By Harrison Blackman ’17

Geosciences Ph.D. student Rachel Harris *20 had a busy fall in 2019, with several conferences and travel engagements on her calendar. So when the spring 2020 semester began, the final one of her graduate student career, Harris was grateful for a schedule which allowed her to remain in Princeton until she submitted her dissertation. “And then, serendipitously the world goes on lockdown,” Harris said.

On March 9, 2020, Princeton University announced it would close the campus in response to the spread of the novel coronavirus, COVID-19. As a result, course instruction was moved online, undergraduate students were sent home over spring break, non-essential employees were asked to work remotely, and laboratory research ceased.

Among the denizens of Guyot Hall, the unprecedented measures of the coronavirus lockdown impacted the trajectories of four Geosciences Ph.D. candidates, who faced the prospect of completing and defending their dissertations remotely. Despite the inherent challenges, Rachel Harris, Jennifer Kasbohm *20, Danielle Schlesinger *20 and Joel Simon *20 all successfully defended their dissertations during the lockdown. For The Smilodon, they’ve also shared some of the cutting-edge science they’ve been working on along the way.
Writing While Quarantined

The spring semester found Jennifer Kasbohm living in New Haven, Connecticut. For a while she traveled to Princeton by train twice a week – a commute which takes four hours each way. Two weeks before the University shut down, Kasbohm became attuned to the growing threat of COVID-19. She expressed the usual concerns – she didn’t want to inadvertently infect others, and she didn’t want to become ill herself. However, Kasbohm was in an enviable position given that she had finished her lab work. If she needed to talk to her advisor, Professor Blair Schoene, she could call him via Zoom. “I was like, I really have no reason to go back,” Kasbohm said.

Kasbohm’s experience reflected that of her colleagues in the 2020 Ph.D. cohort, for whom the lockdown did not disrupt their research so much as make them focus more intensely on the writing process.

Most of Joel Simon’s research involved running calculations on his computer.

“My computer stayed on, my power didn’t go out, so I was okay,” Simon said. “The last few months are really heavily focused on writing. The research is done – you just need to sit down and write the thing.”

Rachel Harris and Danielle Schlesinger developed their own dissertation-writing strategy. Since they lived in the same apartment complex, they formed their own writing ‘boot camp,’ meeting at 9 a.m. every day for two weeks to work together and hold one another account-able. “It’s just a marathon at the finish and you realize you just have to keep going,” Harris said. “It’s not like I could look outside and see people enjoying the weather sunbathing and be like, man, I wish I could do that.”

Still, Schlesinger noted the challenge of not being able to meet with her advisor, Professor Satish Myneni, face-to-face. “It was a very difficult experience to not have that direct contact with someone who has mentored me for five years,” Schlesinger stated.

Meanwhile, Jennifer Kasbohm’s fiancé worked in emergency medicine, so she faced another level of stress. “It would have been hard enough to even just be reading the news and trying to write and focus,” Kasbohm said. “But no, I was also just hoping my fiancé came home safe every day, too – let’s throw that worry on top of everything else.”

Zoom Defenses on the World Stage

One consequence of the lockdown was that dissertation defenses needed to be held over Zoom. As a result, the doctoral candidates would be deprived of their planned in-person celebrations with their colleagues, advisors and families. “I was honestly kind of heartbroken about realizing that I might not be able to defend in-person and participate in the hooding ceremony,” Harris said. “It’s a day that I’ve worked towards for six years.”

Meanwhile, the prospect of Zoom defenses presented their own challenges, noted Schlesinger. “One of the hard things on Zoom is that it feels like you’re shouting into the void,” Schlesinger said, another difficulty adding to the associated problems of inconsistent lighting and wireless connections.

However, the challenges of a Zoom presentation also offered a silver lining – many friends, colleagues and extended family members who lived outside the Princeton area could attend the defenses virtually, a situation not possible under normal circumstances.

Attendees to each of the four defenses received record turnout, ranging from eighty...
to one hundred twenty Zoom participants as friends, colleagues and extended family members tuned in from around the world. Schlesinger’s defense was attended remotely in Israel, Singapore and South Africa; Harris’ included viewers from South Africa, Hong Kong and Australia; and Simon’s featured observers from France, Japan and Poland. Kasbohm even invited her high school physics teacher.

When the defenses ended, many remote viewers stayed on the call for virtual receptions. For Harris, the Zoom celebration went on into the night.

“The party Zoom call officially ended at something like 9 o’clock that night,” Harris said. “It was five hours or so of partying over Zoom. Mostly I think it was my friends getting entertained by my family.”

**From Earth to Mars**

The 2020 “quarantine” Ph.D. cohort worked in various corners of earth science, from remote locations in the Pacific to research related to the possibility of life on Mars.

Joel Simon’s dissertation grew out of the EarthScope-Oceans project, which has launched 50 MERMAID underwater floats (short for “Mobile Earthquake Recording in Marine Areas by Independent Divers”) in the South Pacific, a region more than twice the size of Russia. The installation of the MERMAID floats tripled the number of seismic stations in the area, producing data useful for seismic tomography, a technique for imaging Earth’s subsurface.

Simon’s contribution to the project – a collaboration between his advisor Professor Frederik Simons and institutions in China, Japan, South Korea, the UK, France and New Zealand – has been to develop an algorithm that tags earthquake measurements with timestamps. This allows the dataset to be inverted to discern the origin of seismic waves; some of the findings Simon has uncovered have provided further insight into the character of Earth’s interior.

“Our waves are arriving later than our models predict, meaning we’re traveling through really slow, hot rock,” Simon said. He is continuing his work on EarthScope-Oceans as a postdoc at Princeton.

Jennifer Kasbohm’s dissertation revolved around dual geochronological studies of one of the oldest known flood basalt complexes in the world – the 2.7 billion-year-old Fortescue Group in northwestern Australia – and an investigation of the youngest – the 16 million-year-old Columbia River Basalt Group in Washington State.

“I didn’t go in thinking, I want a snappy title,” Kasbohm said, explaining how her studies of the two igneous provinces emerged organically. To understand the basalt textures she observed in Australia, she read about the Columbia River basalts and discovered they would also be a good target for new geochronology.

Researchers had previously suggested that carbon dioxide released from the Columbia River basalts may have caused the Miocene Climate Optimum, a relatively recent warming event. In her dissertation, Kasbohm concluded it was likely that these basalts contributed to the warming event, though they may not have been the direct cause. She also discovered the basalts had erupted over a period of 750,000 years, 2.5 times faster than previously believed.

Through a National Science Foundation Postdoctoral Fellowship, Kasbohm will work to better understand the timing of carbon dioxide changes throughout the Miocene Climate Optimum.

Rachel Harris’ dissertation examined microbial methane metabolisms to understand the limits of life on Earth and how life might be detected across the solar system. However, on Earth, scientists currently

over estimate the quantity of methane expected to enter the atmosphere versus the methane that actually arrives. Harris’ hypothesis was that methanogens and anaerobic methanotrophs (ANMEs), ancient archaean often found at high pressure environments in the deep ocean, might account for the discrepancy in the methane budget. She used FISH-TAMB, a novel fluorescence in situ hybridization method, to identify marker gene expression within these microorganisms specific to anaerobic methane metabolisms. Her final chapter applied her research to the case study of Mars.

“One big question we wanted to answer was whether methanogens are capable of making methane under Martian conditions,” Harris stated, adding that a follow-up question is “can scientists rule out whether or not there’s potential for biology to play a role in the Martian methane cycle”?

Harris will continue her work on the potential for biological methane on other ocean worlds such as Europa and Enceladus, as a postdoc at Peter Girguis’ lab within the Department of Organismic and Evolutionary Biology at Harvard University.

By contrast, Danielle Schlesinger’s dissertation held implications for climate change here on Earth. Schlesinger studied sea level rise and its relationship with organohalogens, organic salt compounds produced when saltwater comes into contact with shoreline ecosystems. These salts tend to be toxic and carcinogenic; additionally, they contribute to the destruction of stratospheric ozone.

By examining samples from a typical coastal area in South Carolina and a mangrove zone in Panama, Schlesinger discovered both regions produced large quantities of organohalogens. Thus global sea level rise could cause impacted coastal ecosystems to produce significant quantities of organohalogens, from which these compounds could rapidly release to the atmosphere and destroy ozone at a high rate.

“We have this whole large cycle that’s happening,” Schlesinger said. “These coastal ecosystems are going to become of increasing importance to understanding global climate on our environmental systems in the future.”

Schlesinger will follow up her dissertation research with a postdoc at the Johns Hopkins University Applied Physics Laboratory, where she will continue studying contaminant chemistry in the environment and its relation to climate change.

The memories of completing her dissertation in quarantine will stay with Schlesinger. “It was a surreal experience to finish my Ph.D. during a pandemic,” Schlesinger said. “I will definitely remember these few months for a long time.”
By Adam Maloof  
Professor of Geology & Director of Undergraduate Studies

By midterm week in March, the spread of a novel Coronavirus had reached a critical juncture as New York declared a state of emergency. Princeton University announced that starting March 23, lectures, precepts, labs, etc. all would be online, and students would be encouraged (eventually required) to stay home after Spring Break. By March 21, New Jersey Governor Phil Murphy had announced Executive Order 107, which included a statewide stay at home order, bringing a halt to on-campus research and teaching activities.

The Geosciences faculty had the week of Spring Break to convert our in-person lectures, labs, office hours, and field trips into various forms of online learning; a transition that became a half-semester long experiment. Since March, I have spoken to undergraduates, graduate teaching assistants, and faculty, both at Princeton and at peer institutions, consulted course evaluations, and spoken with associate deans to understand what people tried last Spring, and how, as a Department, we might better adapt to this new online environment in the Fall.

Last Spring, some faculty continued live lectures, via conferencing software like Zoom. Others flipped the classroom, pre-recording lectures and then meeting online for live discussion and problem solving. Both approaches had pros and cons. In some ways, live lectures felt less disruptive to the flow and style of the class setup in February. While some students felt a significant decline in the quality of live online lectures and/or their own engagement in the material, others appreciated the new medium of watching a professor draw on slides while lecturing using a digital whiteboard. In flipped classrooms, students appreciated the sometimes more efficient pre-recorded lectures, the ability to watch them when they felt most focused, and the ability to rewatch them to prepare for problem sets or exams. However, students (and faculty) frequently felt that introducing pre-recorded lectures to a class added significantly to the workload, especially if the class time was used for additional live discussions.

Labs and field trips presented an even greater challenge. As one student put it, “you just don’t learn to pipette by watching someone pipette for an hour.” Faculty and students acknowledged that video demonstration of specific processes still could be quite useful, but these demonstrations need to be short and efficient, presented as blocks far shorter than the usual three-hour lab period, and whenever possible, accompanied by hands on experiments the students can do in their kitchen, on their balcony, or in their backyard. To substitute for field trips, I experimented with creating short virtual outcrop visits, leveraging the digital whiteboard and photos both from my collection and from student submissions. Colleagues at other universities tried sending students kits including minerals, rocks, hand lenses, etc. in place of video demonstrations. Currently, we are experimenting with 3D outcrop models generated using structure-from-motion, but as with the lab, virtual outcrop visits just don’t capture the in-person experience.
While there remains room for improvement, as we adapt lab and field experiences to virtual environments, there also is a case to be made for modifying course content to take best advantage of the online learning environment. For example, if you can’t learn to pipette through video demonstrations, perhaps you can spend more time learning quantitative analytical techniques to examine the data coming out of a lab experiment involving pipettes. This type of shift already is happening for senior theses and junior independent work. Since most of our students will not be able to do lab or field projects, they are gaining new skills in data visualization and analysis with data that already exist in the lab or online. This Fall, we are working to strike some balance of teaching the skills we think all budding geoscientists should have, while also focusing on the skills that best lend themselves to online learning.

The challenge most frequently cited by students during the stay-at-home last Spring is the disruption of community. Zoom and other conferencing software are fairly clunky when it comes to maintaining natural conversations in a group setting. This Fall, that challenge only will be intensified, as we will miss out on that first six weeks of in-person class time that we had in the Spring to build faculty-student relationships and a classroom rapport. The realities at home for both faculty and students during the pandemic often have led to frustrating roadblocks that require empathy and adaptability to overcome. Although teaching and learning in the midst of a pandemic is not an experiment any of us would have signed up for, many of the resulting insights and innovations promise beneficial and lasting changes to undergraduate education.

On February 8, 57 high school teams from 9 states competed in the third annual Princeton University Science Olympiad Invitational. This tournament is organized entirely by Princeton students who were competitors themselves in high school, and provides high-level practice for teams preparing for regional, state and national tournaments. Andy Xu ’22 was a co-director of this year’s effort which involved fundraising, writing and judging tests, overseeing campus spaces for the 25 events, and organizing logistics for the attending teams. Here, students compete in the Fossils event held in Guyot Hall.
Unable to host our usual Class Day celebration, we experimented with REMO conferencing software that enabled us to model the Great Hall as a virtual room with a stage and many tables. Before and after the formalities, faculty, staff, students, family and friends were able to virtually hop from table to table, and converse in small groups. A GEO-Commencement address was given by paleontologist and celebrated author Neil Shubin of the University of Chicago, who spoke about the power of observation and the need for humility in science. Then, each senior and faculty advisor came up to the virtual stage and described the senior’s thesis research. While it felt odd to attend this event in front of a computer screen, it was a festive affair that allowed seniors, their families and the Department – including those who might not have been able to travel to Princeton even in non-pandemic times, to celebrate the accomplishments of the Class of 2020.
2019-2020 Ph.D. Recipients and Dissertation Titles

Akshay K. Mehra
Reconstructions of Ediacaran Putative Biominalers via a Novel Serial Grinding and Imaging Technique
Adviser: Adam Maloof
Defense Date: September 25, 2019

Scott A. Maclennan
Temporal Constraints on Archean Crustal Geodynamics and Neoproterozoic Glaciation
Adviser: Blair Schoene
Defense Date: September 27, 2019

Rajkrishna Dutta
High-Pressure Studies of Oxides and Fluorides: Analogos for Ultra-High Pressure Behavior of Planetary Silicate
Adviser: Thomas Duffy
Defense Date: September 30, 2019

Danielle P. Santiago Ramos
Potassium Cycling in Seawater and Teleosts: Insights from Stable Potassium Isotopes (41K/39K)
Adviser: John Higgins
Defense Date: October 10, 2019

Yuzhen Yan
Climate Snapshots and Gas Records from Antarctic Blue Ice Records: Implications for the Mid-Pleistocene Transition and the Last Interglacial
Advisers: Michael Bender and John Higgins
Defense Date: October 28, 2019

Leah Langer
Impact of Topography on Coseismic Modeling and Earthquake Static Slip Inversions
Adviser: Jeroen Tromp
Defense Date: January 28, 2020

Rachel L. Harris
Life on the Fringe: Surveying the Ecophysiological Tenacity of Methanogens and Anaerobic Methanotrophs in the Oligotrophic Deep Surface Biosphere
Adviser: Tullis Onstott
Defense Date: May 1, 2020

Danielle R. Schlesinger
Salting the Earth: Biogeochemical Cycling of Chlorinated and Brominated Natural Organic Compounds in Coastal Ecosystems
Adviser: Satish Myneni
Defense Date: May 4, 2020

Jennifer J. Kasbohm
Calibrating Archean and Miocene Large Igneous Province Emplacement and Geologic Timescales with High-Precision U-Pb Zircon Geochronology
Adviser: Blair Schoene
Defense Date: May 5, 2020

Joel D. Simon
Recording Earthquakes in the Oceans for Global Seismic Tomography by Freely Drifting Robots
Adviser: Frederik Simons
Defense Date: May 11, 2020
FROM THE CHAIR

Let’s start with some good news! Nearly four months after being banished from campus, laboratory research in Guyot Hall is slowly resuming and we are planning for having students on campus in the fall. Dr. Ching-Yao Lai will become the newest member of our climate group, joining the faculty in January 2021.

Now for the nitty gritty. The university shut down at the beginning of spring break in mid March, sent the students home and shut down the labs, requiring everyone to work at home. The faculty rallied and everyone survived teaching the second half of the semester on Zoom (see article on online teaching by Adam Maloof – page 5). Feedback from student evaluations was OK – the students all survived too! The departmental field trip to Cyprus, for which planning was well underway, was cancelled, which was very disappointing especially for the classes of 2020 and 2021. Surprisingly, no other classes were scheduled for travel in spring semester, but all our seminar series and independent research travel plans were also cancelled. We did manage to interview four candidates in our Hess Post-doctoral search – Zoom seminars! – and made offers to two of them, who will be joining the Department this fall (in person we hope!).

All of our research also went “remote.” For many of our theorists, the transition was relatively smooth because their largely computational research proceeded without interruption. For the lab rats, the transition was more challenging. Many people had to drop ongoing laboratory experiments and rapidly figure out something else to do. I think most people – faculty, students and research staff – were pleasantly surprised at how rapidly they identified exciting research projects and acquired the skills to do them online. This involved things like working up previously collected data (sometimes learning completely new analytical skills to do so), crunching numbers that had accumulated in databases elsewhere, undertaking that computational project that just never made it to the front of the queue before, writing that extra paper or proposal, learning a new programming language, etc.

Senior thesis and junior paper research also went remote. Students had to move away from the lab work they had been involved in and the samples they were preparing to analyze, and move to computer-based analyses. Some students switched topics completely, others had already collected sufficient data to allow them to complete the original project as planned. The amazing thing was that all our seniors gave in person (or prerecorded) oral presentations in a big Zoom meeting for the entire Department and they all went well. Congratulations again to our seniors and many thanks for Adam Maloof, Georgette Chalker, Sheryl Robas and Mary Rose Russo for carrying that off (see page 7!)

Class Day was also done remotely, and although it felt strange, the software we used for the event was versatile enough to allow informal conversation as well as individual introductions for each graduating senior. Many thanks to Adam Maloof, Danielle Schmitt, Laurel Goodell, Georgette Chalker and Sheryl Robas for a memorable Class Day event. While it wasn't the celebration that our seniors had envisioned, it still marked four years of hard work and achievement, and our students should be proud of their accomplishments under strange and trying times.

Four Ph.D. students also marked the successful end of their student careers, doing their Final Public Orals online (see lead article by Harrison Blackman). Again, they weren’t the standing room only seminars and crowded celebratory parties normally envisioned, but there was a silver lining: Anywhere from eighty to over one hundred people attended each of the FPO’s – two or three times the number of people our usual classroom venue can accommodate – because the events were more accessible for far flung friends and family when travel was not possible.

In early July, the university’s planning for returning to research was well underway, with each PI making detailed plans for scheduling and staging of research activities under conditions of social distancing and layers of PPE. Researchers were eager to get back to the labs and research has been ramping up since early July. The number of people in Guyot Hall at any one time is still small, but mass specs (never fully shut down) are measuring isotopes again, cell cultures are growing exponentially, and diverse kinds of samples are being processed and measured.
We look to the immediate future with much uncertainty and trepidation. Faculty are investing a huge amount of work this summer (time we would normally spend on research) redesigning and preparing their classes for fall. We are restructuring our classes, figuring out how to communicate and teach in new ways as we plan for a mostly online fall semester. Even with students on campus, classes will be online in order to maintain equity for students whether on campus or not, and to allow safe distancing. Will we have a seminar series? If so, it will all be done by Zoom. What kind of junior and senior independent work will be possible when students are on campus for only one semester and cannot work in the labs?

Over the longer term, we hope, along with the rest of the world, that a vaccine for COVID-19 will soon make a return to residential education and physical lab work possible. Then we’ll need that new Environmental Sciences building, for which planning is proceeding apace. GEO faculty met with the architects over the spring and summer and it’s exciting to see the detailed designs for offices and research labs, meeting and collaborating spaces, classrooms and teaching labs.

Planning for a new building and making new hires are good signs that a brighter future lies somewhere ahead. I am grateful to everyone in the department, and especially our hardworking staff, for making the transition to online everything possible. And the faculty and students for their creativity and commitment to teaching and learning no matter what. Those resources will be in high demand in the coming months, as we work toward and look forward to whatever comes next!

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**ALUMNI NEWS**

James Tralie ’19 has produced and narrated, “MAVEN Explores Mars to Understand Radio Interference at Earth.” The animation was selected for the SIGGRAPH Electronic Theater, an Academy Award-qualifying film festival. Check out the animation at [lnkd.in/daduzgZ](https://lnkd.in/daduzgZ).

Kyle Duffey ’19 works in Baltimore for Outward Bound which has included leading ten 13-year-olds on a 12-day expedition along the Appalachian Trail! He is coauthor on a paper recently published in *Physics of the Earth and Planetary Interiors*, that came out of undergrad research he did in Japan as part of the Misasa International Students Internship Program.

The first chapter of Emily Geyman’s 2019 senior thesis was published in the *Proceedings of the National Academy of Sciences* as “A diurnal carbon engine explains $^{13}$C-enriched carbonates without increasing the global production of oxygen.”

Hannah Tandy ’18 is focusing her graduate studies on the clumped isotope paleothermometer in Aradhna Tripati’s research group at UCLA.

After graduation, Scott Bechler ’17 taught English in Malaysia on a Fulbright Grant and upon return to the U.S. has been working at IBM. This fall, he starts graduate work in environmental economics and policy at Duke University’s Nicholas School of the Environment.


In 2018, Sylvia Dee ’10 joined the faculty of Earth, Environmental, and Planetary Sciences at Rice University. She studies paleoclimate, climate change and long-term changes in the global hydrological cycle. In Houston, she has reconnected with friends from her 2009 YRBA field camp class, including Ben Oliver ’10. Sylvia was a panelist at the PEI 25th Reunion Celebration in 2019 and enjoyed reconnecting with PEI faculty and alumni.

Katy Barnhart ’08 joined the USGS Landslide Hazards Program in April 2020. She is currently working on prediction under uncertainty, for post-fire debris flow inundation.

Raleigh Martin ’08 is wrapping up his American Geosciences Institute Congressional Geosciences Fellowship year, during which he worked for the House Select Committee on the Climate Crisis and contributed to a comprehensive 535-page policy report, “Solving the Climate Crisis.” See: [climatecrisis.house.gov/report](http://climatecrisis.house.gov/report).

In addition to running Quixote Expedition trips to Antarctica, Laura K.O. Smith ’05 is chair of the Polar Citizen Science Collective which...
What did the bison eat? Check their teeth!

Calcium and magnesium isotopes in mammalian tooth enamel yield a rich cache of information about the diet of individual animals. My senior thesis focused on the isotopic record present in bison teeth. I was advised by Professor John Higgins with laboratory assistance from Alliya Akhtar and Jack Murphy. We hypothesized that the isotopic composition of bison tooth enamel would reflect the amount of C3 and C4 grasses in a bison’s diet and in the grasslands where it grazed. Soil and grass samples from Badlands National Park and Fort Niobrara National Wildlife Refuge were collected by volunteers and shipped to Princeton with funds from GSRF. We separated the grass leaves from the roots and measured their isotopic composition using a Neptune Plus multi-collector ICP-MS. We observed isotopic differences between grass roots and leaves and found C3 and C4 grasses had the same isotopic composition. While these observations are not entirely consistent with our hypothesis, they enhance our understanding about biofractionation and suggest the need to consider additional fractionation mechanisms. My research was made possible by GSRF funds, which paid for shipping as well as coordinating sample collection with Dr. Symstad at Badlands National Park and Mr. Hicks at Fort Niobrara National Wildlife Refuge. In the future, I hope to continue investigating information stored in the isotopic record.

Reef environments have been shown to be disproportionately large sources of animal biodiversity throughout the Phanerozoic, as well as in modern oceans. Interestingly, the rise of Earth’s first complex reefs built by animals coincides with the major evolutionary pulses of the Cambrian Explosion; one of the landmark events in the evolution of animal life on Earth. In an effort to investigate these 520 million-year-old reefs, I used the funds awarded to me via the GSRF to conduct a six-week field season in the Yukon Territory of Canada. The field season was a great success, as we discovered a large (~300 m long) reef that was never previously described. Though there were other similar reefs reported in the area, they all were preserved on steep-sided canyon walls, rendering their study near-impossible. This new reef, on the other hand, was on a canyon floor, where all of the overlying rock strata had been eroded away, allowing us to practically walk on the seafloor as it had previously existed 520 million years ago! The ease of access to this reef allowed us to make highly-detailed observations and collect a comprehensive set of samples that I am now processing in the lab with various techniques to create the most accurate depiction of these important ancient environments to date.

For more information about the fund, please contact Nora Zelizer (nzelizer@princeton.edu) or Bess Ward (bbw@princeton.edu).
At the beginning of each Academic year, the Department presents the Arnold Guyot Teaching Awards to graduate student Assistants in Instruction (AIs) who have exhibited excellence in instruction, skillfully interacted with undergraduates to enhance the learning experience, and provided valuable contributions to course curricula.

Ellen Ai was an AI for Danny Sigman’s GEO 102A/B: Climate: Past, Present, and Future. Students commented on how she helped them gain a deeper understanding of the concepts covered in lecture. She also provided valuable input during the development of class activities and assessments.

For four semesters, Raj Dutta *19 excelled as a lab instructor for Allan Rubin’s GEO103: Natural Hazards. In addition, although not an official AI, he assisted with the GEO 378 Mineralogy course, helping students with Raman spectroscopy.

As an AI for Danny Sigman’s GEO102A/B: Climate: Past, Present, and Future Tori Luu provided invaluable input to activities performed in and out of the classroom. Luu also helped develop and implement a week-long professional development institute on Climate and the Ocean for in-service school teachers, in association with Princeton’s Program in Teacher Preparation.

John Tracey was an AI for Tullis Onstott’s course GEO255: Life in the Universe. According to Onstott, Tracey’s overall dedication to the course and skills as an instructor were truly extraordinary, and he played a particularly pivotal role in organizing and evaluating a student competition.

Raj Dutta *19 was awarded a Carnegie Post-doctoral Fellowship from the Carnegie Science Earth & Planets Laboratory where he is continuing to investigate the behavior and phase transitions of materials at the high-pressure and temperature conditions that exist deep in Earth.

Zachary Garvin, graduate student in the Onstott Lab, received a 2020 Walbridge Fund Graduate Award for Environmental Research. Garvin will use this funding to investigate the extent to which soil microorganisms living in Earth’s harshest environments consume climate-relevant gases such as methane, carbon monoxide and hydrogen sulfide.

AGU selected Katja Luxem, graduate student in the Zhang Lab, as an AGU Voices for Science Policy Fellow. Luxem was also selected as a P.E.O. Scholar by the P.E.O. Sisterhood which supports women pursuing a doctoral level degrees, and received the 2019 Walbridge Fund Graduate Award for Environmental Research from The Princeton Environmental Institute.

Harry Hess Postdoctoral Fellow, Nadir Jeevanjee, received the 2019 James R. Holton Award at the AGU 2019 Fall Meeting. This award recognizes outstanding scientific research and accomplishments by early-career scientists.

The Princeton Environmental Institute recognized, Anne Morel-Kraepiel *01, Research Scholar and Lecturer in PEI and GEO, for leading the 2018-2019 ENV Senior Colloquium. She received a necklace crafted in Kenya that symbolizes “issues of sustainable landscapes, wildlife and people, (and) the nexus of challenges that students and faculty in PEI address in their teaching and in their research.”

Devan Nissan, graduate student in the Onstott Lab, was awarded a three-year 2020 NSF Graduate Research Fellowship. This program recognizes scientists early in their graduate training in Science, Technology, Education and Mathematics (STEM) fields.

Danielle Schlesinger *20 (Myneni Lab) and Jack Murphy (Higgins Lab) were both recipients of 2019 Mary and Randall Hack ’69 Graduate Awards for Water and the Environment. Eunah Han (Zhang Lab) is a 2020 recipient. The award
provides research funding to Ph.D. candidates exploring water and water-related topics in a variety of disciplines.

Xin Sun, graduate student in the Ward Lab, was presented with the 2019 Student Abstract Award by the 6th International Conference on Nitrification. Sun was also invited to be a 2020 Selected Participant at the Dissertations Symposium in Chemical Oceanography XXVII meeting scheduled to take place in October.

The Earth, Environmental and Planetary Sciences Department at Rice University awarded Yuzhen Yan *19 a Poh-Hsi Pan Family Postdoctoral Fellowship. Yan’s research focuses on determining past climates by analyzing air extracted from cores of ancient ice.

Wenchang Yang, Associate Research Scholar in the Vecchi Group, was awarded the 2019 Editors’ Citation for Excellence in Refereeing for Geophysical Research Letters by AGU, recognizing him as an outstanding peer reviewer whose expertise contributes to raising the high standards of AGU’s journals.

AOS graduate student Yi Zhang won an Outstanding Student Presentation award at the 2019 AGU fall meeting for her work with Prof. Stephan Fueglistaler and AOS Senior Meteorologist Isaac Held.

Brazil, for Shell.

Suzan van der Lee *96 co-organized this summer’s inaugural Remote On-line Sessions for Emerging Seismologists (ROSES). Over 100 graduate students from all over the world, including some from Princeton, participated in the online sessions and collaborative spaces - and more than double that number have accessed the recorded content.

What a time for Maribeth Price *95 to be Dean of Graduate Education at the South Dakota School of Mines and Technology! She’s put together a “Teaching Online 101” course for her faculty, and also still teaches an online version of her Intro to GIS course.


Cameron Davidson *91 has been named the Charles L. Denison Professor of Geology, an endowed chair at Carleton College where he has been teaching since 2002.

Paul Jewel *89 is in his 31st year on the geology faculty at the University of Utah. He recently published a well-received memoir about his experiences in the U.S. Navy, “Probe the Ocean, Plow the Sea: A Destroyer Sailor’s Vietnam Era Odyssey.” It can be found on Amazon and Goodreads.

David Hohmann ‘88 still works at the Ohio EPA on hazardous waste and doing watershed restoration. He also does volunteer bike repair and undertakes bike adventures, most recently cycling from Columbus to Cincinnati with his son. Hohmann continues to be fascinated with soil and has been making backyard biochar out of tree trimmings and old Christmas trees.

After a Colorado School of Mines Ph.D. and decades as a professional geologist, Evan Anderman ’88 is now a professional photographer who “…seek(s) to challenge our understanding of the relationship between human development and the natural world.” His aerial photography has been exhibited nationally and internationally, and at his own gallery in Denver’s Santa Fe Arts District. In 2013, Anderman was honored with the inaugural Photo District News Duggal Image Maker Award. Peruse his remarkable work yourself at www.evananderman.com and www.youtube.com/user/EvanAndermanPhoto.

Michael Purucker *83 is leading a team that will place a magnetometer on the upcoming lunar lander Peregrine. Scheduled to launch
Archibald MacMartin ‘1865, the Musical Mineralogist

By Harrison Blackman ‘17

When Princeton geology graduate Archibald MacMartin ‘1865 passed away in 1881, he bequeathed 2,500 minerals to his alma mater. His donation formed a principal component of Geosciences’ teaching collection and successive museum displays in Nassau and Guyot Halls.

However, less known is MacMartin’s fascinating role as the founder of The Musical Review, one of the first independent music periodicals in New York City, part of an early wave of professional music journalism in the United States.

In 1845, MacMartin was born to a wealthy Jersey City family. After attending Phillips Academy Andover, MacMartin studied geology under Arnold Guyot at Princeton. After his 1865 graduation, MacMartin continued his studies at the Columbia School of Mines, earning a master’s degree in 1866 and a mining engineering degree in 1868.

MacMartin spent the next few years traveling Europe, where he probably began collecting minerals, an interest he maintained throughout his life. Upon his return to the U.S., he pursued industries related to mining, establishing a Siemens-Martin Steel Works and zinc furnace in Providence, Rhode Island.

But MacMartin retained a passion for journalism and music. After writing a series of articles on steel processing for Joseph Pulitzer’s New York World, MacMartin became the chief music critic for the popular newspaper. His writing was said to be respected by leading conductors of the day, including Theodore Thomas, a major proponent of classical orchestral music in the U.S.

In October 1879 MacMartin started his own music journalism venture, cofounding The Musical Review with budding music critic Gustav Kobbé, who went on to write the definitive volume on operas of the period. According to the Retrospective Index to Music Periodicals, The Musical Review was a weekly publication of 18 pages; its issues featured articles on music history, reviews of contemporary performances and profiles of musicians.

The Musical Review was groundbreaking in that it was among the first American music periodicals to be financially independent of music publishers and instrument manufacturers. This was possible because MacMartin largely self-funded the venture, without requesting a salary as editor.

Ironically, the independence that distinguished The Musical Review led to its premature demise. With cost outpacing revenue, The Musical Review was forced to merge with The Studio, a publication which focused on the fine arts. In April 1881, MacMartin stepped down, and The Studio and Musical Review ended its 67-issue run shortly thereafter. Tragically, MacMartin died a month later of peritonitis at the age of 36.

At the time, an editorial in a rival journal opined: “The Musical Review has expired, and I mourn its death. Not because it was such a good musical paper but because it was a step in the right direction.”

However, MacMartin’s mineral collection lives on as a valuable teaching and display collection in Guyot Hall, representative of several classic localities in Europe and North America. As Jesse Chadwick ‘08 wrote in a 2009 issue of The Smilodon, “The volume of displayed and display-worthy pieces that came from his gift constitutes the strongest evidence for the quality and preparation of these specimens.”

in 2021, Peregrine will be the first moon lander mission by a commercial company, Astrobotics. The mission will go to Lacus Mortis (the “Lake of Death”) and carry NASA payloads.

Lisa Pratt *82 is the Planetary Protection Officer for NASA and the Office of Safety and Mission Assurance. She oversees the responsible exploration of the solar system by developing efforts that protect the science, explored environments and Earth. This includes preventing forward contamination of another world with life from Earth and backward contamination of Earth with a life-form from another world.

After working at the State Department for 21 years on international water and environment issues, mostly having to do with the Middle East peace process, Chuck Lawson *82 is now Secretary of the U.S. Section of the International Joint Commission. The Commission was established by the United States and Canada under the 1909 Boundary Waters Treaty to assist in monitoring and implementing various aspects of the treaty, in order to prevent and resolve disputes over water issues.

Dave Converse ’77 is now President of the Yellowstone Bighorn Research Association (ybra.org), which runs the Red Lodge, MT facility. Due to COVID-19, this summer’s programs have been suspended for the first time in the camp’s history. Facility upgrades are ongoing, as well as planning for future programs.

Cecil Murray *72 is retired from the Geological Survey of Queensland, Australia which included two years as Acting Director. He led a team mapping the geology of Queensland, which is bigger in area than Alaska! His main interest was in the New England Orogen, a convergent continental margin over 1000 miles long, and encompassing island arc, ophiolite, accretionary wedge, forearc basin and continental volcanic arc rocks of Paleozoic age, as well as younger rocks. Murray was awarded the W.R. Browne Medal for Distinguished Service to Australian Geology in 1998, and the Dorothy Hill Medal for contributions to Queensland geology in 2003.

Allen C. Myers ’65 is busy de-accessioning the rock and fossil teaching collection he started from the Department discard pile outside of Guyot Hall. Some are going to grandchildren, some to local children, and some to his own discard pile. (Note that the Guyot pile still exists and gets added to and taken from!)

Zavis “Zip” Zavodni ’64 continues geotechnical consulting work at mines in the U.S. and Canada, focusing on slope and tailings dam stability. Five years ago, he started a one-man LLC after “retiring” from 43 years with the mining company Rio Tinto/Kennecott. He’s enjoying doing mostly remote work during the pandemic—it’s amazing what can be done with drone technology and WebEx!

Dick Chase *63 reports that he has successfully dodged the coronavirus to date, and wonders if the shape of the new Geosciences building will in any way allude to the “guyot” shape of Guyot Hall.

Paul Mecray ’60 recalls his 1958 summer at the Red Lodge YBRA camp with classmates Ron Barks ’60, Steve Jett ’60, Bob Major ’60 and Bill Bryant ’60, that led to an exploration job with the Atlantic Refining Company (ARCO) headed by Henderson Supplee ’26. But then, geologists were being laid off because “we have all the oil we will ever need and no longer need to look for more.” So Mecray earned an MBA from the University of Pennsylvania and moved to the financial side of ARCO. He helped negotiate the acquisition of Union Oil of California (which failed), and of Richfield Oil just before they discovered Prudhoe Bay (which did not fail!) He then spent 37 years with the Wellington Management Company and has now joined Tower Bridge Advisors where he continues to analyze the oil business. Mecray traces his career back to that 1958 summer and the inspiration of faculty members Erling Dorf, Al Fischer, and Bill Bonini, all of which thoroughly infected him with a love of the outdoors and the challenge of finding oil.

Richard Lanza ’59 (Physics) remembers two alumni Red Lodge trips in the 1980’s and Bill Bonini’s excellence as a leader. His daughter Nina earned a Ph.D. at the University of New Mexico and works with current and future Mars rover missions.

Ray Price *58 and wife Mina have retired to an apartment overlooking the headwaters of the St. Lawrence River in Kingston, Ontario, where they enjoy frequent visits from family. Since his retirement from the Geological Survey of Canada, Ray spends time at his emeritus office at Queen’s University mostly in “reflective contemplation.” But he also enjoys transferring geology from stereoscopic images of the southern Canadian Rockies (where he actually handled rocks long ago) to topographic maps, and drawing structure-sections.
And finally, in 1984, the great bluegrass musician and banjoist Earl Scruggs (1924-2012) needed an answer to the burning question, “where do the Great Smoky Mountains end and the Blue Ridge Mountains begin?” Supposedly, after consulting the “International Directory of Important Geologists And Geophysicists,” the local librarian suggested he contact our then Department Chair Sheldon Judson ’42 (faculty 1955-1987). Read an account of this encounter in the Banjo Newsletter at banjonews.com/1984-11/something_earl_has_wondered_about.html.

The Digital Dahlen

By Aiden Blaser

It’s not often you get a chance to pour over the handwritten notes of a scientist, much less one of the world’s leading seismologists. In the summer of 2018 and the following winter, I did just that with the unpublished notebooks of Professor F.A. (Tony) Dahlen who died in 2007, all too soon, at the age of 64. For me as a college freshman, his handwritten notes were more advanced than I was used to reading, but as I archived them, I gained an appreciation of not only the scientific content in the material I was reading, but also of the habits of mind that drive real science.

Dahlen joined the Department faculty in 1970. While I’ve become well-acquainted with his notes, my understanding of his character as a researcher and educator pale in comparison to that of those with whom he most closely worked. In the words of former graduate student Jeroen Tromp *92, now the Blair Professor of Geology, “Tony really was unique in seismology. He picked his own problems and did them his own way. His position as the foremost theoretician of his generation is unquestioned.”

I personally saw the unwavering perseverance that was a staple of Dahlen’s work. Housed within the Dahlen notebooks are pages of detailed exposition, including calculations and sketches, documenting the meticulous thinking that ultimately led to well over 100 published papers. Every step was justified, even to the point of pasting in photocopied chapters of textbooks for topics he was curious about. After reading the notes, I actually felt I had “earned” the right to read those papers.

Growing up in an age of widespread scientific collaboration and joint paper-writing, it is easy to jump straight to the headlines and conclusions. But when we are able to glimpse the thought processes of such a brilliant researcher, we gain insight into the amount of work involved in scientific discoveries and the scientific method. For me, taking the time to slow down and observe the real, day-to-day application of the scientific method helped solidify my confidence in what I now study, even though it no longer aligns with seismology.

You can see the archives at digitaldahlen.princeton.edu/thenotebooks.html.

For further insights into Dahlen’s career, see the program for the 2007 Dahlen Department Symposium at geoweb.princeton.edu/symposium/pdf/dahlen_program.pdf and the National Academy of Sciences memoir at www.nasonline.org/publications/biographical-memoirs/memoir-pdfs/dahlen-jr-francis.pdf.

Aidan Blaser is a senior at Cornell University studying physics. Many thanks to Professor Simons for mentorship in the course of this project, and to Laurel Goodell *83 for editorial assistance.
Class of 2020 Senior Thesis Titles
Abstracts and full theses can be obtained through the University’s Library at geosciences.princeton.edu/senior-thesis.

Roman M. Ackley
**Holocene Climate Change in Norway: A Multi-Proxy Lacustrine Record from Proglacial Lake Kongressvatnet**
Adviser: Allan Rubin

Sam Bartusek
**Turbulent Influence on the Tropical Tropopause Layer: Global Convection-Resolving Model Study**
Adviser: Stephan Fueglistaler

Udit Basu
**Environmental Effects of Deccan Volcanism During the Late Cretaceous**
Adviser: Gerta Keller

Alexander A. Cavoli
**Seed Theory and ENSO Variability: Re-Evaluating the Distribution of Tropical Cyclogenesis**
Adviser: Gabriel Vecchi

Kiley Coates
**Compost Chemistry: Utilizing Food Waste as a Soil Amendment**
Adviser: Satish Myneni

Charles Copeland
**Coupled Soil Moisture and Plant Water Storage Dynamics**
Advisers: Amilcare Porporato
Satish Myneni

Perrin A. Hagge
**Ca and Mg Fractionation in C3 and C4 Grasses and Their Implications For Reconstructing PaleoDiets and Serving as Biosignatures**
Adviser: John Higgins

Polly Hochman
**Isotopic Analysis of Pb in Trenton Tap Water and the Implications for Constraining Sources of Pb Contamination**
Adviser: John Higgins

Liam P. O’Connor
**Pinpointing the Provenance of Deccan Zircons**
Adviser: Blair Schoene

Calvin Rusley
**Effect of Fe and Oxygen Addition on Methane Release from Temperate Wetland Soil**
Adviser: Xinming Zhang

Elizabeth L. Wallace
**Retention and Loss of Fixed Nitrogen in a Pacific Oxygen Minimum Zone**
Adviser: Bess Ward

Laurie A. Zielinski
**Evaluation of a Handheld Raman Spectrometer for Characterizing Cultural Heritage Materials**
Adviser: Thomas Duffy

Congratulations to all of the members of the Class of 2020 for a job well done!
The Department wishes you all the best. Be sure to keep in touch by updating your information using our Alumni Network at geosciences.princeton.edu/alumni-network. We hope that you have enjoyed your experience as a Geoscience major and look forward to seeing you at Reunions 2021.
Class Day 2020

Sam Bartusek ‘20
was awarded the Arthur F. Buddington Award
for overall excellence in the Earth Sciences. He
also won a Sigma Xi Book Award.

Perrin Hagge ‘20
received the Edward Sampson *1914 Award for
distinguished work in the field of environmental
geosciences.

Elizabeth Wallace ‘20
was awarded the Edward Sampson *1914 Award for
distinguished work in the field of environmental
geosciences.

Laurie Zielinski ‘20
won the Chairman’s Award, which recognizes
special achievement in Geosciences, and a
Sigma Xi Book Award. Zielinski also received the
Frederick Barnard White Prize in Archaeology.

Stacey Edmondson ‘21 and
Ona Underwood ‘21
have each won the Benjamin Howell ’13 Prize for
certainty in junior independent work in the Earth
sciences.

Seismic Activity Recordings

It’s been fifteen years since the 1-component, have-to-check-the-ink-and-change-the-paper-daily drum recorder ceased working, but seismic activity is again being recorded at Guyot Hall. Here, Anna Van Brummen ‘17 installs the 3-component Nanometrics Meridian Compact Digital Seismometer on the isolated slab in the Guyot basement. In addition to earthquakes, the instrument has recorded campus blasts from new dormitory excavations near Poe field. The record from the February 18 blast is shown at right, which subjected Department denizens to about 0.003 of the acceleration due to gravity, according to Prof. Frederik Simons’ calculations. Yuri Tamama ‘22 is analyzing campus data as part of her PEI internship, including decreases in seismic background noise due to the COVID-19 shutdown.

See more on this at www.princeton.edu/news/2020/07/07/campus-seismometers-illustrate-compliance-stay-home-order.

Departmental Honors

Highest Honors
Laurie Zielinski ‘20
Calvin Rusley ‘20
Perrin Hagge ‘20

High Honors
Sam Bartusek ‘20

Honors
Charles Copeland ‘20
Liam O’Connor ‘20
Elizabeth Wallace ‘20

Nominated for Sigma Xi Membership
Alexander Cavoli ‘20
Perrin Hagge ‘20
Calvin Rusley ‘20
Elizabeth Wallace ‘20
DEATHS

Alfred (Fred) T. Anderson Jr. *63
January 15, 2020
news.uchicago.edu/story/alfred-t-anderson-scientist-who-studied-rocks-recreate-volcanic-eruptions-1937-2020

Leslie Coleman *55
July 12, 1019
thestarphoenix.remembering.ca/obituary/leslie-coleman-1075813159

John S. Dickey Jr. *69
October 8, 2019
www.legacy.com/obituaries/washingtonpost/obituary.aspx?n=john-dickey&pid=194402420

Mark Holmes ’60
August 17, 2018
www.ocean.washington.edu/story/In_Memoriam_Mark_L_Holmes

John B. Howe ’48
January 20, 2020
www.conwaydailysun.com/community/obituaries/obituary-john-burnham-howe/article_87c33616-3c7c-11ea-b638-23b48fd2e4ed.html

Rose Rozich Bonini
June 14, 2020
matherhodge.com/tribute/details/1954/Rose-Bonini/obituary.html

We fondly remember Rose Bonini, here with her family at the 2017 memorial celebration for husband Bill Bonini ’48 *49 fac. 1952-96. Rose could be listed as S’48 S’49 S fac. 1952-96 P’79 P’81 P’85 P’91 G’11 — and next to include grandson Sam who this year enters Princeton with the Class of 2024! Back row: Loretta Estabrooks, Megan Bonini, Jack Bonini ’79, Nancy Bonini ’81, Sam Miller, Patti Bonini, Jay Bonini. Front row: Jen Bonini ’91, Keegan Miller, Maggie Miller, and Rose.

UNDERGRADUATE NEWS

We’d like to congratulate the Juniors and Seniors for their special achievements over the past year and to wish all of the graduates well as they continue their careers.

As soon as it is safe to travel, Laurie Zielinski ’20 will head to Moffett Field, CA, to participate in the NAGT/USGS Cooperative Field Training Program. Working in the Geophysics Unit under the direction of Dan Scheirer ’87, she will use gravity, magnetic, paleomagnetic, and electromagnetic methods to address a variety of issues in the western U.S., such as assessment of earthquake and volcano hazards and evaluation of geothermal resources. Zielinski was also awarded a Mineralogical Society of America Undergraduate Prize.

Calvin Rusley ’20 is heading to Caltech this fall to start a Ph.D. in Geobiology. He will be working with Woody Fischer and Victoria Orphan in the Division of Geological and Planetary Sciences.

Perrin Hagee ’20 is taking a year off before entering graduate school in the fall of 2021.

Assuming travel works out, Elizabeth Wallace ’20 will be a research assistant for Dr. Chien-Hsiang Lin at the Biodiversity Research Center, Academia Sinica in Taipei, Taiwan. Wallace will be working on a project investigating growth patterns and isotopic signals in fish otoliths.

In September Sam Bartusek ’20 will begin a Ph.D. in the Ocean and Climate Physics program in the Department of Earth and Environmental Sciences at Columbia University. Bartusek will be focusing on atmospheric and climate dynamics, and will be working with Mingfang Ting *90 and Yutian Wu.

Kiley Coates ’20 has relocated to Durham, NC where she joined LabCorp in Research Triangle Park as a lab technician in their COVID-19 lab. Coates is responsible for ensuring that samples, including those with in-patient priority, are being processed as quickly as possible. She also assists with the receipt of samples and preparation for testing.

Prior to senior year, Levy Nathan ’21 is working as a research coordinator in an orthopedics lab at Rush University Medical Center in Chicago. He assists with writing orthopedic journal articles on techniques for shoulder and knee surgeries and also shadows various surgeries, all to prepare him for the MCAT and his goal of attending medical school.
DEATHS, cont.

John Imbrie ’48
May 13, 2016
blogs.ei.columbia.edu/2016/05/19/
john-imbrie-a-pioneer-of-paleoceanography

Marvin E. Kauffman *60
August 15, 2019
lancasteronline.com/obituaries/dr-marvin-e-kauffman/
article_7332fe6d-3024-5db8-b0a7-7d9126e7e367.html

David MacKenzie *54
May 13, 2019
www.legacy.com/obituaries/denverpost/obituary.
asp?n=david-mackenzie&pid=192873400

Robert L. Major ’60
April 10, 2017
paw.princeton.edu/memorial/robert-l-major-60

Casey Moore *71
March 16, 2020
news.ucsc.edu/2020/03/moore-in-memoriam.html

Fritz Gaylord Nagel ’44
February 02, 2019
usobit.com/obituaries-2019/02/fritz-gaylord-nagel-
february-14-1922-february-02-2019

Michael Dee Piburn *67
June 22, 2020
www.legacy.com/obituaries/azcentral/obituary.
asp?n=michael-dee-piburn&pid=196463585