Cornell Engineering
Earth and Atmospheric Sciences

The College of Arts & Sciences

Cornell CALS
College of Agriculture and Life Sciences

EAS NEWS 2017

PUSHING BEYOND EARTH'S SURFACE FOR ANSWERS

STAYING CONNECTED

Li Dong, Ph.D. '06 and Steve Colucci pose at the AMS's June 2017 Conference on Atmospheric and Oceanic Fluid Dynamics in Portland, Oregon.

Joseph Lee '13 and Steve Colucci connect at the AMS annual meeting in Seattle.

Professor Steve Colucci stays in touch with our Atmospheric Sciences alumni. He sees them at American Meteorological Society (AMS) conferences, has ongoing connections through email with many of his former advisees, and enjoys visits from those who return to campus.

EAS faculty are committed to giving students the tools they need to build their future and value ongoing connections with alumni.

Has a former Cornell faculty advisor given you needed encouragement or advice or helped you make important connections to further your career? One of the ways you can give back is by supporting our department as it evolves and changes to meet the needs of educating the younger generation, who will be given the heavy task of caring for our Earth and finding ways to mitigate some of the natural hazards and disasters it will face in the future.

We encourage you to remain connected as we continue to promote science that matters.

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***Cover Image**: Portion of map provided by Geoff Abers (see story on page 7)*

THE EAS 2020 VISION ENDOWMENT

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To raise an endowment of at least one million dollars.

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- Postdoctoral fellowship program
- Research lab equipment, renovations, maintenance
- Undergraduate field training support
- Computer lab support

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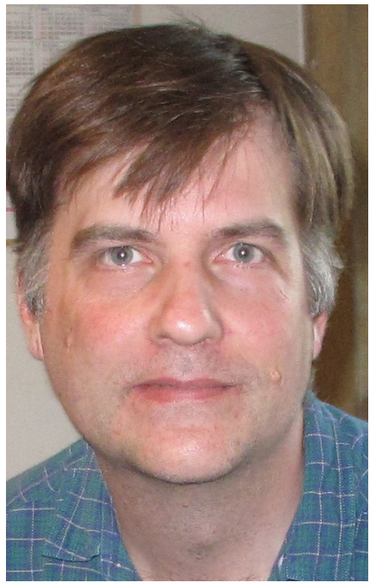
CHAIR'S MESSAGE

DEAR ALUMNI AND FRIENDS,



DAVID HYSELL

I am pleased to be able to report to you for the first time in my capacity as the incoming chair of EAS. I assumed the role in July and, with Rick Allmendinger's help, have been learning the ropes. As our department resides in two colleges and offers degree programs in a third, our position here at Cornell is unusually complex. As our faculty is also small, we are each asked to shoulder more administrative duties than many of our peers. I am most thankful for the support of the faculty for assuming the committee posts and that duties that come with them, which are necessary for the department to function.

So far, we appear to be off to a good start. We are very pleased to welcome our newest faculty member, Esteban Gazel, who comes to us from Virginia Tech as an associate professor. Esteban and his group study processes in the Earth's interior that produce magmas and volcanoes and drive planetary evolution. Esteban's work is conducted both in the field and in the laboratory. Hiring him has had the side benefit of compelling us, finally, to renovate the lab space on the ground floor of Snee. You can practically eat off the floors now! We are looking forward to seeing Esteban populate his laboratory with modern instrumentation.

EAS is furthermore in the process of conducting two searches—one in atmospheric/climate dynamics, and the other in faults, fluids and fluid-rock interactions. The latter position is part of a cluster hire in sustainable subsurface energy performed jointly with Chemical and Biological Engineering and Civil and Environmental Engineering. Looking beyond these two searches, we see that a vigorous hiring cadence will be necessary for the next few years to offset a number of impending retirements. Our goal is to stabilize at a headcount of 19 full-time faculty members and then to grow modestly beyond that. Growth to the point where EAS is comparable in size to its aspirational peer institutions is a central theme of the department's forthcoming strategic plan.

Another recent accomplishment is the completion of a highly constructive meeting of the EAS Advisory Council (AC) which took place in October. This year, the AC included strong representation from geological, ocean and atmospheric sciences. The AC was pleased with the state of the department and broadly endorsed the direction in which we are moving. The following are some of their specific recommendations.

First, the AC encouraged EAS to increase undergraduate and graduate enrollment overall and in atmospheric sciences especially. This can be accomplished in part through improved advertising and marketing, and we are beginning to work with the administration to see how that might be done. We were also encouraged to increase our visibility in the College of Arts and Sciences, the home college of many of our alumni. We are presently seeking real estate on its website.

The AC also supported plans in EAS to develop new professional master's degree programs including a Master of Engineering (M.Eng.) program in remote sensing in the College of Engineering and a five-year master's program in atmospheric science in CALS. Improving ties between industry and academia was a central theme of the AC meeting, building the professional master's programs around projects and funding from industry would be an expedient way to pursue that theme. In the future, we plan to welcome industry representatives to events showcasing undergraduate and graduate research in an effort to build new connections between industry, our students and our faculty.

There have been many other positive developments in EAS which you can read about in the pages of this newsletter. I hope you will continue to keep track of developments within our department and to provide feedback to help us progress.

Best wishes,

Dave

Dave Hysell
Professor and EAS Chair

"I WORK ON FUNDAMENTAL PROCESSES AND IN THAT WAY I CAN HELP FILL IN THE BIG PICTURE OF HOW THE EARTH WORKS. JUST AS IMPORTANTLY, I AM HELPING TO PUT SKILLED STUDENTS WITH CRITICAL MINDS OUT IN THE WORLD. I REALLY WANT TO INSPIRE THE NEXT GENERATION OF GEOSCIENTISTS."

—PROFESSOR ESTEBAN GAZEL

GEOCHEMIST ESTEBAN GAZEL JOINS EAS FACULTY

August 2017, enter Esteban Gazel. Cornell University and the Department of Earth and Atmospheric Sciences has gained a visionary scientist who has immediate plans to renovate a large lab space in Snee Hall to accommodate his ongoing geochemical research.

Gazel has always loved science and wants to do what he can to help people understand the secrets of our planet. Growing up in the suburbs of San Jose, surrounded by volcanoes, gave him an early curiosity about how the Earth works. During his youth, Gazel experienced frequent volcanic eruptions and earthquakes where he lived. He started conducting research at 15 years old in Costa Rica during high school and as an undergraduate at the University of Costa Rica, he continued doing a lot of research to learn more about how the Earth works. During his undergraduate years, Gazel had the opportunity to meet Professor Michael Carr from Rutgers, an expert on the volcanoes he was most interested in, so he applied to Rutgers for graduate school and was accepted into Dr. Carr's lab as a Ph.D. student. From there Gazel became a postdoctoral researcher at Lamont-Doherty Earth Observatory of Columbia University.

Gazel began his professorial career at Virginia Tech in the geosciences department. While at Virginia Tech, he published more than 25 academic papers and won the prestigious Hisashi Kuno Award from the American Geophysical Union's Volcanology Geochemistry Petrology section.

At Cornell, Gazel and his group will continue to research the processes that produce magmas and volcanoes and contribute to the evolution of the planet. They are looking at lava production by mantle melting, the origin of continents, and the deep carbon and water cycles. Gazel is certain that his research will branch out now that he and a couple of his former Virginia Tech students are at Cornell. "There is a longstanding tradition of excellence in Earth Sciences at Cornell," says Gazel. "It is a progressive institution that sees the Earth and atmosphere as a connected system. There are many people here that will make excellent collaborators for me and my students."

Esteban Gazel

Gazel and his team of researchers are looking at what is responsible for the formation of intraplate volcanoes like Hawaii and the Galapagos Islands, how the different types of magma reservoirs formed and how magmas record the compositions of these sources, characterization of volcanic ash at the nanoscale to learn about its composition and also its connection to respiratory disease, and data collected on Mars to learn more about its early geology and planetary evolution.

Investigating ESF and F Region Ionospheric Disturbances

WINDY MISSION: NASA ROCKETS LAUNCH FROM KWAJALEIN ATOLL

NASA sounding rockets have the ability to launch on demand. They fly higher than many low-Earth orbiting satellites. In many cases, they are the only means to study specific scientific phenomena from strategic vantage points worldwide. With these rockets, scientists have the ability to take in-situ measurements by placing instruments directly into regions where and when the science is occurring.

Professor David Hysell is the lead investigator on the Waves and Instabilities from a Neutral Dynamo (WINDY) mission; a project that will involve the study of the equatorial spread F (ESF) and the disturbances that occur in the F region of the ionosphere post-sunset at latitudes near the equator. These disturbances interfere with radio communication, navigation, and imaging systems and pose a hazard to technology and all who depend on it.

In spite of inclement weather and delays, WINDY mission rockets were launched from the Kwajalein Atoll in the Marshall Islands on September 10, 2017. Investigators will use the results from the launch to study the events which precede disturbances of ESF by measuring the influence of horizontal thermospheric winds on the formation of ESF, as well as taking measurements of ionospheric densities and electric and magnetic fields. Winds at very high altitudes carry a tremendous amount of energy and are known to have a direct effect on the ionospheric disruptions that are the focus of WINDY. Since wind measurements at these high altitudes are difficult due to very low atmospheric density, several tracer techniques have been tried and perfected to accomplish the measurements. Lithium vapor and trimethyl aluminum (TMA) gas have been proven particularly effective in optical tracking of visible gases released from the sounding rockets. TMA reacts spontaneously on contact with oxygen to produce a pale white glow visible from the ground. For the WINDY mission, sunlight reflected by the moon will illuminate the lithium, producing an emission that can be detected with cameras equipped with narrow-band filters. Using moonlight for illumination allows the launches to occur later in the evening when the critical ESF conditions occur. Both gases, which are harmless when released at these altitudes, move with the background atmosphere and can therefore be used to determine the wind speeds and direction over the height ranges where the releases occur. Both clouds will remain in the night sky for approximately 30 minutes after launch.

ARPA Long-Range Tracking and Instrumentation Radar (ALTAIR) can monitor the state of the upper atmosphere/ionosphere in order to determine when the large-scale disruptions occur and thus when to launch the rockets and monitor the evolution of the ESF following launches. Of this impressive and versatile radar, Hysell explains, "If you're trying to launch rockets, you can scan the whole sky very quickly. ALTAIR is the finest radar of its kind, a Department of Defense asset."

NASA photo by Mark Griffin

The National Aeronautics and Space Administration (NASA) and Roi mission support teams pause for a photo on the Roi-Namur launch pad with a two-stage 47-foot long Terrier-Black Brant IX (left) and a two-stage 36-foot long Terrier-Malemute rocket (right) in the week preceding the launch.

EARTH'S RESOURCES

EARTH Magazine's October 2017 issue includes a commentary from Cornell's Wold Family Professor in Environmental Balance for Human Sustainability, John Thompson, who summarizes what he feels will be necessary for humans to responsibly develop Earth's resources for future generations and draws attention to the upcoming Resources for Future Generations (RFG2018) Conference to be held in Vancouver, Canada in June of


Photo credit: Anne Thompson

John Thompson

2018. Thompson says, "To continue developing resources responsibly in the future—as will be necessary to further human progress—we need to understand Earth in all its complexity, our relationship to the planet, and the role that humans will play in maintaining supplies of critical resources while also exploiting them more cleanly for the benefit of all. Geoscientists are essential in the process."

Geoscientists and engineers from around the world, in academia, government and industry, along with indigenous people, policy experts, members of civil society and young people—students and early career professionals—will meet at the RFG2018. Thompson says, "The ultimate purpose of the conference is to build the understanding of natural resources and develop ideas about how we can meet the resource demands of the future."

Thompson explains that discovering new natural resources containing the elements, materials and commodities that society needs with sufficient concentrations and characteristics to permit clean, economic extraction, is of ultimate importance. Many current mines have lower concentrations or grades of metals and minerals than in the recent past, and similarly, hydrocarbons are being extracted from more complex, lower-permeability host rocks. The result—we expend more energy, use more water and disturb more land per unit of production than in the past. The challenge will be to discover new high-quality, high-value deposits which could reverse this trend, allowing increased efficiency of extraction per unit of commodity.

Discovering new natural resources is vital, but equally important is how we extract the contained commodities. Historically, extractive industries have not been viewed well by the public. This is hardly surprising given past examples of poor practices, environmental damage and limited distribution of benefits. These industries, however, have changed significantly over the last 30 to 40 years, and will continue to advance by using more efficient technologies, reducing energy consumption and recycling water. Such improvements are welcome and necessary in the effort to design and maintain responsible extraction practices.

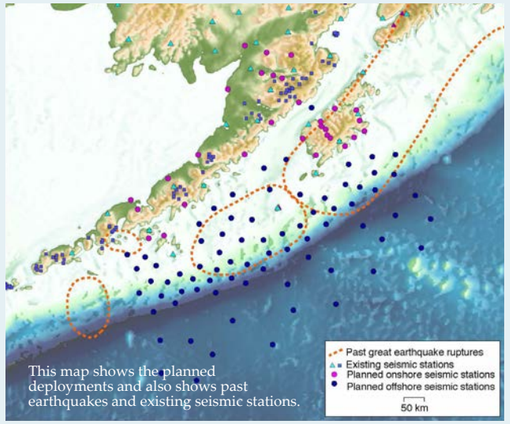
"Geoscientists play major roles in understanding global change, as well as assessing the local and regional landscapes. We need the geoscience community to apply this knowledge to identify and mitigate negative consequences from resource extraction," says Thompson. From the perspecitve of those potentially impacted by resource extraction, he notes that thoughtful engagement is required involving expertise from social and political science as well as geoscience and engineering. "Many technically minded people are uncomfortable bridging the gap to social science, and yet building collaboration across this interface is critical for future resource development that is designed to meet global sustainability goals."

In conclusion, Thompson states, "Earth supports life, obviously including humans, but geological processes also concentrated natural resources that have aided human development for more than 10,000 years. To meet the needs of future generations, geoscientists must work with many others to find and responsibly develop the resources that we will need. Most importantly, we must work collectively to empower future generations to take on the natural resource challenge in all its aspects."

"TO CONTINUE DEVELOPING RESOURCES RESPONSIBLY IN THE FUTURE—AS WILL BE NECESSARY TO FURTHER HUMAN PROGRESS—WE NEED TO UNDERSTAND EARTH IN ALL ITS COMPLEXITY, OUR RELATIONSHIP TO THE PLANET, AND THE ROLE THAT HUMANS WILL PLAY IN MAINTAINING SUPPLIES OF CRITICAL RESOURCES WHILE ALSO EXPLOITING THEM MORE CLEANLY FOR THE BENEFIT OF ALL."

- PROFESSOR JOHN THOMPSON

ALASKA AMPHIBIOUS COMMUNITY SEISMIC EXPERIMENT



This map shows the planned deployments and also shows past earthquakes and existing seismic stations.

Geoff Abers leads a National Science Foundation (NSF) funded project to begin in the spring of 2018, which will involve a major deployment of seismographs onshore and offshore of Alaska. The project will leverage new technology for high-end seismic equipment on the sea floor. This is the first project of this scale in Alaska. Co-PI's from seven other institutions are involved in the project: Colgate University, University of Washington, Columbia University, University of Colorado Boulder, University of New Mexico, Washington University St. Louis, and University of California, Santa Cruz. The National Science Foundation funds the project through four programs: GeoPRISMS, EarthScope, Marine Geology and Geophysics, and PREEVENTS (a natural hazard program).

The seismic experiment covers the part of coastal Alaska that ruptured in a Magnitude 9.2 earthquake in 1964, the second largest earthquake ever recorded, as well as places that look geologically similar but have no record of giant earthquakes. It also covers the Katmai region and nearby volcanic centers; the Katmai eruption in 1912 was the largest recorded eruption of any volcano in the 20th century.

Abers and the project team will deploy 30 instruments on land; the deployment of the 75 marine instruments will be done from ships called Ocean Bottom Seismometers or OBSs. Because this is a "community experiment," all data collected and organized by the project team will be free to anyone who would like it once they are recovered from the instruments. Projects involving major infrastructure commitments are increasingly being handled this way.


Above: Geoff Abers explaining his work to the pilots of the plane he and Patrick Shore (to Abers' right) of Washington University St. Louis chartered.


Graduate students Roque Castaneda and Michael Mann at a project site in the Wrangell area of eastern Alaska.

HOW CONTINENTS BREAK:
Earthquakes, Fault Rocks and Rock Mechanics

On a beautiful autumn day during fall break in October of 2017, about 60 people from Cornell and other universities gathered for the eleventh annual Kaufman Symposium of the Institute for the Study of Continents (INSTOC). The title of the one-day workshop was "How continents break: Earthquakes, fault rocks and rock mechanics."

Several invited speakers traveled to Ithaca to give presentations including Professors **Greg Hirth** from Brown University, **Heather Savage** from Columbia University's Lamont-Doherty Earth Observatory, **Shmuel Rubinstein** from Harvard University, and **Jamie Kirkpatrick** from McGill University. Alumnus and associate professor at Smith College, **Jack Loveless**, Ph.D. '08 was also thrilled to return to campus after many years as one of the guest speakers.

The keynote address, "The Strength of Faults," was given by INSTOC's Jack Oliver Visiting Professor **Emily Brodsky** of the University of California, Santa Cruz. Brodsky spent the entire week at Cornell collaborating with fellow geologists. She gave two other presentations about hydrogeology and the expedition to drill into the fault that moved 50 m during the 2011 Tohoku, Japan earthquake—a major technical challenge to drill almost 1 km below the ocean floor in 7 km water depth.

Cornell faculty also gave presentations at the workshop. Earth and Atmospheric Sciences Assistant Professor **Katie Keranen** talked about induced earthquakes and Associate Professor **Rowena Lohman** talked about detecting induced earthquakes from space. Civil and Environmental Engineering's Assistant Professor **Greg McLaskey** talked about lab experiments simulating earthquakes.

Speakers Katie Keranen (top left) and Rowena Lohman (above) explain their research.

Greg Hirth and Emily Brodsky during a lunch break in the Snee Atrium.

Professor **John Thompson** identified the themes of the symposium and moderated a discussion at the end of the meeting. He referred to some of the outstanding questions posed throughout the day and asked how they could be addressed.

Of course, Professor Emeritus **Muawia Barazangi** kept all of the talks (mostly) on time with help from session chairs Professors **Geoff Abers** and **Larry Brown**. Last but not least, INSTOC's director, **Matt Pritchard**, did a fantastic job of planning and leading the event.

Attendees from Cornell and elsewhere listen intently to the science being presented.

David Hysell began his three-year term as EAS department chair July 1, 2017.

Matt Pritchard was promoted to full professor effective July 1, 2017. Pritchard chairs a current faculty search and the department's strategic planning committee.

Steve Colucci has taken over the role of director of graduate studies in atmospheric science.

Rowena Lohman has replaced Larry Cathles as the new Master of Engineering (M.Eng.) director. Options in this degree program have recently been expanded under Lohman's direction to now include the following: geohydrology, remote sensing, hazards, applied and environmental geophysics, and ocean science and technology.

Geoff Abers co-authored a paper with former student Zachary Eilon this year revealing a new technique to investigate underwater volcanoes that produce Earth's tectonic plates. Through this research conducted on a small tectonic plate called the Juan de Fuca, data indicates that molten rock here is found even deeper within the Earth than previously thought. Results of the work were published in a May 2017 issue of *Science Advances*.

Larry Brown, Katie Keranen, and Matt Pritchard received an Engaged Curriculum Grant for their proposal "Field Geophysics," which aims to bring students out of the classroom and into the field where they will use geophysical methods to collect data about the natural history of the region. Brown was also named an Engaged Faculty Fellow. The one-year fellowship comes with a $3,000 award to implement community engagement into course curriculum.

Esteban Gazel and postdoc Jarek Trela co-authored a paper published in *Nature Geoscience* which detailed their findings that young Costa Rican lavas might reflect pockets of primordial mantle.

Toby Ault is principal investigator of a new National Science Foundation (NSF) award titled Emerging Frontiers. This macrosystems biology project will strive to understand the role of phenology—the rhythm of the seasons which drives the progression of vegetation through its annual cycles from dormancy to activity and back to dormancy—in mediating ecosystem-atmosphere coupling and feedbacks at multiple spatial and temporal scales. Specifically, the researchers are using observational "phenocam" sites (cameras set up across the country to make daily phenological measurements) along with state-of-the-art atmospheric models to understand how plants modify the flow of energy, water, and carbon between the land surface and the atmosphere throughout the annual cycle.

Ault is also working with Sara Warner and Godfrey Simmons of the Department of Performing and Media Arts, as well as the local theater group, Civic Ensemble, to develop a play on climate change, climate science and Tompkins County.

Bruce Monger has received a Weiss Provost's Teaching Fellowship for excellence in his teaching of undergraduate students and contributions to undergraduate education.

In January, Monger traveled to Fiji to provide satellite remote sensing training to 41 participants—university students and working professionals from a variety of different organizations, institutions, and backgrounds. The course taught Python programming using a Linux platform.

Natalie Mahowald was elected the Irving Porter Church Professor of Engineering at the Cornell Board of Trustees October 2017 meeting. The endowed chair appointment became effective November 1, 2017.

In March 2017, Mahowald was selected by the United Nations' Intergovernmental Panel on Climate Change as a lead author on the "Special Report on Global Warming of 1.5 degrees Celsius." The report, expected out in September 2018, will present climate change projections and response options.

In leadership at the department level, Mahowald has served as both the director of undergraduate studies for the science of earth systems major and the graduate field of atmospheric science, as well as serving as chair of the search committee for a current faculty search. At the university level she is the faculty director of environment for Cornell's Atkinson Center for a Sustainable Future.

IRON OXIDE COPPER GOLD OF NORTHERN CHILE

pyrite mineralization in drill core of the Carola deposit

During the first week of July, geological sciences graduate student, Irene del Real, organized a field trip to northern Chile, with travel specifically around the area of Copiapó in the Atacama Desert to visit some of the most characteristic Iron Oxide Copper Gold deposits (IOCG). Irene's thesis has focused on the genetic formation and evolution of IOCG deposits, specifically in the Candelaria-Punta del Cobre district, so this recent field trip was also an ideal opportunity for her to gather more knowledge and enhance her thesis research.

Irene del Real

Participating in the field trip were Professors John Thompson (del Real's advisor) of Cornell, Adam Simon from the University of Michigan, Fernando Barra from the University of Chile, and six other graduate students from both universities. During the seven-day field trip the group visited the Candelaria-Punta del Cobre IOCG district, the Manto Verde IOCG mine, Santo Domingo IOCG deposit, Cerro Negro Norte iron deposit and Quince iron prospect. The trip provided many opportunities for science conversations which could lead to future collaborations between the different research groups.

The entire field trip group poses at the Candelaria open pit iron oxide copper gold mine near Copiapo.

ADIRONDACK LOWLANDS ADVENTURE

Submitted by Chris Siron

Anne Thompson photos

Group at the Benson Mine (L-R): John Thompson, Dave Broughton, Casey Root, Maeve Boland, Chris Siron, Michael Kirschbaum, Gerald Broughton (Laurentian University), Larry Meinert, Murray Hitzman, Michael Mann, Dana Peterson, Nate Stevens, Hannah Lang, Francisco Delgado, Alida Perez Fodich, Irene del Real, Andres Aguirre, Xiaolu (Grace) Li, Katie Grant, John Mason.

Members of EAS embarked on a two-day field trip to the Adirondack lowlands to learn about the fascinating and complex geology that gave rise to the historically important mines of the region. Fourteen students from the Department of Earth and Atmospheric Sciences at Cornell and a guest from Laurentian University (Canada) were led by Professor John Thompson and Chris Siron (Ph.D. candidate in economic geology) and accompanied by five leaders in the field of economic geology: Murray Hitzman and Larry Meinert, both with the United States Geological Survey, Dave Broughton (consultant with Ivanhoe Mines), Maeve Boland (American Geosciences Institute), and Anne Thompson (founder of PetraScience).

The field trip kicked off with a visit to the Empire State Mines' Balmat zinc mine near the village of Gouverneur in St. Lawrence County. The group was hosted by their exploration manager, Michael Kirschbaum, who kindly provided pizzas and a presentation on the geology and mining history of the Balmat-Edward zinc district. The afternoon was spent investigating representative drill core of the deposit and visiting several reclaimed pits that were once mined for zinc ore. Many excellent conversations were had deliberating the depositional environment including potential stromatolites, ore textures, ductile deformation and metamorphism, and the processes that led to the zinc ore bodies.

The group departed Balmat eastward to Cranberry Lake to arrive at our campsite as the sunlight was escaping over the trees. No time was wasted as master chef, Nate Stevens, prepared an exquisite spread of chicken and pork fajitas.

Day two started bright and early with a visit to the now-closed Benson iron deposit that was historically mined sporadically for over a century. After a short examination of the rocks, the group discussed the significance of the local geology and how the deposit may have formed based on mineralogical observations. Continuing west, the group stopped to see mylonitic textures in the Carthage-Colton Shear Zone and a mineralized skarn outcrop near the village of Edwards before having lunch on the banks of the Oswegatchie River. Hitzman debriefed the group's morning observations by drawing a cross section and discussing the significance of the geological relationships.

The last half of the day was spent looking at Adirondack lowland geology with roadside stops to examine the Popple Hill gneiss and the intensely folded and boudinaged marbles to the east of Gouverneur. A trip to the North Country would not have been complete without a stop at Dinosaur BBQ in Syracuse! The adventure would not have been possible without David Hysell providing department funds to support the trip, as well as the AAPG student chapter for covering BBQ, and of course Michael Kirschbaum and Empire State Mines for their accommodation and hospitality.

Murray Hitzman discussing the zinc potential in the western Adirondacks.

OFF-CAMPUS EXPERIENCES

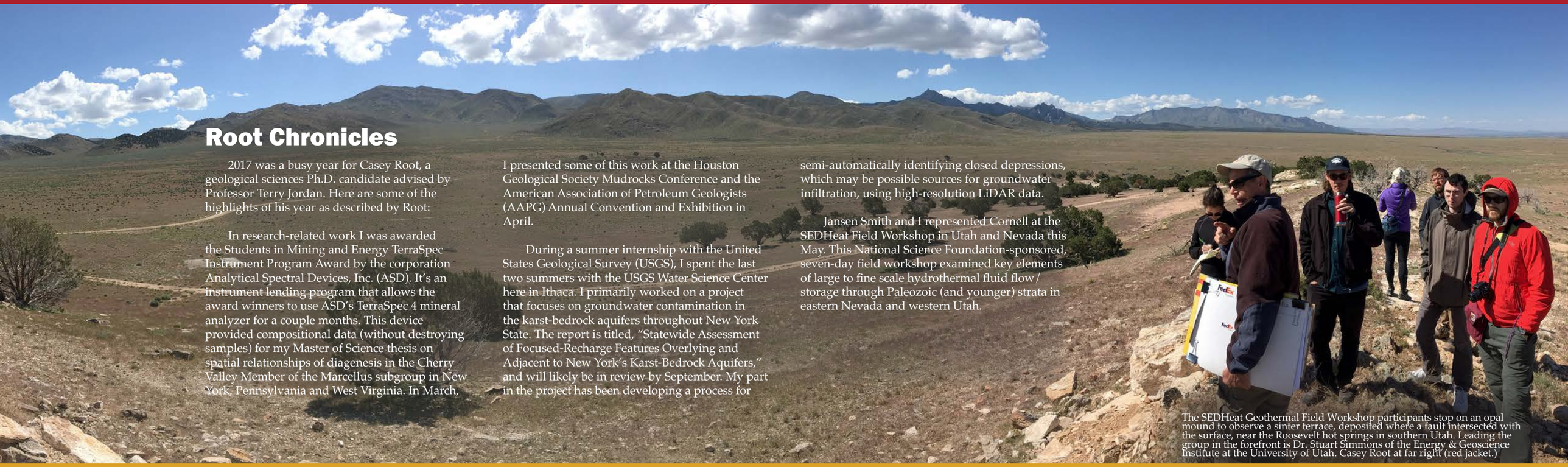
Root Chronicles

2017 was a busy year for Casey Root, a geological sciences Ph.D. candidate advised by Professor Terry Jordan. Here are some of the highlights of his year as described by Root:

In research-related work I was awarded the Students in Mining and Energy TerraSpec Instrument Program Award by the corporation Analytical Spectral Devices, Inc. (ASD). It's an instrument lending program that allows the award winners to use ASD's TerraSpec 4 mineral analyzer for a couple months. This device provided compositional data (without destroying samples) for my Master of Science thesis on spatial relationships of diagenesis in the Cherry Valley Member of the Marcellus subgroup in New York, Pennsylvania and West Virginia. In March, I presented some of this work at the Houston Geological Society Mudrocks Conference and the American Association of Petroleum Geologists (AAPG) Annual Convention and Exhibition in April.

During a summer internship with the United States Geological Survey (USGS), I spent the last two summers with the USGS Water Science Center here in Ithaca. I primarily worked on a project that focuses on groundwater contamination in the karst-bedrock aquifers throughout New York State. The report is titled, "Statewide Assessment of Focused-Recharge Features Overlying and Adjacent to New York's Karst-Bedrock Aquifers," and will likely be in review by September. My part in the project has been developing a process for semi-automatically identifying closed depressions, which may be possible sources for groundwater infiltration, using high-resolution LiDAR data.

Jansen Smith and I represented Cornell at the SEDHeat Field Workshop in Utah and Nevada this May. This National Science Foundation-sponsored, seven-day field workshop examined key elements of large to fine scale hydrothermal fluid flow/storage through Paleozoic (and younger) strata in eastern Nevada and western Utah.



The SEDHeat Geothermal Field Workshop participants stop on an opal mound to observe a sinter terrace, deposited where a fault intersected with the surface, near the Roosevelt hot springs in southern Utah. Leading the group in the forefront is Dr. Stuart Simmons of the Energy & Geoscience Institute at the University of Utah. Casey Root at far right (red jacket.)

STUDENT AWARDS AND HONORS

Alida Perez Fodich (advisor, Derry) received a GSA Graduate Student Research Grant.

Sam Kachuck (advisor, Cathles) received an Outstanding Student Paper Award at the American Geophysical Union's meeting. The paper title was: "Sloppy inversion and optimal experiment design for last glacial maximum Barents Sea Ice Sheet configuration."

Casey Root has been selected for a second year for a grant to support his research expenses. The grant is from the 2017 American Association of Petroleum Geologists Foundation Grants-in-Aid program. See more about Casey's research above.

Anant Hariharan '18, was the chemistry and physical sciences category winner for his poster presentation at the Cornell Annual Spring Forum Research Presentation, spring semester 2017. This forum is a university-wide undergraduate research presentation.

Tasnuva "Ming" Khan '18 and **Marc Alessi** '18, were selected out of 490 students to represent the Cornell delegation at the United Nations Framework Convention on Climate Change Conference of Parties 23 (UNFCCC COP 23) in Bonn, Germany in November. UNFCCC has near universal membership and is the parent treaty of the 1997 Kyoto Protocol. Ming Khan gives an account of the work leading up to this conference and their role as delegates on the following page.

Samantha Moruzzi '20 and **Allison Alcott** '20, received summer research awards from Engineering Learning Initiatives for their project, "Volcano thermal anomalies detected by satellite: Precursors to eruption?" Their faculty supervisor is Matt Pritchard. Moruzzi was one of four featured undergraduates in the summer 2017 issue of *Cornell Engineering Magazine*. The story tells how she pursued undergraduate research opportunities at Cornell.

Three Atmospheric Science undergraduate students were conference presenters at the 2017 Great Lakes Atmospheric Science Symposium in Oswego, NY. **Griffin Mooers** presented his research in the Heavy Rain and Extreme Weather session; **Stephanie Lin** and **Tyler Leicht** gave presentations in the Numerical Modeling session. Mooers is the Cornell Chapter of the Meteorological Society's (CCAMS) co-president; Leight is the CCAMS forecasting chair.

Ming Khan

Marc Alessi

Two EAS seniors traveled to Bonn, Germany in November as Cornell delegates to the United Nations Framework Convention on Climate Change Conference of Parties 23 (UNFCCC COP 23). At the annual meeting, countries negotiate climate change policies, recommendations and goals to keep maximum warming to 1.5 degrees Celsius above pre-industrial levels.

Tasnuva "Ming" Khan, science of earth systems major, and Marc Alessi, atmospheric science major, in Professor Natalie Mahowald's special topics seminar course, Global Climate Change Science and Policy, were chosen by Cornell to attend the convention through a rigid three-step application process starting with over 600 initial applications, narrowed down to 490 viable candidates. Skype sessions allowed them to report back to their class with ongoing learning during the week as "Eco Collaboratives" which was tapped to broadcast to a larger campus audience.

Cornell, a registered observer organization at the annual climate change convention, sent faculty, staff and students as delegates to the event including Allison Chatrchyan, Director of the Cornell Institute for Climate Smart Solutions (CICSS) and a senior research associate in EAS, and Executive Director of CICSS, Mike Hoffmann.

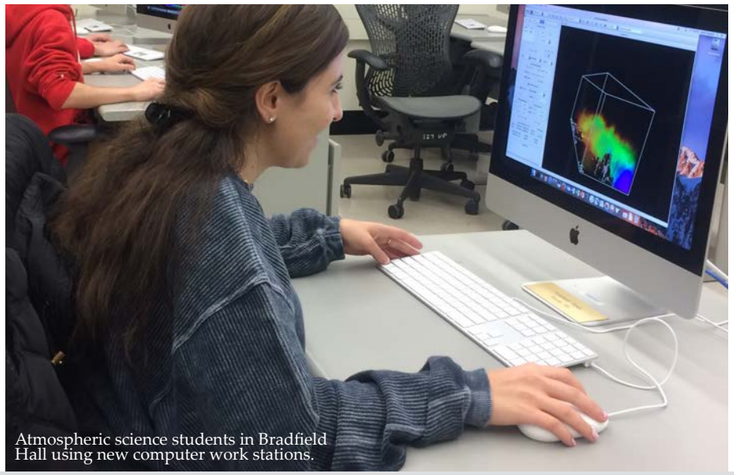
Delegates attended technical seminars hosted by various organizations and countries that presented on issues from climate-change refugees to nuclear power as a means to be carbon neutral. A Cornell booth managed by some of the delegates provided information to attendees on Cornell's efforts towards carbon neutrality and sustainability, and research by various faculty in collaboration with different countries on environmental issues.

ALUMNI THANK YOU

The generosity of several EAS alumni has made possible some needed upgrades to computer workstations in Atmospheric Science's Bradfield Hall computer lab.

Among the donors were alumni Bruce Bailey '74, Mish Michaels '90 and Greg Poulos '89. Engraved gold plates have been affixed to the stations to acknowledge contributors. In some cases, stations were given a special name by the donor—Wind Guy (Bailey) and Bombogenesis (Michaels.)

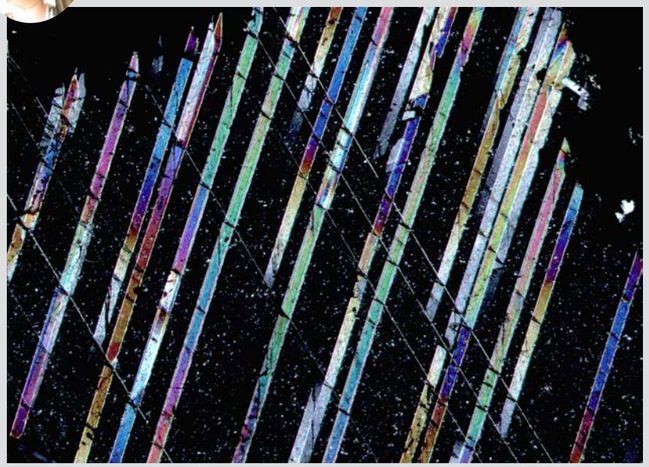
Thank you to all who have contributed to our student educational and research needs.



Atmospheric science students in Bradfield Hall using new computer work stations.

INTRODUCTION: A BLEND OF ART AND GEOLOGY

Science of earth systems major, Hannah Lang '18, has found a way to blend her love of art with her study of geology. Lang's new artwork combines her senior thesis in geology with the art of printmaking. She has produced striking prints which will be displayed in an art exhibit called Introspection in the Olive Tjaden Gallery on campus in November. The prints use imagery collected from viewing thin sections of black shale formation from British Columbia under a microscope.



An original image (taken from a microscope) of a calcite vein within the black shale and tuff bedded rock that Lang is studying. The rock samples used were given to her from the British Columbia mining company, Pretivm.

A lithography print made from a microscope image. Predominantly calcite, with black shale in the lower right corner. Specks of light within the shale are fossils.

TRANSITIONS

JOHN L. CISNE

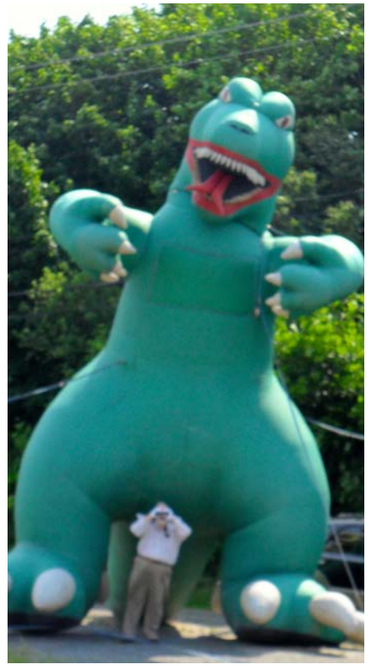
Professor John Cisne, a paleontologist, retired at the end of the spring 2017 semester after 44 years on the Cornell faculty. He received his B.S. from the Department of Geology and Geophysics at Yale University in 1969, and his Ph.D. from the Department of Geophysical Sciences at The University of Chicago in 1973. Cisne came to Cornell as an assistant professor in the Department of Geological Sciences that fall, stayed on as an associate professor and professor, and emerged this past July as a professor emeritus in the Department of Earth and Atmospheric Sciences. He has been a member of the graduate fields of geological sciences since 1973 and ecology and evolutionary biology since 1974.

Cisne started out in invertebrate paleontology as a specialist in Carboniferous trilobites, on which he published his first paper half a century ago this fall. For his Ph.D. research, Cisne studied the very rarely preserved "soft" internal anatomy of trilobites from stereoscopic X-ray photographs of specimens from the famous layer known as Beecher's Trilobite Bed. Long hours in the X-ray darkroom gave Cisne plenty of time (and incentive) to plan the field work he began on coming to Cornell. He used volcanic ash layers as time markers to study the distribution, paleoecology and evolution of Ordovician invertebrates along the submarine slope that led down the Mohawk River Valley into what Cisne helped show was a subduction trench where ancestral North America was then colliding with New England. His work branched out into sea-level change, chemical paleoceanography, synthetic stratigraphy and the mechanics of sedimentary basins. Around this time, he was elected a Fellow of the American Association for the Advancement of Science.

Cisne's later work has focused on the study of ancient and medieval manuscripts as if they were fossils. For instance, he showed from the "population dynamics" of handwritten manuscripts that roughly 10 percent of medieval Europe's copies of its foremost computation handbook, the *Venerable Bede's De Temporum Ratione*, still survive in some form. Cisne's explanation of certain early medieval monks' long-lost secret to illuminating manuscripts like the Book of Kells in astonishingly intricate, microscopic detail centuries before magnifying glasses, much less microscopes, first made news in *The New Yorker*, of all places, before appearing in print.

Cisne is perhaps best known to students from his introductory courses: "Evolution of the Earth and Life," which he taught from 1974 until he entered phased retirement in 2015; and "Dinosaurs," which he organized in 1990 and expects to continue teaching online in Cornell's summer and winter sessions. The course materials are available online through a publicly accessible Facebook group (https://www.facebook.com/groups/1501183123521716/). There, open to all, are the slides and notes from the lectures, plus a years-long running accumulation of news items.

Cisne's career has come full circle. He first had ambitions of becoming an ornithologist, but gave up birds for fossils; and now that birds are dinosaurs, he's back to chasing both, as the picture below shows.



IN MEMORIAM

Jack Bird at a Taughannock State Park alumni picnic in 2014.

Jack Bird, Maura Weathers, and Bill Bassett in 1984.

JOHN M. BIRD

December 27, 1931 - April 28, 2017

Geologist, John "Jack" Bird was one of the pioneers in the 1960s of using the then newborn theory of plate tectonics to explain the geology exposed on the continents. Two classic papers were co-authored by Bird and a colleague and friend, John F. Dewey, in 1970 and 1971 explaining how the geology of mountain belts such as the Appalachians is consistent with, and evidence for, plate tectonics. In 1972, Bird complied a volume of reprints published by the American Geophysical Union which quickly became a benchmark reference on the development of all aspects of the plate tectonics theory.

Bird was fascinated with the study of ophiolites, an odd assortment of iron and magnesium rich rocks whose origin was a mystery to earlier geological concepts. He recognized ophiolites as fragments of oceanic crust thrust up onto the continents by plate tectonic forces. Bird was particularly interested in the extraordinary collection of metallic phases found in the Josephine ophiolite in southwestern Oregon containing iron, nickel, cobalt, osmium, iridium, ruthenium, platinum and gold. He considered these metals to be primordial—in the form of metals ever since Earth formed. Bird actively pursued the study of ophiolites for the rest of his career at Cornell.

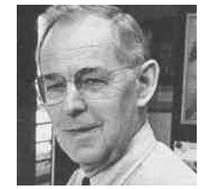
Jack's field work in geology took him to many parts of the world including Newfoundland, Siberia, Italy and Greenland, and across the continental United States from Vermont to Alaska. He loved the outdoors and enjoyed golfing, hunting and fishing.

Colleague and friend, Bill Bassett, remembers of Jack, "He was dedicated to exposing misinformation and replacing it with more reliable information. Generating new ideas was his passion. If his new ideas bothered others, well, that just added a little extra incentive."

Stimulating challenges to conventional wisdom—Jack was always ready for these. He will be missed by many.

ARTHUR L. BLOOM

September 2, 1928 - May 31, 2017



Throughout his long career at Cornell, Professor Art Bloom was a generous local source of information on the superficial geology of the Finger Lakes Region. But his geology colleagues knew that geomorphology, coastlines, and in particular, sea-level change, were his first and chief academic focus. His work on uplifted coral reefs in Papua New Guinea is his most famous contribution to the science, and his publications provide a baseline for what the earth is capable of in the absence of human beings. Bloom's bookshelf contained copies of his early book on *The Surface of the Earth*, translated into German, Polish, Spanish, Portuguese, and Japanese. A later expansion resulted in *Geomorphology: A Systematic Analysis of Late Cenozoic Landforms*, considered the last comprehensive textbook on the subject as subsequent works have focused on subsets of the field.

Sabbatical leaves took Bloom to Australia, twice to Japan, and for lesser periods of time to Korea and China. Research areas included Micronesia and New Guinea, and when the focus of his department shifted to South America his research expanded to Argentina.

Bloom remained a regular visitor of Snee Hall, still maintaining his wit and a twinkle in his eye until shortly before his death. This renowned geomorphologist will truly be missed.

Left: The Bloom family gathered in the Snee Hall atrium in August of 2014 for a reception to celebrate the establishment of the Arthur L. Bloom Fund. Left to right are Eric, Donna, Art, Jay, Ann, Jeff, Ryan, Lori and Pomaika'i front and center.

"Art's geomorphology class, and especially the local field trips associated with it, had a lot to do with helping me learn to make observations of the natural world. He also taught a senior-level oceanography class in 1968 (before that was a common thing) that helped me greatly in my later career. It's the passing of an era."—Jim Kirkpatrick '68

"I think we will all fondly remember Art for his great contributions to geosciences, his take-no-prisoners observations and humor, and of course, the ascots. Like many of us, he was my geomorphology professor. Just this past weekend, while visiting West Virginia, I was searching my memory to find the correct geomorphology terms needed to accurately describe the Potomac's inscribed meanders across the underlying folded strata. I was thinking I needed to consult Art's textbook which is currently sitting on the bookshelf across the office from me. I'm glad I had the opportunity to learn from him, and now I'd better consult that book!"—Harvey Cohen '85

"Art's geomorphology class was the first course I took after introductory geology, which Jack Bird taught. His class was also the first that took me to the field where I began to appreciate what careful observation of earth can teach you. And the way he brought geomorphology into the broader seismology and tectonics theme of the department with his study of uplift of reefs in the south Pacific was exemplary."—Richard Chuchla '78

"Art was not only an outstanding observer of the earth but a strong and interested supporter of any student working to gain some new insight about processes that help shape the surface of the earth or, in my case the moon or Mars."—Ray Willemann '86

"More than any class I have taken, in geology or otherwise, I apply what I learned in Dr. Bloom's class almost every day as I seek to understand, and sometimes explain to others, the surface of the earth that I see as I travel for business and pleasure. Dr. Bloom was a great teacher, always practical and hands on in his approach. He really was a wonderful man."—Jim McDonnell '80

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