By Morgan Kelly, Office of Communications

When one is already in possession of the world’s oldest chunk of ice, perhaps it’s only natural to want to go older.

**John Higgins**, a Princeton University assistant professor of geosciences, led a team of researchers who reported in 2015 the recovery of a 1-million-year-old ice core from the remote Allan Hills of Antarctica, the oldest ice ever recorded by scientists. Analysis of the ice showed that the concentration of carbon dioxide in the Earth’s atmosphere was higher than in the oldest ice core previously, which was 800,000 years old. It also confirmed that atmospheric carbon dioxide and Antarctic temperatures have been directly proportional — as one increased so did the other. The ice is stored in Princeton’s Guyot Hall in a freezer kept at -30° C.

But Higgins wants to go further back in time. He and four other researchers returned to the Allan Hills for seven weeks from mid-November to mid-January hoping to come away with even older ice, preferably 1.5 million to 2 million years old. The work is supported by a $700,000 grant from the National Science Foundation.

“We’re currently in possession of some of the oldest ice that’s been dated and we want to push that further,” Higgins said in November, days before he and his team took off for the Allan Hills via New Zealand. Gases such as carbon dioxide and methane trapped in the ancient ice could...
Researchers led by John Higgins (above, holding ice core), a Princeton University assistant professor of geosciences, spent seven weeks in Antarctica drilling for ice cores over 1 million years old, which would be the oldest collected. The ice could provide a snapshot of how Earth’s climate was—and what it may become. Photo by Preston Cosslett Kemeny, Department of Geosciences

Preston Cosslett Kemeny ’15, a research specialist in the Department of Geosciences who was in Antarctica for the first time, carries an ice auger and marker flags. The invaluable research experience of being in the field in Antarctica comes at the cost of spartan living in a harsh, isolated environment. “It’s stunningly beautiful and there’s a tremendous amount of science to be done,” said Kemeny, who received his bachelor’s degree in geosciences from Princeton in 2015. “But it needs a lot of logistical support.” A plane from McMurdo Station delivered supplies to the camp each week, weather permitting. Photo by Sean Mackay, Department of Geosciences

GS Yuzhen Yan, on his first trip to the southern continent, packs a shipping container with snow to insulate the ice cores and prevent them from melting in transit. The white box weighs nearly 200 pounds and contains nine core segments measuring approximately 30 feet altogether. Despite the all-day sun of the Antarctic summer behind Yan, exposed skin can become frostbitten or, to a lesser extent, frost “nipped” in a matter of minutes. “To do deep fieldwork in Antarctica, you have to be pretty scientifically motivated,” said Higgins, for whom it was his third trip to Antarctica. “It involves long time commitments in less than ideal conditions.” Photo by Preston Cosslett Kemeny, Department of Geosciences

provide clues about conditions on Earth in the distant past—and what they could be in the future if greenhouse gas emissions continue to rise.

Higgins traveled with research specialist Preston Cosslett Kemeny, graduate student Yuzhen Yan, postdoctoral researcher Sean Mackay from Boston University, and drill operator Mike Waszkiewicz of the U.S. Ice Drilling Program. The five men endured the harsh open ice shelf, camping an hour flight by prop plane from McMurdo Station, the research center on the Ross Ice Shelf operated by the National Science Foundation.

Temperatures hovered around -15º C, despite it being the height of the Antarctic summer. Winds sustained a speed of 25-30 miles per hour, slightly less than a tropical storm. Storms lasted five days straight and left behind drifts 12 feet tall.

The photo and video essay published in this article captures the researchers’ experience in one of the world’s most unforgiving places, and explains the techniques and significance of their work.
The researchers’ camp was located in the Allan Hills, about 130 miles northwest of the National Science Foundation’s McMurdo Station research center. The team spent two weeks at McMurdo safe-checking their equipment and gathering supplies. The initial journey to the camp was done in four one-hour trips by plane, moving a total of four tons of goods and gear. The drill and associated equipment alone weighed about one ton. Illustration by Maggie Westergaard, Office of Communications.

These bubbles, several mm in diameter and tinted by Antarctic sunlight shining through the orange field tent, contain trapped ancient air, approximately 1% of which is argon. Using a technique developed by Michael Bender, faculty emeritus and Higgins’ former postdoctoral adviser, researchers date the ice by comparing the abundance of the three stable isotopes of argon — $^{36}$Ar, $^{38}$Ar and $^{40}$Ar — in the trapped air bubbles to isotopic abundances in the modern atmosphere. Because $^{40}$Ar, but not $^{36}$Ar or $^{38}$Ar, is continually added to the atmosphere through volcanic emissions from Earth’s interior, samples of ancient air contain less $^{40}$Ar, but the same amount of $^{38}$Ar and $^{36}$Ar, as the modern atmosphere. The greater the deficit of $^{40}$Ar in the ancient sample, the older the air, and thus the older the ice. Photo by GS Yuzhen Yan, Department of Geosciences.

The Princeton team camped for seven weeks on the barren blue ice of the Allan Hills. Strong winds here scour away ice at the surface, bringing up ancient ice from the depths like a giant conveyer belt. “We’re letting the glacier do the work for us by bringing the old ice to the surface,” Higgins said. For the same reason, blue-ice areas such as the Allan Hills have long been studied for their extraordinary accumulation of meteorites. Photo by Preston Cosslett Kemeny ’15, Department of Geosciences.
The researchers returned to one of the drill sites after the days-long storm to find that their work tent had been destroyed. In the photo above, geosciences graduate student Yuzhen Yan stands ready to dig out the drilling equipment. The researchers ultimately obtained three ice cores: two that are 98 and 205 meters long, and a 20-meter core from the same drill hole as the million-year-old core. Altogether, the cores weigh 4.5 tons. Packed in individual freezer chests, the ice samples will arrive in the United States from Antarctica in April via Los Angeles, then be shipped to the National Science Foundation’s National Ice Core Laboratory in Denver. Higgins and his team will begin determining the age of the ice cores in early summer, examining 500 grams of ice per day — or 14 to 15 centimeters of ice core at a time. “If things go well, by next winter we’ll have a good idea of how old the ice is,” Higgins said. Once the age of the ice is determined, the researchers will work with collaborators to measure the composition of chemicals such as carbon dioxide and methane.

The team had three drill sites that they traveled to by snowmobile, hauling the drilling equipment and tent between sites. The team spent all day at the drill site, monitoring the stop-and-start process while trying to stay warm. Only two or three other research groups undertake this kind of fieldwork, said Higgins, shown above carrying a drill bit filled with an ice core. “It’s a minority who have deep-field camps and a smaller minority doing their own drilling out there,” he said.

The work Higgins published in 2015 showed that when deployed in the right location drilling shallow cores 100-200 meters long could retrieve the old ice scientists need to understand Earth’s past climate without drilling several kilometers into the ice sheet. Higgins and his colleagues came away with the million-year-old ice after drilling 128 meters. The researchers particularly want to go further back in time now to understand a period more than 1 million years ago when ice ages occurred every 40,000 years as opposed to the 100,000-year cycle of the past 800,000 years. “That’s a massive change in Earth’s climate system,” Kemeny said.

Photo by Preston Cosslett Kemeny ’15, Department of Geosciences

Photo by GS Yuzhen Yan, Department of Geosciences
Princeton Women in Geosciences (PWiGS) is a student and postdoc led group with the goal of providing a support network for young scientists as they navigate careers in the Geosciences. PWiGS places particular emphasis on assisting women in this regard, however most of our programming is open to and attended by men and women. Current PWiGS activities include: a dinner series with visiting female scientists, a mentoring program, writing and presentation workshops, as well as social mixers. During these events, we have heard about the diversity of choices and experiences that women in the sciences face, and discussed a variety of topics ranging from personal to professional. Now in our third year, we continue to modify the PWiGS mission and programming based on feedback from participants. One of the surprising findings of the past two years has been the general outpouring of enthusiasm by both men and women for events focused on the ‘behind the scenes’ aspects of navigating a scientific career — finding and applying for jobs, forming collaborations, as well as choosing between research universities, small liberal arts colleges, and independent or government research institutes. While not our initial goal, this has emerged as a beneficial service provided by PWiGS. With this in mind, we hope to include this type of advising and mentoring more directly in the PWiGS mission, an effort that we think benefits members of the Princeton Geosciences community.

Listed below are the PWiGS Dinner Series and Workshop speakers that were hosted in 2015 and 2016.

- Lara Wagner, Carnegie Institute of Washington
- Rita Colwell, University of Maryland
- Joanie Kleypas, University Corporation for Atmospheric Research
- Clara Deser, National Center for Atmospheric Research
- Erika Marín-Spiotta, University of Wisconsin-Madison
- Mary-Louise Timmermans, Yale University

Faculty panel discussion at “Diversity in Science: A Conversation” a joint event hosted by Princeton Women in Geosciences (GEO) and the Women in Science Partnership (EEB). Photo credit: Dr. Johanna Goldman ’15.

Geosciences T-Shirts Sale

The Department of Geosciences is offering the purchase of Princeton Geosciences t-shirts through the mail for $25 each. There are small, medium, large, and extra large shirts in three different color selections available. Each shirt features a vintage 1970s department illustration of the Smilodon and traditional Princeton varsity lettering. To order fill out the coupon specifying quantity, size, and colors, and send along with a check or money order to the address provided.

Proceeds to benefit the Princeton University Geosciences Society

Geosciences T-Shirt Order

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Total: $ ________
Continuing a long tradition, Geoscience graduate alumni are planning a geologic field trip for June, 2017. Scott Wood '85 will lead the trip to Eastern Washington, Northern Idaho, and Western Montana. Geologic highlights under consideration include the Columbia River Basalts, Channeled Scablands, Clarkia fossil beds, Idaho star garnets, the Cour d’Alene mining district, and environmental and mining sites near Butte, Montana. There will also be visits to cultural attractions such as Washington and Idaho wineries, Native American sites, the Cataldo Mission, and historic mining towns. Selection of localities and logistics are still in progress. The trip is expected to last five to seven days. Dates, an itinerary, and preliminary cost estimate will be available shortly.

Graduate alumni considering attending, or those who want to learn more about the trip, should contact Scott at Scott.Wood@ndsu.edu, with a copy to Lincoln Hollister at Linc@princeton.edu. All graduate classes and spouses/partners are welcome. Early expressions of interest would be appreciated, and will help in planning the trip.
Welcome back paleontologist Jack Horner

On November 18, 2015 the department was pleased to welcome back paleontologist Jack Horner, who gave a special seminar in Guyot on “Dinosaur Evolutionary Patterns, or Why it was Good to Get Rid of the Princeton Paleontology Collection.” He also gave a Princeton Public Lecture entitled “Dinosaurs of the Past, the Present, and the Future.”

Jack came to Princeton in the 1970’s to work with Dr. Donald Baird in Natural History Museum then housed in Guyot Hall. Don was curator of the museum from 1973-1988; a fascinating retrospective of Don’s work has recently been published in Atlantic Geology, v. 49, journals.lib.unb.ca/index.php/ag/article/view/atlgeol.2013.004. Jack left Princeton in the early 1980’s for Bozeman, MT where he is currently Curator of Paleontology at The Museum of the Rockies, and Regents Professor of Paleontology at Montana State University.

Soon, however, Jack is “retiring” to Seattle and the University of Washington, Seattle, where a new museum is being constructed to house his Hell Creek formation specimens. Jack will also teach at Chapman University in Orange, California.

Jack’s research covers a wide range of topics about dinosaurs, including their behavior, physiology, ecology and evolution. He discovered the first dinosaur egg nests in the Western Hemisphere, the first evidence of dinosaur colonial nesting, the first evidence of parental care among dinosaurs, and the first dinosaur embryos. The main character in the book and film Jurassic Park is partly based on Jack, and he served as scientific consultant for all the Jurassic Park/Jurassic World films. Jack has written nine books including his latest entitled “The Theory of Dinosaurs” (Princeton University Press).

And now for a bit of history about Guyot Hall and dinosaurs:

• Until 1988, the space now occupied by the Princeton Environmental Institute (PEI) was the Natural History Museum and filled with displays, half GEO-related and half EEB-related.
• The Museum was substantially dismantled in the late 1980’s and most of the vertebrate collection was donated to the Yale Peabody Museum. Other specimens went to the New Jersey State Museum, while the department retained some of the collection for display, including the Allosaurus, the duckbill dinosaur nest, and skeletons of juvenile and hatchling dinosaurs.
• In 2008, the Geosciences Library moved across Washington Road to the newly constructed Lewis Library, where it was merged with the astrophysics, biology, chemistry, geosciences, mathematics, physics and statistics libraries into a combined collection.
• Guyot’s library wing was gutted and reassembled as the current suite of teaching labs and offices. The PEI offices were built around the Allosaurus, which still presides over activities in Guyot Hall.

Led by PUGS, the Department goes to Iceland

From May 19-26, members of the department will be on a field trip to Iceland! The group of 34 undergraduates, graduate students, and faculty/staff will be following an itinerary developed by members of the Princeton University Geosciences Society (PUGS), and teams of undergraduates and graduate students have compiled the trip guidebook. Stops include Thingvellir, where the mid-ocean ridge emerges from the sea; Heimaey Island (Vestmannaeyjar), where the 1973 eruption of the Eldfell initiated the largest-ever attempt to divert lava flows; and the original Geysir; microbe-rich hot springs and spectacular waterfalls. In preparation for the trip, participants met weekly during the spring semester for talks on the geologic processes at work in Iceland and sites that will be visited. The motivations behind the trip are a desire to foster community within the Department and the recognition that field trips are inspirational and educational opportunities to see the world beyond the classroom. The group will return in time for the Department’s Reunions reception, where a slideshow of the trip will take center stage. PUGS members are excited about the trip to Iceland and the prospect of making departmental field trips a regular component of the Geosciences experience at Princeton.
FROM THE CHAIR

As spring finally arrives, even though temperatures remain stubbornly cool in Princeton, we enjoy the flowering trees and the spring green leaves reminding us of the end of another school year. Many members of the Princeton Geosciences Department are heading out for a departmental field trip to Iceland, and will return in time for Reunions to report fully on their adventures. We'll have the full story in next year's Smilodon! Closer to home I am happy to report on some of the departmental adventures over the past year.

Congratulations to Blair Schoene upon his promotion to tenure! Blair received the good news in January and his appointment officially begins in July 2016. Blair and his team continue to blaze new trails through REALLY old rocks (Blair’s new geochronology laboratory was featured in the lead article in the Smilodon Spring 2012, and some of his recent field work in the Smilodon Fall supplement 2015).

We salute Sheryl Ann Robas, our indefatigable Undergraduate/Graduate Administrator, who was honored at the 2016 Employee Service Recognition Luncheon for her 35 years of service to the University. We count ourselves lucky that she has spent most of that time with Geosciences. Sheryl is without a doubt THE MOST IMPORTANT PERSON to most of our graduate and undergraduate students, the person who makes their time in the department productive, useful and fun. I will add my thanks to theirs, for all of Sheryl’s hard work and devotion over the years.

Laurel Goodell *83, our Undergraduate Lab Manager, was recognized for 20 years of service. Laurel is the intrepid coordinator and supporter of our geology introductory courses, the organizer of countless class field trips and laboratories. And we can also thank her for many diverse efforts on behalf of the Smilodon readers, for her work on many of the columns and sections of this publication.

And speaking of service, we said goodbye this year to Bob Koenigsmark, our long time safety and facilities manager. Bob wore so many hats in the department, that not only are we at a loss to know what to do without him, we fear that finding someone to fill his shoes will be impossible. Thanks to Bob for meeting every conceivable challenge from laboratory floods to foreign shipping to rock storage to safety training to finding space for people and instruments to you name it. We hope that he enjoys a long and happy retirement, and I’m sure he is not missing those frantic phone calls. He probably is happy NOT hearing from me!

We also bid farewell and best wishes to David Medvigy, who is moving to Indiana to accept a tenured professorship in the Department of Biological Sciences at Notre Dame University. Congratulations, David! We will miss you!

Jorge Sarmiento was celebrated on the occasion of his 70th birthday at a symposium in his honor. The symposium “Modeling a Living Planet” was held on campus in March and featured two days of presentations by current and former colleagues, students and post docs from Jorge’s many years of leadership in ocean biogeochemistry.

Under the energetic leadership of Adam Maloof, our Undergraduate Department Representative, our undergraduate curriculum continues to evolve in tune with the leading edge of geosciences research and teaching. Adam is the faculty contact for PUGS, the Princeton University Geosciences Society (see their report this issue). Among many other activities this year, PUGS sponsored a charity run in conjunction with the Greater Philadelphia Chapter of the ALS Association in honor of our talented and greatly missed Finance/Grants Manager, Theresa Autino. The day, 16 April, was...
brilliant if cold, and urged on by the enthusiasm and organizational skills of our Administrative Assistant Mary Rose Russo, 60-odd people ranging in age from 13 to “you don’t need to know”, and including many undergrads, graduate students, faculty and staff, ran the 5K course around campus. Many thanks to PUGS for sponsoring the event, and to all the volunteers who helped Mary Rose put on a memorable and worthwhile event.

The evolution of our curriculum reflects the interests of our students and the expertise of our faculty in the two main areas of the department, the Solid Earth and the Environmental Geosciences. In response to the overwhelming importance of climate change in the modern world and the central role of Geosciences in understanding climate past and present, Danny Sigman has developed a new introductory course in Geosciences, “Climate: Past, Present and Future”. The course attracted 122 students the first time it was taught in fall 2015, and already 175 students have enrolled for Fall 2016. We appreciate the hard work and creative dedication of Danny and lab coordinator Danielle Schmitt in the success of this new endeavor.

Climate is an area of growing research interest across the campus, and it has long been one of the strengths in Geosciences. We are currently in the process of adding to our faculty in this area. Stay tuned for new appointment news in future Smilodon issues.

Last year we announced the creation of two new funds intended to support field work by our students. I thank all of those who have contributed (see table for information on the funds); we

Over the past year, the Department of Geosciences has received donations for our Geosciences Student Research Fund (undergraduate and graduate) and our Geosciences Graduate Research Fund (graduate students only). We are very grateful for the generous support we have received from our alumni. Thanks to these initial donations, we can now begin to make awards to our students. A faculty committee will be soliciting requests for funding from Geosciences students for their research and field trips and will make awards based on the merit of the proposals and the amount of available funds.

The Geosciences Student Research Fund (GSRF) was announced in the Smilodon in May 2015. The GSRF will support both graduate and undergraduate research opportunities in the Department of Geosciences. These funds will allow students to pursue research topics that are of most interest to them, independent of the availability of federal grant funding. The GSRF will help students to investigate the most promising avenues of science and undertake entirely new, and unproven, areas of research that may be too speculative to receive government funding. This support might also supplement grant funding by serving as seed money to pursue related new ideas and proposals. Students may apply to use the funds for purposes that include, but are not limited to, field research, ocean voyages, Arctic/Antarctic research trips, lab analysis and computational studies.

A second fund, the Geosciences Graduate Research Fund (GGRF) will support graduate student research with an emphasis on field work, including graduate student led group expeditions. At least 50% of the funds allocated every year will be committed to field work, unless the applications for field work support do not reach that level.

For further information, please contact Nora Zelizer (nzelizer@princeton.edu) or Bess Ward (bbw@princeton.edu). The fund will be administered and managed by and used to benefit solely the Department of Geosciences students.

The Department of Geosciences gratefully acknowledges donations over the past year given in honor of the following former Geosciences faculty members:

William Bonini
David Crerar
Robert Hargraves
Sheldon Judson
Jason Morgan
John Suppe
We are pleased to announce the awards presented at Class Day 2015

Arthur F. Buddington Award
Yuem Park '15

Edward Sampson, Class of 1914
Prize in Environmental Geosciences
Preston Cossett Kemeny ‘15

Benjamin F. Howell, Class of 1913,
Junior Prize
Claire Zarakas ‘16

Chairman’s Award
Tiffany Cheung ‘15

Sheldon Judson ’40/William E. Bonini ’48
Teaching Award
Joan Cannon ’15

Sigma Xi Book Award
Preston Cossett Kemeny ’15

Sigma Xi Membership Nominated
Yuem Park ’15,
Preston Cossett Kemeny ’15
Leticia Bombieri ’15

Congratulations to all for a job well done!
Stay tuned for the next “Smilodon” to find out
the recipients of the Class of 2016 Awards.

2016 Princeton Events

GSA Annual Meeting, Denver, CO
September 25-28

Events honoring Lincoln Hollister (faculty emeritus)
• Field trip 402: A Visit to the Regional Aluminum Silicate Triple-Point Metamorphic Rocks of Northern New Mexico: A Field Trip to Honor the Career Contributions of Lincoln Hollister to Petrology and Tectonics, September 21-24, led by Chris Daniel (Hess Fellow, 1998-2000), Chris Andronicos *99 and Ruth Aronoff. For more info go to community.geosociety.org/gsa2016/science-careers/fieldtrips#collapse2
• Technical Session T155: Fifty Years of Innovation in Petrology and Orogenic Systems: A Tribute to Lincoln Hollister, organized by Harold Stowell *87 and others (date and time TBA).

Princeton/YBRA alumni reception
Monday Sept 26, 7-9:30 pm
(location TBA)

AGU Annual Meeting
San Francisco, CA,
December 12-16
Alumni reception
(time and location TBA)

We deeply appreciate your dedication and continued interest in and support of our students. The funds have already made a difference in providing opportunities for our students, and some of their work and experiences supported by these funds will be highlighted in future issues. For more information about the funds, please contact Nora Zelizer (nzelizer@princeton.edu) or Bess Ward (bbw@princeton.edu).

UNDERGRADUATE NEWS

Check out the exciting adventures on which the GEO Undergrads will be embarking over the coming year:

Kate Begland ’17 has been awarded a Grand Challenges summer internship, offered through the Princeton Environmental Institute (PEI). During this internship, she will investigate how increasing atmospheric carbon dioxide and increasing temperature may affect mixed layer depth and the distribution of carbon in the Southern Ocean. The Southern Ocean has a profound influence on global climate and changes in Southern Ocean circulation and productivity are projected to have a significant influence on future climate trends. Kate will be working with Prof. Jorge Sarmiento to help to determine how changes in circulation and productivity might affect circulation and future climate.

Kellie Swadba ’17 is heading to Canberra, Australia where she will spend the summer working with Paul Tregoning at the Australian National University’s Geodynamics and Geodesy group of the Research School of Earth Sciences. Tregoning’s group uses geo-technical tech-
Over the past year, our undergraduates have performed exciting research!
Below is a list of the titles of the
Senior Theses of the Class of 2016
Want to learn more? You can obtain the abstracts, and even full theses, by visiting the following website (provided by the University’s amazing library system) and searching by the student’s name.
rbsc.princeton.edu/mudd

Ryan Barker
U-Pb TIMS-TEA GEOCHRONOLOGY AND A NEW CHRONOSTRATIGRAPHY FOR THE CAÑADON AASFAITO BASIN, CENTRAL PATAGONIA
Adviser: Blair Schoene

Rebecca Lowy
IRON AND MANGANESE CO-ADSORPTION OF ARSENIC, AND POTENTIAL OF Fe-Mn NANOCRYSTALLINE COATED CALCITE GRAINS FOR FILTRATION OF DRINKING WATER
Adviser: Satish Myneni

Alyson Beveridge
MEASURING THE CHANGING MASS OF GLACIERS ON THE TIBETAN PLATEAU USING TIME-VARIABLE GRAVITY FROM THE GRACE MISSION
Adviser: Frederik Simons

Weber Liu
ANALYSIS OF MARTIAN TOPOGRAPHY VIA A PARAMETERIZED SPECTRAL APPROACH
Adviser: Frederik Simons

Ethan Campbell
WHERE THREE OCEANS MEET: NITRATE ISOTOPE MEASUREMENTS FROM THE SOUTH ATLANTIC ALONG 34.5°S
Adviser: Danny Sigman

Sophia Myers
AN INTER-TROPHIC EXAMINATION OF NITROGEN ISOTOPES IN THE NORTH ATLANTIC
Adviser: Bess Ward

Alison Campion
CONSTRAINING THE TIMING AND AMPLITUDE OF PROPOSED GLACIOEUSTASY DURING THE LATE PALEOZOIC ICE AGE WITH A CONTINUOUS CARBONATE RECORD IN SPAIN
Adviser: Adam Maloof

Evan O’Brien
A MULTIPLE STRESSOR MODEL OF CLIMATE CHANGE EFFECTS ON GROWTH AND SURVIVAL OF LARVAL CRASSOSTREA GIGAS
Adviser: Jorge Sarmiento

Shanna Christian
ABANDONED OIL AND GAS WELLS IN PENNSYLVANIA: WELL ATTRIBUTES AND EFFECTIVE PERMEABILITY
Adviser: Michael Celia

Anteneh Sarbanes
LONG TERM DROUGHT SIGNATURE OF STANDARDIZED VEGETATION INDEX
Adviser: Eric Wood

Jay Dessy
TOWARDS QUANTIFYING THE RISK OF COMPOUND HEAT WAVE EVENTS: PROJECTIONS OF FREQUENCY AND SEVERITY
Adviser: Michael Oppenheimer

Anjali Taneja
AN EXAMINATION OF CLIMATE VARIABILITY AND INTERNATIONAL MIGRATION IN SUB-SAHARAN AFRICA
Adviser: Michael Oppenheimer

Collin Edwards
MINING METAGENOMIC DATA TO UNDERSTAND THE LIFESTYLE OF ATMOSPHERIC METHANE OXIDIZING BACTERIA IN ANTARCTIC SURFACE SOIL
Adviser: T. C. Onstott

Ethan Vasquez
A PHYSIOLOGICAL APPROACH TO DETERMINING ECOSYSTEM PRODUCTIVITY IN THE ARCTIC
Adviser: Michael Bender

Atleigh Forden
RECONSTRUCTING FISH ECOLOGY FROM OTOLITH GEOCHEMISTRY: PAST AND PRESENT
Adviser: Bess Ward

Fiona West
THE HERBIVORY COST OF N\textsubscript{2} FIXATION AND ITS EFFECT ON THE ABUNDANCE OF NITROGEN FIXING TREES IN A TROPICAL FOREST
Adviser: David Medvigy

Claire Zarakas
PROPAGATING UNCERTAINTY FROM PLANT TRAITS TO ECOSYSTEM DYNAMICS IN A DRY TROPICAL FOREST
Adviser: David Medvigy

Congratulations to all of the members of the Class of 2016 for a job well done!
The Department wishes you well and is excited to hear where your careers take you, so be sure to keep in touch! Best of luck with your future endeavors. It’s truly been a pleasure working with you and we hope that you have enjoyed your time in Guyot!
niques, (e.g. data obtained from satellites such as GRACE) to investigate changes in Earth’s surface resulting from ice mass changes resulting from changes in climate and deformation due to tectonic and tidal deformation.

Adrian Tasistro-Hart ’17 will spend June with Profs. Adam Maloof and Blair Schoene performing field work in Bolivia. Adrian will be continuing a study he began last year, in which he is investigating the cyclostratigraphy of a cretaceous lacustrine system. Upon his return, he will head to Boulder, CO to with work Dr. Carrie Morrill of NOAA’s Paleoclimatology laboratory and with Dr. Clay Tabor at the National Center for Atmospheric Research (NCAR). He will be using outputs of General Circulation Models for the late Cretaceous to model the lake system in Bolivia.

Vivian Yao ’17 will be returning to the Bermuda Institute of Ocean Sciences (BIOS) to conduct experiments with a graduate student from Prof. Danny Sigman’s research lab. The project entails culturing corals, which will be brought back to Princeton, where Vivian will measure their nitrogen and carbon isotopic signatures to gain information on coral feeding behavior and the symbiotic relationship with coral polyps and zooxanthellae (autotrophs that live within coral polyps). The findings will contribute to the just-emerging scientific conversation of whether nutrient level variation (caused by increased vertical ocean water mixing, a possible result of rapid climate change) could threaten the future of coral reefs.

Paul Yi ’17 has been selected as a PEI Environmental Scholar, an honor that rewards student who have shown exceptional promise in their academic coursework. Paul will be working with Dr. Sonya Legg at the National Oceanographic and Atmospheric Administration’s Geophysical Fluid Dynamics Laboratory. Ocean mixing affects the global overturning circulation, which then impacts Earth’s climate by affecting the ocean’s heat and carbon storage as well as its sea level. However, mixing occurs on such small spatial scales that their effects are added separately into climate model simulations through parameterizations. Using numerical simulations, he will improve these parameterizations by investigating how tidally-driven ocean mixing, resulting from the breaking of internal waves, is affected by changes in latitude and by bottom topography.

This summer, Ryan Barker ’16 will begin working at H2C in Manhattan. H2C is an independent, health care-focused, strategic advisory and investment banking firm.

As a Princeton in Asia Post-Graduate Fellow, Alyson Beveridge ’16 will spend the next year in Nan, Thailand teaching English through theater and music.

This coming fall, Ethan Campbell ’16 will continue his studies by enrolling as a Ph.D. candidate in the School of Oceanography at University of Washington.

Shortly after graduation, Shanna Christian ’16, will head to Platteville, CO to begin her Geological career as a wireline engineer with Schlumberger.

Anjali Taneja ’16 will serve as an Intramural Research Training Award Fellow at the National Institutes of Health (NIH). She will be working on clinical genomics and public health studies within the National Human Genome Research Institute (NHGRI).

Upon graduation, Claire Zarakas ’16, will venture to Cambridge, MA to work as a Climate Change Research Assistant for Abt Associates, a firm that works with federal and state government agencies to improve the quality of life and economic well being of people worldwide.

**ALUMNI NEWS**

Christine Y. Chen ’13 is a Ph.D. student in the MIT-WHOI Joint Program studying paleoclimatology. She was recently named a National Geographic Young Explorer and a Mamont Scholar of the Explorers Club, for her research reconstructing past rainfall patterns from ancient lakes in the central Andes.

After 5 years at the University of Nevada, Reno, Sean Long *11 is now Associate Professor of Earth Science at the School of the Environment, Washington State University. He works on orogenic systems and has active projects in the Bhutan Himalaya, the U.S. Cordillera in Nevada and Utah, and the Bolivian Andes. He teaches structural geology, field camp and graduate classes on tectonics.

Katy Barnhart ’07 is currently a postdoc at the Annenberg Public Policy Center of the University of Pennsylvania. Her recent article “Mapping the future expansion of Arctic open water” in the journal “Nature Climate Change” is also reviewed in the “New Yorker” magazine. (www.newyorker.com/tech/elements/a-new-map-of-the-arctic)
**2016 Ph.D. Recipients and Dissertation Titles**

**Blake Dyer**
*Stratigraphic Expression and Numerical Modeling of Meteoric Diagenesis in Carbonate Platforms During the Late Paleozoic Ice Age*
Adviser: Adam Maloof

**Johanna Goldman**
*Environmental Factors Influencing Phytoplankton Productivity in the Context of Climate Change*
Adviser: Francois Morel

**Anne Gothmann**
*Fossil Corals as Archives of Secular Variations in Seawater Chemistry*
Adviser: Michael Bender

**Xuefeng (Nick) Peng**
*Nitrogen Cycling in Strong Redox Gradients of Marine Environments: Oceanic Oxygen Minimum Zones and Salt Marsh Sediments*
Adviser: Bess Ward

**Jahnavi Punekar**
*Planktic Foraminifera Extinctions and Delayed Biotic Recovery in the Late Maastrichtian-Early Danian: Link to Global Environmental Catastrophes?*
Adviser: Gerta Keller

**Brandon Stackhouse**
*The Effects of Physical and Biogeochemical Changes on Carbon Emissions from Mineral Cryosols from the Canadian High Arctic*
Adviser: T. C. Onstott

**Xingchen (Tony) Wang**
*Nitrogen Isotopes in Scleractinian Corals: Modern Ocean Studies and Paleoceanographic Applications*
Adviser: Danny Sigman

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**David Bartels ’06** is finishing his medical residency at Massachusetts General Hospital in Boston and pursuing a specialty in pediatric anesthesiology.

**Naomi Levine ’03** is Gabilan Assistant Professor of Biological Sciences and Earth Sciences at the University of Southern California. She was recently selected as a 2016 Alfred P. Sloan Foundation Research Fellow “in recognition of distinguished performance and a unique potential to make substantial contributions to (her) field.”

At the end of March, **Bill Langin ’99** moved from his role at Shell as Exploration Manager in Petroleum Development Oman, to General Manager at Queensland Gas Company in Brisbane, Australia — a company Shell obtained in the recent merger with British Gas.

**Andy Lecuyer ’98** lives in Louisville, CO and works as an executive in the TV industry for Dish Network and enjoys exploring Colorado’s mountains on skis, bike, and feet. He keeps up with **Sarah Albano ’98** who is an engineer with Integral Consulting, Inc.

**Julie Polhemus ’95** works seasonally for the National Outdoor Leadership School (NOLS), instructing backpacking courses in the North Cascades, the Adirondacks, and north of the Arctic Circle in Sweden and Norway. Her essay, “Mountains to Climb” was featured in the April 2016 issue of Brain, Child magazine.

**Arielle Levine ’95** is on the faculty of the Department of Geography at San Diego State University. She recently coauthored a study in Science on how social indicators influence the goals of sustainability.

After many years in oil & gas, in 2012 **Cecily Kovatch ’94** moved over to renewables. She is currently Senior Director of Ash Reuse & Innovation at Covanta Energy, the world’s largest waste-to-energy company, where she leads an effort to reuse the ash produced by power plants. She feels she is back to her geology roots as she looks at ash, gravel, aggregate and precious metals every day! Cecily also enjoys volunteering, speaking at “Women in STEM” events and researching the latest in fitness and nutrition.

**Cam Davidson *91** is Professor of Geology and Director of the Interdisciplinary Science and Math Initiative at Carleton College. He and John Garver (Union College) recently published a paper in the “American Journal of Science” that summarizes much of their work in Alaska, with an emphasis on the detrital zircon story and what it tells about Cordilleran terrane translation. Spoiler alert: the rocks came from southern California! To learn more about this work, much
trachytic rocks, studies of Archean diamonds that imply early plate tectonics, Corsican blueschists and continued work on anorthosites. Lew invites old and new friends and colleagues to contact him at Lewis.Ashwal@wits.ac.za.

Wayne Lau '79 has joined the Centre for Sustainable Development at the Department of Engineering at Cambridge University as a Visiting Researcher.

Trevor Forde '74 has a research vessel based at Indiantown Marina, FL that is available for exploring coastal waters from Florida south to Cuba, St. Vincent and the Grenadines. He is currently teaching aviation to a special needs high school group at Bergen Community College in Paramus, NJ and starting a company that involves cultural exchange, coastal exploration, and student mentoring. A ride in the Frasca G 1000 Cessna 172 is open to all; contact Trevor at 4capntnt@gmail.com.

After a career in the oil and gas industry, in 1994 Wayne D Pennington, '72 moved to Michigan Technological University where he served as chair of the Department of Geological and Mining Engineering and Sciences and is now Dean of the College of Engineering. He also spent 2009-10 in Washington, D.C. as a Jefferson Science Fellow with the U.S. Department of State and the Agency for International Development, and in 2012 served as president of the American Geosciences Institute (AGI).

J. David Bukry '67 is enjoying his USGS Scientist Emeritus status in Menlo Park, CA.

Donald Burt '65 is completing his 41st year of teaching geology at Arizona State University.

Alexander Williamson '61 *62 reports on a wonderful trip to Hawaii during which he and his wife flew via helicopter over Kilauea (in eruption since 1983). It was in one of its “quieter” phases and only slowly oozing through one of its vents, but they were quite pleased to keep it at a respectful distance.

Ken Deffeyes *59 (faculty emeritus) enjoys his “seven-day weekends” and has published four books since retiring. Three were about Hubbert’s analysis of the world oil supply — world oil production peaked right on schedule, the price of oil shot up and from what little he learned in undergraduate economics, he expected a higher price to match a lower supply. Nope, the world economy collapsed and Ken went out of the oil business. His latest book Nanoscale: Visualizing an Invisible World (MIT Press) is by Deffeyes and Deffeyes; it includes wonderful illustrations by
son Stephen and extended captions by Ken. Several smaller projects have clarified things Ken did not fully understand as a student. One was using a card-stock solar compass constructed by daughter Emma’s fourth graders to “shoot a solar” and find an accurate north. Another was celestial navigation of a ship; the traditional reduction of star sights uses a least squares reduction, but Ken has worked out a least-absolute-value method, which he remembers being suggested by Jon Claerbout, a Guyot visitor in the 1970’s. He is currently struggling with the digital equivalent of a draftsman’s French curve.

Jay Lehr ’57 is still working full time as Science Director of the Heartland Institute, a free market think tank. His career has included writing, co-writing or editing 36 books; the most recent of which is “The Encyclopedia of Renewable Energy and Shale Gas” (John Wiley and Sons). Jay hopes to ride his unicycle in the 2016 Parade, for the 18th consecutive year.

At 91, Bill Brown *57 isn’t traveling much these days, but enjoys time with Winnie and his 12 great grandchildren.

Fred Roots *49 is the recipient of the 2016 Explorers Club Medal, the highest honor bestowed by the Club for “extraordinary contributions to polar research” and a career that has included the Norwegian-British-Swedish Antarctic Expedition (1949-52), being a contributing author of the Antarctic Treaty, and developing the Polar Continental Shelf Program. In his response at the awards dinner, Fred talked about attending the 1953 dinner, being seated next to Matthew Henson (a member of the Robert Peary expedition to the North Pole in 1909) and presenting evidence that the climate changes identified in the northern hemisphere had counterparts in the southern hemisphere — thus introducing the concept of global climate change. Fred also talked about his 1960’s work observing the newly launched polar-orbiting satellites and determining the wobble and migration of Earth’s center of rotation. This led to corrections in aircraft navigation tables and to formulae for the northern hemisphere Global Position System that was then just being developed. His remarks also highlighted new knowledge about phenomena and processes in the high latitudes, and the importance of the polar regions to the rest of the planet.

Deaths

Robert Ramsdell *50
3/3/2014
obits.nj.com/obituaries/trenton/obituary.aspx?pid=170130619

Michael Hriskevich *52
1/31/2014
www.queensu.ca/geoI/Michael%20Hriskevich

Clinton Dahlstrom *52
1/15/2015
paw.princeton.edu/issues/2015/11/11/sections/memorials/7399/

Donald Baker *55
7/18/2010
paw.princeton.edu/memorial/donald-r-baker-55

Reginald Shagam *56
4/19/2008

Fred Langford *60
1/24/2015
www.legacy.com/obituaries/thestarphoenix/obituary.aspx?pid=174068736

Daniel Barker *61
5/21/2015
www.jsg.utexas.edu/about/history/faculty-through-time-in-memoriam/daniel-stephen-barker/

William Perkins *70
1/25/2012
www.stmarys-ca.edu/professor-bill-perkins-a-gentleman-and-a-scholar

Kelly Sponberg ’98
8/28/2015
paw.princeton.edu/memorial/kelly-b-sponberg-%E2%80%9998
DEPARTMENT OF GEOSCIENCES
Baby Onesies Sale

The Department of Geosciences is offering the purchase of Princeton Geosciences baby onesies through the mail for $20 each. Two sizes available: 6 mos. and 18 mos. Each shirt features a vintage 1970s department illustration of the Smilodon and traditional Princeton varsity lettering. To order fill out the coupon below and mail along with a check or money order to the address provided.

Photo courtesy of Associate Research Scholar Sarah Jane White.

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