PennState
College of Earth
and Mineral Sciences

Department of Geosciences

2024

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On the cover...

Polar Earth Observing Network monitoring station that collects GPS and seismic measurements to understand ice sheet behavior. Credit: POLENET

DEPARTMENT HEAD'S MESSAGE

Welcome to our annual magazine, which is one of the ways we share stories from our past year and reconnect with our alumni and friends. The department is quite healthy, with a steady or slightly growing enrollment. We continue to have about two hundred undergraduate students and roughly eighty graduate students in our various degree programs.

Our department and its programs continue to be highly ranked nationally and internationally. Research expenditures continue to demonstrate excellence, with most of the funding from the National Science Foundation (NSF), the National Aeronautics and Space Agency (NASA), and the Department of Energy (DOE). We are fortunate to be able to share these successes with our alumni and friends, who also support our efforts with generous support to our students and programs. Thank you for your continued support.

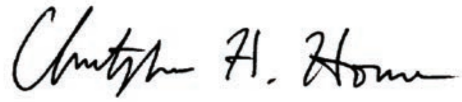
In this magazine, we welcome two new faculty members. Nicolas Choquette-Levy, who is joining our department this coming winter, and conducts research focused on using geoscience data to facilitate local governance frameworks for climate adaptation. Eric Kirby joins our department this coming summer as our next department head. Eric's research focuses on the interplay between climate, erosion, and tectonics during the growth and decay of mountain ranges.

This year, we celebrated the remarkable geochemistry career of Sue Brantley, who retired at the end of 2024. Over her career, she was a tremendous force in both research and teaching, positively impacting many of our students and publishing a numerous highly cited papers. One of our challenges as a department will be replacing the oversized impact Sue had on all of our work and how she elevated our department.

The past summer saw our first implementation of our new four-week field camp structure. The students had a great experience learning GIS and field mapping in Utah, Montana, and Wyoming. Ensuring such authentic, hand-on experiences is one of the areas for which our alumni support is most evident. Support from alumni and friends enhances these types of educational experiences and makes these experiences affordable to our students.

I am only an acting department head, slipping into this role for a year before Eric Kirby arrives. This year, I have gained new perspective on how special our department is. We have outstanding faculty and staff, excellent students, and supportive alumni and friends.

Sincerely,



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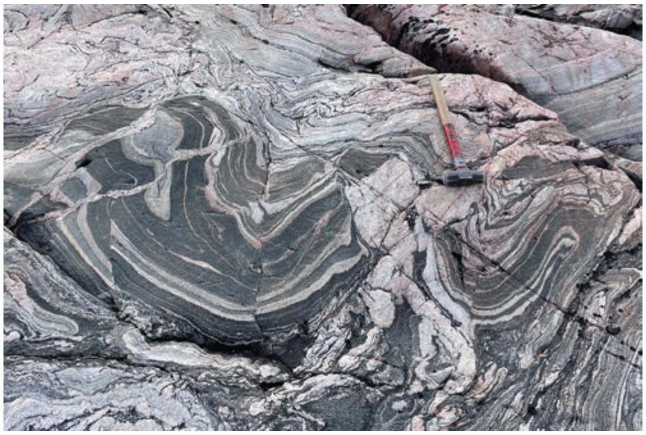


Rock steady: Study reveals new mechanism to explain how continents stabilized

Ancient, expansive tracts of continental crust called cratons have helped keep Earth's continents stable for billions of years, even as landmasses shift, mountains rise and oceans form. A new mechanism proposed by **Jesse Reimink**, Rudy L. Slingerland Early Career Professor, and **Andrew Smye,** associate professor of geosciences, may explain how the cratons formed some three billion years ago, an enduring question in the study of Earth's history.

"To make a planet like Earth you need to make continental crust, and you need to stabilize that crust," said Reimink. "Scientists have thought of these as the same thing—the continents became stable and then emerged above sea level. But what we are saying is that those processes are separate."

https://tinyurl.com/5bn9wb7k

New tool to help decision makers navigate possible futures of the Colorado River

The Colorado River is a vital source of water in the Western United States, providing drinking water for homes and irrigation for farms in seven states, but the basin is under increasing pressure from climate change and drought. A new computational tool developed by a research team, led by **Antonia Hadjimichael**, assistant professor of geosciences, can help decision-makers explore many plausible futures and identify consequential scenario storylines—or descriptions of what critical futures might look like—to help planners better address the uncertainties and impacts presented by climate change.

"Our scenario planning process recognizes that planning for the future comes with many uncertainties about climate and water needs. So, planners have to consider different possibilities, such as a high-warming or a low-warming scenario." https://tinyurl.com/46d874m6


Image: USGS


Image: Adobe Stock

Q&A: What fossils reveal about ancient Australian forests and fire

Australia's forest ecosystems, renowned for their extraordinary diversity of rare plants and animals, also play a vital role in mitigating climate change by absorbing and storing carbon. New fossil discoveries are reshaping the understanding of modern forest management practices. According to **Peter Wilf,** professor of geosciences, current methods, including prescribed burning, may be disrupting the integrity of Australian rainforests.

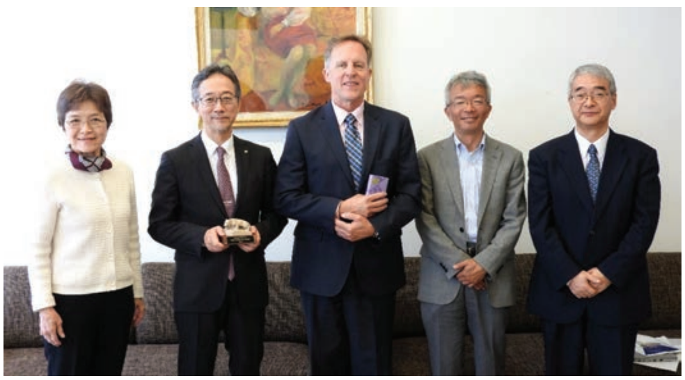
Read a Q&A by Wilf and Robert Kooyman, an honorary research fellow at Macquarie University, examining fossil evidence from across the Southern Hemisphere to better understand the history of these forests. https://tinyurl.com/yrm578p5

Rock permeability, microquakes link may be a boon for geothermal energy

Using machine learning, researchers at Penn State have tied low-magnitude microearthquakes to the permeability of subsurface rocks beneath the Earth, a discovery that could have implications for improving geothermal energy transfer.

"This suggests seismic monitoring could broadly be used to improve geothermal energy transfer efficiencies across a wide range of sites," said **Pengliang Yu**, postdoctoral scholar at Penn State and lead author of the study.

"Yu's work is part of our effort to advance geothermal exploration and geothermal energy production using machine learning methods, said co-author **Chris Marone**, professor of geosciences. "Our lab studies show clear connections between the evolution of elastic properties prior to lab earthquakes, and we are excited to see that similar relationships are observed in nature." https://tinyurl.com/57pxd5c3



Penn State, Tohoku University eye further research partnership activities

Lee Kump, the John Leone Dean in the College of Earth and Mineral Sciences, visited Japan's Tohoku University, to discuss numerous opportunists to expand engagement in research collaboration and education exchange with Penn State.

"Already one of the premier research universities in Japan, Tohoku is poised to take research excellence to the next level with a focus on international collaboration," said Kump.

Kevin Furlong, professor of geosciences, and **Takeshi Kakegawa**, professor of the Graduate School of Science and a Penn State alumnus, said they plan to create a joint Tohoku-Penn State graduate course. Based on strategic goals and student interests, the initial topic for this course will focus on aspects of disaster science. https://tinyurl.com/5cx4ajkb

Trees struggle to 'breathe' as climate warms, researchers find

Trees are struggling to sequester heat-trapping carbon dioxide (CO2) in warmer, drier climates, meaning that they may no longer serve as a solution for offsetting humanity's carbon footprint as the planet continues to warm, according to a new study led by Penn State researchers.

"We found that trees in warmer, drier climates are essentially coughing instead of breathing," said **Max Lloyd**, assistant professor of geosciences and lead author on the study recently published in *Proceedings of the National Academy of Sciences.* "They are sending CO2 right back into the atmosphere far more than trees in cooler, wetter conditions." https://tinyurl.com/4keh43je

Image: Warren Reed Penn State

Image: NASA

New approach improves models of atmosphere on early Earth, exo-planets

As energy from the sun reaches Earth, some solar radiation is absorbed by the atmosphere, leading to chemical reactions like the formation of ozone and the breakup of gas molecules. A new approach for modeling these reactions may improve our understanding of the atmosphere on early Earth and help in the search for habitable conditions on planets beyond our solar system.

The researchers reported that using a statistical method called correlated-k can improve existing photochemical models used to understand conditions on early Earth.

"One way we search for potential life in space is to look for biosignatures," said **James Kasting,** Evan Pugh University Professor Emeritus of Geosciences, Atherton Professor, and co-author of the study. "For detecting that we need some kind of telescope to give us spectra of the atmosphere. And then a photochemical model like ours can help calculate the chemical condition in the atmosphere and potentially find biosignatures. And that calculation is very important for searching for life in space." https://tinyurl.com/4b8ppphh

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Scientists examine how wastewater practices in Florida Keys impact water quality

Wastewater contains nutrients that can overfeed algae, leading to harmful algal blooms and pollution issues in the ocean and other waterways. A new study by researchers at Penn State tracked how these nutrients migrate from disposal sites in the Florida Keys, and the results have already informed wastewater practices in the region.

Many treatment facilities in the Florida Keys perform initial biological and chemical treatment of wastewater and then inject it into shallow wells, less than one-hundred feet underground. In theory, remaining nutrients like inorganic phosphate would adsorb or stick to the surface of the porous limestone bedrock as the wastewater plume travels in the subsurface before reaching coastal waters. But potential wastewater contamination has been detected in groundwater and near shore waters, suggesting current wastewater treatment and disposal techniques may be insufficient, according to Penn State research.

"Our findings suggest the use of shallow injection as a disposal mechanism for treated wastewater should be reevaluated at facilities with large discharge capacities," said **Miquela Ingalls**, assistant professor of geosciences and corresponding author on the study. "Further analytical and quantitative approaches like the ones we used here may help determine whether wastewater injection can be considered the direct equivalent of a point-source contaminant discharge."

https://tinyurl.com/5xmyasps

Undergraduate Bridget Reheard: Goldwater Scholar

by Sean Yoder

Bridget Reheard is one of the three Penn Staters selected as Goldwater Scholars for 2024-25. Goldwater Scholars are selected for their potential as leaders in the fields of natural sciences, mathematics, and engineering. About 5,000 students from across the U.S. applied for one of the 438 awarded scholarships available in 2024.

For the past three years, Reheard, of Lancaster, Pennsylvania, has been researching the implications of brines from Marcellus Shale fracking on stream ecosystems. She is pursuing a double major in geosciences and wildlife and fisheries science. Reheard is both a Schreyer and Millennium Scholar.

"I am studying how potential releases of these hypersaline brines may affect aquatic benthic macroinvertebrate—think insects, crustaceans, etc. that live on the stream bottom—and fish communities in Sproul and Tiadaghton state forests here in Pennsylvania," Reheard said.

Previously, she conducted research with the Duke University Marine Lab to evaluate changes to genes in the Atlantic killifish in response to the presence of polycyclic aromatic hydrocarbons (PAHs) in the Atlantic Wood Industries Superfund site along the Elizabeth River in Virginia. Reheard explained that changes to certain genes that regulate the metabolism of PAHs can be beneficial since the normal breakdown of these substances can result in DNA adducts and mutations that may reduce survivorship. This past summer, she worked on a project with the NOAA Hollings Marine Laboratry in Charleston, South Carolina, to experiment on the toxicity of different concentrations and mixtures of per- and polyfluoroalkyl substances on larval sheepshead minnow survivorship and gene regulation.

"Being involved in undergraduate research has solidified my interest in aquatic toxicology and genetics and has greatly prepared me for attaining higher education," Reheard said. "I aim to earn a Ph.D., so having the background and knowledge that I do and having been able to identify a field that matters a lot to me will prove to be pivotal as I search for programs that match my interests and goals."

Reheard said she faced financial difficulties as she finished high school and entered college, working multiple jobs and tutoring to make ends meet. Earning a Goldwater Scholarship was a special moment, she said.

"I will always be grateful to the Millennium Scholars Program and the Schreyer Honors College for elevating me from poverty conditions to a college education with their financial and academic support," Reheard said. "I knew that having the opportunity to go to college with all the obstacles I faced early in my life meant that I had to do everything in my power to make the most of it."

Reheard has served in multiple officer positions of the Penn State chapter of the Wildlife Society. The organization holds a lot of meaning for her, she said, as it provided a way to engage students interested in wildlife careers from a professional and hands-on perspective. She is also part of the American Women in Geosciences and Geosciences Club, the Gamma Sigma Delta Honors Society, and Phi Beta Kappa Honors Society. She said she also enjoys playing soccer with the Centre Soccer Association. ⌘

Doctoral Student Kayla Irizarry: Research to better understand early Earth diversity supported by Ford Foundation

by Patricia Craig

Kayla Irizarry, a doctoral candidate in geosciences, is using her Ford Foundation Predoctoral Fellowship to better understand what controlled diversity in Earth's earliest complex ecosystems. Her research focuses on the Cambrian period, about 485 million to 541 million years ago, which was a prolific time of change in the history of life known as the "Cambrian Explosion."

"The Cambrian Explosion was a dramatic transition when simple, soft bodied animals gave way to animals with limbs, heads, hard skeletal parts, and complex sensory organs like eyes," Irizarry said.

However, in the middle and late Cambrian, species diversity tended to flatten out with high background extinction rates and frequent large extinction events. Irizarry's research seeks to answer the question: Did fluctuating oxygen conditions control extinction and diversification during this diversity plateau in the latter half of the Cambrian?

"Nearly all animal phyla evolved during the Cambrian Explosion, but in the middle-to-late Cambrian, marine invertebrates experienced high extinction rates hypothesized to have been triggered by persistently low oxygen conditions in the ocean," Irizarry said.

Irizarry said she wants to look at this question through both a geochemist lens and a paleontologist lens.

"Geochemists will look at the fluctuating oxygen conditions in the ocean, which have been identified by geochemistry, and say it probably affected the animals; and paleontologists will say that the fossil assemblages look like this so maybe this has something to do with the oxygen levels. Not enough researchers are playing both roles," Irizarry said. "Few studies have combined geochemical and quantitative paleontological data to understand the mechanism by which low oxygen conditions affected marine invertebrate communities."

The Ford Foundation Predoctoral Fellowship is administered by the National Academies of Sciences, Engineering, and Medicine and provides funding of $27,000 per year for three years.

"I am so thankful for this fellowship," Irizarry said. "This funding will pay my salary for the next three years and allow me to focus on my research full time."

Irizarry was one of eighty-seven graduate students awarded a Ford Foundation Predoctoral Fellowship for 2023 and was the only Penn State recipient. She is advised by Mark Patzkowsky, professor of geosciences, and Kimberly Lau, assistant professor of geosciences.

Irizarry earned her bachelor's degree in earth and environmental science from Brooklyn College and her master's degree in geosciences from Penn State. She expects to graduate with her doctorate in June 2026. ⌘

2024 Field Camp

by Roman DiBiase

2024 marked a few big changes for the Penn State Geosciences Field Camp. As part of a transition to make Field Camp more accessible for students, the capstone course was split into two sections: a two-credit class in the spring semester focused on field methods, data analysis, and geologic mapping using GIS; and a four-week trip to the intermountain west in summer 2024. Thirty-four students flew into Salt Lake City, and then took a road trip through the spectacular geology of Wyoming, Montana, and Utah.

Associate Research Professor Erin DiMaggio led the first exercise out of the Yellowstone Bighorn Research Association in Red Lodge, Montana, where students investigated the late Cretaceous sedimentology and stratigraphy of Elk Basin. Next, the group stayed at Colter Bay campground in Grand Teton National Park, studying the Quaternary history of Jackson Hole, Wyoming with Associate Professor Roman DiBiase.

Assistant Professor Max Lloyd and Professor Kevin Furlong then led the students through exercises based out of Alta, Utah. The group braved a heat wave to look at rocks associated with the Neoproterozoic Snowball Earth at Antelope Island; set up a makeshift garage lab to analyze water samples collected from the Great Salt Lake and streams draining the Wasatch Mountains; and analyzed the Sevier and Neogene deformation expressed in Little Cottonwood Canyon.

Postdoctoral scholar Leila Joyce Seals joined for a second year to implement a contextual co-curriculum focused on engaging landscapes and field sites in the context of modern histories, including visits to Fossil Butte National Monument and the Wind River Reservation.

The graduate teaching assistants for this course, Charlotte Connop, Sarah Jonathan, Young Kim, and Leonie Strobl, were key to its success both in terms of education and logistics—including a heroic campground grilling effort! ⌘

Above photo: Under a double rainbow at the top of Signal Mountain, Grand Teton National Park. Photo credit: Roman DiBiase
Lower photo: Students examining an outcrop of pre-Cambrian tidal rhythmites in Big Cottonwood Canyon, Utah. Photo credit: Kevin Furlong

EARTH BENEATH ICE SHEET KEY TO PREDICTING SEA LEVEL RISE FROM WARMING CLIMATE

by Patricia Craig

Findings from an international team of researchers, including those from Penn State, suggest that Earth's natural forces could substantially reduce the melting of the West Antarctic Ice Sheet and its impact on rising sea levels, but only if carbon emissions are swiftly reduced in the coming decades. By the same token, if emissions continue on the current rising trajectory, Antarctic ice loss could lead to more sea level rise in the future than previously thought, according to the researchers.

The researchers published their findings in *Science Advances.*

"The West Antarctic Ice Sheet (WAIS) is one of the largest ice masses on Earth and how it responds to future warming from greenhouse gas emissions is one of the greatest uncertainties in estimating future ice sheet stability and projecting ice mass losses" said **Andrew Nyblade**, professor of geosciences at Penn State and co-author on the study. "This is especially important since nearly 700 million people live in coastal areas and could be affected by sea level rise, and its impact could possibly reach trillions of dollars by the end of the century."

The study, led by McGill University in Canada and including a team of scientists from Canada and the United States, focuses on how parts of the WAIS interact with the solid Earth beneath and how that dynamic is influenced by carbon emission levels. This relationship has not been thoroughly explored in previous studies, the researchers said.

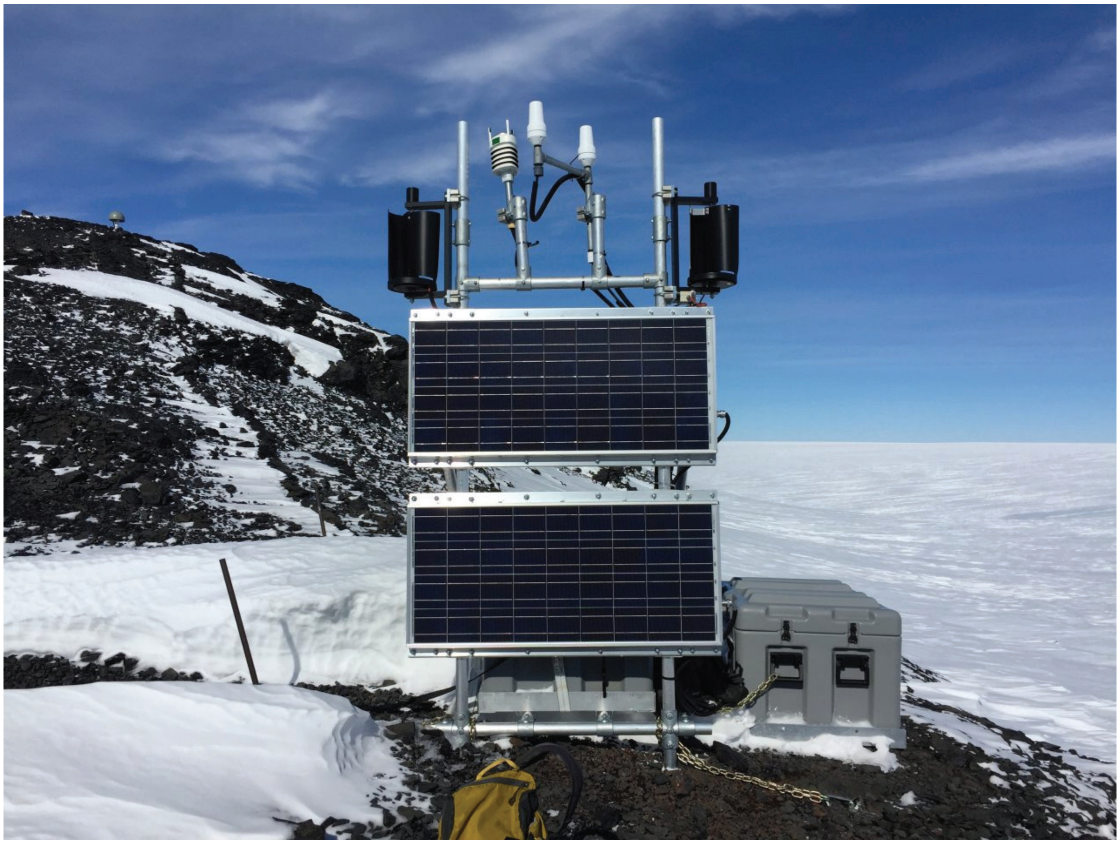
"Our findings show that while some sea level rise is inevitable, swift and substantive action to lower emissions could prevent some of the most destructive impacts of climate change, particularly for coastal communities," said Natalya Gomez, associate professor and Canada Research Chair in Ice sheet-Sea level interactions at McGill University.

Above photo: A monitoring station in West Antarctica that is part of the Polar Earth Observing Network (POLENET) network of GPS and seismic stations. Credit: POLENET.

Nyblade explained that the ice sheet changes are influenced by and can impact more than sea levels.

"The solid Earth can have a big impact on what could happen to the ice sheet," Nyblade said. "The weight of glaciers and ice sheets depresses the land beneath them, and as the ice melts, the Earth's surface rebounds with the reduced load."

The zone where the ice sheet transitions from sitting on bedrock to floating on the ocean is referred to as the grounding line, Nyblade said.



Close up photo of Polar Earth Observing Network monitoring station that collects GPS and seismic measurements to understand ice sheet behavior. Credit: POLENET

"Much of the WAIS is grounded below sea level, making it susceptible to melting by warming ocean waters flowing beneath the ice sheet," Nyblade said. "As the Earth pushes back up from underneath, the bottom of the ice rises so it's harder for seawater to get underneath, slowing the melting process."

The researchers found that if emissions drop quickly, limiting global warming, this uplift can act as a natural brake on ice-mass loss and this dynamic can reduce Antarctica's contribution to sea-level rise by up to 40 percent.

However, their model showed that if carbon outputs keep pace and the planet heats up quickly, the rebounding land will not be enough to slow the rapidly melting ice, and instead pushes more ocean water away from Antarctica, accelerating sea-level rise along populated coastlines.

To assess the impact of the three-dimensional (3D) Earth structure on the WAIS and future global sea levels, the team coupled a global glacial isostatic adjustment model, which incorporated Earth's 3D structure, to a dynamic ice-sheet model. Their model used geophysical field measurements from the U.S. ANET-POLENET project, which pioneered large-scale deployments of sensitive instruments to record the bedrock uplift and seismic signals traveling through the Earth across large expanses of Antarctica. These extensive field measurements were essential for characterizing the three-dimensional variations of the Antarctic mantle incorporated in the study, said the researchers.

"Our 3D model peels back Earth's layers like an onion, revealing dramatic variations in thickness and consistency of the mantle below," said **Maryam Yousefi**, a geophysicist at Natural Resources Canada and previously a postdoctoral fellow at Penn State who worked with Nyblade. "This knowledge helps us better predict how different areas will respond to melting. It's the first model to capture the relationship between Antarctica's ice and the underlying Earth in such detail."

Other researchers on the study included **David Pollard**, research professor emeritus of geosciences at Penn State; Robert DeConto from the University of Massachusetts Amherst; Shaina Sadai from the University of Massachusetts Amherst and the Union of Concerned Scientists; Andrew Lloyd from Columbia University; Douglas Wiens from Washington University; Richard Aster from Colorado State University; and Terry Wilson from the Ohio State University.

The Canadian Natural Sciences and Engineering Research Council, the U.S. National Science Foundation and the Canada Research Chairs program funded this project. ⌘

Marsquakes may help reveal whether liquid water exists underground on red planet

by Matthew Carroll

If liquid water exists today on Mars, it may be too deep underground to detect with traditional methods used on Earth. But listening to earthquakes that occur on Mars—or marsquakes—could offer a new tool in the search, according to a team led by Penn State scientists.

When quakes rumble and move through aquifers deep underground, they produce electromagnetic signals. The researchers reported in the journal *JGR Planets* how those signals, if also produced on Mars, could identify water miles under the surface. The study may lay the groundwork for future analyses of data from Mars missions, according to **Nolan Roth**, a doctoral candidate in the Department of Geosciences and lead author.

"The scientific community has theories that Mars used to have oceans and that, over the course of its history, all that water went away," Roth said. "But there is evidence that some water is trapped somewhere in the subsurface. We just haven't been able to find it. The idea is, if we can find these electromagnetic signals, then we find water on Mars."

If scientists want to find water on Earth, they can use tools like ground-penetrating radar to map the subsurface. But this technology is not effective miles under the surface, depths where water may be on Mars, the scientists said.

Instead, the researchers recommend a novel application of the seismoelectric method, a newer technique developed to non-invasively characterize Earth's subsurface. When seismic waves from an earthquake move through an aquifer underground, differences in how rocks and water move produce electromagnetic fields. These signals, which can be heard by sensors on the surface, can reveal information about aquifer depth, volume, location, and chemical compositions, according to the researchers.

"If we listen to the marsquakes that are moving through the subsurface, if they pass through water, they'll create these wonderful, unique signals of electromagnetic fields," Roth said. "These signals would be diagnostic of current, modern-day water on Mars."

On water-rich Earth, using this method to identify active aquifers is challenging because water exists in the subsurface even outside of aquifers, creating other electric signals as seismic waves move through the ground. This background noise must be separated from the aquifers' signals, the scientists said, for accurate identification and characterization.

"On Mars, where the near-surface is certainly desiccated, no such separation is needed," said **Tieyuan Zhu**, associate professor of geosciences and Roth's adviser and co-author. "In contrast to how seismoelectric signals often appear on Earth, Mars' surface naturally removes the noise and exposes useful data that allows us to characterize several aquifer properties."

The researchers created a model of the Martian subsurface and added aquifers to simulate how the seismoelectric method would perform. They found they could successfully use the technique to analyze details about the aquifers, including how thick or thin they are and their physical and chemical properties, like salinity.

"If we can understand the signals, we can go back and characterize the aquifers themselves," Roth said. "And that would give us more constraints than we've ever had before for understanding water on Mars today and how it has changed over the last four billion years. And that would be a big step ahead."

Roth said future work will—surprisingly—involve analyzing data already collected on Mars.

NASA's Insight lander, launched in 2018, delivered a seismometer to Mars that has been listening to marsquakes and mapping the subsurface. But seismometers have difficulty distinguishing water from gas or less dense rock.

However, the mission also included a magnetometer as a diagnostic tool to help the seismometer. Combing data from the magnetometer and the seismometer could reveal seismoelectric signals, the scientists said.

Sending a dedicated magnetometer meant to conduct scientific experiments on future NASA missions could potentially produce even better results, the researchers said.

"This shouldn't be limited to Mars—the technique has potential, for example, to measure the thickness of icy oceans on a moon of Jupiter," Zhu said. "The message we want to give the community is there is this promising physical phenomena—which received less attention in the past—that may have great potential for planetary geophysics."

Yongxin Gao, professor at Hefei University of Technology in China, also contributed.

The Penn State E. Willard and Ruby S. Miller Fellowship and the National Natural Science Foundation of China supported researchers involved on this work. ⌘

Left photo: One of the last images ever taken by NASA's InSight Mars lander shows its seismometer on the red planet's surface in 2022. Credit: NASA.

MERCURY RISING: Study sheds new light on ancient volcanoes' environmental impact

by Matthew Carroll

Massive volcanic events in Earth's history that released large amounts of carbon into the atmosphere frequently correlate with periods of severe environmental change and mass extinctions. A new method to estimate how much and how rapidly carbon was released by the volcanoes could improve our understanding of the climate response, according to an international team led by researchers from Penn State and the University of Oxford.

The scientists reported in the journal *Nature Geosciences* that they have developed a new technique to estimate excess mercury left behind in the rock record due to ancient volcanic activity. The technique can estimate carbon emissions from large igneous provinces (LIPs), volcanic events that can last millions of years and produce magma that reaches Earth's surface and forms lava flows hundreds of miles long.

"Large igneous provinces are often used as an analog for human-caused climate change because they occur relatively rapidly geologically and release a lot of carbon dioxide," said **Isabel Fendley**, assistant research professor of geosciences and lead author of the study. "But one big challenge we address with this study is that to date, it has been really difficult to figure out exactly how much carbon was released by these volcanoes."

The researchers analyzed core samples that capture a twenty-million-year record of the early Jurassic period and found mercury levels increased during the peak activity of the Karoo-Ferrar large igneous province and the associated Toarcian Oceanic Anoxic Event, a period of extensive environmental and climate change some 185 million years ago.

However, the total estimated carbon emissions using the mercury records were significantly lower than what carbon-cycle models had predicted would be necessary to cause the observed environmental changes.

The findings suggest the volcanism triggered positive Earth system feedbacks—climate and environmental responses to the initial warming that in turn produced more warming. These positive feedbacks may be as important as the primary emissions in these large carbon emission scenarios, and current carbon cycle models may be underestimating the effects of a given amount of emissions, the scientists said.

"What this shows us is that there are Earth system responses that exacerbate the effects of the carbon the volcanoes emitted," Fendley said. "And based on our results, these feedback processes are actually quite important but not well understood."

Accurate estimates of LIP carbon emissions are important for understanding the impacts of positive and negative carbon-cycle feedback processes on future climate projections, the scientists said.

"In addition to historical climate change and understanding the history of life, it's also relevant for how we understand Earth's climate and how we investigate what happens to the environment after you release large amounts of carbon dioxide into the atmosphere," Fendley said.

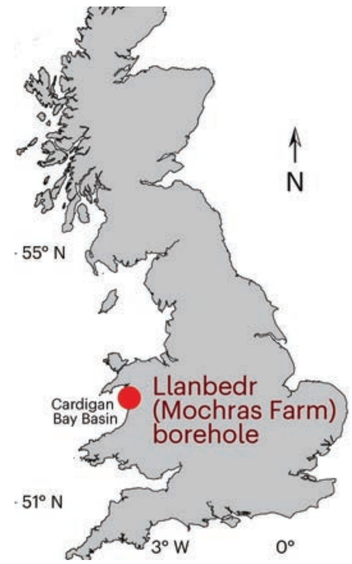
Estimating the quantity of carbon emissions associated with LIPs has been a challenge in part because scientists have an incomplete record of how much lava erupted. The Karoo-Ferrar LIP, for example, occurred on the former supercontinent Gondwana, and that material is now spread out across the southern hemisphere, spanning modern-day Southern Africa, Antarctica, and Tasmania, the scientists said.

The researchers instead turned to mercury, which is released as a gas during volcanic eruptions but was otherwise rarely found in high concentrations in the environment prior to human activity. Looking at the chemistry of rocks in the core samples, the scientists were able to determine how much mercury would be expected based on environmental conditions and how much extra was present caused by the volcanoes.

They developed a method to convert the measured changes in mercury concentrations to the volume of mercury gas emissions. Using the ratio of mercury gas emissions to carbon emissions in modern volcanoes, they estimated how much carbon the ancient volcanoes released.

The researchers said the core samples, from the Mochras borehole in Wales, U.K., provided a unique opportunity to conduct this research. The long record showed the first clear evidence that there were significantly larger volcanic eruptions during this time period compared to the preceding fifteen million years, the scientists said.

"The large amount of existing geochemical data from the Mochras Farm (Llanbedr) borehole in Wales, drilled by the British Geological Survey, plus the very well-constrained chronology, provided a unique opportunity that enabled this analysis," Fendley said. "The decades-worth of previous work on the Mochras core enabled us to reconstruct original gas fluxes over millions of years, for periods that are traditional targets for paleo-environmental studies as well as the background state."



Upper photo: Core samples from the Mochras Farm (Llanbedr) borehole in Wales. Credit: Stephen Hesselbo Right Map: Location of Mochras borehole in Wales, U.K.

Other researchers on the project were Joost Frieling, postdoctoral research assistant, and Tamsin Mather and Hugh Jenkyns, professors, at the University of Oxford; Michael Ruhl, assistant professor at Trinity College Dublin; and Stephen Hesselbo, professor at the University of Exeter.

European Research Council and the Natural Environment Research Council provided funding for this work. ⌘

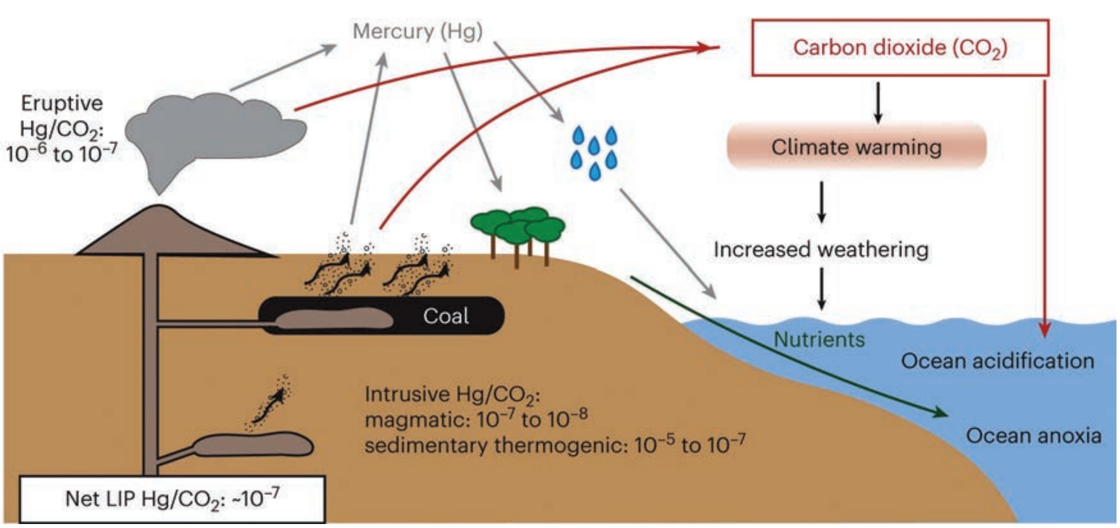


Illustration of direct and indirect feedback effects of LIP-associated CO2 emissions and simplified LIP mercury emissions pathways. Typical Hg/CO2 ratios are shown for each volatile source (eruptive, intrusive magmatic and intrusive thermogenic), and an approximate net LIP-associated Hg/CO2 value.

Giant fossil seeds from Borneo record ancient plant migration

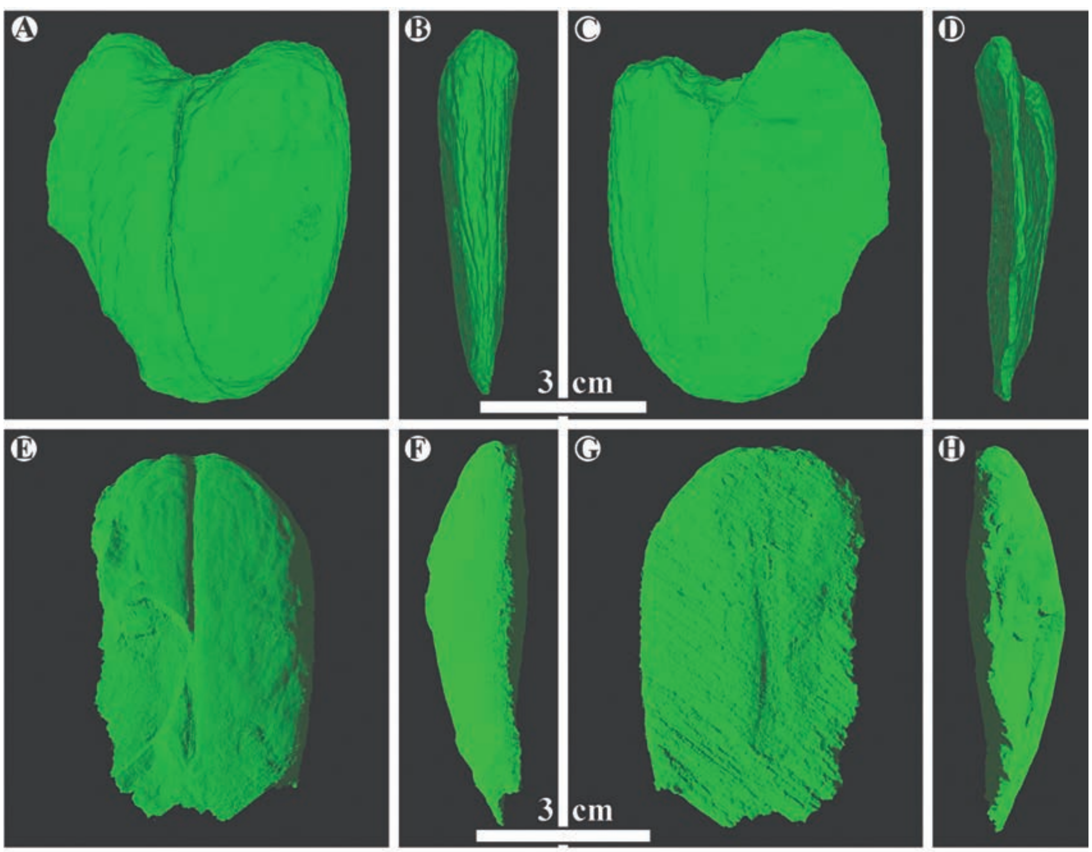
by Matthew Carroll

Ancient fossil beans about the size of modern limes, and among the largest seeds in the fossil record, may provide new insight into the evolution of today's diverse Southeast Asian and Australian rainforests, according to Penn State researchers who identified the plants.

They discovered that the fossils represent a now extinct legume genus that lived in Southeast Asia that was closely related to modern *Castanospermum*, known as the black bean tree. This tree is only found today in the coastal rainforests of northern Australia and neighboring islands. The team, which also included paleontologists based in Indonesia, Canada, the United Kingdom, and elsewhere in the United States, reported their findings in the *International Journal of Plant Sciences.*

The fossils, discovered in Indonesian Borneo, date back to the Eocene period approximately thirty-four to forty million years ago. They suggest that the ancestors of the black bean tree migrated from Asia into Australia during the tectonic-plate collision that brought the landmasses together and allowed for an exchange of plants and animals between the continents. The collision of the Southeast Asian and Australian tectonic plates, which began about twenty million years ago and continues today, led to a large exchange of plant and animal species between the landmasses, the scientists said.

The findings provide the first macrofossil evidence of a plant lineage moving from Asia into Australia after the Asia-Australia tectonic collision, the researchers said. The fossils are also the oldest definite fossil legumes—the bean family—from the Malay Archipelago and the first fossil record anywhere of plants related to the black bean tree.



Scans of the a giant fossil legume revealed the extinct species is a relative to the modern black bean tree. Credit: Edward Spagnuolo

"These fossil seeds suggest that the ancient relatives of *Castanospermum* migrated into Australia from Southeast Asia during the tectonic collision event and later went extinct in Asia," said **Edward Spagnuolo**, a doctoral student in the Department of Geosciences and lead author of the study.

The suggestion is in opposition to most of the existing direct macrofossil evidence for plant migrations, which represents lineages that moved from Australia into Asia. According to the scientists, the lack of direct evidence for movement from Asia to Australia is at least partially due to a poor plant fossil record in the Malay Archipelago, which includes the Philippines, Indonesia, East Timor, Papua New Guinea, and parts of Malaysia.

"It's really hard to collect fossils in this part of the world," Spagnuolo said. "Most surface rocks are destroyed by the heavy tropical rainfall or covered by vegetation, agriculture, and buildings, so there are few places to look for fossils other than mine and quarry exposures. There is also very little paleontological infrastructure. We're fortunate to have a partnership with

Indonesian paleontologists at Institut Teknologi Bandung in Java, who make this work possible."

An international research team, including **Peter Wilf,** professor of geosciences at Penn State, collected the fossils in 2014 from the seams of a coal mine in South Kalimantan, Indonesian Borneo.

The collection included three large beans, pollen samples, and about forty leaves. Along with plants, the team also discovered diverse fossilized bird tracks, burrowing traces of marine invertebrates and fossil turtle remains, among other fossils recently published or under continued study.

The seeds are some of the largest in the fossil record, excluding coconuts and some other palms. They would have grown in a pod that most likely reached up to three feet long, or the length of a baseball bat, and fit up to five seeds, the scientists said.

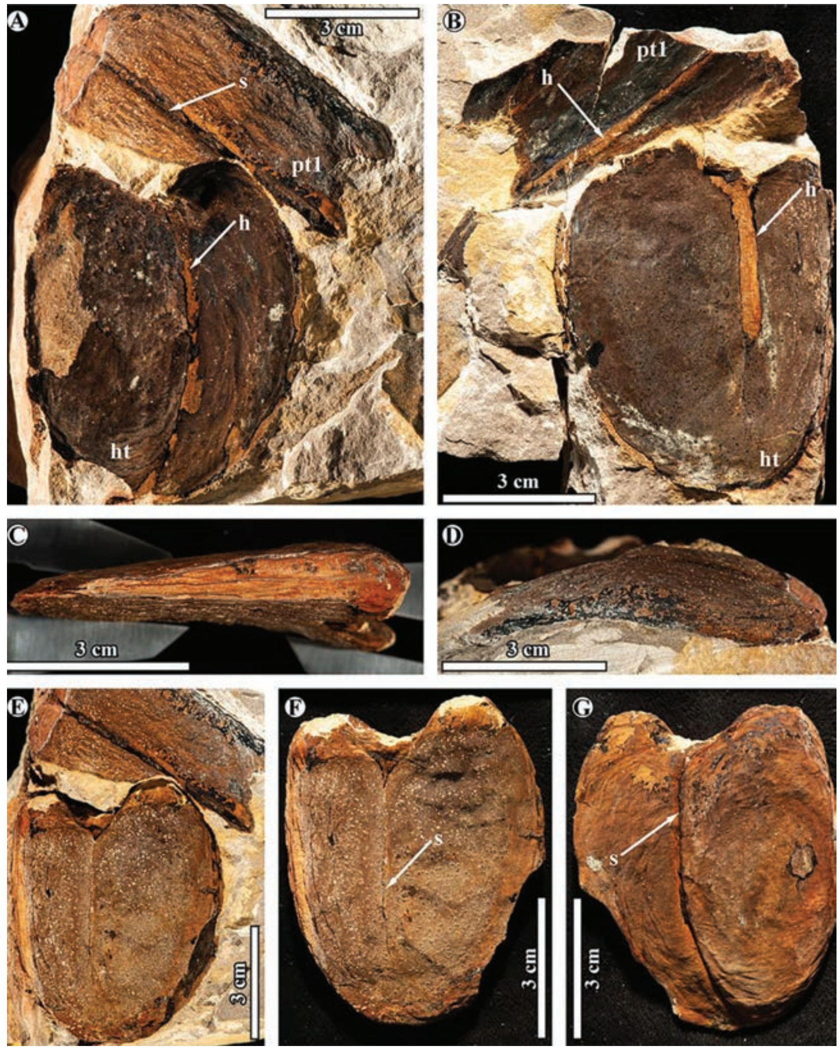
After field work, the fossils were loaned to Penn State, where the seeds underwent CT scan imaging. Spagnuolo and Wilf analyzed the fossil beans taxonomically, describing anatomical characters useful for identification, and found they most closely resembled modern *Castanospermum,* which has no previous fossil representatives.

"Although some of the characteristics of these fossils are common across legumes, there is no fossil or living legume group besides *Castanospermum* that has a combination of features closely matching the fossils," Spagnuolo said. "That makes us confident with our identification."

The fossil seeds were named *Jantungspermum gunnellii*. The genus name refers to the heart shape of the fossil—jantung means heart in Indonesian and spermum means seed in Latin. The species name honors the late Gregg Gunnell, a vertebrate paleontologist formerly of the Duke University Lemur Center, who led the field trip.

Legumes are a diverse family of flowering plants, with about 20,000 species alive today that include many large tropical trees, the scientists said. But despite their abundance and diversity in modern ecosystems, these seeds are the only definite legume fossils from before the Neogene period, the interval between 2.6 million and 23 million years ago, in the Southeast Asian wet tropics.

"The tropics are the most diverse biome on Earth," Wilf said. "We know very little from the fossil record about how tropical ecosystems evolved, especially in



Giant bean fossils of the newly described extinct legume Jantungspermum gunnellii were found in Indonesian Borneo. The legumes were closely related to the Australian back bean tree, Castanospermum, found today only in lowland rainforests of northern Australia and neighboring islands. Credit: Provided by Edward Spagnuolo

Asia, even as extinction risks are rising quickly, and we lose vast areas every year to deforestation. The Penn State paleobotany group is working on this problem in the field with colleagues in several Asian countries, and the new giant fossil beans from Borneo are a fantastic example of the discovery potential."

These findings confirm legumes' presence in Southeast Asia and fill a critical hole in the fossil record, the scientists said.

"We have a great legume fossil record for much of the world but not Southeast Asia," Spagnuolo said. "Our work highlights the neglected paleobotanical potential of this region and the need for more fossil sampling in the Malay Archipelago."

The National Geographic Society, the U.S. National Science Foundation and Penn State supported researchers involved in this work. ⌘

Alley awarded National Medal of Science, highest honor US bestows on scientists

Richard Alley, renowned geoscientist, is the fifth Penn Stater in history to receive the prestigious award

by Adrienne Berard

Arati Prabhakar, director of the White House Office of Science and Technology Policy, awards Richard Alley, Evan Pugh University Professor of Geosciences at Penn State, the National Medal of Science during an awards ceremony at the Eisenhower Executive Office Building in Washington, D.C., Jan. 3. Credit: Photo by Ryan K. Morris.

Richard Alley, Evan Pugh University Professor of Geosciences at Penn State, was awarded the National Medal of Science at a White House ceremony on Jan. 3.

Alley was one of twenty-three individuals and two organizations awarded the 2025 National Medals of Science and National Medals of Technology and Innovation, the nation's highest honors for achievement and leadership in science and technology.

"Dr. Alley is deeply deserving of this most prestigious honor, and it is heartening to know that our nation sees in him what the Penn State community has known for decades," said Penn State President Neeli Bendapudi. "Dr. Alley is the epitome of an exceptional scientist. His career studying our planet's ice sheets has shaped Earth science and climate policy throughout the world. He exemplifies the very best of our University, inspiring others through his pursuit of knowledge and his commitment to advancing solutions for a sustainable future. This honor reflects the profound impact of his research on our world and future generations."

Alley studies the planet's largest and oldest ice sheets to help predict future changes in climate and sea level. He led a team that discovered Earth experienced abrupt changes in climate in the past—and likely will again. His meticulous study of two miles of ice cores from Greenland and Antarctica revealed key "switches" and "dials" in Earth's climate that can lead to environmental changes with significant ecological and economic impacts.

"My piece of this story is small, but our community as a whole provides reliable, useful information that can help people, and I'm grateful for the opportunity to contribute to this important effort and to the National Medal of Science for highlighting it," Alley said. "The discoveries we have brought home, together with an immense amount of information from other scientists and engineers, show clearly that if we effectively use our knowledge on climate and energy, we can build a larger economy with more jobs, improved health, and national security, as well as a cleaner environment for all."

The National Medal of Science was established by the U.S. Congress in 1959 and is administered by the U.S. National Science Foundation (NSF). The medal is the highest recognition the nation can bestow on scientists and engineers. A committee of experts is appointed by the president of the United States to evaluate the nominees for the award, which, according to an NSF statement, is given to "individuals deserving of special recognition by reason of their outstanding contributions to knowledge in the physical, biological, mathematical, engineering, or social and behavioral sciences, in service to the Nation."

Alley joined the faculty of Penn State in 1988 after graduating from the University of Wisconsin in 1987. He said he views the award as a testament to decades of work with colleagues and students at Penn State, including the **Penn State Ice and Climate** group and more broadly in the University's Earth and environmental and energy sciences.

"This honor is a richly deserved recognition of Richard's lifelong work as both a scientist and public educator," said Andrew Read, senior vice president for research at Penn State. "He has lifted the entire Penn State research enterprise through his enthusiasm and passion for work with global impact. I also must

Alley (cont. on next page)

International Geobiology Course designed to help students hone field, lab geobiology skills

by David Kubarek

For the second year, Penn State hosted the International Geobiology Course (IGC), funded by the Agouron Institute and Simons Foundation. **Katherine Freeman**, Evan Pugh University Professor of Geosciences, and **Jennifer Macalady**, professor of geosciences, directed the course.

The course explores how microbial life and the Earth have shaped each other and brought together seventeen students pursuing their doctoral degrees.

Students conducted research in central Italy and New York's Fayetteville Green Lake before traveling to Penn State to analyze their findings.

Central Italy's Frasassi cave system contains microbial life that endures harsh anoxic conditions, similar to potential life on other planets. Same for Green Lake, which researchers think approximates Earth's anoxic bodies of water that existed up until about 2.5 billion years ago. Course objectives included exploring how life and Earth processes are linked, by studying microbial ecosystems and biosignatures in modern and ancient thermal springs, tracking biological signatures within ancient sediments, learning testing methods in both the lab and the field, and writing and understanding research papers.

"My colleagues and I were delighted to bring the International Geobiology Course to Penn State," Freeman said. "This is our second year as hosts of this highly regarded course, which has taught generations of young scholars, many of whom are now scientific leaders in this innovative field. For me, hands down, the best is working with students from all over the world together with our incredibly talented team of instructors." ⌘

https://tinyurl.com/mv544pbh

Upper photo: Students move through Italy's Frasassi Cave System. Credit: Mackenzie Best
Lower photo: Graduate students in the International Biology Course collect samples with Max Lloyd, assistant professor at Penn State. Credit: Rachel Housego

Alley (cont.)

acknowledge his role as a mentor to generations of Penn State students, who come here to learn from leading scholars like Richard. His teaching is not limited to our community; he showed the world that the history of our planet is written in layers of ice, a history that will inform our future."

For decades, Alley has been an enthusiastic science communicator. He has authored or coauthored over 300 peer-reviewed scientific papers, hosted the PBS special, *Earth: The Operators' Manual* and wrote its companion book, authored a popular account of climate change and ice cores called *The Two-Mile Time Machine*, and regularly appears in national and international media outlets. In recent years, Alley served as one of the authors on the U.N. Intergovernmental Panel on Climate Change, whose members shared the 2007 Nobel Peace Prize.

"Those who earn these awards embody the promise of America by pushing the boundaries of what is possible," according to a statement issued by the White House. "These trailblazers have harnessed the power of science and technology to tackle challenging problems and deliver innovative solutions for Americans and for communities around the world. Their accomplishments advance American leadership in science, technology, and innovation, and their work inspires the next generation of American leaders." ⌘

Susan Brantley to retire after 40 years at Penn State

by Matthew Carroll

This summer, a group of Penn State professor Susan Brantley's former graduate students organized a special session at the prestigious Goldschmidt Conference in Chicago to honor their mentor.

Students, collaborators, and colleagues shared cutting-edge research in areas that Brantley spent her career advancing like water-rock interactions and critical zone science.

But her students distilled Brantley's impact to a simpler message.

Plastered on conference name tags, shirts, and water bottles were stickers that read: Be brave enough to be bad at something new—Be like Sue.

"That's very congruent with the kinds of things I say, and it really touched me a lot that it is what they remember me for," said Brantley, Evan Pugh University Professor and Barnes Professor of Geosciences.

Brantley will retire in December after nearly forty years at Penn State, and during her career she was never afraid to try something new.

Ever experimenting in research and leadership roles alike, Brantley rose to the top of the field of geochemistry while blazing a trail for women in a traditionally male-dominated discipline. And she helped shape Penn State for those who followed through leadership roles, like serving as the longtime director of the Earth and Environmental Systems Institute.

"I have a lot of gratitude," she said. "I couldn't have done it without a really good place like Penn State. Our college in particular has been a really good place for me. And you know, I changed our college, but our college changed me."

A fighter

As a young graduate student at Princeton who had grown fond of her urban surroundings, Brantley wasn't sure about the idea of moving to central Pennsylvania.

Her adviser, David Crerar, received his doctorate from Penn State, and that connection combined with the University's lofty reputation in the geosciences were enough to convince her to come for an interview when an assistant professor position opened.

At the time, it was a daunting prospect. Brantley would be the only female faculty member in her department. A senior scientist at another university warned her, "You'll never make it—they are going to eat you alive."

"I've always kind of been a fighter," Brantley said. "In college, someone told me that crew was the hardest sport. So, I tried it. If you are going to tell me I can't do something, I'm going to go do it."

So, Brantley took the job. And she never left. She said at Penn State she found an environment that allowed her to succeed while becoming a better person, scientist and, most importantly, mentor.

Brantley advised nearly forty doctoral candidates at Penn State, and more than two-thirds of them were women.

"When I went to grad school, we had a small incoming class and about half were women," she said. "But the number of women who actually went all the way through and got their Ph.D. was much smaller. So I am proud of helping people come into the field and then stick in the field."

Alexis Navarre-Sitchler, one of those graduate students, is now a professor and department head at the Colorado School of Mines and co-chaired the poster session in honor of Brantley.

Navarre-Sitchler said it wasn't what Brantley did as a mentor, but what she didn't do. She never let her students believe something was too hard to figure out.

"Sue taught me to be brave when working in the unknowns of science and that serves as a guidepost for me still today," Navarre-Sitchler said. "She showed us that it is OK to step into a room, speak loudly and say, 'This is important. I don't know the answer, but I have ideas for how we should do it and who can help us.' And then she got to work."

A laboratory in the critical zone

Brantley earned her bachelor's degree in chemistry from Princeton, but after taking a geology course she discovered a passion in addressing questions about rock weathering and soil formation. She continued at Princeton earning her master's and doctorate in geological and geophysical sciences.

She found that measuring how quickly geochemical reactions happen in the lab did not necessarily translate to how quickly they happen in the field.

"Because I was a chemist, the lab part of it made sense to me, but it was a geoscience program and I really wanted to be able to say, 'If I measure this in the lab it means it's going to happen this fast in the field,' Brantley said. "And we could never make that extrapolation. Really, almost my whole career I've been

looking at that question—how can you measure the rate of something in the lab and then predict it in a field setting?"

Over time, Brantley realized that in the lab you have one mineral reacting with one solution in a flask, but in the field myriad processes all around are engaging with the reaction.

"It became really clear that it was impossible in some ways to make the extrapolation," she said. "You couldn't do it in a flask. You had to look at the whole thing."

That idea was captured by the emerging field of critical zone science, a cross-disciplinary effort to study the thin outer layer of Earth where rock, soil, water, air, and living organisms interact and shape the planet's surface.

Brantley became a driving force in developing critical zone research in the United States. The effort led to a $40 million U.S. National Science Foundation-funded program that established Critical Zone Observatories across the world— ncluding at Penn State.

Critical zone science, for example, has helped scientists better understand the complex interactions that influence weathering, the breakdown of rocks at Earth's surface that acts as a thermostat that helps control the planet's temperature.

"That was probably the most fun part of my career," Brantley said. "It was so interactive. It brought so many students in, and you could feel their excitement. Scientists all around the world were excited. It was a wonderful time."

A wildcatter

In 2003, Brantley was appointed as director of the Earth Systems Science Center, now named the college's Earth and Environmental Systems Institute (EESI), a position formerly held by Eric Barron, Penn State president emeritus and dean emeritus of the College of Earth and Mineral Sciences.

Brantley set out to help researchers address hard and important societal questions related to the sustainability of life on Earth and how to communicate with the public about these issues.

"I always wanted to make scientists' lives easier to do great science," Brantley said. "And that's how I perceived my own job as an administrator. If someone had a problem and they couldn't get a really cool piece of science done, I viewed my role as finding out what I could do to help them get it done."

Under Brantley, EESI assembled researchers to address important issues like the environmental and social impacts of the Marcellus Shale gas boom that began in Pennsylvania around 2007.

She began to see her job as director of a small institute within the University through a geology analogy—the wildcatters in the oil and gas industry who seek out high-risk, high-reward drilling opportunities.

"A wildcatter may not have a lot of money compared to the big players, and they are just trying new things," Brantley said. "They are risk takers, and you know, they might make mistakes. But they also might find a new reservoir. And I thought of EESI as being like that."

What's next

Brantley plans to continue conducting research after her retirement. What she'll miss, though, is the ability of an administrator to help others solve their problems.

"I think that's what I miss the most, really, because I can still do science," she said. "I love thinking about scientific problems. I can still do that, and I can do more of it now because I have more time."

Brantley said she and her husband, Andy Nyblade, professor and former head of the Department of Geosciences, will maintain their home in State College. But they will do more traveling, including visiting their daughters, who are both early-career geoscientists. Their daughters also happen to live near some of Brantley's favorite places to ski and paddle on her kayak—two of her passions.

"I feel very happy about retirement, because I'm really happy with the kinds of things that I have already done, and now I have the freedom to do more of the same, but less of the same," Brantley said. "And I have a lot more time to be outside." ⌘

Sridhar Anandakrishnan, professor of geosciences, received a Fulbright Scholar Award for the 2024-25 academic year to conduct research in Australia. He was also awarded the Seligman Crystal by the International Glaciological Society.

Susan Brantley, Evan Pugh University Professor and Barnes Professor of Geosciences, was named a Distinguished Daughter of Pennsylvania for 2024.

Donald Fisher, professor of geosciences, received the 2024 Wilson Award for Outstanding Service from the College of Earth and Mineral Sciences.

Tanya Furman, research professor of geosciences, was elected to the AGU Board of Directors for a two-year term, effective January 2025.

Antonia Hadjimichael, assistant professor of geosciences, received a 2024 Gladys Snyder Faculty Enrichment Grant from the College of Earth and Mineral Sciences.

Peter Heaney professor of geosciences, was recognized with a 25-Year Service Award from the College of Earth and Mineral Sciences.

Christopher House, professor of geosciences, received the 2024 Wilson Award for Excellence in Research from the College of Earth and Mineral Sciences.

Miquela Ingalls, assistant professor of geosciences, was awarded a five-year, $975,000 National Science Foundation CAREER grant. She also received the James Lee Wilson Award from the Society for Sedimentary Geology.

Tushar Mittal, assistant professor of geosciences, was named a 2024 Packard Fellow by the David and Lucile Packard Foundation. He was also named a Sustainable Minerals, Metals, and Materials Fellow by Scialog.

Mark Patzkowsky, professor of geosciences, was elected as president-elect of the Paleontological Society. He was also selected to serve as science editor for the journal *Geology*.

Anastasia Piliouras, assistant professor of geosciences, was elected for second term as treasurer of the Association for Women Geoscientists. She also recieved a special recogntion award for service to the association.

Jesse Reimink, assistant professor of geosciences and Rudy L. Slingerland Early Career Professor, received the 2024 Paul F. Robertson Award for Research Breakthrough of the Year.

Christelle Wauthier, associate professor of geosciences, was appointed associate director of the Institute for Computational and Data Sciences.

Professor Andrew Nyblade steps down as head of geosciences

Department sustained research success and improved diversity amid pandemic under his leadership

by David Kubarek

Five years ago, Andrew Nyblade became head of the Penn State Department of Geosciences with a road map based on his vision for the department. In 2019, just like all other road maps of that era, a stack of new tasks quickly piled on top of it.

Nyblade instead found himself embroiled in the fallout of a global pandemic. COVID-19 sidelined in-classroom instruction, lab and field work, research, travel, and conferences: nearly all aspects of the routine activities in the department.

Nyblade, a professor of geosciences with a research focus on geophysics and tectonics in regions such as Africa, Antarctica, and Pennsylvania, said his best laid plans would have to wait. In the immediate, he needed to steer his department through uncharted waters.

"The COVID-19 pandemic really shifted my focus," said Nyblade, who stepped down June 30. "We were able to accomplish some of the things I set out to do such as improving diversity among our faculty. But my initial task became continuing research and education during the pandemic. My main goal became making sure the department could endure the pandemic."

Knowing that research was a longtime strength of the department, Nyblade worked to create opportunities for people to stay in touch during the lockdown and sought research alternatives for faculty and students who couldn't travel. In one case, the department rallied to create a virtual experience for students who were required to participate in field camp to graduate. The department used Google Earth, drone footage, images, and datasets to create a learning experience much like the traditional one.

Nyblade joined Penn State as a National Science Foundation postdoctoral scholar in 1992 before joining the faculty two years later. He was met by a welcoming and accepting mentoring system from senior faculty, so that's something he wanted to preserve, despite the pandemic challenges.

He made a few key faculty hires that expanded the department's research breadth while fulfilling his goal of increasing diversity of the faculty because historically geosciences is one the least diverse science fields.

"In retrospect, I think the department is doing extremely well," said Nyblade, who will remain on the geosciences faculty. "We've made a lot of hires and many of them were made during the pandemic with completely remote candidate searches. To me, that's the overall highlight of my tenure: we hired tremendous junior faculty in the past five years and at the same time improved the diversity of the department."

Nyblade grew up in Tanzania, the son of missionaries. Later during his research career, he returned to Africa for research and teaching. For a geoscientist, it's a fascinating place for tectonic research. But it's also an opportunity for budding geoscientists there to create career opportunities while understanding the Earth beneath them.

Diversity has always been a focus for Nyblade. It's why, with the help of colleagues in South Africa, he co-founded AfricaArray, an initiative to train and educate Africans in scientific fields vital to natural resource development. The goal was to promote, strengthen and maintain a workforce of highly trained African geoscientists and researchers for Africa. Nyblade plans to publish the results of the twenty-year effort during his sabbatical this year.

Countless studies point to how an increase in diversity leads to a stronger workforce and Nyblade said he believes his profession is leaving a lot of great ideas behind.

"I feel strongly that the people we educate should look like the general population," Nyblade said. "Everyone is bringing great ideas to the table. If we're not educating a diverse group of students, and we don't have a diverse group of faculty, then we're missing out. People arrive at science and education with different perspectives, and we make the best advances—educational and scientific—if we have a diversity of views. And we're not where we need to be." ⌘

Nicolas Choquette-Levy

Choquette-Levy joined the department as an assistant professor of climate risk and decision making in January 2025. Prior joining the Penn State faculty, he was a postdoctoral associate at Cornell University in the Department of Global Development, working with Professor Andrew Reid Bell to develop better policy interventions to secure rural liveihoods against rising climate and environmental risks. He previously was a postdoctoral associate in the Earth and Environment Department at Boston University.

He obtained his Ph.D. in science, technology, and environmental policy from the School of Public and International Affairs at Princeton University. He earned his master's degree in energy and environmental systems from the University of Calgary, and then worked for five years in the Canadian oil and gas industry to develop plans for managing environmental and social risks. He earned two bachelor's degrees from the University of Southern California, one in biomedical engineering and the second in international relations.

Eric Kirby

Kirby, currently professor of geological sciences at the University of North Carolina, will be the new department head, effective July 1, 2025. He started his academic career at Penn State in 2002 as an assistant professor and was promoted to associate professor in 2008. In 2013, he joined the faculty at Oregon State University.

His research focuses on understand the interplay between climate, erosion, and tectonics during the growth and decay of mountain ranges. Research includes assessing dynamics of slip along active fault systems; evaluating mountain building along convergent margins and strain accumulation along megathrust plate boundaries, characterizing landscape response to spatial and temporal variations in rock uplift; evaluating surface deformation and uplift in response to mantle flow; reconstructing uplift and erosion of the Tibetan Plateau; and assessing the interplay among hydrology, soil erosion, rock fracture, and landscape evolution.

Kirby earned his B.A. in geology from Hamilton College, his M.S. in geology from the University of New Mexico, and his Ph.D. in geology from the Massachusetts Institute of Technology.

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David P. "Duff" Gold Undergraduate Scholarship Fund: *Carlin Blash, Madison McEvoy, Parker Przybylski, Jacklynne Radlinsky, Bridget Reheard*

John C. and Nancy Griffiths Scholarship: *Ethan Newcomer, Akira Regotti, Matthew Roy*

James and Nancy Hedberg Scholarship: *Ziyao Chen, Emma Enos, Claire Martin, Charlotte Meade, Mackenzie Nordai, Rayna Palkewicz, Alexa Raabe, Ariel Ratsep, Breton Sorber, Emily Stoller, Izabela Wasilewska*

Arthur P. Honess Memorial Award: *Sarah Ambrozak, Rogel Theo Aponesto, Evan Jakovac, Elizabeth Johnson, Benjamin Kilian, Michael Ludwikoski, Jaimie Madden, John Reams, Nathaniel Scott, Jack Tkacik, Alexander Tuinstra, Ava Yurchak*

Benjamin F. Howell, Jr. Award: *Neel Andrew Allen, Kathryn Brodeur, Olivia DiPrinzio, Mara Grigore, Logan Madden, William Palumbo, Kaitlyn Toth*

Ronald A. Landon Endowment in Hydrogeology: *Mackenzie Barker, Amanda Gardner, Sofia Sarracino*

Maureen and Dennis Maiorino Undergraduate Scholarship: *Heather Bittle, Stiles Costello, Kaitlin Dasovich, Kayla Foster, Ethan Merckx, Jacob Miller, Nathan Vesel*

The Millennium Scholars Program: *Katerina Taylor, Rasha Elwakil, Zharia Hill, Bridget Rehard, Ava Yurchak, Saia Pride*

Perez Family Undergraduate Scholarship: *Gabriel Maldonado-Goytia, Jeremy Small, Zharia Hill*

Thomas Kenneth (T.K.) Reeves, Jr. Family Scholarship: *Michael Cobaugh, Angelina LaRose, Anna Penird*

Robert F. Schmalz Award: *Austin Arnold, Daniel Cooke, Caitlin Dooley, Raheel Hadi, Emerson O'Neill, Grace Roti, Gabriel Skeete, Andre Wang, Abigail Weiner, Sean Woods*

Julie and Trem Smith Family Undergraduate Scholarship: *Sydney Bopp, Marsella Degnan, Raheel Hadi, Alexis Kennedy, Jesse McConville, Jeffrey McGuckin, Samantha Rowe, Dean Sanwirja, Jason Sargent, Sophia Seck, Andrew Sutton, Mo Wales, Niles Williams*

Daniel and Deborah Stephens First-Time Endowed Scholarship: *Sophia Alfieri, Luis Bohan, Chastin Bullard, Colin McCormack, Daniel McSweeney, Evan Moore, Michael Moyer, Gerald Pribula, Cierra Serabian, Gavin Snyder, Daniel Sweeney*

Timothy and Courtney Watson Undergraduate Scholarship: *Cris Madison Bailey, Dylan Cornett, Alexander Czeczulin, Carmen Dyer-Glaser, Simon Goff, Alexander Peppiatt, Kelly Steel*

Trustee Scholarships and Endowments

John and Elizabeth Holmes Teas Scholarship Fund: *Elizabeth Johnson, Sarah Kummerfeldt, McKenzie Russell, Sophia Seck, Emma Stolinas,Clair Winters, Sophia Wood, Ryan Zaff*

Newsham Family Undergraduate Scholarship: *Bridget Reheard, Grace Boyle, Ryan Zaff*

Bruce Miller Scholarship in the College of Earth and Mineral Sciences: *Amrita Anand*

Al Guber Fund in Academic Excellence: *Akira Regotti*

George L. Ellis Scholarship: *Alexander Cerminaro, Amanda Gardner, Arnav Lund, Owen Purcell, Sarah Kummerfeldt, Seanna Pryor, Zachary Terefenko, Rahil Zaid, Zoe Zenker*

Jesse A. Miller Trustee Matching Scholarship in the College of Earth and Mineral Sciences: *Julia Gadsby, Amanda Urist*

Michael Loudin Family Trustee Scholarship: *Alexis Kennedy, Sophia Seck, Alexander Waldman*

GRADUATE
Scholarships & Awards

Field Camp Awards

Joseph Berg Award for Undergraduate Research in Geosciences: *Gabriel Vanderbrink*

The Edwin L. Drake Memorial Scholarship: *Zachary Baran, Dylan Cornett, Cris Kocian, Angelina LaRose, Ethan Merckx, Jacob Miller, Rylan Morgan, Mariam Salama, Sophia Seck, Niles Williams*

Arthur P. Honess Memorial Award: *Rahil Mohd Zaid, Sophia Wood*

Kappmeyer-Isaacs Field Camp Award: *Rahil Mohd Zaid, Rayna Palkewicz, Sophia Wood*

Earle S. Lenker Fund for Field Studies in Geology: *Rogel Theo Aponesto, Mackenzie Barker, Kaitlin Dasovich, Amanda Gardner, Madison McEvoy, Jeffrey McGuckin, Akira Regotti, Samantha Rowe, Ava Yurchak*

Timothy B. and Cindy Lynch Mullen Scholarship: *Kathryn Brodeur, Evan Jakovac, Owen Purcell*

Reif Undergraduate Summer Field Camp Endowment: *Sarah Ambrozak, Grace Druschel, Sarah Kummerfeldt, Parker Przybylski, Grace Roti, Collin Taylor*

Dr. David E. W. Vaughan and Mrs. Julianne S. Vaughan Field Camp Fund: *Sarah Ambrozak, Grace Druschel, Sarah Kummerfeldt*

Undergraduate Research Enhance Fund – Geosciences: *Nathaniel Scott*

Alley Family Graduate Scholarship: *Ian Lee, Caleb Norville, Alexander Thames*

Cannon Family Graduate Symposium Award:
Safiya Alpheus, Dani Buchheister. Rory Changleng, Ella Do, Emma Hartke, Madison Hernandez, Sierra Melton, Roger Ort, Karen Pham, Jackson Saftner, Ava Spangler, Jasmine Walker

Chevron Scholarship:
Madison Hernandez (recipient of the Chevron Earth Science Diversity Support Award for Fall 2024), Ethan Merckx, Cris Kocian, Angelina LaRose, Sarah Ambrozak, Sarah Kummerfeldt

R.J. Cuffey Fund for Paleontology: *Kayla Irizarry, Caleb Norville, Karen Pham, Evan Ritche, Tengxiang Wang*

Baker-Hughes Scholarship:
Joseph Miller, Jackson Saftner, Jasmine Walker

Charles E. Knopf, Sr. Memorial Scholarship:
Enock Bunyon, Denali Kincaid, Madison Hernandez, Oliver Neilson, Ava Spangler, Cole Stern, Amanda Urist

The Paul D. Krynine Memorial Fund:
Raphael Affinito, Danielle Buchheister, Rory Changleng, Dongyoun Chung, Gabriel Dos Santos, Juliana Drozd, Brandon Fong, Luis Alejandro Giraldo Ceron, Thomas Givens, Emma Hartke, Eric Hasegawa, Ran He, Ethan Heidtman, Mingxi Hu, Kayla Irizarry, Young Cheol Kim, Denali Kincaid, Yusuke Kubota, Ian Lee, Fran Meyer, Roger Ort, Emma Perkins, Karen Pham, Nolan Roth, Youki Sato, Erik Schoonover, Noshin Sharmili, Edward Spagnuolo, Cole Stern, Leonie Stobl, Adam Stone, Alexander Thames, Amanda Urist, Tengxiang Wang, Amanda Willet

Michael Loudin Family Graduate Scholarship: *Raphael Affinito, Yusuke Kubota, Leonie Strobl, Alexander Thames, Em White, Leah Youngquist*

Hiroshi and Koya Ohmoto Graduate Fellowship:
Renan Beckman, Yusuke Kubota, Adam Stone

Earle S. Lenker Graduate Fellowship:
Brandon Fong, Thomas Givens, Kayla Irizarry, Nolan Roth, Youki Sato, Edward Spagnuolo

Richard R. Parizek Graduate Fellowship:
Ran He, Madison Hernandez, Ava Spangler

Freeman and Patzkowsky Graduate Research Fund:
Emma Hartke, Ran He, Kayla Irizarry, Fran Meyer, Erik Schoonover, Miranda Sturtz

Pavlin Fund for Graduate Research Innovation:
Luis Alejandro Giraldo Ceron

Pottorf Endowment for Graduate Excellence:
Raphael Affinito, Rory Changleng, Ella Do, Brandon Fong, Emma Hartke, Eric Hasegawa, Ran He, Ash Keenan, Ian Lee, Aristle Monteiro, Karen Pham, Edward Spagnuolo, Youki Sato, Adam Stone, Alexander Thames, Elizabeth Tofte, Tengxiang Wang, Amanda Willet, Leah Youngquist

Shell Geosciences Energy Research Facilitation Award:
Rafael Affinito, Nolan Roth, Jasmine Walker

Richard Standish Good Graduate Scholarship:
Dani Buchheister, Fran Meyer

Donald B. and Mary E. Tait Scholarship in Microbial Biogeochemistry:
Dani Buchheister, Hanna Leapaldt, Roger Ort

Barry Voight Volcano Hazards Endowment:
Denali Kincaid

Scholten-Williams-Wright Scholarship in Field Geology:
Fran Meyer, Leonie Strobl

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