CornellEngineering
Earth and Atmospheric Sciences

CornellCALS
College of Agriculture and Life Sciences

EAS MAGAZINE

2020

FROM VOLCANOES ON EARTH TO LAVA EXO-PLANETS

Page 2

EAS DIRECTOR'S MESSAGE

GEOFFREY ABERS

Dear Alumni and Friends,

This is a fall like no other. We are teaching students online and in person, many of us continue to work from home and are wondering how people communicated before ZOOM. Still, I am very proud that Cornell has managed to reopen the campus to students, and stay reopened. Every week about fifty thousand diagnostic tests are performed, of which only about six are positive. One key has been impressive vigilance on the part of the students to make sure we continue to stay open. Masks are worn everywhere, and everybody is very careful to follow occupancy and safety guidelines. When I go to Snee Hall to teach three times a week, that classroom feels like the safest place in the country.

Snee Hall is otherwise something of a circus. The collocation of the full department has triggered a major renovation on all floors, in addition to two major geochemistry lab construction projects, so contractors are abundant. And did I mention we are teaching in person? The renovations are by far the largest since the building opened in 1984, and are providing some much-needed modernization, acoustic treatments, and a modern Map Room for teaching and research. We are on track for the Atmospheric Science groups to move in January. Most people are working from home so that the construction has less of an impact than it might otherwise—a small silver lining.

In this newsletter I am delighted to welcome the newest Atmospheric Science faculty, Angie Pendergrass and Flavio Lehner, both of whom started this September (Pages 13-14). Angie is an expert on extreme precipitation, helping answer the question "how extreme is extreme" and making connections between changes in the Inter-Tropical Convergence Zone and broader climate change. Flavio has been working on the critical problem of separating natural variability from long-term changes in complex climate records, and also on climate change coupling with hydrologic variability. Both come from the National Center for Atmospheric Research and together they greatly strengthen the climate side of our program.

Next year, 2021, will be the 50th anniversary of our joining the College of Engineering, a key moment in the history of EAS and worth commemorating. It has become increasingly clear that the problems we work on—mitigating natural disasters and risk, understanding climate change and its impacts, and securing resources and energy in a sustainable way—are among the biggest societal problems this century and are central to much going on across campus. Our work is fundamental to the Engineering College priorities.

I want to remind you all about the value of the EAS 2020 Vision Endowment. The Vision Endowment provides EAS with resources to achieve high-priority goals that are otherwise difficult to attain. The EAS Vision Endowment is about half way to its million-dollar goal, and needs your help to get there.

The Vision Endowment supports a wide array of educational and research missions. One goal is to support graduate recruiting fellowships, to ensure all of our first-year students can enter the program without being tied to work on narrowly-focused faculty grants. The fellowships that we have secured have helped us recruit some stellar students. A related priority is to establish a competitive, endowed postdoctoral fellowship. It would be targeted to high-visibility, cross-disciplinary research areas that are sometimes difficult to fund off grants.

At the undergraduate level, the field

experience remains a critical capstone for many, but it can pose a financial burden—we would like to expand our ability to offer financial assistance there. We are modernizing the teaching labs and the Vision Endowment plays a critical role. For example, a generous gift this year (Page 1) provided modern microscopes for one lab, and the Vision Endowment added to each a fully digital data collection system. Industry-standard software licenses or analytical equipment also would provide students with quality data experiences. The Endowment can also support needs of the very popular project teams we are beginning to form, and novel research laboratory equipment for high-risk projects. Especially in this financially challenging year, we rely heavily on the generosity of fund contributors like you.

I hope you enjoy the update.

Geoffrey Abers

TABLE OF CONTENTS

INSIDE THIS ISSUE

SUPPORT EAS

EAS 2020 Vision Endowment

Earth and Atmospheric Sciences has been undergoing a period of vigorous faculty renewal which is driving changes in the research thrusts of the department, the graduate and undergraduate curricula offered, and the relationships with other departments in the College of Engineering, CALS, and Arts and Sciences.

The department's presence in three colleges and exciting new initiatives affords tremendous opportunities for **impact across the campus and with the outside world**.

With new opportunities come special needs associated with rapid growth and a university business model that compels departments to function autonomously.

For more information on how your support can make a difference, please email Paige Onstad at po86@cornell.edu.

Support Our Vision

GIVING IMPACT

Jonathan Brewer Ph.D. '81 recently gifted a set of microscopes to Earth and Atmospheric Sciences to be used for undergraduate instruction. The microscopes were given in honor of his late father, Douglas Brewer, 1925-2018, Professor of Experimental Physics at the University of Sussex. Douglas Brewer was a firm believer in the importance of good data and logical reasoning to scientific research.

The new microscopes are an advantageous addition to the department, affording the ability to change the way students work in the classroom. Instead of students trying to remember or sketch what they see through a microscope, they will be able to take photos and reference them while working outside of class. The use of the camera and image analysis will be done on an iPad that connects to the microscope.

"The students will be able to acquire high-quality imagery during their labs, capture it, and take it home for further analysis," says David Hysell, Professor in Earth and Atmospheric Sciences. "They'll also have a permanent record of their work to cultivate and share."

The new microscopes will be used in a range of undergraduate classes including earth materials, geochemistry, and more.

Douglas Brewer was one of the founding members of Physics at the University of Sussex when it opened in 1961. He initiated low-temperature experimental work there and developed a major research group. He then went on to became head of the department.

Douglas Brewer was widely appreciated for his effort to support his students. "He was very good at looking after his students in personal terms," says Brewer. "But also, he was very good at tapping into sources of funds to make sure they had support for their research projects."

Jonathan Brewer greatly enjoyed his years in Earth and Atmospheric Sciences, describing his time there as a "very rich experience."

He worked closely with Jack Oliver, Sidney Kaufman, and Larry Brown on the Consortium for Continental Reflection Profiling (COCORP) project, the first national program for exploring the continental crust with seismic reflection technology.

The consortium's work in the 1970s and '80s led to major advances in scientific understanding of the structure and formation of the continents and spurred deep seismic exploration programs in more than 20 countries.

After he left Cornell, Jonathan Brewer returned to the UK to continue research on the deep crust using seismic reflection data. After a 28-year career in the UK Foreign Service, he now works as a consultant for the United Nations in New York.

Brewer's advice for current students: "Time spent collecting good data is never time wasted."

FROM VOLCANOES ON EARTH TO LAVA EXO-PLANETS

By Erin Philipson

Contrary to the devastation that most people associate with active volcanoes, they are actually crucial to life on Earth and an important force of nature. In fact, volcanoes are essential in the overall evolution of the planet and a requirement for planetary habitability.

Esteban Gazel, associate professor in Earth and Atmospheric Sciences (EAS), has long used volcanoes to understand more about processes inside the planet. "To me, volcanoes are probes into the deep Earth," says Gazel. "I use them as a way to reach really inaccessible parts of the interior of the planet."

Volcanoes are an important place where energy and mass are transferred from the inner part of the planet to the outer part of the planet. Volcanoes bring material from the deep earth such as magma and crystals to the Earth's surface—processes that happened in the interior of the Earth are recorded in the chemical compositions of these materials.

Gazel has spent most of his career working to understand melting processes, deep volatile cycles, and their impact in the overall evolution of the planet.

"THERE ARE THOUSANDS OF EXOPLANETS DETECTED AT DIFFERENT EVOLUTIONARY STAGES, EACH PROVIDING A SNAPSHOT TO OUR OWN EARTH'S PAST AND FUTURE." —ESTEBAN GAZEL

"These cycles are really important because, for example, the air you are breathing today is air that has been recycled through volcanoes," says Gazel. "If we didn't have volcanoes on planet Earth, there wouldn't be the fragile balance needed for the development of life, and the conditions necessary to sustain habitability."

Haleakala Volcanic Eruptions.

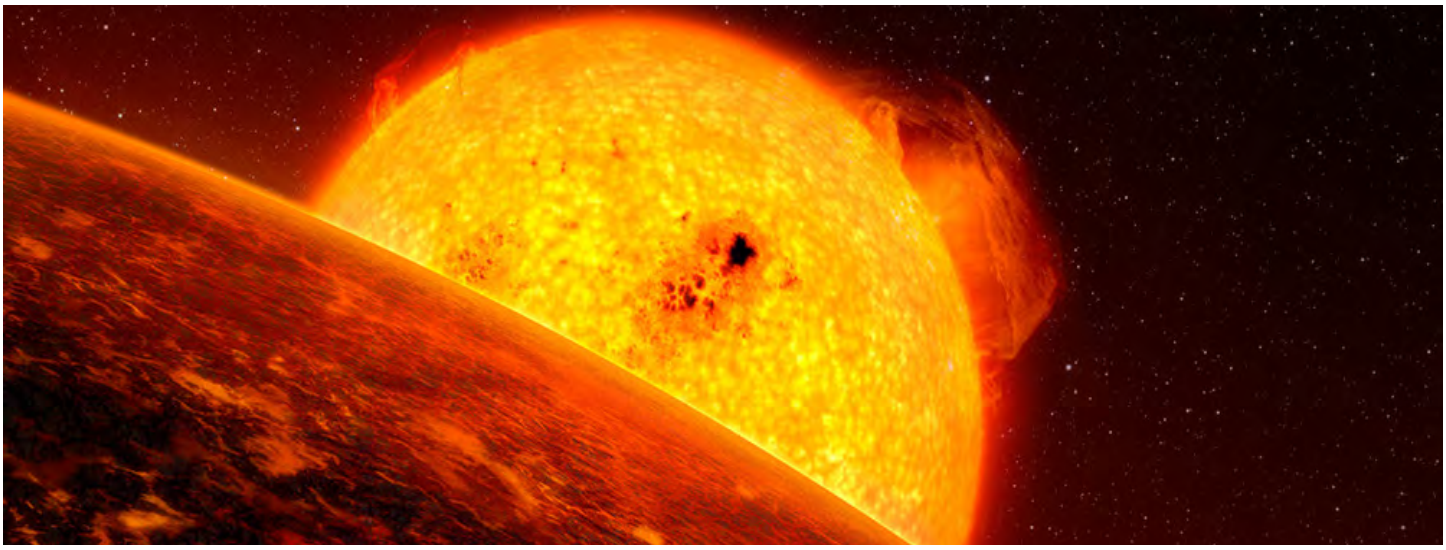
Gazel and collaborators from Cornell's department of Astronomy are working on two new projects funded by the Heising-Simons Foundation to study lava exo-solar planets. They will use this research to better understand the evolution of planet Earth and how volcanoes and melting processes have impacted this evolution and the evolution of other planets.

"There are thousands of exo-planets detected at different evolutionary stages, each providing a snapshot to our own Earth's past and future."

Gazel joined Cornell in 2017 with a grant from NASA to study the composition and evolution of Mars. This grant and his interest in studying other planets in our solar system inspired Gazel to join the Carl Sagan Institute as a fellow. The institute was based on the pioneering work of Carl Sagan at Cornell and supports an interdisciplinary team from across campus to develop the toolkit to find life in the universe.

Lisa Kaltenegger, director of the Carl Sagan Institute and associate professor in Astronomy, and Nikole Lewis, deputy director of the Carl Sagan Institute and assistant professor in Astronomy are collaborating with Gazel to develop new projects to study lava exo-planets, which are worlds molten or partially molten due to the close proximity to their star.

With the use of a powerful infrared telescope, scientists can use infrared radiation and the absorption of infrared radiation by molecules to assess the composition of a planet. The James Webb Space Telescope, a massive NASA project, will have the ability to provide extensive data that will be essential in determining the composition of lava exo-planets. The telescope will be the largest, most powerful and complex space telescope ever built and launched into space.



Lava Planet.

However, libraries of molten lava composition don't yet exist, which are essential to interpret the data collected by the James Webb Space Telescope. "James Webb will provide all of this wonderful data, but we don't have comprehensive libraries of compositions of molten lava," says Gazel.

With the support from the Heising-Simons Foundation, Gazel and Postdoctoral Associate Marc-Antoine Fortin, will be conducting the experiments necessary to start building a library of molten lava compositions. Once the experiments are done they will work with Kaltenegger to model spectroscopic signals expected from exo-planets calibrated to the new experimental results.

The Heising-Simons Foundation is also supporting another project in the form of the 51 Pegasi b Fellowship, which provides funds for three years of postdoctoral work. Emily First, one of eight winners of the Fellowship, will be joining Gazel's lab to gather a wide variety of rock types, representative of those on rocky planets across the solar system. She will measure how the rocks absorb and emit light and synthesize these findings into the composition library with the collaboration of Lewis and Kaltenegger.

"It's energizing to know that the composition catalog I'm building has the potential to support countless exo-planet research projects in the years to come," First said in an article written about the fellowship in the *Cornell Chronicle*.

Gazel has also made a number of key contributions to the scientific community, including the discovery of the hottest lavas in the last 2500 million years and their information about survival of deep-Earth reservoirs, the origin of continental crust on volcanic arcs, and how intraplate volcanoes are formed by sampling domains at the mantle's transition zone.

"We found a clear indication of the role of the Mantle's transition zone in the generation of volcanoes," said senior author Esteban Gazel in an article about the project in the *Cornell Chronicle*.

Gazel was recently funded by NASA to start a new project on the global impact of volcanic ash on the Earth system as an interdisciplinary collaboration with Professors Natalie Mahowald and Matthew Pritchard from Earth and Atmospheric Sciences. As part of this interdisciplinary study, Gazel's team will focus on studying the micro and nano-fraction of volcanic ash components, as these materials can travel miles away from the primary volcanic hazard source and trigger the most substantial global impact.

Gazel's new lab includes state-of-the-art facilities to study melt and fluid inclusions, element diffusivity on crystals, as well as spectroscopic signals of melts and of volcanic ash.

In addition to being a fellow at the Carl Sagan Institute, Gazel is also a fellow at Cornell's Atkinson Center for Sustainability and is the Director of Undergraduate Studies in Earth and Atmospheric Sciences.

Most recently, Gazel was awarded the Daniel M. Lazar '29 Excellence in Teaching Award, the highest award for teaching in the College of Engineering at Cornell University.

BRAUDY FOUNDATION FUNDS
PHASE II OF DUST AND DROUGHT RESEARCH

By Erin Philipson

The Braudy Foundation—founded by Bob Braudy '65, M.Eng. '66, and his wife, Judi—has committed to funding a second five-year phase of a collaboration between Cornell's Department of Earth and Atmospheric Sciences (EAS) and Northern Arizona University (NAU) that will use drones to chase dust storms and learn about their effects on the atmosphere.

The research will be led by Toby Ault, associate professor in EAS, and Nick McKay, associate professor at NAU, who made important breakthroughs in the first phase of the Braudy-funded project. Over the past four years, the Cornell-NAU team discovered new dimensions of dust, drought, land use, and climate change on the southern Colorado Plateau. The high elevation of the region, which encompasses portions of Arizona, Colorado, New Mexico and Utah, makes the area particularly vulnerable to climate change and has been the focus of many climate scientists.

At NAU, McKay and Steph Arcusa, an early-career scientist funded by the project, developed new paleoclimate lake records that defy standard models of how the atmosphere picks up dust from the land surface and deposits it downstream. Ault and Carlos Carrillo, a Cornell postdoctoral associate funded by the project, introduced new methodologies for simulating the large-scale effects of drought and dust in the region using numerical models of the global circulation.

"I THINK OF THEM AS COLLABORATORS... THEY CONTRIBUTE IDEAS AND CONTENT TO THE PROJECT, AND OFTEN THEY WILL FIND A UNIQUE PIECE OF INFORMATION THAT FORCES US TO SCRATCH OUR HEADS AND DIG DEEPER."—TOBY AULT

Phase I of the project revealed the counterintuitive result that dusty periods in the U.S. Southwest did not correlate with preindustrial periods of drought.

"The NAU team started finding these really clear dust deposits," Ault said, "and at first I thought, 'exactly, megadrought,' but then it turned out that, no, we just don't really understand what's controlling dust emissions in that region during preindustrial times."

Since those preindustrial times, however, dust has been heavily influenced by the presence of disruptive human activity and land use such as cattle grazing, which, the team hypothesizes, makes dust emissions more sensitive to droughts now than it was a few centuries ago.

Unanswered questions from the first phase inspired the highly ambitious research goals for the newly-funded second phase—tracking the flow of dust from the land surface into

the atmosphere using low-cost sensors mounted on drones and weather balloons. The drones will aim to move with dust storms in the atmosphere and physically collect samples for research. The Cornell-NAU team and the Braudys began developing the idea for Phase II in September of 2019.

There is a lack of knowledge in the scientific community about what dust does once it's moving along in the atmosphere. The Braudys and the Cornell-NAU team found this problem particularly interesting and set out to develop technology to collect samples of dust and data while in the atmosphere.

Phase II will establish a new undergraduate internship program for rising juniors and seniors at Cornell. Students will join a research and innovation team tasked with developing new technologies to observe dust in the atmosphere as it is mobilized and deposited. The open-ended aspect of this research experience fits well into the project team model that Cornell Engineering is known for—giving students real-world experience with tools, modeling and data in a team-based setting.

Bob and Judi Braudy have a long-standing affinity with upstate New York and Cornell Engineering, which has led to several gifts and collaborations over the years, focused on providing students with hands-on experience. In 2009, the Braudys endowed an ethics workshop that brings together faculty and students from Cornell Engineering, the SC Johnson College of Business and the Law School.

Diversity and inclusion will be paramount to Phase II of the project, and members of underrepresented communities in STEM will be encouraged to apply from across Cornell.

"One of the big problems we see," said Ault, "is that institutional biases can reinforce existing inequalities, which creates a divide between the average and the outstanding college graduate. And, admittedly, I think all of us have inadvertently perpetuated this problem in one way or another, in part because we haven't been proactive enough in our efforts to combat it."

Yet Ault also believes that Cornell's highly diverse engineering program and its mandate to provide an education to "any person… any study" makes it uniquely positioned to disrupt the narrative of institutional bias.

THE BRAUDYS, 'TRUE COLLABORATORS'

Bob Braudy graduated from Applied and Engineering Physics then went on to complete his M.Eng. in the Sibley School of Mechanical and Aerospace Engineering. Judi Braudy attended Binghamton University, a short hour drive from the Cornell campus.

Ault describes the Braudys as true collaborators in the project—contributing ideas and influence over the direction of the research.

"I think of them both as collaborators," says Ault. "They contribute ideas and content to the project, and often they will find a unique piece of information that forces us to scratch our heads and dig deeper. We've all really enjoyed and appreciated that aspect of the research."

DIVERSITY AND INCLUSION WILL BE PARAMOUNT TO PHASE II OF THE PROJECT, AND MEMBERS OF UNDERREPRESENTED COMMUNITIES IN STEM WILL BE ENCOURAGED TO APPLY FROM ACROSS CORNELL.

Bob Braudy has extensive experience with drone technology from his long-term appointment on the Coconino County Sheriff's Search and Rescue team in Flagstaff, Arizona. The team is one of the few across the country to be certified by the Mountain Rescue Association and conducts about 140 missions per year. Search and rescue teams use drones to assess emergency situations and the extent of injuries in locations that are dangerous for humans to access.

Bob and Judi Braudy at Weta Workshop in Wellington, NZ.

EAS RECEIVED $1.4M GRANT TO STUDY THE GLOBAL EFFECTS OF VOLCANIC ASH ON THE EARTH SYSTEM

By Erin Philipson

Every year at least 50 volcanic eruptions affect over 10% of the world's population. Some eruptions like Pinatubo (1991) and Laki (1783) were so powerful that they globally impacted the climate of our planet. The interdisciplinary research team of Natalie Mahowald, Esteban Gazel, and Matthew Pritchard from Earth and Atmospheric Sciences received a $1.4M grant from NASA to study the global effect of volcanic ash on the Earth system. The project involves collaborators from the National Oceanic and Atmospheric Administration (NOAA) and the Jet Propulsion Laboratory (JPL), among other institutions.

The project integrates volcanology, remote sensing, composition of volcanic materials, and atmospheric science expertise to understand the relationship between volcano pre-eruptive behavior, geochemical signatures, and volcano ash composition, and their impact on climate and ocean productivity bringing together concentrations from across Earth and Atmospheric Sciences.

Volcanoes are the main locations for energy and mass exchange between the interior of the Earth and the atmosphere, therefore playing a critical role in the habitability and climate of the planet. Volcanic ash has a series of impacts on the Earth system including changes to weather and air-quality. Air-quality disrupts aviation, and in some cases, fertilizes downwind ocean regions and changes ocean biogeochemistry.

"The study will focus on micro (less than 50 micros) and nano fraction volcanic ash components, that are generally not considered traditional volcanology studies," said Gazel, associate professor in Earth and Atmospheric Sciences. "This is critical as these materials can travel miles away from the primary volcanic hazard source and trigger the most substantial global impact."

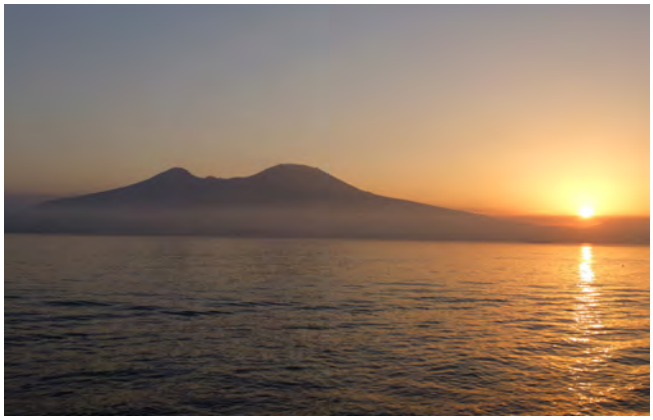
Over the past decade, volcanic ash emissions have not been well characterized and have not been included in earth system models. Mahowald, Gazel, and Pritchard are combining remote sensing with in situ chemistry and volcanic eruption measurements to address an important and under-studied question: what is the role of volcanic ash in current and future climate and biogeochemistry?

"For the first time, we will create a database of satellite observations of volcanic ash from the 250 largest volcanic eruptions between the years 1978 and the present," said Pritchard, professor in earth and atmospheric sciences. "We will then use the database along with in situ chemistry observations as input to earth system models to understand the impact of the ash on temperature, precipitation, and feedbacks with life in the ocean and on land."

Not only will the team characterize past emissions, but they will look for predictive capabilities. First by identifying relationships between pre-eruptive gas, thermal emissions and ground displacement of volcanoes, and the composition and amount of eruptive material. Then they will use past records of emissions from volcanic eruptions to assess the importance of future eruption scenarios that can impact the Earth system.

The findings of this project aim to improve the understanding of volcanic aerosols and to what extent background eruptions are modifying aerosol distributions, weather, climate and biogeochemistry. The study also aims to test whether the characteristics of pre-eruptive unrest are related to eventual erupted material and evaluate the potential impacts of large eruptions in the future.

"Volcanoes are one of the most powerful forces of nature and have long lived in human psychology as an incredible force—think of Atlantis or the goddess Pele," said Mahowald, the Irving Porter Church Professor of Engineering. "With this project we will link volcanology, remote sensing and climate science to bring our understanding of volcanoes into the 21st century to see how volcanoes can change climate."



Sunrise at the bay of Naples, with Vesuvius, the famous volcano that destroyed the city of Pompeii.

PHOEBE COHEN '02

By Erin Philipson

Phoebe Cohen '02 came to Cornell thinking she would major in Biology until she took Oceanography with Professor Chuck Greene.

Cohen was drawn to the Science of Earth Systems major (now called Earth and Atmospheric Sciences) because of its ability to meld her interest in earth science and biology. The diverse course offerings in the major allowed her to take classes in geosciences and in ecology and evolution—empowering her to explore her interest in the intersection of earth and life.

One of the more transformative experiences Cohen had as an undergraduate was participating in the Hawaii summer program, an interdisciplinary earth science-ecology program. The program allowed participants to do a wide range of research tasks—students walked to active lava flows, cut down invasive ginger plants, and studied coral reefs. "It was a really incredible experience because it integrated so many aspects of the earth sciences and ecology," said Cohen.

During her junior year, Professor Lou Derry assisted Cohen in securing a summer research position at Harvard, studying geochemistry which she quickly realized wasn't for her. However, this experience led her to realize her true passion—studying tiny fossils. Cohen later went on to complete her Ph.D. at Harvard.

Towards the end of her senior year, Cohen knew she wanted to attend graduate school but needed a break before starting. After a conversation with Warren Allmon, director of the Paleontological Research Institution (PRI) and Professor in EAS, Cohen decided to stay in Ithaca and work for the PRI after graduation.

Warren Allmon was a true mentor and advocate of Cohen—taking her to Geological conferences, introducing her to important people in the field, and recommending her to Harvard graduate school. "Over the two years I worked for him [Allmon], I was able to stay connected with the science that I was interested in. I really developed my interest in the area I work in now, which is the fossil record of early life," said Cohen.

Even after her time at PRI, Allmon continued to be her advocate. In 2012, when Cohen won the Geological Society of America Young Women in Science Award, Allmon was her citationist.

"IT WAS A REALLY INCREDIBLE EXPERIENCE BECAUSE IT INTEGRATED SO MANY ASPECTS OF THE EARTH SCIENCES AND ECOLOGY." —PHOEBE COHEN

"Very occasionally a young person comes along who truly stands out, who has the right combination of intelligence, creativity, motivation, and enthusiasm to give them extremely high potential to contribute to your field—in my case paleobiology. I have not met many of these in my 20-year career—perhaps 3 or 4. Phoebe Cohen is one of them. She is one of the most extraordinary young people I have ever met, with the potential to rank among the very best in our field," said Allmon in his citation for the award.

Cohen is now an Associate Professor of Geosciences at Williams College where she nurtures her dual passion for paleontology and education. Cohen is currently working with partners from Syracuse University and the University of California, Santa Barbara on an NSF-funded project that seeks to re-examine long-held beliefs about what early life on Earth was like. Cohen and her colleagues analyze tiny fossils to collect evidence that is informing them about how life interacted with the Earth before the appearance of animals.

Cohen advises current EAS students to take advantage of the small department and make connections with people in different stages of the career path like postdocs, graduate students, and faculty. The small class sizes and dedicated faculty allow students to get one-on-one attention at an enormous university like Cornell.

EXPLORATORY RESEARCH INTO GEOTHERMAL ENERGY AND FUNDAMENTAL EARTH SCIENCE QUESTIONS

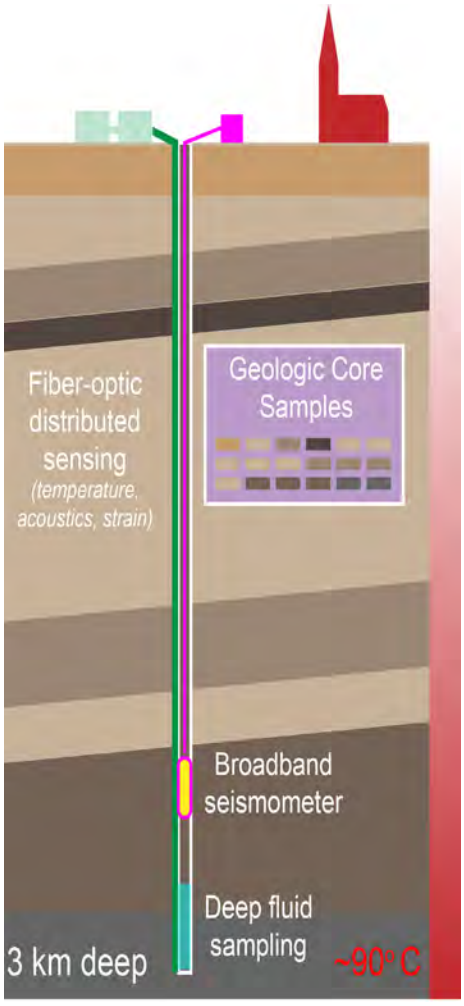
By Erin Philipson

Cornell has secured a U.S. Department of Energy grant to fund exploratory research—in the form of a 2-mile-deep borehole—that is expected to total $7.2 million. The borehole will help verify the feasibility of using a novel geothermal energy system to heat buildings on the Ithaca campus while launching a range of research projects in the earth sciences.

Cornell's interest in the subsurface comes as it proposes Earth Source Heat—an enhanced geothermal energy system that would extract heat from deep sedimentary or basement layers and use it to warm buildings. Data from the borehole will help inform the design of the system and provide answers to underlying questions about the Earth.

"THIS ALLOWS US TO LEARN ABOUT FUNDAMENTAL PROCESSES AND CONDITIONS WITHIN THE SUBSURFACE THAT CAN REDUCE TECHNICAL RISKS FOR GEOTHERMAL PROJECTS HERE AND AROUND THE WORLD, WHILE ALSO PROVIDING INSIGHTS THAT CAN HELP ADDRESS LOTS OF OTHER EARTH SCIENCE PROBLEMS AS WELL."

Leaders of the project refer to the research borehole as a 'science observatory' because it will be a rare opportunity to study active behaviors of deep subsurface rocks and fluids—their mechanical, chemical, and thermal states and interactions, according to the grant's co-lead, Patrick Fulton, Croll Sesquicentennial Fellow and Assistant Professor in Earth and Atmospheric Sciences.



Schematic of pilot borehole.

"It's not often that we get direct access down to 2 or 3 kilometers below ground," says Fulton. "This allows us to learn about fundamental processes and conditions within the subsurface that can reduce technical risks for geothermal projects here and around the world, while also providing insights that can help address lots of other earth science problems as well."

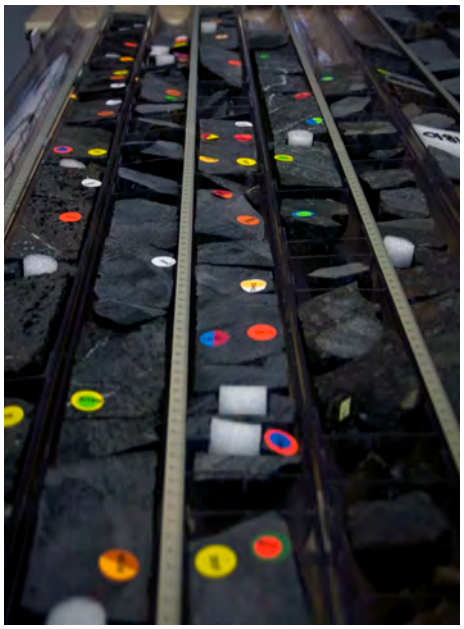
In January of 2020, Cornell brought together 35 researchers from around the world to design experiments that could be incorporated into the borehole. In addition, this workshop also included about 20 Cornell faculty members, students and facilities professionals. That borehole science workshop, sponsored by the International Continental Scientific Drilling Program, led to the basic design for the research borehole. Yet it also revealed other high priority experiments, some of which could underpin future research collaborations and funding.

"The international geothermal research community and the national geosciences community were eager collaborators in imagining novel experiments, and they generously lent their expertise to transform those ideas into a practical drilling and science plan," said grant co-lead Teresa Jordan, the J. Preston Levis Professor of Engineering in Earth and Atmospheric Sciences. "The borehole offers the chance to simultaneously achieve practical and scientific goals by focusing on learning the complex relationships between pore pressure, stress and strain in heterogeneous rock, across conditions that span from natural to human perturbations, and

short to long time scales."

The project is an example of Cornell's Living Laboratory experience. Groundbreaking earth science and engineering research can be conducted at real-world scale, rather than only in laboratories. The data from the research borehole will be publicly available—providing scientists from inside and outside the university with information about the subsurface and geothermal practices that may otherwise be unavailable.

"This project does a fantastic job of providing unique, significant scientific data while directly contributing to a carbon-neutral campus," says Geoffrey Abers, Chair of Earth and Atmospheric Sciences. "It shows how the best science can be used to help us sustainability inhabit the planet."



Core samples collected from a scientific drilling project, similar to samples that will be collected from the borehole. (Photo provided by Patrick Fulton)

The borehole, which will be 4 inches in diameter in its deepest section and located on Cornell-owned property, will be subject to an environmental review and a permitting process, according to grant co-lead Jefferson Tester, the David Croll Sesquicentennial Fellow and Professor in the Smith School of Chemical and Biomolecular Engineering

"THE BOREHOLE OFFERS THE CHANCE TO SIMULTANEOUSLY ACHIEVE PRACTICAL AND SCIENTIFIC GOALS BY FOCUSING ON LEARNING THE COMPLEX RELATIONSHIPS BETWEEN PORE PRESSURE, STRESS AND STRAIN IN HETEROGENEOUS ROCK,

A core of rock archived by the NYS Museum reveals crystalline basement rocks like ones that may be encountered in the lower part of the exploratory borehole.

EAS AWARDS AND HONORS

FACULTY

Geoffrey Abers, Professor, appointed the Chair of Earth and Atmospheric Sciences for a three-year term starting July 1, 2020.

Louis Derry, Professor, was elected a fellow of the Geological Society of America (GSA) and received the McCormick Excellence in Advising Award.

Patrick Fulton, Assistant Professor, was elected to the BRB2020 Cohort and was named a Croll Sesquicentennial Fellow in 2019.

Natalie Mahowald, Irving Porter Church Professor in Engineering, was one of the Web of Science 2019 Highly Cited Researchers, which recognizes the world's most influential researchers, received a Research Excellence Award and was a Provost Research Innovation Award winner. Her project, The Teacher-Friendly Guide to Climate Change, received a national award from the National Center for Science Education.

Matthew Pritchard, Professor, was named a Faculty Fellow in Community Engaged Learning by Cornell's Office of Engagement Initiatives and was named a Benjamin Meaker Visiting Professor at the University of Bristol.

Teresa Jordan, J. Preston Levis Professor, received the Society for Sedimentary Geology William H. Twenhofel Medal. which is the highest award for outstanding contributions.

Rowena Lohman, Associate Professor, received the Daniel M. Lazar '29 Excellence in Teaching Award and was named a Benjamin Meaker Visiting Professor at the University of Bristol.

Arthur DeGaetano was appointed Director of Undergraduate Studies for Atmospheric Sciences and had his paper "Regional Influences of Mean Temperature and Variance Changes on Freeze Risk in Apples" selected for the ASHS Outstanding Extension Publication Award in 2018.

Toby Ault, Associate Professor, was named a Faculty Fellow in Community Engaged Learning by Cornell's Office of Engagement Initiatives.

Esteban Gazel, Associate Professor received the Daniel M. Lazar '29 Excellence in Teaching Award from the College of Engineering.

Charles Green, was appointed to the Executive and Strategic Planning Committees of the Ocean Visions Consortium.

Dan Karig, was recognized as one of the "Giants of Tectonophysics" at the American Geophysical Union Meeting in 2019.

Susan Kay, was selected for the 2019 Distinguished Career Award from the Mineralogy, Geochemistry, Petrology and Volcanology Division of GSA, won the Herbert Thomas Award of the Chilean Geologic Society, and became the first woman approved for Emeritus status in EAS.

Richard Allmendinger, was approved for Emeritus status in 2019.

William White, was approved for Emeritus status in 2019.

Lawrence Cathles, was approved for Emeritus status in 2019 and received the Penrose Gold Medal from SEG.

Steve Calucci, was approved for Emeritus status in 2020.

STUDENTS

CORNELL AWARDS

Meyer Bender '29 and Stephen Bender '58 Memorial Scholarship

Established in 1981 by the Bender family in honor of Meyer Bender '29, who was one of the most generous and innovative benefactors to the department. The scholarship now also honors Meyer's son, Stephen Bender '58.

Award Recipient: Paula Burgi, Ph.D. candidate in Geological Sciences.

EAS Excellence in Research Award

Established in 2011, the award is given annually to an advanced student pursuing a doctoral degree whose research has led to the creation of new knowledge that is recognized in their specialty discipline as a significant advance.

Award Recipient: Michael Mann, Ph.D. candidate in Geological Sciences.

Estwing Award

This award is given to the outstanding graduate student of the academic year.

Award Recipient: Patricia MacQueen, Ph.D. candidate in Geological Sciences.

Chester Buchanan Memorial Award

Presented each year to "that outstanding senior majoring in geology," as recommended by the department faculty.

Award Recipient: Arjun Hausner '20

Bryan Isacks Excellence in Teaching Award

Established in 2007 by the late Timothy Dubbels '93 in honor of Professor Bryan Isacks to recognize a graduate student who is highly effective as a teaching assistant.

Award Recipient: Emerson Sirk, Ph.D. candidate in Atmospheric Science.

Cornell Merrill Presidential Scholar

Awarded to the most outstanding graduating seniors at Cornell University, while also recognizing the teachers who have played a significant role in ensuring their success."

Award Recipient: Ellen Park '20

Michael W. Mitchell Memorial Fund

Awarded to outstanding juniors or seniors majoring in EAS. The award is given to a "geology student who proves themselves adept at other liberal arts fields as well as geology—a student of the world."

Award Recipients: Jack Elstner '21, Elena Fernandez '20, Jane Suhey '20, and Leena Sen '21.

CALS Excellence Award

Given each year to seniors in CALS that have achieved academic excellence.

Award Recipient: Carley Eschliman '20

Outstanding Graduate TA Award

Given to TA's with distinguished performance in the role.

Award Recipient: Colin Evans, Ph.D. in Atmospheric Science.

Frank H. T. Rhodes Award

Given each year to a senior in EAS who has excelled academically.

Award Recipient: Ellen Park '20

EXTERNAL AWARDS

Whyjay Zheng, Ph.D. student, and Professor Matt Pritchard published a paper in *Geophysical Research Letters* that was among the top 10% downloaded.

Patricia MacQueen, Ph.D. candidate, was one of only 14% of applicants selected to receive a 3-year NASA Fellowship worth $135,000 in the FINESST competition.

Paul Morgan, M.S. student, received an Outstanding Student Presentation Award at the Fall AGU meeting in 2019.

Paula Burgi, Ph.D. candidate, received an Outstanding Student Presentation Award at the Fall AGU meeting in 2019.

Celina Scott-Buechler, M.S. student in the Atmospheric Science Graduate Field, was appointed a Knauss Congressional Fellow and now works in the Office of Senator Corey Booker.

Jack Elstner '21, is a Michael Mitchell Memorial Award recipient and was appointed as a NOAA Hollings Scholar.

MEGAN HOLYCROSS

By Chris Dawson

"I did not grow up camping or spending a lot of time in the woods," says Megan Holycross. "I wasn't indoctrinated into a love of the outdoors and camping the way a lot of geologists are." As she says this, you can tell Holycross herself is aware of the irony contained in the fact that she is one of the newest faculty members of Earth and Atmospheric Sciences (EAS). Holycross joined the faculty in the summer of 2020, after spending a year at EAS as a visiting assistant professor. Before coming to Ithaca, she was a postdoctoral fellow at the National Museum of Natural History.

"THE EAS FACULTY ARE DOING EXCELLENT SCIENCE AT SUCH A HIGH LEVEL AND AT THE SAME TIME THEY ARE ALL VERY COLLEGIAL AND APPROACHABLE." —MEGAN HOLYCROSS.

Perhaps not surprisingly, Holycross does most of her research in the lab. Her goal is to understand the processes that have differentiated the chemistry of earth's solid interior. "The instruments in my lab in Snee Hall are capable of achieving temperatures and pressures that recreate the conditions up to 120 kilometers deep in the earth," says Holycross. "I am studying what happens in the lower crust and the upper mantle of the earth."

More specifically, Holycross uses controlled laboratory experiments to develop new geochemical tools to quantify the rates (time) and conditions (temperature, pressure, redox state) of magmatic and metamorphic processes. "The idea is that if you control all of the variables of the experiment and then you compare the outcome of the experiment to a natural rock you are then able to say something about how that rock formed and its history."

Holycross grew up outside of Detroit, Michigan and traces her interest in geology and earth science to the national conversation around climate change spurred by the release of the 2006 documentary film An Inconvenient Truth. She was a competitive swimmer in high school and says this contributed to an interest in hydrology and wanting to understand how water interacts with rocks. Holycross went to Michigan State University and earned a B.S. in environmental geoscience.

During her undergraduate studies Holycross had a Research Experience for Undergraduates (REU) at the American Museum of Natural History in New York City. "It was outside what I was interested in as an undergrad, but at the time I thought 'hey, it'll be fun to spend a few months in New York City even if I don't love the work.' The thing is," Holycross continues, "I really fell in love with the science. I got to work with someone who was doing what I do now—high temperature/high pressure experiments—and it changed my academic path."

Holycross went back to Michigan State and loaded her schedule with classes that would allow her to apply for doctoral programs in experimental geochemistry. She was accepted to Rensselaer Polytechnic Institute in Troy, New York and joined the lab of Professor Bruce Watson. "I studied the diffusion of trace elements in magmatic systems," says Holycross. "And we used the experimental data to understand how chemical profiles in natural samples can be used to "tell time" and understand the history of that rock."

"BIG PICTURE-TYPE OF QUESTIONS REQUIRE INTERDISCIPLINARY WORK AND THAT KIND OF WORK IS A REAL STRENGTH OF CORNELL" —MEGAN HOLYCROSS.

Holycross is excited to be at Cornell for many reasons. "I think of what I do as materials science of the earth," says Holycross. "And the fact that Cornell has such a strong materials science department means lots of possibilities for collaboration. In fact, the opportunities for collaboration across the institution are awesome. "Big-picture-type" of questions require interdisciplinary work and that kind of work is a real strength of Cornell. The EAS faculty are doing excellent science at such a high level and at the same time they are all very collegial and approachable. On top of that, there is the opportunity to work with bright, motivated students."

Now that she is at Cornell, Holycross plans to continue to use high pressure/high temperature experiments to learn more about the evolution of the earth.

ANGELINE PENDERGRASS

By Erin Philipson

Angeline Pendergrass has joined the Earth and Atmospheric Sciences as an assistant professor. Pendergrass, who joined in September 2020, was drawn to Cornell by the people. "The reason I like science is that I want to learn new things about the world, so being in an intellectually stimulating environment surrounded by people curious to learn about many different topics is really important to me," says Pendergrass.

Pendergrass will be working on Earth's hydrologic cycle and its response to climate variability and change; with a particular focus on extreme precipitation events in the context of the distribution of precipitation in space, time and intensity.

"WE WENT FROM PLENTY OF SNOW ON THE GROUND, TO WIDE-OPEN BLUSTERY WINTER SKIES AND WHAT NEVER SEEMED TO BE ENOUGH SNOW ACCUMULATION... BUT THE IDEA OF STUDYING THE ATMOSPHERE AS A CAREER REALLY STARTED TO COME TOGETHER IN HIGH SCHOOL." —ANGELINE PENDERGRASS

Her research is grounded in a top-down approach that considers fundamental questions about precipitation and its change, including: what role does precipitation play in the flow of energy through the climate system, and what can we learn about precipitation and its change from this? How have extreme precipitation events changed in the past, how will they change in the future, and what processes drive these changes? How accurately do models simulate the hydrologic cycle, and how can we improve their accuracy? What are the causes and consequences of changes in the hydrologic cycle for circulation of the atmosphere and oceans, climate sensitivity, and society?

In order to address these questions, she develops compact but powerful and useful metrics to describe the characteristics of precipitation. Her toolbox includes theory, analysis of observations, and a hierarchy of models from fully coupled climate models to radiative transfer models and heuristic stochastic models.

Weather has intrigued Pendergrass since she was a young child. She remembers a very notable change in weather when her family moved from the east to west side of Lake Michigan. "The change was dramatic—we went from plenty of snow on the ground, to wide-open blustery winter skies and what never seemed to be enough snow accumulation... But the idea of studying the atmosphere as a career really started to come together in high school," says Pendergrass. Her interest in math, physics and the weather led her to decide to study meteorology in college.

Pendergrass studied meteorology at the University of Miami in Florida where she had a number of undergraduate research opportunities. During her undergraduate years, she worked on projects to calculate the flux of water vapor into and out of the Caribbean basin, compare methods of bias correction for weather forecasts and do a case study of a sea fog event on the Yellow Sea in China.

Pendergrass worked on a project her senior year that launched her into the area of research she is in today. She worked with Professor Brian Soden, one of her mentors, to adapt radiative kernels that Soden had been using to diagnose climate feedbacks at the top of atmosphere to the surface energy budget, connecting the surface energy budget to precipitation change.

"THE REASON I LIKE SCIENCE IS THAT I WANT TO LEARN NEW THINGS ABOUT THE WORLD, SO BEING IN AN INTELLECTUALLY STIMULATING ENVIRONMENT SURROUNDED BY PEOPLE CURIOUS TO LEARN ABOUT MANY DIFFERENT TOPICS IS REALLY IMPORTANT TO ME." —ANGELINE PENDERGRASS

After a foray into data assimilation for paleoclimate for her Master's thesis, Pendergrass then went on to pursue her Ph.D. in atmospheric sciences at the University of Washington. She looked at changes in precipitation in response to warming—extended what she'd started as an undergrad, diagnosing the changes in the atmospheric energy budget that balanced global-mean precipitation change in response to greenhouse gas and also aerosol forcing.

FLAVIO LEHNER

By Erin Philipson

Flavio Lehner has joined Earth and Atmospheric Sciences as an assistant professor. Lehner, joined the department in September of 2020, and is excited to join a department of smart and friendly people at Cornell. "Climate science is inherently an interdisciplinary science and solving its puzzles requires the kind of open-mindedness and excellence that a place like Cornell has fostered since its foundation," says Lehner.

"CLIMATE SCIENCE IS INHERENTLY AN INTERDISCIPLINARY SCIENCE AND SOLVING ITS PUZZLES REQUIRES THE KIND OF OPEN-MINDFULNESS AND EXCELLENCE THAT A PLACE LIKE CORNELL HAS FOSTERED SINCE ITS FOUNDATION."
—FLAVIO LEHNER

Lehner will continue his work on issues of climate change and variability in a department that lives in both the College of Agriculture and Life Sciences and the College of Engineering. He will be building a research group that employsstate-of-the-art model simulations and observations to understand and ideally reduce the uncertainties associated with climate projections.

His research strives to improve our collective understanding of large-scale climate variability and change and its influence on regional climate impacts such as droughts, heatwaves, or wild fires. Lehner's interest ranges from seasonal to centennial climate variability, how it imprints on regional weather and climate, and how it influences our ability to detect and attribute changes in climate.

Lehner grew up in the city of Basel, Switzerland and received his bachelors degree from the University of Basel and his masters degree from the University of Bern. He then went on to complete his Msc thesis at the University of Bern on the influence of climate change on the freshwater balance in polar regions, using climate models.

Most of this thesis work focused on the last about 1000 years, which were characterized by a relatively stable climate globally. "This makes it an ideal test bed to study natural climate variability, so that when suddenly some strong climate change occurs (like right now), we have a robust baseline to determine how much of this sudden climate change is consistent with natural variability and how much isn't," says Lehner.

Within this broader topic, Lehner focused on the North Atlantic and Arctic Oceans and how their state and variability influence the climate surrounding these ocean basins. He worked mostly with global climate models and combined them with observations and paleoclimate reconstructions.

During his thesis, Lehner worked with Thomas Stocker, a notable Swiss climate scientist focused on oceanography, and Christoph Raible, a senior atmospheric scientist. The two helped shape the way Lehner thinks about climate issues and encouraged him to think about them through both the oceanographic and atmospheric lens.

"THIS MAKES IT AN IDEAL TEST BED TO STUDY NATURAL CLIMATE VARIABILITY, SO THAT WHEN SUDDENLY SOME STRONG CLIMATE CHANGE OCCURS, WE HAVE A ROBUST BASELINE TO DETERMINE HOW MUCH OF THIS SUDDEN CLIMATE CHANGE IS CONSISTENT WITH NATURAL VARIABILITY AND HOW MUCH ISN'T."
—FLAVIO LEHNER

Angeline Pendergrass, Lehner's partner, also joined Earth and Atmospheric Sciences as an assistant professor. Lehner credits Pendergrass for helping him to appreciate the inequality and sometimes outright sexism in the sciences, and what scientists can do to forge a more equal scientific community.

There are many unanswered questions about the impacts of climate change on the environment. What will the tropical Pacific Ocean do in a warmer climate? Are plants going to react strongly or weakly to elevated levels of CO^2 and will their reaction push streamflow, soil moisture and water resource management into new regimes? In which regions will it rain more or less in a warmer climate? Lehner hopes to answer some of these questions with his group at Cornell.

COLIN EVANS

UNDERSTANDING CLIMATE CHANGE TO PLAN FOR FUTURE DROUGHTS

By Chris Dawson

Many people love the sound of the rain, but very few of us are then inspired by that sound to earn a doctorate in Atmospheric Science. Colin Evans, Ph.D. candidate in Associate Professor Toby Ault's Emergent Climate Risk Lab (ECRL), is doing exactly that.

Of course, it's more than just the sound of the rain. That was certainly an early impetus to learn more about the interplay between Earth and the atmosphere, but then Evans' hometown of Owego, NY experienced a 100-year flood, a 500-year flood, and a 1000-year flood in the span of just six years. "It became clear that something far from normal was going on," says Evans, "and I wanted to learn more about climate change to get a better understanding of what is happening and how we can prepare ourselves better for the new realities."

Evans started by earning a B.A. in Environmental Studies from Wells College in Aurora, NY. "As an undergraduate I thought I wanted to be a teacher of some sort, says Evans. "Over time, I could feel myself shift to focus more on policy. In either case, I knew I wanted to continue on and get at the very least a Master's degree."

In 2013 Evans began a Master's program in Atmospheric Science and Meteorology at UMass Lowell, where he completed a thesis project on validating the 2015 update to the NAM and GFS3 forecast models in modeling the atmospheric boundary layer.

When Evans graduated with his M.S. from UMass, he knew he wanted to continue on to a doctoral program, but was not sure exactly where. He decided to take some time to do some research and make a decision based not solely on the name and reputation of the specific programs, but rather on his interest in the work being done by specific researchers.

Evans and his wife, Jessica, moved to Binghamton, NY where he was a Residence Director at SUNY Binghamton and Jessica enrolled in an intensive one-year accelerated nursing program. Evans used this time to delve into atmospheric science and decide what most interested him and whose work might match his interests best. "Taking that time was the best thing," says Evans. "I found Toby Ault's work and it aligned really well with my interest in learning more about drought. So I applied to just one school: Cornell."

"I WANTED TO STUDY SOMETHING MEANINGFUL, SO IT WAS AN EASY DECISION TO COME TO CORNELL AND WORK IN TOBY'S EMERGENT CLIMATE RISK LAB."

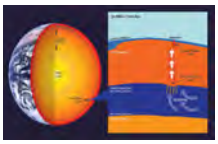
Evans was accepted into the doctoral program at Cornell and began his studies with Ault in the fall of 2017. "Climate projections show many parts of the world drying out as a result of climate change," says Evans. "I wanted to study something meaningful, so it was an easy decision to come to Cornell and work in Toby's Emergent Climate Risk Lab." Ault's primary research focus is drought in the Southwestern United States and its connection to the El Nino/La Nina cycles in the Eastern Pacific Ocean, and Evans contributes to this work. At the same time, Evans has broadened his own focus to understanding how seasonal and longer-term droughts develop in the Northeastern United States.

"I believe that moving forward, we are going to see more seasonal drought in the Northeast," says Evans. "Springs and summers will probably be drier, with more precipitation falling in the fall and winter. We don't really know the atmospheric dynamics that lead to long-term drought in the Northeast. Once we know, we can look at projections and have a better sense of how to prepare."

Long-term drought could have enormous consequences for the Finger Lakes and the rest of Upstate New York. Agriculture is an $8 billion industry in New York. The last seasonal drought to hit the area hard was in 2016, when 90% of western New York's berry crop and a whopping $1 billion in agricultural production were lost. Long-term drought would be even more devastating to the economy of the state and to the lives of farmers and farm communities.

Evans wants to understand atmospheric dynamics and their effects on the climate of the Northeast so that policy-makers can plan for the increased incidence of drought. How water is stored and used, which plants are grown, and how land are used are all policy decisions that will benefit from a greater understanding of drought. Evans, who has always loved to solve puzzles, sees the climate as the most challenging puzzle he has ever taken on. "How the Northeast responds to climate change really depends on politics," says Evans. "If we are serious about making positive changes, they will be based on institutional, systematic changes. And those sorts of changes only happen when policy-makers have good information and the commitment to do what the research supports."

EAS NEWS



From Earth's deep mantle, scientists discover a new way volcanoes form: Esteban Gazel and a team of geoscientists have discovered the first direct evidence that material from deep within Earth's mantle transition zone—a layer rich in water, crystals and melted rock—can percolate to the surface to form volcanoes.

Cornell Atkinson awards $250K in COVID research grants: Cornell Atkinson Center for Sustainability funded a joint project between EAS and the Department of Communications—Gregory Dietl, Jaleigh Pier and Jonathan Schuldt will conduct a national survey to determine if a prolonged and severe pandemic can change public support for conversation.

Dust in the Atmosphere May Have Fertilized the Ancient Ocean: New research investigates dust's role in primary production during the Carboniferous and Permian periods. "It is fascinating that this mechanism that has been explored extensively in the current climate, and the glacial/interglacial cycles, could also be operating so far in the past," said EAS Professor Natalie Mahowald.

$7.2M grant funds exploratory research into Earth Source Heat: The Earth Source Heat project, of which Teresa Jordan and Patrick Fulton are major collaborators, secured a U.S. Department of Energy grant, expected to total about $7.2 million to help verify the feasibility of using a deep geothermal energy system to heat Cornell's campus.

Report fosters ag industry climate-change tracking: Art DeGaetano, Professor in Earth and Atmospheric Sciences, is one of nine scientists who have co-authored a report to help the nation's farmers, producers and commercial agricultural managers reduce risk in the face of climate change.

Cornell's Earth and Atmospheric Sciences eliminates GRE Requirement: Both graduate fields in Earth and Atmospheric Sciences have announced that they will be dropping the requirement for the general GRE test as part of a national trend in Earth and Atmospheric Sciences to eliminate the GRE to promote equity and inclusion in the field.

Cornell Atkinson awards $1.1M to innovative projects: Cornell Atkinson Center for Sustainability awarded a seed grant to an interdisciplinary project that reduces levels of air pollution in India from agricultural burning. The project is led by Natalie Mahowald and Peter Hess from the College of Engineering, Andrew McDonald from the College of Agriculture and Life Sciences, and Prabhu Pingali from The Dyson School.

Whyjay Zheng and Professor Matthew Prichard publication was among the top 10% downloaded: A paper published by EAS Ph.D. candidate, Whyjay Zheng, and Professor Matthew Pritchard in *Geophysical Research Letters* was among the top 10% downloaded papers!

Scientists track plant diseases riding across globe with dust: A Cornell University interdisciplinary team, including Natalie Mahowald, received a grant from NASA to better understand how plant pathogens that travel the globe with dust particles might put crops at risk, especially in places where people struggle to eat.

Billions could soon live in areas too hot for humans without air conditioning, study says: Professor Natalie Mahowald was quoted in CBS News on a new study that reveals that in 50 years, 2 billion people will be living in places too hot without air conditioning.

'An Advocate for Science': A Reflection on the late President Frank H.T. Rhodes' Scientific Legacy at Cornell: Warren Allmon, Hunter R Rawlings III Professor of Paleontology, used to frequently host the late President Frank Rhodes in his paleobiology course. When Rhodes visited the paleobiology course as a guest lecturer, Allmon's students were able to learn about how paleontology research has evolved over the past several decades.

Supercomputing future wind power rise: The study co-authored by Cornell EAS Professor, Sara Pryor, and Sibley School of Mechanical and Aerospace Engineering Professor, Rebecca Barthelmie, investigated plausible scenarios for how the expansion of wind turbines can be achieved without the use of additional land.

Cornell joins global research university climate alliance: Cornell University became a founding member of the International Universities Climate Alliance, spearheaded by President Martha Pollack and Earth and Atmospheric Sciences Professor, Natalie Mahowald.

For grounded forecast of volcanic unrest, spy from above: To better predict explosive, fiery volcanic activity, Kevin Reath, postdoctoral researcher and Matthew Pritchard, professor in EAS, have proposed a new classification system to discern the stages of a volcano's unrest—as seen from smart, perceptive satellites.

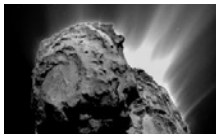
A 51 Pegasi b astronomy postdocs to work with Esteban Gazel: Emily First, a winner of the Pegasi b Fellowship in Planetary Astronomy, will be joining Cornell for three years of postdoctoral work under the mentorship of Esteban Gazel from Earth and Atmospheric Sciences.

40th anniversary of the eruption of Mount St. Helen's volcano, of which Professor Abers conducted extensive research: This seminal event was the most destructive eruption in the U.S. and gave birth to much of the modern science of volcanology. Professor Geoffrey Abers and his group have been part of a major study of Mount St. Helen over the last several years, called Imaging Magma Under St. Helen's (iMUSH).

Mars' crustal evolution does not follow Earth's formula: Esteban Gazel and colleagues from the University of Nevada, Las Vegas and the University of Tennessee saw no indication the Martian crust was formed by plate tectonics or a true continental crust. Their theory: Crystallized magma welled up from inside the red planet.

'Borehole of opportunity' attracts international scientists: About 35 researchers traveled to campus for the workshop, where they were joined by about 20 Cornell faculty members, students and facilities professionals to design experiments that would be incorporated into the university's proposal to dig a 2.5-mile-deep borehole as part of an enhanced geothermal energy system.

Ault: Future droughts may 'eclipse' those of the past: "Droughts of the future may eclipse those of past centuries in their duration, severity and frequency," said Toby Ault, associate professor of earth and atmospheric science, in a paper, "On the Essentials of Drought in a Changing Climate," published April 17 in *Science*.



Dancing debris, movable landscape shape Comet 67P: Sam Birch, a recent Ph.D. alum and Alex Hayes, a member of the graduate field of geological sciences, research on comets was featured in the *Cornell Chronicle*.

Cornell geologists detect rapid 'ice stream' at Arctic glacier: Cornell geologists, examining the desolate Vavilov ice cap on the northern fringe of Siberia in the Arctic Circle, have for the first time observed the rapid ice loss from an improbable new river of ice.

Students have 'eye-opening' experiences at Climate Week NYC: Cornell students met with officials from the Kingdom of Tonga at Climate Week NYC, including students from Earth and Atmospheric Sciences in October 2019.

Esteban Gazel and Allison Chatrchyan receive Atkinson Venture Fund (AVF) Grants: Researchers will employ cutting-edge systems and synthetic biology, geochemistry and microsystems engineering to explore using Gluconobacter oxydans, a naturally occurring microbe, to extract REE's from ore through commercially viable and efficient bio-leaching, therefore lowering the carbon footprint of smart energy systems that require these critical ingredients.

Atmospheric winds carry nutrients from Africa to Amazon: "It's so counterintuitive that the air would deposit this amount of nutrition for the land," said Natalie Mahowald, the Irving Porter Church Professor of Engineering in Earth and Atmospheric Sciences, discussing new research in the Proceedings of the National Academy of Sciences.

Published by Earth and Atmospheric Sciences
Editor: Erin Philipson, Dawn McWilliams, and Chris Dawson
Writers: Erin Philipson, Chris Dawson
Cornell University
Earth and Atmospheric Sciences
Snee Hall
Ithaca, NY 14853-5401

facebook.com/CornellEarthandAtmosphericSciences/

twitter.com/CornellEAS

eas.cornell.edu