UCLA

Earth, Planetary, and Space Sciences

2020-2021 Newsletter

Greetings from the Chair

Welcome to our annual newsletter for the Department of Earth, Planetary, and Space Sciences. In this issue we share some interesting events and highlights from the 2019-2020 academic year.

For much of that time EPSS was grappling with the COVID-19 pandemic, along with the rest of the world. As the positive cases rose in March 2020, the UCLA campus shut down (except for certain essential activities) and remained closed to general use through Summer 2021. The shutdown began just as Winter term classes were starting finals, and students, instructors, and teaching assistants scrambled to transition quickly to virtual exams, and to put the Spring 2020 courses online. Thanks to an intense collective effort, EPSS has been able to continue our educational mission safely throughout the pandemic. All the same, we are very glad to be returning to on-campus classes and research, and especially to once again venture into the field.

Even though the UCLA campus remained closed, research continued through both remote work and essential on-site activities. Investigators adapted and persevered through the ups and downs of the pandemic, delaying field work and laboratory measurements while focusing on remotely collected or archived data, or theoretical analyses. One essential research activity that did proceed, through both on-site and virtual effort, was the design and construction of magnetometers for the upcoming Europa Clipper mission to Jupiter's icy moon (page 16). As I write this letter in 2021, four UCLA-built magnetometer sensors were just delivered to the Jet Propulsion Laboratory in Pasadena for testing, before an expected launch date in 2024.

Several stories in this newsletter highlight field work in EPSS done before and during the pandemic shutdown, including reports of class trips to the Grand Canyon in Arizona (page 2) and Rainbow Basin, in the California Mojave region (page 9), as well as an oceanographic expedition in the nearby Santa Barbara basin (page 3). Earlier oceanographic research on the history and consequences of poorly regulated dumping of pesticides and their by-products remains relevant today (page 7). The 2020 virtual summer field camp is also featured (page 11), along with the virtual Exploring Your Universe outreach event (page 17).

EPSS researchers have not paused in their work to better understand our planet and solar system. This issue highlights new measurements of the rotation of our sister planet, Venus (page 5), and improved techniques for distinguishing possible radio signatures of intelligent civilizations on other worlds (page 8). This edition also features several interviews with EPSS students and staff (pages 12-15), and the story of an award-winning collaborative film project on the northern lights (page 6).

Throughout the past year, our commitments to research, teaching, and outreach have had to bend and adapt to a global crisis. We continue to be grateful for the support of our friends and alumni, and hope to be able to welcome you at upcoming events at UCLA in the not-too-distant future.

Warm regards,

Edwin Schauble

IN THIS ISSUE

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Front Cover
Zoomin' Poleta (page 11)
Photo credits: Alexa Terrazas and An Yin

Back Cover
Ceiling Tile
Photo credit: Helen Carter

Sedimentology Along the "Trail of Time"

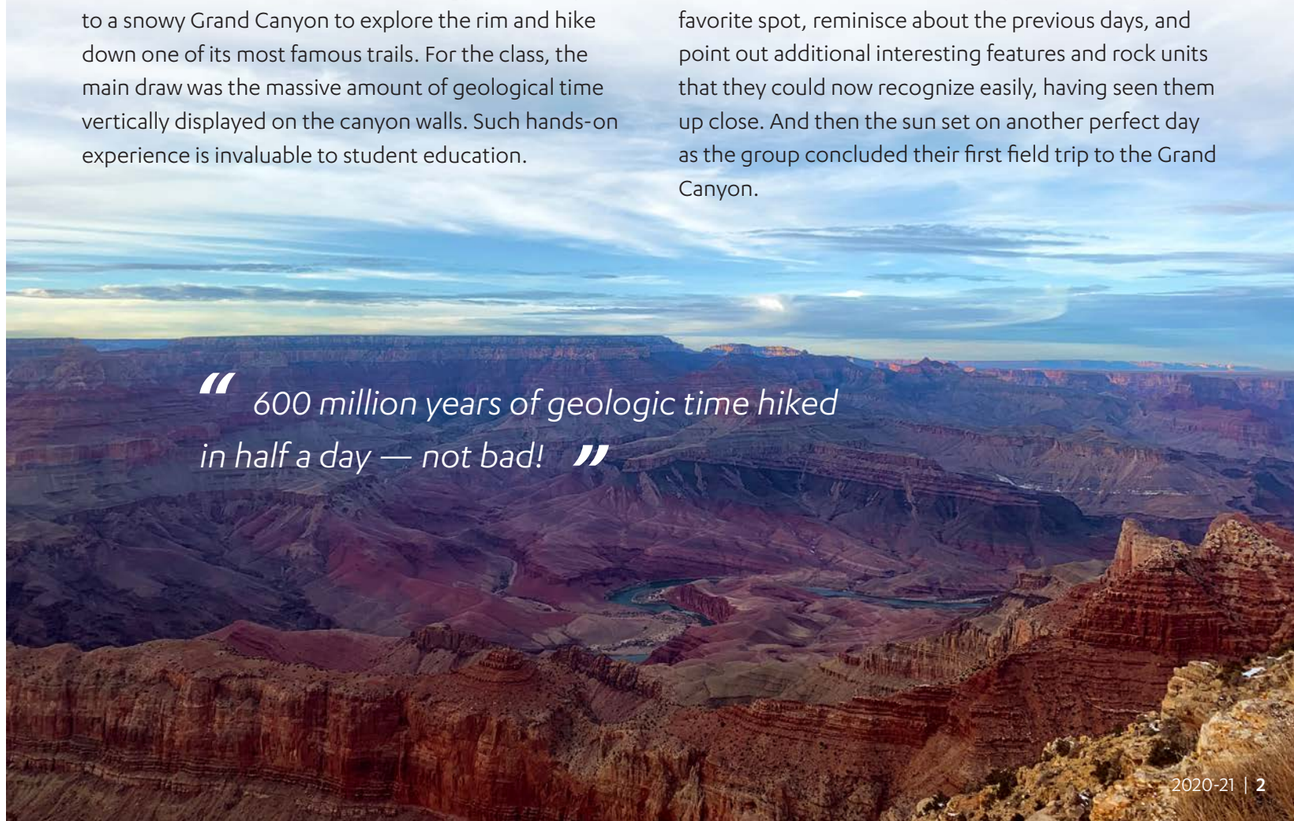
By Taylor Dorn

America's earliest national parks were established mainly to preserve geological formations, but initially not with a goal of scientific preservation. Rather, these areas were set aside to protect the geologic features that made them so visually stunning. From the geysers in Yellowstone to the granite cliffs of Yosemite, and the red, orange, and white hoodoos in Bryce Canyon, each park represents a unique geology that continues to draw large numbers of visitors. While all the national parks have beautiful views, there is no better place to learn geology than at Grand Canyon National Park.

Examining hand samples in the lab is standard for EPSS classes; however, student field trips allow students to see rocks in-situ and observe the layers as they were originally deposited. In January 2020, students in EPS SCI 143 (Advanced Sedimentology) took a trip to a snowy Grand Canyon to explore the rim and hike down one of its most famous trails. For the class, the main draw was the massive amount of geological time vertically displayed on the canyon walls. Such hands-on experience is invaluable to student education.

The trip centered around students choosing a topic associated with the park, such as the geologic history of a specific rock unit, the effect of humans throughout the park's history, or the magnitude of time visible on the canyon walls. One presentation took place on the "Trail of Time," a nearly three-mile walk along the rim, where each meter represents a million years of Grand Canyon geologic history. The following day included a hike down the Bright Angel Trail to the Indian Garden campground (and all the way back up, unfortunately!). Many students continued on to Plateau Point, where they glimpsed a stunning view of the Colorado River and thousands of feet of strata. 600 million years of geologic time hiked in half a day—not bad!

Secluded Navajo Point, located forty minutes east of Grand Canyon Village, served as the final stop. Students took some time at this viewpoint to identify their favorite spot, reminisce about the previous days, and point out additional interesting features and rock units that they could now recognize easily, having seen them up close. And then the sun set on another perfect day as the group concluded their first field trip to the Grand Canyon.



"600 million years of geologic time hiked in half a day — not bad!"

Seafloor Expedition in the Santa Barbara Basin

By Tina Treude, David (DJ) Yousavich and De'Marcus Robinson

Left to Right: *De'Marcus Robinson, David (DJ) Yousavich, Felix Janssen (AWI), Tina Treude, Sebastian Krause, and Frank Wenzhoefer (AWI)*

Oceanography on the R/V Atlantis

Deep below the waves, at the bottom of the world's oceans, there exists a mysterious and elusive world. It is an ecosystem in and of itself, with organisms thriving at near-freezing temperatures, and withstanding pressure that could crush a human. While these benthic (i.e., on or near the seafloor) ecosystems are critical to the chemistry and biology of the oceans, few people have ever seen them. They are populated by microbes of the deep.

In the fall of 2019, Professor Tina Treude and her lab embarked on a 14-day research expedition on the R/V Atlantis, a world-class research vessel, to investigate how seasonal deoxygenation and benthic microbes alter the chemistry of the seafloor and water column in the Santa Barbara Basin.

Located between mainland California and The Channel Islands, this oceanic basin is home to a naturally occurring oxygen minimum zone. In the absence of oxygen, microbial life must utilize other molecules as electron acceptors in order to "breathe." The microbes exhaust a predictable cascade of electron acceptors (nitrate, manganese, iron, sulfate, CO_2) based on how much energy they can derive. These more "exotic" electron acceptors become a hot commodity in oxygen minimum zones, and their consumption by microbes can have a huge impact on the benthic geochemistry (and therefore early sediment diagenesis). As oxygen minimum zones spread in the world's oceans, it is imperative for us to understand how these anoxic waters and the microbes that thrive in them are modulating the environment.

Along with Prof. Treude, the UCLA research team included graduate students Sebastian Krause, De'Marcus Robinson, and David Yousavich. They were joined by scientists from UC Santa Barbara (UCSB) and the Alfred Wegener Institute (AWI) in Germany.

Together, they studied the microbes living in the Santa Barbara basin. The joint science team's main objective was to investigate whether benthic microbes could be inducing or spreading the anoxic conditions. The primary suspects are filamentous sulfur-oxidizing bacteria that form dense microbial mats on the seafloor (below). These bacteria specialize in "breathing" oxygen and nitrate as well as "eating" sulfide and carbon dioxide instead of organic matter.

Above*: Pushcores inserted by ROV Jason into a microbial mat for analysis of geochemical parameters and microbial community composition.*

To study these sulfur-oxidizing bacteria, the research team took sediment samples and conducted experiments along a transect that went through areas both with and without microbial mats. Sediment cores were taken with the aid of the remote operated vehicle (ROV) Jason (bottom image). These cores were processed on board to study sediment porewater geochemistry and molecular biology. Some were injected with radioactive material to determine metabolic rates. In addition, the fluxes of metabolically relevant solutes into (e.g., oxygen, nitrate) and out of (e.g., ammonium and sulfide) the sediment were studied with benthic chambers and microprofilers that were deployed on the seafloor by the ROV. Photographic mapping and 3D oxygen surveys of the basin were done with the autonomous underwater vehicle (AUV) Sentry.

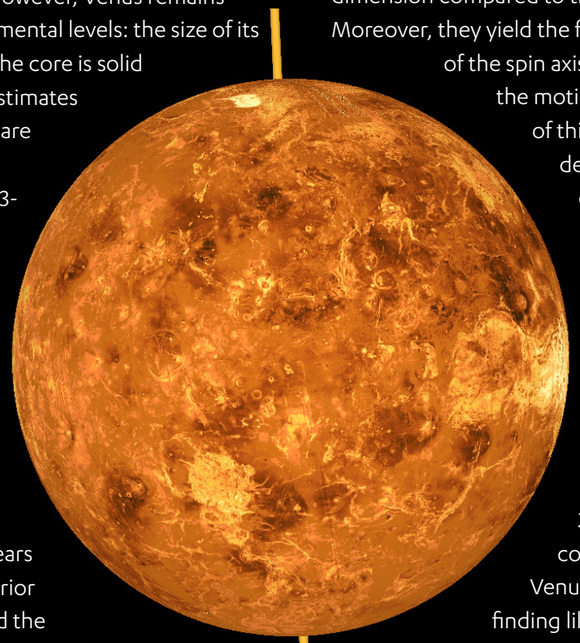
The NSF-funded research expedition was one of two planned expeditions in the Santa Barbara Basin to better understand seasonal deoxygenation patterns.

Below*: ROV Jason deployment into the ocean to study and sample the seafloor of the Santa Barbara Basin. Krause, Frank Wenzhoefer (AWI)*

High-Precision Radar Observations Probe the Interior and Atmosphere of Venus

By Jean-Luc Margot

Venus is Earth's nearest planetary neighbor and closest analog in the Solar System in terms of mass, radius, and density. However, Venus remains enigmatic on several fundamental levels: the size of its core is unknown; whether the core is solid or liquid is uncertain; and estimates of its average length of day are discordant. Venus also is distinctive because of its 243-day retrograde rotation and four-day atmospheric super rotation, 60 times faster than the solid body, which is not fully understood.



Our team of researchers has used an innovative radar technique and observations spanning 15 years to characterize Venus's interior structure, length of day, and the astonishing influence of the atmosphere on the length of day. To use an imperfect analogy, we treat Venus as a giant disco ball, illuminate it with a flashlight 100,000 times more powerful than yours, and watch the reflections as they sweep over the surface of the Earth. In reality, we transmit a radio wave at 3.5 cm (1 in) wavelength from the 70 m Goldstone Solar System Radar in California, and we record the radar echoes at Goldstone and the 100 m Green Bank Telescope in West Virginia. Because the echoes are tied to the rotation of Venus, the time that it takes for the radar pattern to travel from Goldstone to Green Bank (about 20 seconds) provides a direct measurement of Venus's length of day. In addition, the precise time of day at which the patterns at Goldstone and Green Bank resemble one another is determined by the orientation of Venus's spin axis.

The observations improve the knowledge of the spin axis orientation by a factor of approximately 10 in each dimension compared to the current best estimates. Moreover, they yield the first estimate of the motion of the spin axis in space, which is similar to the motion of a spinning top. The rate of this so-called spin precession depends directly on the distribution of mass inside the planet. Our observations suggest that the core size of Venus is approximately 3500 km (2200 mi), very similar to Earth's.

We found that the length of day (LOD) on Venus exhibits variations of at least 20 minutes, a remarkable consequence of changes in Venus's massive atmosphere. This finding likely explains why previous estimates of the average LOD on Venus were discordant, and highlights a potential problem for future landed missions: the uncertainty in the inertial position of the intended landing area could grow by 3 km (2 mi) between launch and landing, simply as a result of LOD variations.

Our observations also revealed a tentative periodicity corresponding to the length of the solar day, which points to a possible explanation for the LOD variations. Mountain ranges near the equator disrupt atmospheric flow, and the resulting mountain torques may explain the transfer of momentum between the atmosphere and the solid planet. Such torques have been previously modeled by former EPSS postdoc Thomas Navarro and EPSS professor emeritus Gerald Schubert.

EPSS Science Supports Film Fellowship Winner

By Emmanuel Masongsong

> *"The northern lights are a scientific and spiritual anomaly that have enraptured people all over the world for thousands of years"*

Congratulations to UCLA Theater, Film and Television MFA student Marian Whitaker, winner of a Sloan Foundation Fellowship for her "Northern Lights" action-adventure screenplay. Working closely with EPSS Space Physics Professor Vassilis Angelopoulos to ensure technical accuracy, Marian was selected as one of six finalists in a competition to promote the interplay of cinema and science. She received a $15,000 award to support her education and further develop the film.

Based loosely on her real-life experiences as a camp counselor in Alaska, Marian tells the story of an ambitious young Native American space researcher trapped in the role of a glorified babysitter. While studying the northern lights, she tries to teach kids about space science, although she secretly yearns to escape her remote Alaskan village and work for NASA. One night, while she is on a field trip deep in the forest, disaster strikes and she finds herself on an unexpected adventure with an auspicious, glowing aurora overhead.

"The northern lights are a scientific and spiritual anomaly that have enraptured people all over the world for thousands of years," Marian explained. "So I decided to explore its mysteries and phenomena through space weather science."

Her narrative is timely as society becomes ever more dependent on satellite technology such as GPS, weather and communications, with more people venturing into space – and soon to the Moon, or even Mars. Space is still very hazardous due to eruptions of solar flares that can spew intense radiation.

"By studying spacecraft observations and computer simulations, we are working toward one day predicting space weather just like we do for weather on Earth," said Prof. Angelopoulos. "From the ground, geomagnetic storms are witnessed as the mesmerizing auroral lights, but they also can manifest as temporary power and communications blackouts."

Hopefully, the "Northern Lights" movie will proceed to final production so more people can learn about the exciting science behind auroras and their impact on society and our daily lives.

DDTs in Southern California Ocean

By M. Indira Venkatesan

In the late 1970s, the Santa Monica and San Pedro basins were investigated to identify marine and terrestrially derived organic compounds and their long-range transport processes. Anomalous amounts of DDTs (dichloro-diphenyl-trichloroethane, developed in the 1940s as the first of modern synthetic insecticides) were found in the sediments of deep waters (> 800 meters). From 1960 through the 1970s, as dated by Pb-210 chronology, maximum levels of DDT were found in core sections. Sediment cores collected in the 1980s yielded a similar pattern of subsurface maximum DDTs. Near one dumpsite, an otter trawl collected petroleum tar cake that was found to be loaded with DDTs, along with petroleum hydrocarbons.

Extraction of organic compounds from sediments. ***Photo Credit:*** **Joo-Yeul Baek**

The Montrose Chemical Company (Torrance, CA) produced DDTs from 1940 to 1970. Domestic use of DDTs was banned in 1970, but production for export continued until 1982. In 1977, the manufacturing of PCBs (polychlorinated biphenyls) was banned. Caustic waste from DDT and PCB production was discharged through sewage outfalls, while acid and petroleum refinery wastes were allowed to be dumped in deeper basins. Nearshore sediments exhibited DDTs and PCBs profiles generally akin to the outfalls discharge. By contrast, in the deep basin sediments and tar cake, the 1) anomalously high levels of DDTs; 2) ratios of metabolites (i.e., DDT degradation products); and 3) detection of small/negligible PCBs amounts in 1960 and 1970 suggested a unique source of DDTs, one that did not originate from the outfalls.

If DDTs were only transported from sewage outfalls by long range transport, the deep-water sediments should have a ratio of DDTs to PCBs similar to the effluents, since both classes of compounds are not easily biodegradable. Therefore, we concluded that DDTs in deeper basin sediments and tar cake must originate from acid wastes leaking from corroded drums buried in the designated dumpsites. County records show that waste barrel drums were often pierced to make them sink to the ocean floor. This corroborates the findings of high levels of DDTs (over and above the bioturbation effects) in the sediment sections dating to the 1960s and 1970s, during maximum production (Venkatesan, 1998; Venkatesan et al., 1980, 1996). It was not known where, and how many of, these drums were buried. Also, some nearshore sediments received significant input of acid wastes, either from a deeper dumpsite by sediment transport, or the wastes had been 'short-dumped' nearby for economic benefits.

Recently, UC Berkeley researchers (Kivenson, et al., 2019) used underwater deep-sea robot cameras between the Santa Monica and San Pedro basins to discover punctured waste barrels strewn all over the ocean floor. According to the LA Times review of historic records, an estimated nearly half a million drum barrels could still be in the ocean floor. These findings confirm our earlier conclusions that high levels of DDTs in our deep sea and nearshore sediment originated from the wastes dumped.

More details of the UCLA, UCB and other, related studies on the toxic wastes in the SoCal oceans and their disposal can be found in the Los Angeles Times article from Oct 25, 2020: https://www.latimes.com/projects/la-coast-ddt-dumping-ground/

UCLA SETI Group Awarded NASA Grant to Search for Technosignatures

By Jean-Luc Margot

In a welcome turning point, NASA has ended a decades-long funding drought for the search for extraterrestrial intelligence (SETI). NASA funding for SETI dried up in 1993, when Congress terminated NASA's nascent SETI program. But the agency changed course and recently awarded a three-year grant to the UCLA SETI Group to search for the presence of civilizations around 100 newly discovered exoplanets.

Estimates of the number of habitable worlds in the Galaxy vary. Based on observations with NASA's Kepler telescope, researchers place the number between 300 million and 10 billion. The profusion of planets, coupled with the abundance of life's building blocks in the universe, suggests that life itself may be abundant and that other civilizations may exist.

With Mars 2020, Europa Clipper, and the James Webb Space Telescope, tens of billions of federal dollars are being invested in the search for biological activity on other worlds, so-called biosignatures. In contrast, there has been relatively little investment in the search for technosignatures, which provide evidence of technological activity. The UCLA SETI Group has focused on searching for radio emissions from other civilizations, which are detectable thousands of light years away. The volume of the Galaxy that can be sampled with a radio search for technosignatures is millions of times larger than the relatively small, local bubble conducive to the search for biosignatures.

The NASA grant will expand the UCLA SETI Group's ongoing search, which currently targets exoplanets discovered by NASA's TESS mission. Since 2016, EPSS has offered an annual SETI course in which students use the largest fully steerable telescope on Earth, the NSF's Green Bank Telescope, to collect terabytes of data and search for technosignatures. In the process, students learn valuable skills, such as collaborative software development, signal processing, and analysis of big data sets. The UCLA SETI Group has trained nearly 100 students so far. Because the students take an active role in algorithm development and data analysis, they are listed as co-authors of the group's publications, with three articles published in the Astronomical Journal.

Read more about the UCLA SETI Group at https://seti.ucla.edu

"We have developed some really powerful algorithms," said UCLA graduate student Paul Pinchuk, noting that the number of signals detected by the UCLA program in a given frequency range surpasses those of other recent searches by a factor of 200. "I am thrilled that NASA will provide funding for students like me," he said. The NASA grant will primarily support the cost of a graduate student and will not cover rental costs for NSF's telescope. The UCLA SETI Group has relied on the generosity of private donors to cover telescope expenses.

In 2020, the Queen's Road Foundation, chaired by EPSS Board of Advisors member Fritz Demopoulos, donated $50,000 to support the UCLA SETI Group. Dr. Jean-Luc Margot and everyone at EPSS are tremendously excited and grateful for Fritz's generosity, which ensures that we can continue our work on expanding the search and making the search accessible to many students.

Exploring Rainbow Basin: Our First Experiences in Geologic Mapping

By Kevin Coffey, Chris Lambert and Arthur Lo

For many EPSS undergraduates, EPS SCI 61 is the first immersive, overnight field experience and introduction to geologic mapping, an essential skill for all geoscientists. In Fall quarter 2019, we spent two weekends mapping Rainbow Basin near Barstow, CA. We were incredibly fortunate to be led by the legendary instructor, Dr. Kevin Coffey, and his two teaching assistants, Andrew Parisi and Marina Argueta, who fostered an appreciation for geology in us all.

From the start, it was clear that serious learning was about to take place. Never one to squander an opportunity for teaching, Kevin regaled us with fascinating geology facts about the surrounding landscape as we drove north through the desert. His guided tour primed us for the task ahead and distracted us during the grueling seven-hour drive.

Early the next morning, we were awakened by an animated Kevin trumpeting geology puns: "I know it may be tuff, but don't take this moment for granite! It's time to rock and roll!" As we parked in the field area, Kevin kicked things off by blasting the Jurassic Park theme song from his truck speakers, while he scrambled up the nearest knoll and proclaimed, "Let's start mapping!"

There were moments of awkward, confused stumbling as we stared quizzically at the blank maps; despite our excitement, we had no idea where to begin. To our relief, Kevin, Andrew and Marina spent the morning patiently guiding us through the fundamentals of identifying mapping units, analyzing topography, and discerning folds and faults. Later, we would continue mapping in smaller groups. A wonderfully collaborative atmosphere permeated the class, with students eager to share discoveries and insights. Contacts and traces were repeatedly scribbled and erased on rapidly filling maps as tentative speculation gave way to spirited debate out in the field, in the car, or even around the campfire.

> *"Mapping is a challenging exercise in geologic interpretation, spatial thinking, and rugged tenacity."*

Mapping is a challenging exercise in geologic interpretation, spatial thinking, and rugged tenacity. Having been pampered by pristine textbook examples, we initially struggled to identify stratigraphic features. However, as we combed through the landscape and filled in the maps, we noticed connections between features and gradually puzzled out the geology of the area. We were particularly thrilled to find mudcrack casts, which were critical for determining stratigraphic direction. Trying to infer the subsurface from exposed contacts was a puzzling task, but we felt great satisfaction once we deduced that the main structure is a large, doubly-plunging syncline. We strove to be rigorous scientists and left few stones unturned as we proposed and tested hypotheses. This occasionally entailed adventurous climbs up steep terrain to gain better vantage points. Despite shaky legs, and a close call involving an open map board and a particularly strong gust of wind, our efforts were rewarded with a shared feeling of fulfillment and a newfound sense of togetherness as we motivated one another to go the (literal) extra mile to learn.

Support EPSS field trips!
https://epss.ucla.edu/giving

Top: *Class photo of EPS SCI 61, Fall 2019;* ***Bottom left:*** *Kevin Coffey standing atop one of the peaks overlooking the study area with the rest of the class making their way to the summit;* ***Bottom right:*** *Students posing next to exposed outcrop.*

When we look back at those colorfully detailed maps, we inevitably smile as we recall the meaningful learning, blossoming friendships, and marvelous stories shared during our excursion to Rainbow Basin. For many of us graduating during pandemic times, this experience was the only geologic mapping actually completed in the field. EPS SCI 61 will forever remain in our memory as a truly transformative and impactful experience.

Zoom in' Through the Poleta Folds

By Alexa Terrazas

Our 2020 Summer Field Camp class started in an unprecedented manner – through a computer screen. We, the undergraduate students in EPS SCI 121F, had been eagerly anticipating a monthlong mapping and camping experience in the White-Inyo Mountains, long a UCLA EPSS tradition. However, due to the ongoing COVID-19 campus closure and pandemic-related health and safety regulations, Professor An Yin, and our two TAs, Valeria Jaramillo and Abijah Simon, were tasked with redesigning the mapping field course from in-person to remote. At first, the news was disappointing but we recognized it as the best way to keep everyone safe so we determined to find a silver lining during this unusual time of social distancing.

On the first day of class, we rolled out of bed, poured ourselves a cup of coffee, and logged onto Zoom, eager to get to work. Lectures were scheduled from 9 am to 12 noon. During this time, we used Google Earth to familiarize ourselves with our field area, the Poleta Folds. From an aerial view, we could identify geological features such as fault offsets, folds, and possible contacts that we would not have been able to recognize easily on foot. Special guest appearances were made by our furry friends: Hazel, the black cat, Luna, the golden retriever, and Cora, the foster kitten.

Outside of class, we spent countless hours on Zoom calls with our mapping groups, plotting the eight Poleta Formation units, pondering the complicated formation history of the area, and bonding during game nights.

Once a week, An organized "field trips" to other planets and moons in our solar system that exhibit complex geology, such as Mars, Pluto, and Europa. We looked forward to these remote trips as exciting to apply our knowledge of Earth processes to other rocky and icy bodies.

"Once a week, An organized "field trips" to other planets and moons..."

Weekly, we formally presented our findings and reflected on each other's interpretations, and then focused heavily on scientific writing by communicating our results in a comprehensive final report. An joked that this project would challenge us to "use our brain" (it did); we were required to be imaginative, critical, and systematic.

Even though our summer field camp experience was not what we had expected, the online format helped improve our communication and writing skills, which will be vital to our professional development as aspiring geoscientists. We also learned how to use industry standard programs, such as Adobe Illustrator and Photoshop, to create visually appealing and logically sound maps and cross sections.

Ultimately, the remote learning experience taught us to never take for granted the field trips that we enjoyed in previous years. It also taught us to take advantage of every learning opportunity that presents itself. Nevertheless, we also intend to actually visit the Poleta Folds field area in the near future, to appreciate the geology in person and to compare our findings.

Selected Interviews

Ariel Graykowski

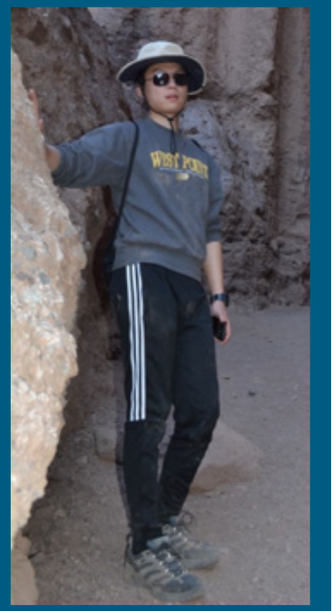
This year, graduate student Ariel has been keeping busy and adapting to a new workflow.

As an undergraduate student, Ariel studied physics and astrophysics. Since then, she has discovered a passion for planetary science: an interdisciplinary field involving astronomy, physics, and geology. Ariel currently studies observational astronomy of the Solar System, also known as Planetary Astronomy, and works with Professor David Jewitt "researching comets and other small bodies in the Solar System."

During the early months of the pandemic, Ariel developed some new hobbies including plant collecting, making little Pokémon figurines with polymer clay, and fish keeping with fellow EPSS graduate student, Tyler Powell.

Ariel has found that exploring unexpected pathways can be the most rewarding. Her primary life advice is to "be opportunistic," a trait she credits to helping her get into grad school. "Just because you're a physics major, don't be afraid to take an opportunity in the geology department," Ariel advised. If there is an opportunity that sounds interesting, take it.

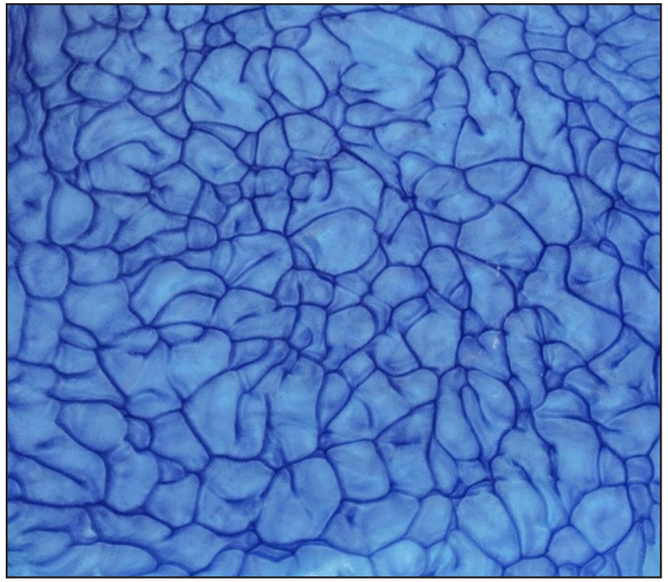
Currently, Ariel is exploring different paths for her own future, including academia, university postdocs, national labs, and industry. She is looking for just the right fit, which her advisor has encouraged. She enjoys being where cutting-edge science is taking place, like in EPSS, and will carry that value into her search for future opportunities. Ariel hopes to defend her thesis and graduate soon and, until then, she is happily conducting research to finish.



Yufan Xu

Yufan Xu learned experimental and lab skills as an undergraduate in a cross-curricular program studying Applied Math, Engineering, and Physics at the University of Madison, Wisconsin. He came to UCLA in 2017 to pursue a PhD and study assimilated fluid dynamics in the SpinLab of Professor Jon Aurnou. As an international student, Yufan stayed in L.A. during the pandemic and has kept in contact with his family through video chat. During the long days at home, he has kept things interesting by focusing on writing and exploring new hobbies, such as hiking, playing guitar, and pottery.

He also has spent many hours writing a research paper. Initially, he was interested in heat transfer and dynamical behaviors inside of a liquid metal; however, based on modelling, he developed a theory about a new processional wave, which has potential applications in explaining geophysical phenomena at near-mantle boundaries. Fortunately, since he had finished the lab experiments prior to the campus closure, he was able to take advantage of the quiet time at home to focus on writing. Yufan's paper was recently accepted for publication.

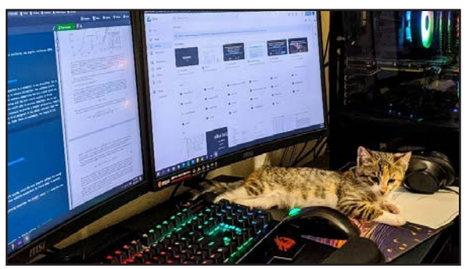


Xu's image "Gaia's Tessellation" was featured among the top 10 selections and showcases fluid dynamics.

During the shutdown, Yufan also submitted a photo from Exploring Your Universe (EYU) to the 2020 UCLA Science Libraries "Science is Art" Competition. His photo, "Gaia's Tessellation" (above), was featured among the top 10 selections and showcases fluid dynamics, as well as the innovation of the SpinLab (www.spinlab.ess.ucla.edu) group.

With rheoscopic fluid out of production due to the pandemic, the Spinlab team was able to replicate it by extracting rheoscopic particles (stearic acid crystals) from shaving cream. These particles form shiny flakes with the same density of water, making the internal structure of liquids visible. You can view all of the featured "Science is Art" artwork at www.intersectionsinscience.wordpress.com/gallery.

As VP of Event Planning for the EPSS Student Organization (EPSSSO), Yufan is especially grateful to his fellow graduate students for their support during the past year. EPSSSO transitioned from a largely in-person group to remote gatherings via the GatherTown platform. This allowed many existing traditions to continue while everyone has been working from home.



Grad school is challenging; it's great to have a support group, and creating a sense of community is what makes EPSS unique.

Yufan and his fiancée adopted a kitten, Nini, who has been a huge source of joy. Nini likes to sit on Yufan's computer keyboard, and once even managed to send Prof. Aurnou a Slack message of garbled text.

The pandemic has taught Yufan how to focus on himself and on those he loves, and to find a healthy work-life balance. Looking back on the many ups and downs, he hopes to appreciate the unique moments as good memories.

Taylor Lonner

Taylor Lonner, recent graduate of EPSS, has been up to some exiting scientific work. As an undergraduate, Taylor learned a lot in Professor Jon Aurnou's Advanced Matlab course, building things with Arduino's open-source electronic prototyping platform. From there, Prof. Aurnou suggested Taylor build a device as part of his lab.

Taylor has been hard at work using the UDV to map velocity fields on her device. The device is a rotating table, which is used to spin a large tank of water and simulate fluid outer core dynamics. It's been a year-long effort, with the complexities involved in building such a device, and with the unique requirements of safe, limited, on-campus research work. Taylor explained, "I get velocity fields from the UDV, temperature fields from the IR Camera at the top, and temperature profiles using a wireless Arduino system that I built." Working on-campus in safe isolation was a change from EPSS's collaborative lab environment. However, Taylor believed it was important to prioritize safety, and was grateful for the chance to conduct experimental research in the labs during this time.

Taylor has always been fascinated by every aspect of space – stars, planets, and everything in-between. Her piece of life advice is to follow your passions, even if there is no specific path to get to the end goal. If you are passionate about something and apply yourself, you will forge your own path and get where you want to be, eventually.

Morgan Carrington

Morgan Carrington, EPSS undergraduate student, learned to make the best of things while enduring the challenges of the COVID-19 pandemic. From fun moments like seeing bioluminescent waves at the beach to more serious tasks like learning a lot about sanitation to keep safe, 2020 has been a complicated year.

For Morgan, continuing her studies from home was difficult. Hands-on fieldwork courses typically are a large part of the third-year experience for Geology majors, something Morgan was eagerly looking forward to. During the pandemic, however, those courses were adapted substantially to fit the remote learning environment, creating a very different experience from what she had envisioned.

Just prior to the pandemic, Morgan was accepted as a Caltech WAVE Fellow. She excelled in this program as she discovered her passion for Planetary Geology. Morgan studied subduction in Astkhik Planum, Venus and learned a lot about space from the experience. Although she surprised herself, as she never expected to pursue this area of geology, Morgan explained that "everything is connected."

After Morgan finishes her undergraduate degree, she may go straight to graduate school. She firmly believes in the importance of maintaining a work-life balance, while pursuing multiple interests. Someday, she would like to work at JPL or be a professor at a university.

Rod O'Connor

When news of the impending COVID-19-related campus shutdown broke in March 2020, EPSS IT Director Rod O'Connor quickly realized that he must drop all current projects and figure out how to transition everyone to a remote work and learning environment. One of his biggest challenges involved setting up the staff, since many campus personnel/payroll, financial, etc. systems are designed to prevent sensitive data from leaving the institution. Suddenly, his new objective was to ensure that this information could be accessed (safely!) from off campus.

Actualizing such monumental changes required a lot of problem solving, and multiple steps, such as creating a new website, leveraging certain online resources, recording meetings and lectures, using digital document-sharing platforms, and increasing collaboration with IT teams across campus. Rod was fortunate to have help from fellow IT colleague, Anthony Sansone, who worked diligently to maintain normal functioning of administrative computers and provide individual support, as needed.

On the instruction side, the rapid transformation to remote learning promoted intense use of campus resources like CCLE (Common Collaboration and Learning Environment), more universal digital support for students, and standardization of various processes. Of necessity, some tools were adopted rapidly, such as DocuSign, Slack, Calendly, and digital document-sharing platforms.

In general, Rod was impressed with the department's ability to adapt to disruption while continuing to provide quality support to EPSS students, staff, faculty, and researchers. He notes the increased agility and flexibility of the department as an invaluable benefit, and becoming more comfortable with change as his own biggest takeaway. "No one likes the amount of change we've been forced to make, but some change has been positive."

MISSION COMPLETE

The EPSS Space Magnetometer Team Perseveres Through the Pandemic

By Robert Strangeway

Europa Clipper is the NASA flagship-class mission to explore Jupiter's moon Europa. This moon has an icy surface, and based on magnetic field observations from the Galileo spacecraft, there is evidence for a liquid water ocean under this surface. This leads to the intriguing question: can Europa support life?

In order to address this question, Europa Clipper is instrumented to determine the properties of the ice shell and liquid ocean. As Europa orbits Jupiter it passes through different magnetic fields associated with Jupiter's and Europa's orbital motion. This, in turn, generates induced magnetic fields whose characteristics depend on the ocean properties, such as depth and conductivity. These are important parameters to better assess the possibility of life on Europa.

In the late summer of 2021 the EPSS space magnetometer team delivered four fluxgate magnetometer sensors to be integrated with the Europa Clipper instrument suite. This was a combined effort with NASA's Jet Propulsion Laboratory (NASA/JPL), with NASA/JPL providing the electronics that work with the fluxgate sensors to measure the magnetic field at Europa. This successful delivery was no small feat given that production of the sensors was set to begin just as the COVID-19 pandemic shut most of the world down.

Building instruments for NASA missions is very much a hands-on process, but pandemic restrictions made that difficult. Managing lab activities while enforcing social distancing requirements created unprecedented hurdles involving everything from the need to duplicate and space out work stations to creating a special laundering facility for the delicate lab coats that were necessary to demagnetize anyone working on a component of the sensors.

UCLA/EPSS benefited from significant help from JPL, which provided technician and Quality Assurance support for the sensor build. These oversight activities would normally have taken place in person. However, due to the strict capacity and distancing restrictions throughout most of 2020 and early 2021, all this oversight had to be done remotely with painstaking photo documentation of every minute step in the production process.

Despite unpredictable and unfathomable challenges that required a high level of adaptability and perseverance, the EPSS group succeeded, and the four sensors were delivered to JPL.

Now, the UCLA team of scientists, engineers, and technicians are all looking forward to the Europa Clipper launch, planned for 2024, and its arrival at Jupiter in 2030.

Vicente Capistrano of the EPSS Space Magnetometer Team closes a shipping case containing one of the completed sensors.

EYU 2020: A "Virtual" Success

By Abijah Simon

How could we take the largest on-campus science outreach event at UCLA and turn it virtual? With hundreds of hands-on activities and science experiments, a planetarium, special science talks and an award ceremony, it seemed like it would be impossible to convert the bustling day of events at Exploring Your Universe (EYU) to a virtual format. But a group of graduate students from various UCLA departments came together on the organizing committee to tackle the challenges of continuing EYU's tradition of providing hands-on, accessible science education for all ages.

> *"...EYU's tradition of providing **hands-on science education** for all"*

On November 1, 2020 at 12pm, the event kicked off with an award ceremony and exciting presentation about black holes by Dr. Andrea Ghez, recipient of the 2020 Nobel Prize in Physics. On the virtual main stage, live science talks for all ages such as "Why is Antarctica melting?" (Jordyn Moscoso, EPSS, and Ken Zhao, AOS) and "Unrolling the History of the Earth" (Andrew Parisi, EPSS), followed by questions from the audience, continued until 5pm. **Hundreds of volunteers helped out in the 43 virtual science booths** that were divided into virtual demos, DIY science experiments, and a virtual planetarium. Dr. Ghez showed up again to volunteer in the Galactic Center's virtual demo booth, while other demo booths such as "The Wonder of Minerals" displayed various minerals and the growth of rock candy.

Before the event, we posted a list of basic home supplies for participants to gather for the interactive booths, but we were unsure how many people would actually be prepared with the items ahead of time. We were thrilled when hundreds of children and families showed up with cornstarch, food coloring, and other supplies to follow along with the volunteers and conduct science experiments in their own homes.

As a surprise addition to the event, made possible by the virtual platform, we even added Q&A rooms where expert scientists answered live questions about everything from Earth's Interior to COVID-19. The hands-on engagement and live interaction throughout the event captured the attention of even those who had been experiencing Zoom fatigue throughout the week.

In fact, data after the event showed that the average user time spent at the event was over two hours! While nobody knew what to expect for the virtual version of Exploring Your Universe, a turnout of thousands of engaged participants from all over the world surpassed our expectations of what would be possible for this year's event. While we hope to return to an in-person experience after the pandemic, we have learned a lot from this experience and will incorporate the lessons learned into future years of EYU. Thank you to the hardworking graduate student organizing committe, our volunteers and speakers, and generous donors who made this event possible.

Trash-cano: Volcanic Eruption in a Bin

EYU Volunteer Christina demonstrates how volcanoes erupt while a participant follows along

LAUNCHing into STEM

An aspiring astronaut builds straw rockets

Chemistry in the Kitchen

Getting messy mixing cornstarch/water

SPIN Lab

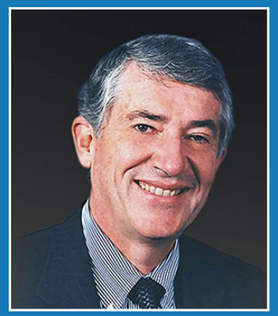
Surface tension in milk

EYU Organizing Committee members gathered together with award recipient and keystone speaker Dr. Andrea Ghez.

***Recordings** of science talks and booths can be found at www.ExploringYourUniverse.org*

EXPLORING YOUR UNIVERSE AT UCLA

In Memoriam



Paul Coleman

1932-2019

Paul Coleman, 87, pioneer of space exploration and developer of space physics

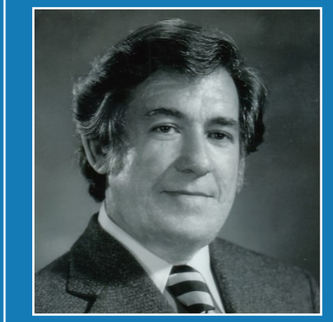
Paul Coleman, Professor Emeritus in Earth, Planetary, and Space Sciences, passed away on April 6, 2019 in Los Angeles, following a distinguished career in geophysics and space physics. He was 87.

In 1966, Paul Coleman earned a Ph.D. in Space Physics from UCLA and soon joined the UCLA faculty, where his research laboratory was instrumental in developing space physics at UCLA. Professor Coleman's decades of research influenced NASA's Explorer satellites, the Pioneer series of deep-space probes, the Mariner series of planetary spacecraft, Apollo's 15 and 17, and Galileo.

NASA awarded Paul Coleman the Exceptional Scientific Achievement Medal twice, for exploration of the solar system (1972) and for exploration of the moon (1972). In 1985, Coleman was appointed to the National Commission on Space by President Reagan and, in 1991, Vice President Quayle appointed him to serve on the Vice President's Space Policy Advisory Board. Coleman also served as President and CEO of Universities Space Research Association (USRA), a nonprofit supporting space-related scientific research and technology development at universities.

Paul Coleman was extremely passionate about space exploration and making it as accessible as possible. He was hard-working, inspiring, passionate, humble, and good-natured, and made an incredible impact on all who knew him.

Adapted from LA Times (4/16/2019)



Orson Anderson

1924-2019

Orson Anderson, 94, distinguished mineral physicist and UCLA professor

Orson Anderson, longtime UCLA professor and distinguished mineral physicist, passed away in Salt Lake City, Utah on June 19, 2019. He was 94.

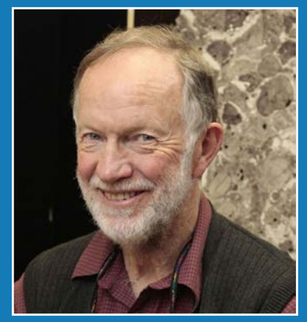
A pioneer in the field of mineral physics and acoustic measurements in solid materials, Orson Anderson and two postdoctoral research colleagues created the first laboratory of mineral physics in 1963.

Professor Anderson started at UCLA in 1971 and stayed until he retired in 2002. For more than three decades, he was a member of the Institute of Geophysics and Planetary Physics (IGPP) and the Department of Earth and Space Sciences (ESS). One of his significant achievements was the development of resonance ultrasound spectroscopy (RUS) that allowed for single-crystal adiabatic elastic moduli to be measured at high temperatures. Orson's research and analysis provided a lasting influence in the fields of physics and geophysics.

Over the course of his life, Orson Anderson made great contributions within the scientific community. He truly valued and enjoyed collaborating with fellow scientists around the world. In turn, he was a great source of inspiration and admiration to his colleagues.

Adapted from Eos (7/8/2020)

In Memoriam



John Wasson

1934-2019

John Wasson, 86, cosmochemist and co-creator of the UCLA Meteorite Collection

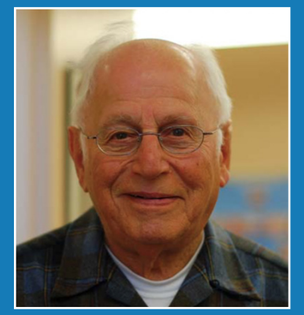
John Wasson, a world-renowned expert in meteorites and lunar rocks who had a mineral named after him, died at home in Los Angeles on September 7, 2019. He was 86.

A professor emeritus of Earth, Planetary, and Space Sciences, Wasson helped devise modern chemical classifications for the space debris that can fall to Earth as brief fireballs or "bolides" big enough to create an impact crater. He joined the UCLA faculty in 1964 and remained active on campus, cycling into his office every day, until recently.

Wasson co-created the UCLA Meteorite Collection, the largest collection on the West Coast. "While his passion for science, eloquence and warmth transformed many UCLA faculty and students into cosmochemistry enthusiasts, his dedication to the meteorite gallery helped tens of thousands of visitors gain a deeper appreciation for the secrets of the solar system," said Miguel García-Garibay, dean of the division of physical sciences. Celestial bodies may carry 'wassonite,' a rare titanium sulfide mineral that was named in honor of John T. Wasson.

Located in room 3697 of the Geology Building, UCLA's collection contains more than 2,500 samples from about 1,500 different meteorites.

Adapted from UCLA Newsroom (9/15/2020)



John Rosenfeld

1920-2020

John Rosenfeld, 100, fixture of mineralogy and petrology teaching and mentorship

John Rosenfeld, Emeritus Professor in UCLA's Department of Earth, Planetary, and Space Sciences, passed away in Santa Monica on August 15, 2020, shortly after his 100th birthday. John was a fixture of mineralogy and petrology teaching and mentorship at UCLA for most of its history, and after retirement remained a friendly and engaging presence in EPSS.

He received his Ph.D. from Harvard in 1954, and in 1957 joined what was then the UCLA Department of Geology, where he conducted in-depth petrologic studies of metamorphic rocks, focusing on terranes in New Hampshire and Vermont. John saw himself as a cross-disciplinary scientist - a field-based geologist first, but one who coupled field data with theory and laboratory observations. His tool of choice in the laboratory was the optical microscope and he was widely acknowledged as a superb microscopist.

Throughout his long career, John was always concerned and caring about students, staff and faculty colleagues, especially striving to improve communication and collegiality. In addition to sponsoring a weekly departmental tea and cookies event, he established the John L. and Juanita B. Rosenfeld Graduate Fellowship Fund in EPSS, saying, "It is gratifying that my gift will help UCLA graduate students for many generations to come."

Adapted from EPSS website (10/8/2020)

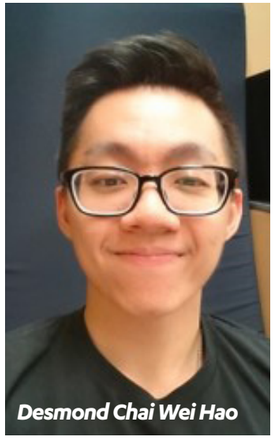
EPSS VIRTUAL COMMENCEMENT CELEBRATION

June 13th
2020

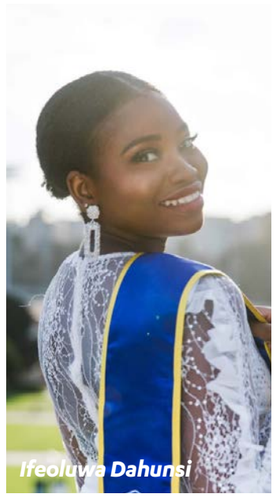
Complete list of graduates on pg. 22


Ellen Wright Alexander

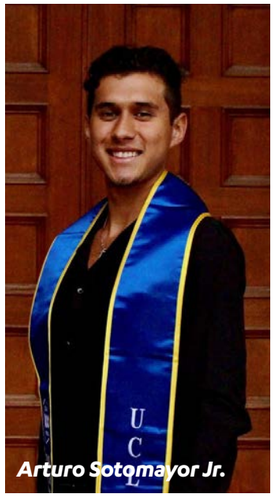

Emily Kate Hawkins


Desmond Chai Wei Hao

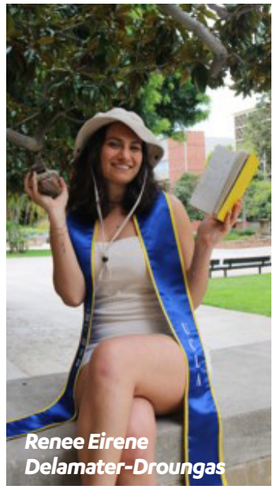

Sara Michelle Thornburgh


Ifeoluwa Dahunsi


Alexandra Rose Denny


Arturo Sotomayor Jr.


Michelle Elizabeth Carter


Renee Eirene Delamater-Droungas


Maria Vincent


Travis James Gilmore

Bachelor of Arts

Ursula Eunice Victorino Gomez

Jacob Alexander Hoffman

Bachelor of Science

Michelle Elizabeth Carter
Ifeoluwa Dahunsi
Renee Eirene Delamater-Droungas
Alexandra Rose Denny
Suzanna Gevorgyan
Travis James Gilmore
Julia Caitlin Gonzales
Beaux Fernando Guajardo
Desmond Wei Hao Chai Wei Hao
Shane Kenyon Houchin
Laura Maria Iglesias
Christian Duran Levine
Taylor Leigh Lonner
Eduardo Rodriguez Lemus
Arturo Sotomayor Jr.
Ivan Gregory Aquino Tadeja
Erick Edward Teck
Jacob Joseph Thomas Uphoff
Maria Vincent

Minors

Uriah Kishon Ikaika Blackwell
Mahala Dominique Herron-Butland
Andrew Knudson
Rebecca Anne Lewis
Sophie Ellen Taylor
Sara Michelle Thornburgh
Carolyn Wu

Master of Science

Han Bao
Xiyuan Bao
Sanjana Santosh Prabhu Desai
Akash Gupta
Leslie Insixiengmay
Yang Li
William Kennedy Misener
Tyler Powell
Yi Qi
Ashley Marie Schoenfeld
Kevin Shao
Robert Nguyen Ulrich
Yufan Xu
Yanan Yu

Doctor of Philosophy

Ellen Wright Alexander
Emily Kate Hawkins
Chen Shi

Undergraduate Awards

Eugene B. Waggoner Scholarship

Christian Duran Levine
Taylor Leigh Lonner

Dean Oberste-Lehn Research Award

Norma Angelica Contreras
Julia Gonzales
Alexis Light
Lorraine Nicholson
Venezia Ramirez
Valeria Villa
Jade Wight

Clarence A. Hall, Jr. Summer Field Award

Christopher Takahiro Lambert

Departmental Summer Field Award

Tony Li Tran

Dean Oberste-Lehn Summer Field Award

Claire Elizabeth Divola
Amanda Roeliza Guilalas Hunt
Alexis Light
Monica Eliza Mendoza
Siti Nabila Binti Mohd Nizam
Alexa Terrazas
Diana Jean Urda

John & Frances Handin Scholarship

Desmond Chai Wei Hao
Maria Vincent

Donald Carlisle Undergraduate Research Award

Siti Nabila Binti Mohd Nizam

J. Douglas and Patricia Traxler Research Scholarship Award

Beaux Guajardo
Shane Kenyon Houchin

Clem Nelson Summer Field Award

Eduardo Rodriguez Lemus

Kenneth D. Watson Summer Field Award

Abdullah Hasif Bin Mohd Lokman

Horodyski Summer Field Award

Ivan Gregory Aquino Tadeja

Graduate Awards

Eugene B. Waggoner Scholarship

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

Alexandra Doyle
Ashley Schoenfeld

Outstanding Teaching Award

Presented to graduate students to recognize outstanding performance in teaching

Tyler Horvath
Leslie Insixiengmay
Sebastian Krause
Will Misener
Simran Sangha
Yufan Xu

Constantine & Perina Panunzio Scholarship

Presented to graduate students on the basis of merit, endowed by alumnus Constantine & Perina Panunzio

Ariel Graykowski
Akash Gupta
Heather Kirkpatrick

Outreach Award

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

Tyler Powell
Francisco Spaulding-Astudillo
Ethan Tsai

FINESST Grant Recipients

Four EPSS graduate students were awarded highly competitive, three-year Future Investigators in NASA Earth and Space Science and Technology (FINESST) grants offered by NASA. This is one of the most prestigious NASA student awards offered to graduate students who are pursuing research that is aligned with the NASA Science Mission Directorate in one or more of the following areas: Earth sciences, heliophysics, planetary science and astrophysics.

Akash Gupta

PI: Hilke Schlichting
9/01/2020-8/31/2023
Investigating Planet Evolution under the Core-Powered Mass-Loss Mechanism at Longer Orbital Periods and Determining its Observable Signatures
Award #: 80NSSC20K1372

Andrew Parisi

PI: Mark Harrison
9/01/2020-8/31/2023
A Test of the Late Heavy Bombardment Hypothesis: Concordancy in Multiple Isotopic Systems
Award #: 80NSSC20K1394

Ethan Tsai

PI: Vassilis Angelopoulos
9/28/2020 - 9/27/2023
Miniaturized Search Coil Magnetometer for CubeSat-based Space Weather Investigations
Award #: 80NSSC20K1507

Colin Wilkins

PI: Vassilis Angelopoulos
10/01/2019 - 9/30/2022
Development of a Wide Energy Detector in CubeSat Form-Factor
Award #: 80NSSC19K1439

Donor Recognition

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, 2019 and June 30, 2020 are listed on the opposite page. Gifts made after June 30 will be acknowledged in the 2021-2022 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 endowments focused on equity, diversity, and inclusion between $100,000 and $1,000,000. Please contact Brooke Sanders (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

Vassilis Angelopoulos and Mary Christianakis
Marilyn and Steven Bachman
Jessica Ban and Jeff Peterson
Nancy and Gary Beverage
Tracy and Stuart Berge
Richard Bild and Karen Robinson
Bruce Bilodeau and Deborah Wechsler
Michael Binder and Sheila Etzkorn
Jolan and Gary Bostrup
Rose and Charles Blount
Penelope Borax and John Donald
Matthew R. Bourke
Geralyn and Jack Brostrom
Gabriele and Dwight Carey
Beth Carter and Michael Murphy
Lucy Chen
Mason Chuang
Mila and Xenophon Colazas
Patricia A. Colville
John C. Connor
Esther and William Cornell
Kathryn and Robert Crippen
Caroline and James Dawson
Robyn Dean and Ernesto Rodriguez
Andrew and Elizabeth De Sosa
Sharon Lander-Defibaugh and Stephen Defibaugh
Julie De Lilly and Stevan Dumas
Frederick Demopoulos
Marcelle and Brian Dicker
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Yona and Edward Shulaker
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Herbert Slavin
Lily S. K. Soley
Larisa Stephan and E. Scott Channell
Gary E. Strathearn
David Szumigala and E. Ellen Daley
Cornelia and Robert Talboy
Joyce Tang and Johnson Kin
Ashwin Vasavada
Margaret A. Veitch
Theodore A. Vierra Jr.
Susan Bell-Warner and Scott Warner
Gudrun and John Wasson
David K. Whitney
Christopher P. Wong
Sami Yanikian
An Yin and Sandy Tuan
Irwin Zim

UCLA College | Physical Sciences
Earth, Planetary & Space Sciences

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Los Angeles, CA 90095-1567

www.epss.ucla.edu

Some things never change...