years, including the student interaction space currently known as the Commons Room (page 21). EPSS faculty again earned major awards (page 21). EPSS has major involvement in three NASA spacecraft that launched this year: the InSight mission to Mars (page 3), the ELFIN mission (page 12), and the Parker Solar Probe that will provide our closest view of the Sun to date. Dr. Nathan Myhrvold, an EPSS alumnus, provided key support to our graduate program by establishing a graduate student fellowship (page 7). We had another excellent round of undergraduate research projects (pages 15–17), which are funded by the generosity of our alumni and friends. Our outreach events continue to receive praise from many attendees. Our faculty and distinguished alumni lectures are pitched to a general audience and foster interactions between participants and EPSS students, postdocs, researchers, and faculty (page 5). EPSS once again co-hosted Exploring Your Universe, UCLA's annual science festival that welcomes thousands to campus each year (pages 8–9). We continue to send students to a variety of field locations to promote memorable hands-on and eyes-on learning experiences (pages 10, 11, and 16). This year, students in Field Geophysics (EPSS 136C) witnessed the eruption of Kilauea on the Big Island of Hawaii. EPSS is making a special fundraising effort to enable such field trips in the future with our first ever SPARK crowdfunding campaign that ends on December 31, 2018. To date, we have reached 43% of our \$20,000 goal, and we ask for your support to contribute to our campaign and publicize it. Finally, I am thrilled to announce that we added a spectacular sample to the Meteorite Gallery: a slab of the second largest meteorite in the United States (page 4). I invite you to come and see it and reconnect with us in the process.



We very much value your involvement with EPSS. If you would like to partner with us on some of our initiatives, including named spaces, fellowships, or colloquium series, endowed student awards and scholarships, funds for outreach or field trips, or other projects, please reach out to me at [chair@epss.ucla.edu](mailto:chair@epss.ucla.edu) or 310.825.1475. Through June 30, 2019, we are able to secure 1-to-1 matching contributions for qualifying gifts (page 22).

Warm regards,  
Jean-Luc Margot

A handwritten signature in black ink that reads "JLMargot". The signature is stylized and written in a cursive-like font.

## In this issue

Fritz Demopoulos	3
Looking inside Mars	3
Old Woman	4
Special lectures	5
New faculty	6
Graduate fellowships	7
EYU 2018	8
Summer field	10
Geophysics capstone	11
ELFIN satellites	12
Observing at Keck	14
Research awards	15
Archean tectonics	16
Chondrite meteorites	17
Commencement	18
Student awards	20
Faculty awards	21
Commons Room	21
Gifts and giving	22
Donor recognition	23

## Chair

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## Editing/Layout

Hilda Avanesian and JLM

## Front Cover

Field Geophysics (EPSS 136C) students study volcanism on Kilauea (page 11).

Photo credit: William Greer.

## Center Spread

Student-built satellite ELFIN

## Back Cover

ELFIN satellites in Earth's magnetosphere

Photo credit: NASA/E. Masongsong.

# Fritz Demopoulos Joins Board of Advisors

We are thrilled to announce that Frederick “Fritz” Demopoulos joined the EPSS Board of Advisors. Fritz is the founder of Queen’s Road Capital. He has been involved in a number of entrepreneurial and philanthropic activities over the past two decades, mostly within the Greater China region. He is passionate about establishing businesses and creative disruption, exploring the ideas behind science and science fiction, and contributing to his community through education and gender equality. Fritz co-founded Qunar, one of China’s largest online travel marketplaces and Shawei, China’s largest online sports media company. He also held senior executive positions at News Corporation Limited and NetEase, Inc. As a big supporter of UCLA and a native of Southern California, Fritz serves on the EPSS Board of Advisors as well as on the Board of Directors of the UCLA Center for Management of Enterprise in Media, Entertainment & Sports. He also sponsors the UCLA Velocity Women’s Summit. Fritz earned an MBA from UCLA and a BA from Cal State Fullerton. He is a long-term resident of Hong Kong along with his wife and two daughters.



## Looking Inside Mars by Caroline Beghein

NASA’s InSight mission launched from Vandenberg Air Force Base headed to Mars on May 5, 2018, sending a spacecraft that landed on the surface of Mars on November 26, 2018. InSight (Interior exploration using Seismic Investigations, Geodesy and Heat Transport) is the first mission dedicated to the study of Mars’s deep interior. The spacecraft transports multiple instruments, including a magnetometer developed by EPSS Professor Chris Russell, and a seismometer called SEIS (Seismic Experiment for Interior Structure) that will record marsquakes. EPSS Professor Caroline Beghein is one of a few scientists who were selected to join the InSight science team as part of NASA’s Participating Scientist Program. She will be using the seismic signals generated by marsquakes to map the planet’s deep interior. In particular, her contributions will help determine the thickness and structure of the mantle, which will improve our knowledge of the thermal state of the planet’s interior and help uncover how Mars and other rocky planets formed. EPSS Researcher Peter Chi is also involved in the mission and will study the induced magnetosphere and the interior of Mars with InSight magnetometer data and data from other spacecraft. University of Paris Diderot Professor Philippe Lognonné, the SEIS Principal Investigator, will be an EPSS visiting professor in Winter 2019, when the spacecraft will be sending its seismometer data to Earth. He will teach a timely course titled “Planetary Seismology and Geophysics.”

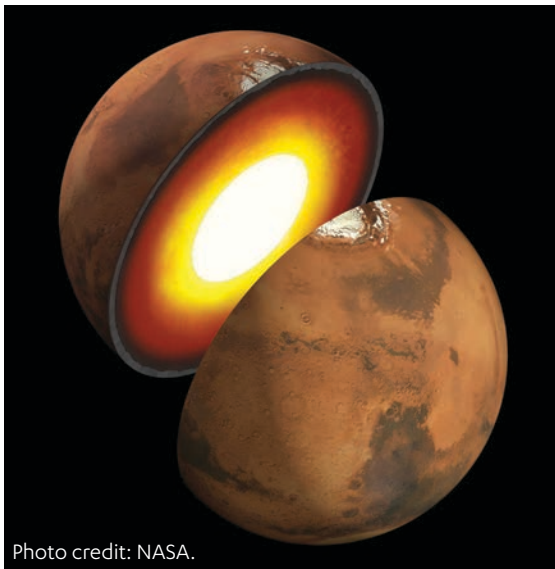


Photo credit: NASA.

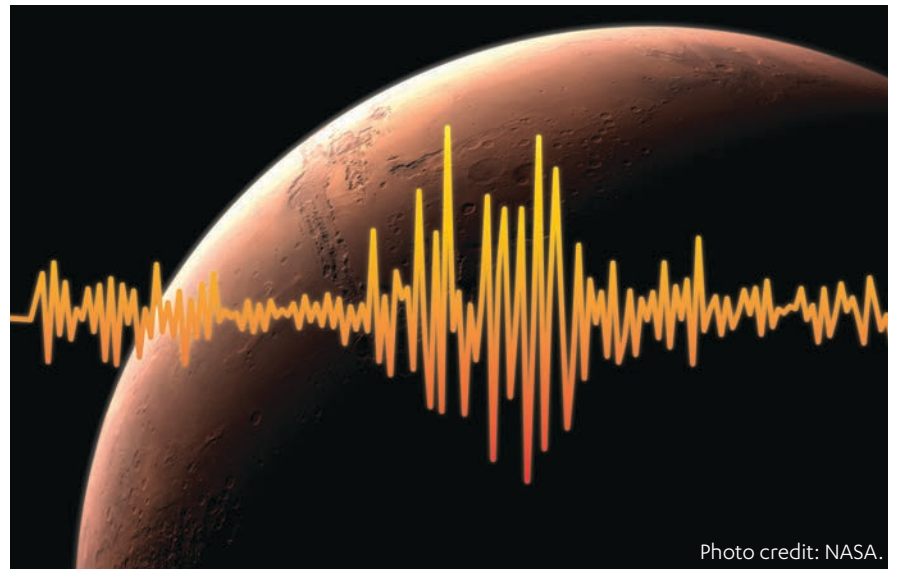


Photo credit: NASA.

# The Old Woman Has Arrived



Photo credit: Kevin McKeegan.

Professor John Wasson stands next to a slab of the Old Woman meteorite in the UCLA Meteorite Gallery.

A 3-ton iron meteorite, the second largest meteorite in the USA, was discovered in 1976 in the Old Woman Mountains east of Twentynine Palms, CA. There was a custody battle between the Smithsonian Institution in Washington, the prospectors who found the meteorite, and the museums of California. Now, 40 years later, thanks to the persistent efforts of EPSS Professor John Wasson, the UCLA Meteorite Gallery received as a long-term loan this beautiful, polished-and-etched slab of the Old Woman. The total mass of the slab is 80.5 kg (177.4 lb).

## Observing and Connecting with the Moon

by Emmanuel Masongsong

NASA's International Observe the Moon Night (IOTM) was presented locally by UCLA EPSS and iPLEX on October 20, 2018. The event is a yearly reminder to celebrate our nearest planetary neighbor. It enables many visitors to view the Moon up close for the first time in their lives. About a dozen volunteers operated various large and small telescopes, revealing glorious detail of craters, the darker maria or seas, and other lunar features. Families gathered around a video montage projected on the telescope dome, showing descriptions of NASA's Apollo program, simulations of lunar formation and cratering, lunar eclipses, and a documentary describing UCLA's uranium-lead dating of the Moon to 60 million years after the Solar System formed. An extra special treat was provided by Professor David Paige and the Lunar Reconnaissance Orbiter team: real Apollo moon dust viewed under a microscope! One Apollo 11 sample was from mare regolith from the Sea of Tranquility and was significantly darker than the Apollo 17 sample from the lunar highlands. A few historical Apollo artifacts such as a 1/6 gravity lunar drill and command module seat both used in ground tests were also available for viewing courtesy of UCLA Research Astronomer Michael Rich. Jason Utas's collection of lunar and Martian meteorites for the public to see and touch was another highlight. Visitors were thrilled to ask the scientists questions, look at the bright orbs of Mars and Saturn, and connect with the Moon.



Apollo 11 Moon dust.

Photo credit: Emmanuel Masongsong.

# Distinguished Alumni and Faculty Lectures

This year's distinguished alumni lecture was given by Yale University Professor Dave Bercovici, who was recently elected to the National Academy of Sciences. Dr. Bercovici earned his Ph.D. from UCLA in Geophysics and Space Physics in 1989 under the guidance of Professor Gerald Schubert. More than 130 guests of all ages attended his talk titled "Plate Tectonics, Natural Disasters, and the Evolution of Planet Earth" on October 29, 2018. Prior to the talk, EPSS alumni and friends mingled with 24 EPSS faculty members at a reception in the lobby of the California NanoSystems Institute. Dr. Bercovici's talk took us on a fascinating and wide-ranging tour of Earth's plate boundaries and associated hazards. A panel with Dr. Bercovici, EPSS Professor Carolina Lithgow-Bertelloni, the Louis B. and Martha B. Slichter professor of geophysics, EPSS Professor Lingsen Meng, the Leon & Joanne V.C. Knopoff professor of physics and geophysics, EPSS graduate student Abijah Simon, and EPSS undergraduate student Christina Kitamikado addressed audience questions and concluded the event. A videorecording of the event is available on the EPSS website.

This year's EPSS faculty lecture was given by Professor Margaret Kivelson, who is a member of the National Academy of Sciences. It was titled "Magnetic Structures in the Solar System" and held on February 12, 2018. Approximately 175 guests attended the event. Prior to the talk, attendees enjoyed a reception where they had the opportunity to interact with EPSS students, postdocs, researchers, and faculty. The lobby was buzzing with activity in part because of educational exhibits about a variety of topics, including space weather, sunspots, solar eclipses, the ELFIN mission (pages 12–13), and the Parker Solar Probe. Professor Kivelson gave a superb overview of magnetic phenomena in the Solar System. A panel moderated by EPSS Chair Jean-Luc Margot tackled a variety of interesting audience questions. A videorecording of the event is available on the EPSS website.

Professor Kivelson has been a role model and mentor to many. She received her Ph.D. in 1957 and joined UCLA in 1967, at a time when there were few women in science. She recently received two lifetime achievement awards, the Gerard P. Kuiper Prize from the American Astronomical Society and the Jean-Dominique Cassini Medal from the European Geosciences Union. She has been a source of inspiration and support to many students. Because we are so proud of Professor Kivelson's scientific contributions and impact as an instructor and role model, we have launched a fundraising effort to establish the Margaret G. Kivelson Graduate Fellowship. Fellowships will honor the career of Professor Kivelson and her dedication to mentoring students in the sciences, including underrepresented students. You can partner with us to make a lasting impact and enable this fellowship at <https://epss.ucla.edu/giving>.



Professor Margaret Kivelson



The panel discussion at the EPSS faculty lecture: EPSS assistant researcher Christine Gabrielse, EPSS graduate student Michaela Villareal, EPSS undergraduate student Jessica Artinger, Professor Margaret Kivelson, Professor Jean-Luc Margot. Photo credit: Mojghan Haghnegahdar.

# New Faculty: Carolina Lithgow-Bertelloni



Professor Carolina Lithgow-Bertelloni, a geodynamicist, joined EPSS in July 2018. Professor Lithgow-Bertelloni received her B.S. in Geology from the University of Puerto Rico in 1987, and completed her Ph.D. at the University of California, Berkeley in 1994. She then moved on to a postdoc at the oldest Geophysical Institute in the world in Göttingen, Germany, the Department of Terrestrial Magnetism as an NSF postdoctoral fellow, and faculty positions at University of Michigan and University College London. This peripatetic academic life matches an equally diverse background, having been born in the Caribbean from an Italian mother and a Dominican father, and then alternately living in Puerto Rico and Italy. A love of history and classics led to an initial interest in geophysical prospecting for ancient ships, which morphed into a love for global tectonics after her first class in geology. She has a long-standing interest in the global inner workings of the Earth and how they manifest themselves at the surface, via plate motions, topography or even climate change and biological evolution (yes, evolution!). It was a way to integrate geological insight with the equally appealing fluid dynamics of the mantle and mechanics of the lithosphere. She has conducted and instigated research integrating past geological and geophysical observations (e.g., plate motions, topography, sedimentary basin sequences) with dynamical models of Earth's mantle. Integrating life and work, and understanding the importance of Earth's composition and structure to dynamics, she has also developed, along with Professor Stixrude, a fully self-consistent thermodynamic model to predict mantle properties. Her honors include the David and Lucile Packard Fellowship for Science and Engineering in 2001 and the Alfred P. Sloan Foundation Fellowship. She is joined by her husband, Professor Lars Stixrude, another new EPSS faculty member, and their 15-year-old son Gabriel.

# New Faculty: Lars Stixrude

Professor Lars Stixrude, a mineral physicist, joined EPSS in July 2018. Professor Stixrude received his B.S. in Geology and Physics from the University of Delaware in 1985, and completed his Ph.D. at the University of California, Berkeley in 1991. He then moved on to a postdoc at the Geophysical Laboratory, and faculty positions at Georgia Tech, University of Michigan, and most recently University College London, where he also served as Head of Department. Combining his love for the richness of the natural world with the power and generality of physics, he has long been fascinated with the behavior of Earth-building materials and what they can teach us about the largest scales of planetary evolution. He has played a leading role in developing new approaches to the study of planetary interiors based on quantum mechanical simulation and advanced thermodynamic modeling, which have led to new insights into the mineralogy and temperature of Earth's inner core, the composition and dynamics of the mantle, and the physical properties of minerals and melts at high pressure. Most recently, he has become interested in Earth's earliest evolution, its transition from a molten magma ocean state to the largely solid mantle we see today, and what fossil evidence may remain of its origins in the geochemistry of plumes and the seismic structure of the deep mantle. His honors include the James B. MacElwane Medal of the American Geophysical Union in 1998, and election as a fellow of the American Association for the Advancement of Science and Academia Europaea. A native of Delaware, Professor Stixrude has spent far too long in cloudy climes, and has looked forward to returning to sunny California. He is joined by his wife, Professor Carolina Lithgow-Bertelloni, another new EPSS faculty member, and their son Gabriel.



# The Impact of Graduate Student Fellowships

The approximately 75 graduate students in our program play a critical role in our mission. During their studies and training at UCLA, they provide the bulk of our research results and critical assistance with instruction. They are also essential partners in our outreach efforts. We strive to continually improve the support for our students. The teaching assistantships and university allocations cover at most 1/3 of the academic year support of our graduate students. For the remaining 2/3 and for summer support, EPSS relies on fluctuating grant support, competitive extramural fellowships (NASA, NSF, etc.), or gifts from alumni and friends. Endowment gifts are especially valuable because they provide stable funding and allow us to recruit the very best students regardless of the availability of grant funds aligned with the student's research interests at the time of admission. We were delighted that Dr. Nathan P. Myhrvold, an EPSS alumnus, decided to take advantage of the Chancellor's and Dean's matching programs (page 22) to establish a graduate student fellowship that will fund students who conduct research in the fields of earth, planetary, and space sciences, including related fields such as paleontology, astrobiology, and SETI. Dr. Myhrvold is the founder of Intellectual Ventures and the former Chief Technology Officer at Microsoft. In the Summer 2018 edition of the UCLA College Magazine, Dr. Myhrvold emphasized the importance of graduate student support: "Graduate



Nathan Myhrvold

students are an incredibly important part of the [university] workforce and research machinery. There are lots of ways to give back, but very few have as much leverage or impact as supporting graduate students." We are extremely grateful to Dr. Myhrvold for his vision and generosity. Endowments from other generous donors are enabling support for three graduate students this academic year. **The John L. and Juanita B. Rosenfeld Graduate Fellowship** was established by EPSS Professor John Rosenfeld. It has been awarded to Kevin Shao, a second-year graduate student who works with Professor Seulgi Moon. Kevin is examining the spatial distribution and characteristics of precipitation-induced landslides and comparing them to catchment erosion rates in the eastern end of the Himalaya, with the goal of providing insights into the mechanics of long-term landscape evolution in the region. **The W. Gary Ernst Graduate Fellowship** was established by former EPSS Professor and Chair W. Gary Ernst and Charlotte Ernst. It has been awarded to Simran Sangha, a fourth-year graduate student who works with Professor Gilles Peltzer. Simran is using Synthetic Aperture Radar Interferometry (InSAR) to map surface deformation since 1997 in real time over the Afar Depression, a broad extensional region encompassing the meeting point of three diverging plate boundaries, to characterize fault behavior and contribute to the current repertoire of knowledge surrounding rift systems. **The J. Douglas and Patricia Traxler Graduate Fellowship** was established by the estate of alumnus J. Douglas Traxler (Geology B.S. '42, M.A. '48). It has been awarded to Justin Higa, a first-year graduate student who works with Professor Seulgi Moon. Justin studies tectonics and geomorphology to examine the influences of 3D topographic stress on giant landslides on volcanic islands.

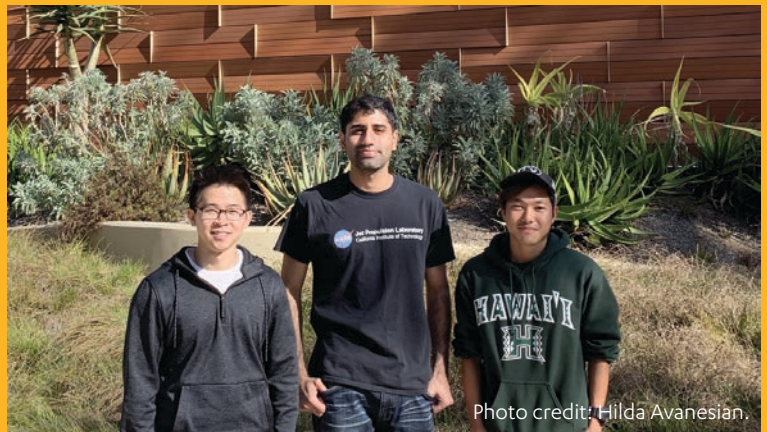


Photo credit: Hildā Avanesian.

Recipients of the Rosenfeld, Ernst, and Traxler graduate student fellowships (left to right): Kevin Shao, Simran Sangha, Justin Higa.

# Exploring Your Universe 2018

On November 4, 2018, EPSS once again co-hosted the annual Exploring Your Universe science festival, which is family friendly and always open to the public, and regularly welcomes thousands of people to campus for hands-on experiments, exciting lectures, and tours of the Meteorite Gallery. EPSS is proud to have co-sponsored this popular outreach event every year since its inception in 2009. EPSS volunteers showcased 12 exhibits, including earthquake, magnetism, and fluid dynamics demonstrations. Other booths described some of the NASA missions that UCLA leads or participates in, including the ELFIN mission (page 12), the Parker Solar Probe, THEMIS and ARTEMIS, and Mars 2020. Rocks, minerals, and fossils were also beautifully displayed and described to attendees. EPSS students, researchers, and faculty enthusiastically answered the call for volunteers and communicated their passion for science to inquisitive minds.

EPSS is proud to have co-sponsored the Exploring Your Universe science festival every year since its inception in 2009.

Thousands of participants were infected by the enthusiasm of Earth, Planetary, and Space Sciences volunteers.







Exploring Your Universe 2018 photos: (Top left) Attendees discover aspects of fluid dynamics with dye and liquids on rotating table platforms. (Bottom left) Attendees experiment with plasma globes and learn about electric charges. (Top right) An EYU volunteer demonstrates the effect of magnetism to explain the science behind the ELFIN student satellite mission (page 12). Two replicas of the ELFIN CubeSats are visible on the table. They were used to describe the components and functionality of the satellites. (Bottom right) EPSS Researcher Alan Rubin discusses meteorites with a budding young scientist. Photo credits: Mojghan Haghnegahdar (this page) and Damon Cirulli (opposite page).

# Summer Field Program

by Lauren Gentile and Ellen Hoppe

As the temperature outside soared to 124°F, we exchanged wary looks with the 10 other students as EPSS Professor An Yin led us into Death Valley, CA. We were on our first field trip of Summer Field. Thus far, we had spent our days familiarizing ourselves with the eight units of the Poleta Formation that we would be mapping over the next few weeks, trying to stay hydrated, and making Camp Nelson feel like home. As the summer progressed and we interacted with other schools, we realized how lucky we were to be camping together. Even though other schools may have had chefs, dorms, showers, and Internet access, we had a campsite just 10 minutes from our mapping area at Poleta Folds, and a strong bonding experience of running our camp as a team. We took pride in our UCLA camping tradition, which includes a system of water retrieval from 10 miles down the mountain, cooking groups, and campfires to boost morale. Our hard work and enthusiasm made camp run efficiently, allowing us to focus on mapping and learning as much as we could from the real-world lessons in the several disciplines of Earth science that this trip had to offer. Each day, after eight hours of mapping and a quick swim in the Owens River, we turned our focus to academic papers, each preparing to present to the class on a different topic and attempting to unravel the histories of the cryptic strike-slip and thrust faults we found each day. After Professor Yin spent an evening revealing secrets of Poleta Folds through Play-Doh demonstrations, we were filled with a sense of awe and were excited to return to the field the next day to search for kinematic indicators to confirm our new hypotheses. The first sigma clast (a feature indicating the direction of slip in a fault zone) that we found on our own will forever be seared into our minds, along with the sense of triumph that accompanied the knowledge that we had correctly applied theory learned in the classroom to real field geology. As the summer progressed, we had several other educational opportunities including hiking to Long Lake to study textures in the plutons of the Sierra Nevada, contrasting the basaltic lava flows of the Big Pine volcanic field with the rhyolite domes by Mono Lake, examining impressive dropstones representing the global glaciation of “Snowball Earth”, examining sedimentary and metamorphic structures in the White Mountains, and venturing into the incredible ancient forest of the oldest living organisms on Earth: the bristlecone pines. Summer Field was a unique experience that has helped us to grow toward our respective professional goals by teaching us how to conduct fieldwork, create maps and reports, understand geology in a variety of contexts, collaborate with one another, and most importantly learn and grow from the challenges and triumphs of spending a month in the field.



Professor An Yin’s goals for Summer Field students include developing critical thinking skills, integrating sound field observations with hypothesis testing, enhancing teamwork, and improving oral and written communication skills.

2018 Summer Field Program participants on the Big Pine volcanic field.

Photo credit: An Yin.

# Spring 2018 Geophysics Capstone Course

by Fiona MacCarthy

The anticipation was high as our group convened at LAX in Spring 2018. There were 13 of us from EPSS, and we had a plethora of instruments to bring to the field with us. The junior and senior geophysics majors at UCLA were on their way to Hawaii to conduct field work. The data collected would become the backbone of our spring quarter studies. Upon our arrival in Kilauea, HI, it was hot and humid even after sunset. In the morning, we headed to Kilauea Military Camp, where we stayed in old military barracks for the week. On the second day, we arrived at the camp and headed to the USGS Hawaiian Volcano Observatory where we were greeted by USGS geophysicist Jim Kauahikaua, our host for the week. From there, we enjoyed a view of Halema'uma'u Crater. During our first observation, the crater was wrapped in fog with a faint glow peeking through. Throughout the week, we conducted numerous experiments all around the island. The first one involved a 12-mile hike in the basaltic lava fields (cover photo) in search of active flows and learning how to use the very low frequency (VLF) meter and self-potential (SP) probes. It was a long hot day in the sun, and we were all grateful for our bunks afterward. On our fourth day on the island, we drove several hours to Hilo to begin gravity measurements starting at sea level and continuing up Mauna Loa. The measurements would enable detection of a high-density core. Finally, we spent two days trekking through the jungle taking VLF, SP, and magnetic measurements across an ancient dike that formed 45 years ago with the goal of monitoring changes over time by comparing our results with previous measurements. On our last evening, we all gathered in one room to input data on our laptops and then we began plotting the data. When we walked outside on our way to dinner, we noticed an ash cloud coming from the crater. We made our way to the summit after sunset and witnessed lava fountains where we had previously seen only a faint glow. This increased activity would eventually give way to the overflow and eruption on Kilauea that would come in the month following our departure. During the remainder of Spring 2018, we used our data to quantify characteristics of the water table and its interaction with an intruded dike, comparing our results to measurements obtained over the past 45 years. We also analyzed our gravity data and compared a model of Mauna Loa to Olympus Mons on Mars. Finally, we were able to compile months of work into a final project. The time in the field and the wonderful opportunity to go to an active volcano were instrumental to our understanding of the life and work of geophysicists. It was a culmination of years of study applied to real-life scenarios.

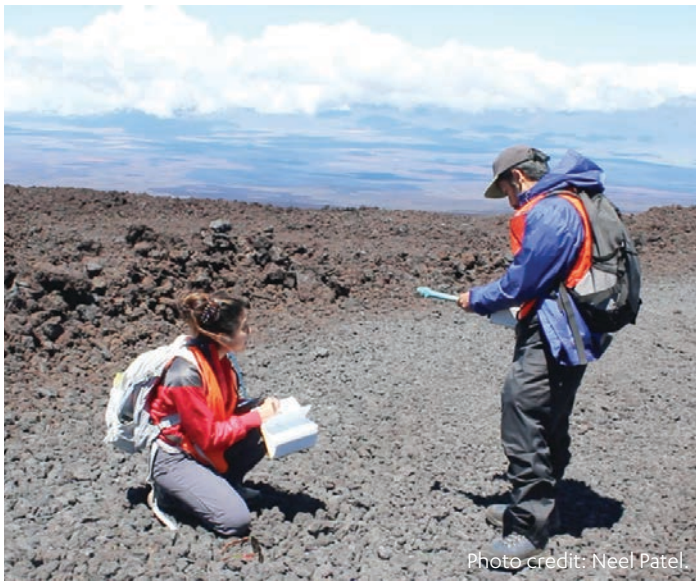


Photo credit: Neel Patel.



Photo credit: Neel Patel.

Students enrolled in the Spring 2018 EPSS 136C Field Geophysics course taught by EPSS Prof. Paul Davis take measurements during their field trip to Hawaii. (Left) Using the VLF meter on Mauna Loa, HI. (Right) Gravity measurements at sea level in Hilo, HI.

Support EPSS field trips at <https://epss.ucla.edu/giving>

# Student-led Team Launches Two Satellites

After a decade of planning and five years of intense construction and testing by more than 250 undergraduates, UCLA made history by launching its first-ever spacecraft. The Electron Losses and Fields Investigation CubeSat mission, or ELFIN, was directed by EPSS Professor Vassilis Angelopoulos, who also manages two other NASA missions that study space weather. Over 50 Bruin alumni, faculty, staff, and current students witnessed the predawn launch on September 15, 2018 from Vandenberg Air Force Base, cheering loudly as their hopes and dreams roared through the clouds and into orbit. The twin ELFIN micro-satellites, each weighing about eight pounds and roughly the size of a loaf of bread, will help scientists better understand magnetic storms in near-Earth space. These storms are a typical form of space weather when the Sun is active and produces flares and violent solar eruptions. Occasionally the Sun unleashes large amounts of electromagnetic energy that can reach Earth's space environment, powering the magnificent northern and southern lights. "The aurora is sort of a TV screen, space physicists can tell if something interesting or important is going on in space by looking at the aurora," said Angelopoulos. ELFIN will search for signatures of certain magnetic waves that produce "killer electrons," which are hazardous to GPS and weather satellites, astronauts, and even our electrical grid on the ground. Space weather research is crucial for space tourism and space exploration, and can reveal clues about the fundamental physics of magnetic fields around other planets and distant stars. EPSS has built instruments flown on many international space missions for over 40 years, going back to magnetometers on Apollo 15. Members of our faculty continue to lead cutting-edge space science missions, especially with the recent successful launches of ELFIN, the Mars InSight lander, and the Parker Solar Probe that will study the Sun up close. By applying student ingenuity to smaller satellite designs like CubeSats, simpler hardware and software can be developed far more quickly and reach space more cheaply than traditional large satellites. Even more importantly, ELFIN provides students with invaluable experience that builds confidence and expertise working as a team, and develops problem-solving skills that prepare students for careers in academia and industry alike.



Photo credit: NASA.

The ELFIN satellites lift off on a Delta-II rocket.

# to Study Space Weather

by Emmanuel Masongsong



Illustration credit: Emmanuel Masongsong/NASA.

Nearly the entire spacecraft was built in-house: circuit boards were populated and programmed, the chassis was CNC-machined by students in the Prototyping Lab, and test models were frozen and heated in a thermal vacuum chamber to simulate conditions in space, all within EPSS. Uncommon among CubeSats, ELFIN is directly controlled by undergraduate student operators, beaming down data twice daily to the Mission Operations Center at EPSS on the second floor of the Geology Building. This unique infrastructure enables UCLA to support future student space missions. ELFIN will operate for about two years until atmospheric drag will eventually cause the satellites to fall out of orbit and burn up in the atmosphere. The satellites will leave no space debris behind, but will certainly make their mark on countless future Bruins. ELFIN was funded jointly by NASA and the National Science Foundation, with support from the Aerospace Corporation, Tyvak NanoSatellite Systems, Inc., and California Polytechnic State University, San Luis Obispo, as well as other public and private partners.

“I never imagined being involved in a NASA mission as an undergraduate,” said Ethan Tsai, now a UCLA graduate student and ELFIN’s project manager. Commenting on the launch, he said “It’s really been a very emotional moment for a lot of students here.”

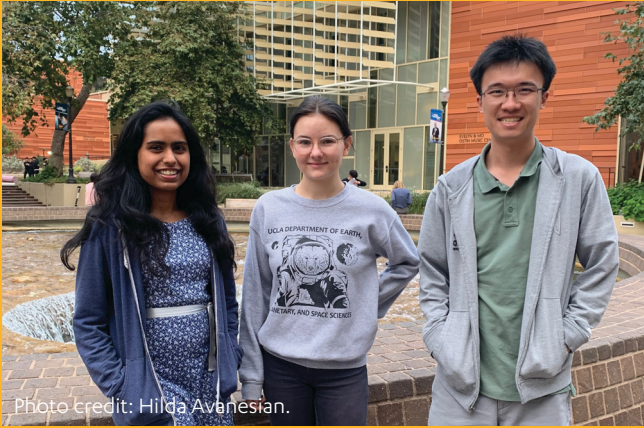
# As Madame Pele Rose from the Depths, We Looked to the Skies

by Ariel Graykowski



Four kilometers above sea level, the summit of Mauna Kea in Hawaii is the amazing home of the W.M. Keck Observatory. The two Keck telescopes are the largest optical telescopes in the world, with primary mirrors that are each 10 meters (~33 feet) in diameter. They allow lucky astronomers to study objects like stars, galaxies, and the giant black hole in the center of the the Milky Way in great detail. My work, however, involves celestial objects that are much closer to home: small bodies in the Solar System such as comets and planetary moons. During the summer of 2018, I was a Keck Visiting Scholar, and as such, I had unique exposure to the newest addition to the Keck instrument family, NIRES. NIRES (Near Infrared Echelle Spectrometer) is an instrument that reveals the chemical composition of the objects we observe by taking their spectrum in the infrared. My goal was to learn how to use this instrument to study objects in the Solar System, reduce and interpret the data, and develop an algorithm to streamline the data reduction process for future observers. My Keck mentor, Dr. Percy Gomez, scheduled engineering time that allowed me to use NIRES for three half-nights over the course of the five-week visiting scholars program. I learned how to efficiently use the instrument and we conducted engineering tasks, such as testing how well the instrument focused at varying elevations. Between tasks, there were short periods of time to gather science data. With these data, I learned how to reduce and extract spectra from an image. My mentor and I then developed an algorithm so that a future observer can do quick data reduction while they are observing. These quick results help the observer to decide if they have taken enough images to achieve a good signal-to-noise ratio. This ease-of-use will allow for a better observing experience, and a greater interest in NIRES from scientists all over the world. Strong volcanic activity in Kilauea made for some unique observing experiences. Occasionally, Kilauea earthquakes shook the telescopes, forcing us to shut down observations for a while to make sure that no damage was done. We also battled sulfur from the volcano which, if mixed with the humid air, forms sulfuric acid that is capable of damaging the instruments in a different way. Although Madame Pele, Hawaii's goddess of volcanoes, posed a fiery threat, we still managed to take data on bright comets in the night sky, and I had a fun and productive internship. I learned a lot and I plan to use NIRES for future research on small bodies in the Solar System.

# Undergraduate Research Awards



Recipients of EPSS undergraduate research awards (left to right): Maria Vincent, Jewel Abbate, Norris Khoo, Nicole Jewell (not shown).

Thanks to the generosity of alumni and friends of the Department, we have been able to incentivize undergraduate research in EPSS for the second year in a row. An annual call for proposals is sent to undergraduate students and faculty, and about four proposals are selected on the basis of merit. Each award funds up to 20 or 40 hours a week of a student's research time during the academic year and summer, respectively. Most awards are supplemented by travel funds to present the results at a scientific conference. We are pleased to showcase the recipients of the 2018 research awards (see also pages 15–17).

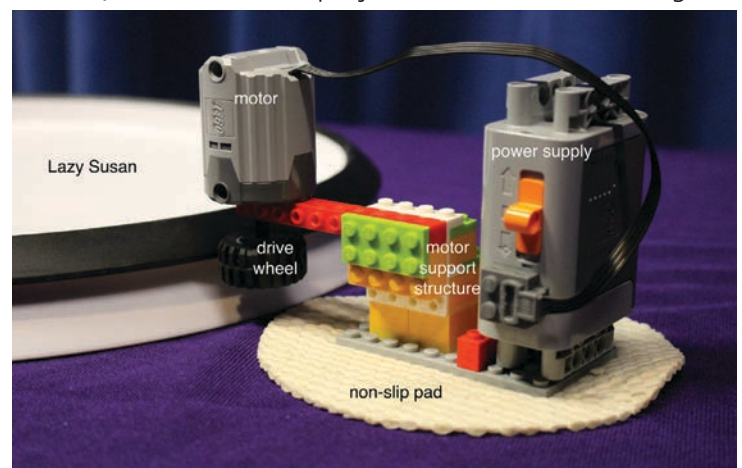
Two students benefited from the Straus Family Fund for Undergraduate Opportunity. Jewel Abbate worked with Professor

Vassilis Angelopoulos on a project titled “High resolution magnetic profiling using a dual magnetometer UAV aerial survey system.” Norris Khoo worked with Professor Jon Aurnou to design a novel LEGO-based rotating table that can be used by educators at all levels to teach broadly applicable atmospheric, oceanic, and planetary interior fluid dynamics concepts (page 15). Thanks to the J. Douglas and Patricia Traxler Scholarship Fund, Nicole Jewell worked with Professor An Yin to study the Archean tectonics of the Limpopo Belt, South Africa (page 16). The Donald Carlisle Undergraduate Research Endowed Fund made it possible for Maria Vincent to work with Professor Kevin McKeegan on X-ray mapping of carbonaceous chondrites to hunt for carbonate minerals (page 17). Award recipient Nicole Jewell remarked: “Undergraduate research is crucial for students to be involved in, as it allows them to develop necessary skills for future employment and enriches the undergraduate experience.”

## Adventures in Fluid Dynamics

by Norris Khoo

Thanks to the generous support of the Straus Family Fund for Undergraduate Opportunity, I carried out two separate research projects in the EPSS Simulated Planetary Interiors Lab. For the first project, I designed a novel LEGO-based rotating table (Fig. 1) that can be used by educators at all levels to teach broadly applicable atmospheric, oceanic, and planetary interior fluid dynamics concepts. This work, performed in collaboration with Professor Jon Aurnou and postdocs Spencer Hill and Juan Lora, will be published in the December issue of the Bulletin of the American Meteorological Society (<https://doi.org/10.1175/BAMS-D-17-0215.1>). For the second project, I worked on the design, construction, and troubleshooting of a novel laboratory model that approximates thermal convection that occurs in the low latitude regions of Earth's liquid iron core. Known as the “Coreaboloid,” the device is centered around a 0.7 m diameter rapidly rotating cylindrical tank of water. The “Coreaboloid” team, which includes Ashna Aggarwal, Taylor Lonner, and Professor Jon Aurnou, plans to study the laboratory model in preparation for a publication on convectively driven jets and turbulent vortices in the region that likely controls the generation of Earth's magnetic field.



# Archean Tectonics of the Limpopo Belt

by Nicole Jewell



Photo credit: An Yin.

EPSS undergraduate student Nicole Jewell examines 2.6-billion-year-old granulite-facies metamorphic rocks in the Limpopo orogenic belt of South Africa.

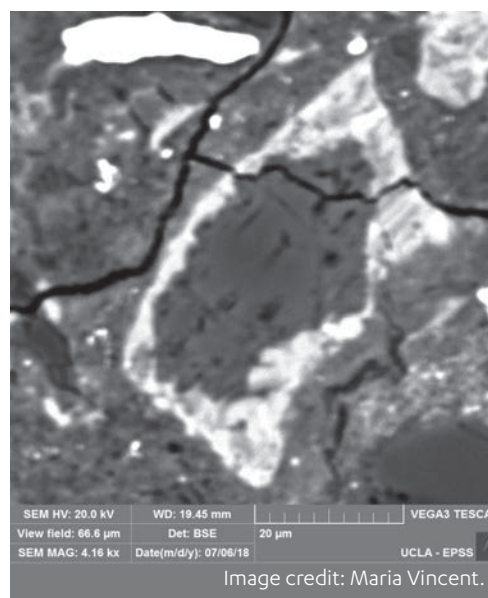
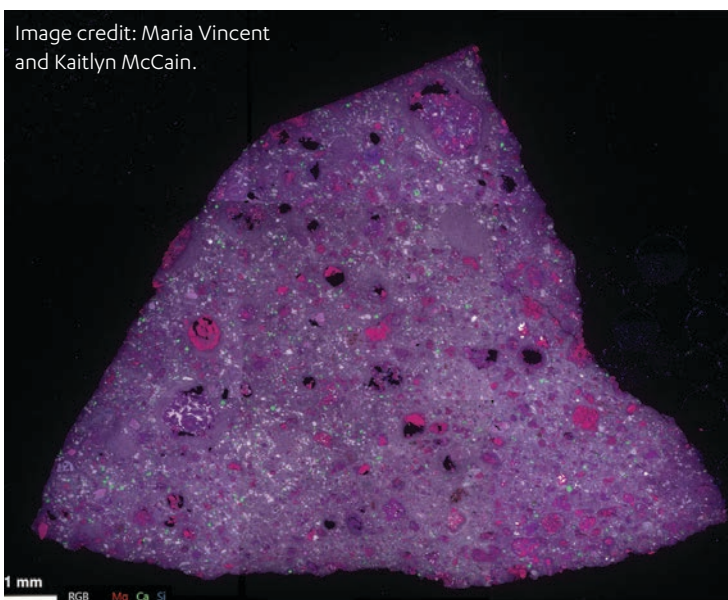
Thanks to a J. Douglas and Patricia Traxler Undergraduate Research Award, I was granted the opportunity to travel to South Africa, Botswana, and Zimbabwe to study some of the Earth's oldest rock formations. Our science goal was to collect samples for geochronological dating and determine the kinematics of the area. We harvested over 50 samples and worked in several locations over the course of two weeks. Most of our field sites were in South Africa: Rhenosterkoppies greenstone belt, the Hout River, Khavagari shear zone, Nthabalala oblique-slip shear zone, and a few others. In Botswana, Wilburt Kehelpannala led our field trips through the Limpopo Belt and the Zimbabwe Craton, where we collected several samples within the shear zones. We explored the Great Dyke of Zimbabwe, where we collected a few samples for dating. Our current objective is to accurately date the formations from each country and piece together the tectonic history to better understand the large event which occurred approximately 2.0 billion years ago. I presented preliminary results of our research at the 2018 meeting of the Geological Society of America. This field and research experience gave me the opportunity to not only see some of the oldest structures in the world, but also to expand my education. Collaborating with diverse geologists in varying disciplines provided me with a unique learning experience. Field work can be difficult, but this trip helped to solidify what I learned during my undergraduate studies and gave me more confidence. I hope to use these skills throughout my professional career. I am planning on continuing my education in pursuit of a graduate degree.



# X-ray Mapping of Carbonaceous Chondrites: a Hunt for Carbonate Minerals

by Maria Vincent

One way to go back in time to the formation of the Solar System is to study meteorites. We can learn about the materials that formed the Solar System and the processes that occurred during and after the formation of asteroids and planets by studying the mineralogy, chemistry, and isotopic compositions of meteorites. A particularly interesting group of meteorites is the carbonaceous chondrites, especially its subgroup, the CM chondrites. CM chondrites contain volatile elements and organic matter, and experienced fluid-rock interaction in an asteroid prior to their delivery to Earth. This interaction gave rise to carbonate minerals, which are strong evidence of the presence of liquid water. These carbonates can be analyzed to learn more about the conditions in such water-rich bodies. Thanks to a Donald Carlisle Undergraduate Research award, we investigated the CM chondrites Murchison and QUE97990 to search for carbonates. By using a scanning electron microscope (SEM), we produced maps of polished surfaces of each meteorite that can be interpreted to study major element chemistry and mineralogy at the microscopic scale. The SEM scans an electron beam over a selected region of the sample to generate an image. The image produced depends on the kind of interaction of the electrons with the minerals in the sample that is being detected. In this project, we obtained X-ray maps of the samples, where each element emits characteristic X-rays at unique energies upon interaction with the beam. We assigned colors to elements to quickly identify minerals on a map: red, blue, and green to magnesium, silicon, and calcium, respectively. The carbonates have a high concentration of calcium and low abundance of silicon, causing them to appear bright green on a map (Fig. 1, Left). Closer analysis (at higher magnification) of each carbonate grain showed calcium in high abundance, followed by oxygen and carbon. We identified them as calcite, a common carbonate in less-altered CM chondrites like Murchison and QUE97990. The various carbonates present in each sample, which differ in the abundance of an oxygen isotope (O-17 and O-18), and the presence of a rim (Fig. 1, Right) or the absence thereof tells us that a complex aqueous alteration process took place in the sample. We were able to obtain individual images of the carbonates by detecting electrons that bounced off the surface of the sample. The images thus formed are called back-scattered electron (BSE) images. This analysis gives us an idea about the kinds of carbonates that are present in the sample, and we plan to follow up with SEM scans of additional CM meteorites exhibiting different degrees of aqueous alteration. Isotopic analyses of these carbonates using the



ion microprobe will then give us more information on the formation conditions of carbonates, and help us understand the alteration processes that took place on these meteorites.

(Left) RGB X-ray map of a section of Murchison. Red is assigned to Mg, green to Ca, and blue to Si. (Right) Carbonate from the sample QUE97990.

# Commencement 2018



Photo credit: Hilda Avanesian.

Seven of our ten Ph.D. recipients celebrate at Commencement with EPSS Graduate Advisor Vassilis Angelopoulos (left) and Vice-Chair Edwin Schauble (right).

# Degrees

## Bachelor of Arts

Hayley Lauren Bricker	Eloy R. Torres
Carey Kuang-Ruey Chang	Meghan Elizabeth Tucker
Andrew-Joseph Q. Magracia, Jr.	Teddy Vang
Leo Triet Pham	Jack Andrew Vorster

## Bachelor of Science

Jewel Alessandra Abbate	Ashley Christine Miller
Marina Olivia Argueta	Ryan Michael Missel
Michael G. Arreola-Zamora	Isaac Chongmyong Park
Corey James Bair	Neel Patel
Randon James Flores	Christian Niguel Pelayo
Lauren Carol Gentile	Coralie Dean Rodriguez
Drew Elliot Sachs Gomberg	Una Gaylin Schneck
Ernest Alexandre Gomis	Judy Julieta Sibaja, Jr.
Jerimiah John Harris	Aaron Heshel Tannenbaum
Van Van Huynh	Alexandra Villa
Nicole Louise Jewell	Justin (Hian Ing) Voon
Norris Chih-Min Khoo	Tristan Jon Whisenant
Chao-Hua Lu	Casey A. Yamamoto-Hillman
Mitchell Marine Metz	



Photo credit: Hilda Avanesian.

## Master of Science

Ellen Wright Alexander	Jessica Chen Lin
Margaret Yexin Deng	Kaitlyn A. McCain
Tian Feng	Bryce Akio Mitsunaga
Ariel Graykowski	Raquel Gouveia Nuno
Danielle Maxine Hastings	Simran Singh Sangha
Emily Kate Hawkins	Abijah El-Fakih Simon
Heather Kirkpatrick	Jason Allen Utas
Erin Janelle Leonard	Yuqing Xie

## Doctor of Philosophy

Zagid Abatchev	Zixu Liu
Sean Faulk	Christopher McGuire
Amanda Kathryn Garcia	Emily Foote Smith
Mojhgan Haghnegahdar	Michaela Nicole Villarreal
Peter Jasura Haproff	Zheng Xing



Photo credit: Hilda Avanesian.

Commencement speaker Charles Elachi with Lauri Holbrook (left) and Undergraduate Advisor Gilles Peltzer (right).

# Students and Student Awards

EPSS welcomed 13 new graduate students in Fall 2018 from a pool of over 130 applicants. Over the past year, EPSS awarded 16 M.S. degrees and 10 Ph.D. degrees (page 19). Our students continue to succeed in their professional endeavors. We maintain a list of professional outcomes at <http://eps.s.ucla.edu/people/alumni/> and welcome any updates you may have. If you are looking for talent, please consider EPSS graduates. We are proud of the training they receive and of their overall performance and preparedness for the workplace. Undergraduate and graduate student awards are listed below, and undergraduate research awards are highlighted on page 15.

## *Undergraduate Awards*

### *Clarence A. Hall, Jr. Scholarship*

Presented in honor of Professor Emeritus Clarence A. Hall, Jr.

*Drew Elliot Sachs Gomberg*

### *John & Frances Handin Scholarship*

Presented to undergraduates for scholastic excellence, endowed by alumnus John W. Handin & his wife, Frances

*Corey James Bair*

*Tristan Jon Whisenant*

*Casey Amanda Yamamoto-Hillman*

### *Eugene B. Waggoner Scholarship*

Presented to undergraduates for scholastic excellence, in honor of alumnus Eugene B. Waggoner

*Randon James Flores*

*Norris Chih-Min Khoo*

*Una Gaylin Schneck*

### *Kenneth D. Watson Summer Field Award*

Presented to summer field students, in honor of Professor Ken Watson

*Chao-Hua Lu*

*Yingchi Wang*

### *Deane Oberste-Lehn Field Award*

Presented to summer field students, in honor of alumna Deane Oberste-Lehn

*Madeline Janet Biebel*

*Lauren Carol Gentile*

*Ellen Ann Hoppe*

*Nicole Louise Jewell*

*Audrey Michelle Sapien*

*Judy Julieta Sibaja, Jr.*

*Alexandra Villa*

### *Walter S. Harris Summer Field Award*

Presented to summer field students in memory of Walter S. Harris

*Rabbi Tshiyoyo Kankolongo*

*Mitchell Marine Metz*

### *Straus Family Undergraduate Research Award*

*Jewel Alessandra Abbate*

*Norris Chih-Min Khoo*

### *Donald Carlisle Undergraduate Research Award*

*Maria Vincent*

### *Traxler Undergraduate Research Award*

*Nicole Louise Jewell*

## *Graduate Awards*

### *Eugene B. Waggoner Scholarship*

Presented to graduate students on the basis of merit, endowed by alumnus Eugene B. Waggoner

*Kynan Hughson*

*Man-To Hui*

### *Harold and Mayla Sullwold Scholarship*

Presented to graduate students on the basis of merit, endowed by Harold and Mayla Sullwold

*Erin Leonard*

*Lior Rubanenko*

*Simran Sangha*

*Ailin Zhang*

### *Extramural Funding Award*

Presented to graduate students who secured multi-year funding from an extramural agency

*Ariel Graykowski*

*Kaitlyn McCain*

*Ashley Schoenfeld*

*Robert Ulrich*

### *Outreach Award*

Presented to graduate students to recognize excellence in education and public outreach

*Mojhgan Haghnegahdar*

*Heather Kirkpatrick*

*Kaitlyn McCain*

*Krista Sawchuk*

### *Outstanding Teaching Assistant*

Presented to graduate students to recognize outstanding performance in teaching

*Kevin Coffey*

*Daniel Fineman*

*Ariel Graykowski*

*Kynan Hughson*

*Jamie Lucarelli*

*Ashley Schoenfeld*

# Faculty Awards

We are thrilled to report that EPSS faculty have been recognized for their accomplishments with the following recent awards (partial list). A full list of faculty awards is available on our website at <https://epss.ucla.edu/faculty-awards/>.

- Ray Ingersoll: 2017 A. Eugene Fritsche Lifetime Achievement Award from the Society for Sedimentary Geology.
- Margaret Kivelson: 2017 Gerard P. Kuiper Prize from the American Astronomical Society.
- Margaret Kivelson: 2018 Jean-Dominique Cassini Medal from the European Geosciences Union.
- Carolina Lithgow-Bertelloni: 2018 Francis Birch Lecturer of the American Geophysical Union.
- Craig Manning: 2017 Norman L. Bowen Award from the American Geophysical Union.
- Craig Manning: 2017 Geochemistry Fellow of the Geochemical Society.
- Craig Manning: 2017 Geochemistry Fellow of the European Association of Geochemistry.
- Kevin McKeegan: 2018 J. Lawrence Smith Medal from the National Academy of Sciences.
- Chris Russell: 2017 NASA Distinguished Public Service Medal.
- Aradhna Tripathi: 2017 Presidential Early Career Award for Science and Engineering
- Aradhna Tripathi: 2017 Bromery Award for Minorities from the Geological Society of America.
- Aradhna Tripathi: 2018 Fellow of the Geological Society of America.

# Commons Room Renovation

Many of our alumni remember the beloved student interaction space currently known as the Commons Room (Geology 3680).

During the summer of 2018, thanks to gift funds matched by the Dean, we were able to conduct a major renovation (i.e., carpet, wall, ceiling) and expansion of the space. We purchased new modular tables, chairs, lounge furniture, cabinets, microwave oven, sink, projector, screen, and



Photo credit: Jean-Luc Margot.

large-format display to improve the quality of the student experience. We invite you to come visit the new space.

# Comings and Goings

The Department welcomed two new staff members this year:

- Steve Zuniga is our new personnel and payroll analyst.
- Anthony Sansone is our new programmer analyst who supports information technology (IT) needs.
- Roderic O'Connor has been promoted to the position of IT director.

Two staff members departed over the past year:

- Steven Salyards retired after many years of service as IT director.
- William Greer officially retired, but we are thrilled that he continues to work for EPSS on a recall appointment.

# Gifts and Giving

We are extremely grateful for the gifts that enable our mission. Donors who made gifts to the Department of Earth, Planetary, and Space Sciences between July 1, 2017 and June 30, 2018 are listed on the opposite page. Gifts made after June 30 will be acknowledged in the 2019 newsletter.

We would especially like to thank those donors who have contributed endowed gifts to the Department (listed below). Endowed gifts are particularly helpful because they enable initiatives in perpetuity. As we experience reduced state support and fluctuating grant support, endowments ensure that we can continue to improve the quality of EPSS research and teaching, and elevate the Department's worldwide reputation.

For a limited time, EPSS has a rare opportunity to secure a 1-to-1 match for any endowment between \$100,000 and \$1,000,000. Please contact the EPSS Chair or Brooke Sanders ([bsanders@support.ucla.edu](mailto:bsanders@support.ucla.edu)) for details.

**Donald Carlisle and Gloria Gálvez-Carlisle**

Donald Carlisle Undergraduate Research Endowed Fund

**W. Gary and Charlotte Ernst**

W. Gary Ernst Endowed Graduate Fellowship

**John and Frances Handin**

John and Frances Handin Endowed Scholarship

**Charlotte H. Johnston**

Walter S. Harris Summer Field Endowed Fund

**Joanne V.C. Knopoff**

Leon and Joanne V.C. Knopoff Term Chair in Physics and Geophysics

**Nathan P. Myhrvold**

Nathan P. Myhrvold Graduate Fellowship

**Deane Oberste-Lehn**

Deane Oberste-Lehn Endowed Scholarship

**Robert and Jeannette Paschall**

Robert and Jeannette Paschall Endowed Fund

**John L. Rosenfeld**

John L. and Juanita B. Rosenfeld Endowed Graduate Fellowship

**J. William and Jane Shen Schopf**

J. William and Jane Shen Schopf Endowed Faculty and Staff Enrichment Fund

J. William and Jane Shen Schopf Endowed EPSS Spousal/ Partner Employment Opportunity Fund

**Wilbur B. Sherman**

Wilbur B. Sherman Endowed Fellowship

**Joe and Andrea Straus**

Joe and Andrea Straus Endowment for Undergraduate Opportunity

**Harold and Mayla Sullwold**

Harold and Mayla Sullwold Endowed Scholarship

**J. Douglas and Patricia Traxler**

J. Douglas and Patricia Traxler Scholarship

**Eugene B. and Winifred Waggoner**

Eugene B. Waggoner Endowed Scholarship

**Mary Lou and Ward Whaling**

Louis B. and Martha B. Slichter Endowed Chair in Geosciences

# Donor Recognition

Vassilis Angelopoulos and  
Mary Christianakis  
Jonathan Aurnou and Sarah Kremen  
Hilda Avanesian  
Steven and Marilyn Bachman  
Shirley Baher  
Jessica Ban  
Jeremy and Caroline Boyce  
Gary and Nancy Beverage  
Bruce Bilodeau and  
Deborah Wechsler  
Michael Binder and Sheila Etzkorn  
Charles and Rose Blount  
Wendy Bohrson  
Darcy Bondurant  
Penelope Borax and John Donald  
Matthew Bourke  
Phillip Brack  
Jack Brostrom  
Dwight and Gabriele Carey  
Vallabh Chauhan  
Lucy Chen  
Mark Ching  
Mason Chuang  
Xenophon and Mila Colazas  
Patricia Colville  
John Connor  
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Joseph and Leah Fontaine  
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H. Douglas Garbin  
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Clarence Hall and Lauri Holbrook  
Tod and Babette Harding  
Michael Hartinger  
Kelly Havens  
Robert Hindle  
Robert Hollingsworth  
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Gregory Jesmok  
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Gordon Jones  
Kenneth and Shauna Kelsch  
Margaret Kivelson  
Charles and Carolyn Knobler  
Jeffrey and Diane Knott  
Philip Koch and Faith Curtin  
Candace Kohl  
Eddie and Joy Kwong  
Patrick Lam  
Guan Le and Zhi Wang  
Rhonda and Keith Lee  
Larry Lesyna  
Laraine Lietz-Lucas  
Timothy and Beth Lincoln  
Juhn and Hsiu-Yin Liou  
Steven Lipshie  
Kenneth and Carina Lister  
Karen Loomis  
Jean-Luc Margot and Sabina Jacobs  
Emmanuel Masongsong  
Chris Mattinson  
Kevin and Grace McKeegan  
Robert Meade  
Paul Merifield  
John and Helen Meyers  
David and Suzanne Michels  
Toby and Monica Moore  
Randolph and Renata Mulder  
Steve and Cindy Myers  
Nathan Myhrvold and  
Rosemarie Havranek  
Joseph Nahama and  
Beth Mensing-Nahama

Bill Neill and Kathryn Albright  
James Odlum  
A. Thomas Ovenshine  
Gilles Peltzer  
Steven Persh and Jennifer Newbury  
Edward Pittman  
Joseph Polovina  
James Powers and Abby Kavner  
Nguyen Quan and Briande O'Hara  
Frank Ramos  
Shannon Reese  
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Robert and Susan Rich  
Marcelle Richardson-Dicker and  
Brian Dicker  
Judith and James Roach  
Alexander and Jane Robinson  
Brian and Lisa Rohrback  
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Dean Runyan and Elizabeth Evans  
Sandra Rush  
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