

# Earth and Environmental Science News

University of Pennsylvania | Department of Earth and Environmental Sciences

Summer 2011



*View of the Geology Garden from Smith Walk. Boulders of local rock are arranged by age, and four floras of living fossils represent vegetation in North America 7, 25, 45, and 200 million years ago. One can listen to a lecture about the garden on a cell phone.*

## Welcome

Dear Friends and Alumni of Penn's Department of Earth and Environmental Science (EES),

I am happy to report on the latest developments in our department.



This academic year saw the arrival of our latest faculty addition, **Dr Jane Willenbring**, who joins us as an Assistant Professor. Jane completed her Ph.D. at Dalhousie University in Halifax, Nova Scotia and was recently a researcher at the National Center for Earth-surface Dynamics in the US and a Humboldt

*Assistant Professor Jane Willenbring.*

postdoctoral fellow at the German Research Center for Geosciences in Potsdam, Germany. Her research involves extracting and measuring extremely rare isotopes produced by cosmic radiation in air, rocks, and soils. To facilitate Jane's research we have built Penn's Cosmogenic Isotope Laboratory, which has increased the Department's analytical facilities considerably and led to substantial rearranging of departmental

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laboratory resources. Soon after Jane's appointment, she published a paper in the premier journal *Nature* (Long-Term Stability of Global Erosion Rates and Weathering during Late-Cenozoic Cooling, *Nature*, Vol. 465, pp 211-214). Jane's study is one of the **Research Spotlights** in this newsletter.

**Professor Hermann Pfefferkorn** will be stepping down from full time teaching this year. However, we are thankfully not saying goodbye. Hermann will retain an active presence in the Department in both teaching and research. Hermann will continue to organize the hugely successful annual Geobiology Symposium and administer the awards of the Paleontology Summer Stipends. He will maintain his mentoring of junior faculty and will serve on Ph.D. and Masters student committees. Through the reduced teaching load he has now more time for research. But Hermann plans to continue to teach one or two courses the Department needs during the Spring Semester.

This year, Earth surface processes were again at the center of an unfortunate series of devastating natural disasters that led to financial, environmental and human losses, most notably the Japanese earthquake and tsunami with the resulting meltdowns at the Fukushima Nuclear Power Plant complex, and the Mississippi River floods in April and May 2011 (see **Research Spotlight**). The Japanese earthquake was a magnitude 9.0 (Mw) undersea megathrust earthquake off the coast of Japan that occurred on Friday, 11 March 2011. It was the most powerful known

earthquake to have hit Japan, and one of the five most powerful earthquakes in the world overall since modern record-keeping began in 1900. The earthquake triggered extremely destructive tsunami waves of up to 40 meters!

The Mississippi River floods in April and May 2011 were among the largest and most damaging recorded along the U.S. waterway in the past century, comparable in extent to the major floods of 1927 and 1993. In April 2011, two major storm systems deposited record levels of rainfall on the Mississippi River watershed. EES faculty, staff and students are actively involved in studying both of these disasters, trying to make a difference in how we live with emerging hazards and risks.

The Department's research of the Japanese earthquake and the Mississippi floods meets our aim of generating fundamental and applied research of international quality, with impacts both within and beyond the discipline. This year we were awarded numerous grants from national and international agencies. We spent this money wisely and an indicator of our success are the 66 peer reviewed publications in the most highly ranked scientific journals, including *Nature*, *Science* and the *Proceedings of the National Academy*, three books and numerous presentations to professional societies. In additions to Jane's *Nature* paper, the notable publications that transcend traditional sub-disciplinary divisions include:

- **Professor Peter Dodson** and our visiting professor, Phil Manning, recently published a paper in *Science* (Trace Metals as Biomarkers for Eumelanin Pigment in the Fossil Record, *Science*, DOI: 10.1126/science.1205748) that showed how trace metals in fossils can be used to determine the pigmentation patterns of creatures dead for more than a hundred million years (see **Research Spotlight**).
- **Dr Andrew Kemp** (EES PhD, 2009) and Ben Horton published a paper this year in the *Proceeding of the National Academy* (Climate related sea-level variations over the past two millennia, *PNAS*, Vol. 108 (27), pp. 11017-11022). Their new study illustrated that the rate of sea-level rise along the U.S. Atlantic coast is greater now than at any time in the past 2,000 years and showed consistent link between changes in global mean surface temperature and sea level (see **Research Spotlight**).



*Associate Professor Ben Horton and Dr Jessica Pilarczyk are analyzing the Japanese tsunami sediments from the Sendai coastal plain to provide a modern analog for the interpretation of prehistoric tsunami deposits in the geologic record.*

- **Dr Irina Marinov's** publication in *Biogeosciences* (Changes in ocean circulation and carbon storage are decoupled from air-sea CO<sub>2</sub> fluxes, *Biogeosciences* Vol. 8, pp. 505-513) used a complex Ocean General Circulation Model to study the impact of changes in oceanic circulation on air-sea fluxes of carbon dioxide. A worrisome finding is that (commonly observed) air-sea carbon dioxide fluxes are a poor indicator of the underlying ocean circulation and of deep ocean carbon storage.

Our faculty also edited three books this year:

- Mark H. Scheihing (EES PhD 1982) and Christopher Wnuk (EES PhD 1984) edited a commemorative volume ("Festschrift") in the *International Journal of Coal Geology* (v. 83, issue 2-3, p. 87-344) in honor of Hermann Pfefferkorn. It contains 19 contributions by authors from North America, Europe, South America, and Asia. The papers cover topics on systematics, paleoecology, paleoclimatology, and taphonomy of Paleozoic to modern floras with an emphasis on Carboniferous and Permian paleobotany. Hermann's former student Walt Cressler and former postdoc Ben LePage (together with a coauthor) named a new species of a late Devonian seed after Hermann!
- **Professor Fred Scatena** and colleagues were editors on a 74 chapter book "Tropical Montane Cloud Forests: Science for Conservation and Management" that was published by Cambridge University Press (ISBN 978-0-521-76035-5) in December. The book is a follow-up to a 1994 volume and demonstrates how far our understanding of these unique landscapes has developed in the past 2 decades.
- **Professor Emeritus, Robert Giegengack** and colleagues edited the volume "Climate Crises in Human History", published in the *Transactions* series of the American Philosophical Society (ISBN 9781606189214). Contributions were drawn from participants at a conference by the same name in the University Museum in November 2008. One of those participants was Jennifer Smith (EES PhD 2001) who is now an Associate Professor at Washington University in St. Louis.

The Department now has its largest team of postdoctoral scientists in its history. These researchers come from all over the globe. **Dr Federico Falcini** is working with **Assistant Professor Doug Jerolmack** in his Sediment Dynamics lab. Fede did his undergraduate and graduate studies at the University of Rome "La

Sapienza", Italy. The Sea Level Research Lab houses two postdocs under Ben Horton's supervision: **Dr Simon Engelhart**, a former PhD student of EES, and **Dr Jessica Pilarczyk**, who has recently arrived from McMaster University, Canada. **Dr Raffaele Bernardello** works with Irina Marinov in the Ocean Biogeochemistry and Climate Change lab. Raffa did his undergraduate studies in Genova, Italy and his graduate studies in Barcelona, Spain. **Dr Gilles Brocard** is working with Jane Willenbring on the Puerto Rico CZO project. Gilles is a native of France where he did his undergraduate and graduate work and did previous postdocs at the University of Lausanne and the University of Minnesota. **Dr Jose Manuel Fernandez** recently completed a two-year postdoctoral fellowship while working with **Assistant Professor Alain Plante** to develop thermal analysis methods to characterize soil organic matter stability. He will be returning to Madrid for a position with the Spanish National Research Council. Following on his heels, Alaine Plante will be welcoming **Dr Clement Peltre** this fall. Clement hails from France and recently completed his PhD studying soil organic matter in agricultural soils with particular emphasis on the use of infrared spectroscopy.

Moving to teaching, the Department graduated over 70 students in the academic year; 26 undergraduates (19 ENVS and 7 Earth Science), 47 Professional Masters students, and 2 Doctoral students. In addition, 7 students received minors from the Department. This is the largest Earth Science group graduating in many years! Several of our graduating seniors won awards and honors: two were inducted into Phi Beta Kappa, several were awarded Greg and Susan Walker Endowment grants and the Climate Action grants. A few of the other awards our students earned include: the NASA Pennsylvania Space Grant Consortium Award, PennVention Grand Prize Award, Tapper Innovation Connect Award, QVC Consumer Innovation Award, and the Design Circle Inc. Design for Manufacture Award. The Department was very busy teaching this year. Indeed, we offered more than 77 full courses that ranged from freshman seminars to advanced graduate level courses, in addition to numerous independent studies and cross-listed classes.

Once again, thank you for your support and interest in the Department and bearing with me in summarizing our activities. I hope this newsletter finds you well, and I wish you all the best for the coming year.

Warm regards,

**Ben Horton**

## Research Spotlight: The myth of the shrinking mountains

New Assistant Professor Jane Willenbring provides an explanation for the apparent accelerated sedimentation in the past 5 million years. This is the principal result of an analysis that Jane and GFZ scientist Friedhelm von Blanckenburg published in the Journal "Nature" (13.May 2010). "The constant increase in the volume of accumulated sediment that has taken place in the past 5 million years does not exist" Jane explained. The globally observed four-fold acceleration of sedimentation is an artifact of the observations. Important geological hypotheses that are based on this observation now require revision.

Erosion by water and ice, and chemical weathering of rocks of the Earth's surface lower

mountains over millions of years. The rock eroded is now found in sediment. Measurements of the thickness of sediment deposited globally in oceans and on the continents surrounding large mountains has resulted in the finding that the amount of sediment that is deposited per unit of time has continuously risen in the past 5 million years. "To produce this additional sediment, mountains need to erode with similarly accelerated rates" Jane asserts. Hypotheses for the cause of this phenomenon have assumed the increased global growth of mountains by movement of tectonic plates, which resulted in accelerated erosion. But the opposite has also been suggested: the mountains existed long before the observed increase, but only a shift in global

climate such as the onset of the ice age ~3 million years ago accelerated erosion of the mountains which in turn rose by removing this weight. "To date neither of these hypotheses, however, was explained by satisfactory geologic processes" Jane concluded.

In addition to her research published in Nature, the isotopes Jane uses can measure rates of landscape change and date both buried sediments and rocks and sediment at the Earth's surface as well as trace past solar cycles in ice cores. She has applied this technique to a diverse set of problems related to geomorphology and climate change on all seven continents. Indeed, since moving to Penn Jane has been awarded over a half million dollars from the National Science Foundation (NSF) to study the East Antarctic Ice Sheet and the rise of the Anatolian plateau in Turkey.



*The picture shows sediment generated by both glacial and fluvial processes at Monte Disgrazia of the Northern Italian Alps. Once disintegrated into small particles, the minerals exposed from solid rocks will contribute to the long-term withdrawal of atmospheric CO<sub>2</sub> by weathering. In their Nature article, Willenbring & von Blanckenburg show how such weathering processes have been steady on a global scale for the past 10 Million years, and that geologists have been misled for years by a timescale effect into the belief that this process accelerated. Photo credit: von Blanckenburg.*

## Research Spotlight: X-Ray Technique for Determining Pigmentation Patterns in Fossils



Shown here is an artist's conception of the pigmentation patterns in *Confuciusornis sanctus*, a ~120 million year old species, the oldest documented to display a fully derived avian beak. Patterns are based on chemical maps of copper and other trace metals in several fossils of this organism. Trace metals, copper especially, are found to exhibit patterns which reveal eumelanin pigment distribution in the living organism. In the background is a picture of one of the fossils used to derive the artist's drawing.

Professor Peter Dodson and Dr Phil Manning have reconstructed the appearance of ancient animals by using the world's most powerful X-rays. This new study was published in the Journal "Science" (July 1<sup>st</sup>, 2011). Peter and Phil have long studied fossils of the earliest birds, including *Confuciusornis sanctus*, which lived 120 million years ago and was one of many evolutionary links between dinosaurs and birds, and *Gansus yumenensis*, which is considered the oldest modern bird and lived more than 100 million years ago. Their partnership with researchers from Manchester and Stanford,

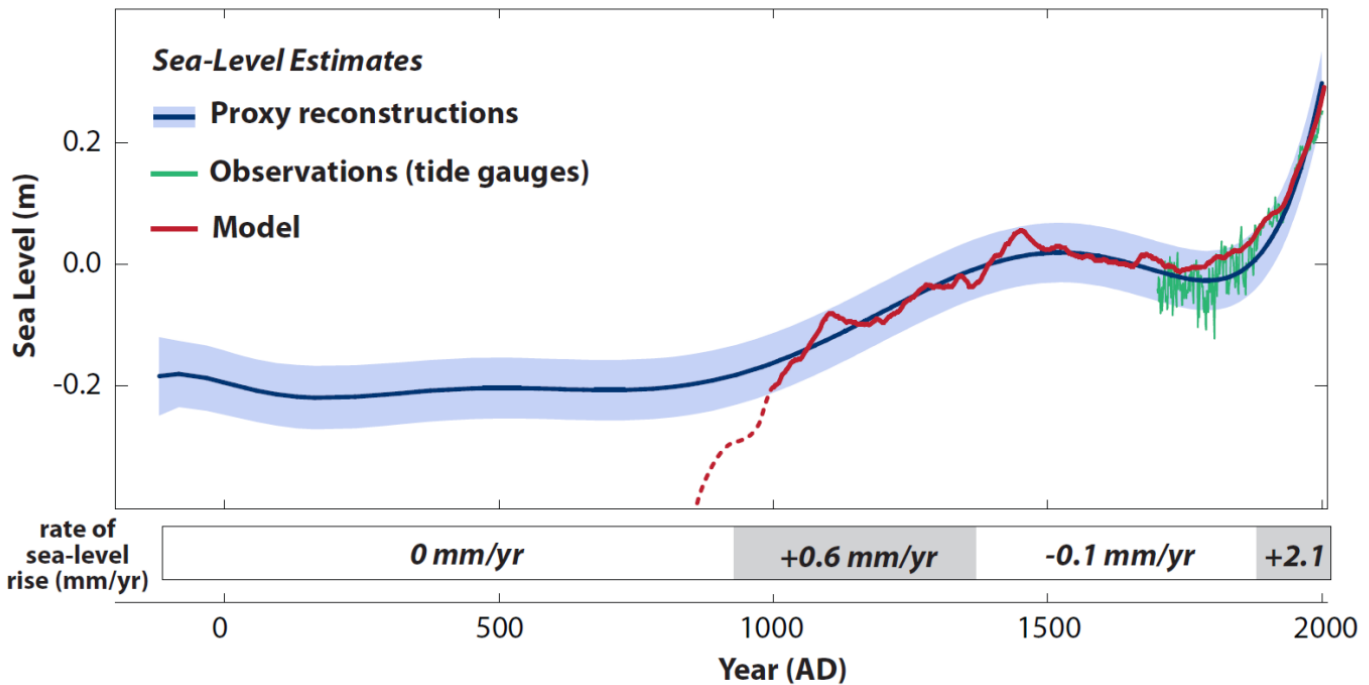
however, has opened a new avenue of investigation.

Peter explained, "I had long believed that pigments in dinosaurs were a matter for artists not paleontologists. Now we are coming this close to lifting the veil. I am tremendously excited." The study by Peter, Phil and colleagues applies synchrotron x-ray techniques to several fossil and extant organisms, including *Confuciusornis sanctus*, to map and characterize possible chemical residues of melanin pigments. Results show that trace metals, such as copper, are

present in fossils as organometallic compounds most likely derived from original eumelanin. The distribution of these compounds provides a long-lived biomarker of melanin presence and density within a range of fossilized organisms. Metal zoning patterns may be preserved long after melanosome structures have been destroyed.

"This provides more than just insight to fossil pigments. The technique allows us to map the chemistry of biosynthetic pathways in long extinct animals" Phil explained.

## Research Spotlight: Fastest Sea-Level Rise in Two Millennia Linked to Increasing Temperatures



Proxy (salt marsh), observations (tide gauge and satellite) and model reconstructions of sea-level for the past 2000 years.

Dr Andrew Kemp (EES PhD 2009) who is now at Yale's Climate and Energy Institute and Associate Professor Ben Horton of the Department's Sea-level Research Laboratory have shown that the rate of sea-level rise along the U.S. Atlantic coast is greater now than at any time in the past 2,000 years, and have shown a consistent link between changes in global mean surface temperature and sea level. This study was published in the *Proceeding of the National Academy* (June 22<sup>nd</sup> 2011).

"Sea-level rise is a potentially disastrous outcome of climate change, as rising temperatures melt land-based ice and warm

ocean waters," Ben said. "Scenarios of future rise are dependent upon understanding the response of sea level to climate changes. Accurate estimates of past sea-level variability provide a context for such projections" said Andrew, the study's lead author.

The research provides precise data of sea-level rise using a unique analysis of sediment cores from coastal salt marshes in North Carolina,

In the new study, Ben and Andrew, plus colleagues from the US and Europe, provided the first continuous sea-level reconstruction for the past 2,000 years and compared variations in

global temperature to changes in sea level over this time period. The team found that sea level was relatively stable from 200 BC to 1,000 AD. Beginning in the 11th century sea level rose by about half a millimeter per year for 400 years associated with a warm climate period known as the Medieval Climate Anomaly. There was a second period of stable sea level associated with a cooler period called the Little Ice Age that persisted until the late 19<sup>th</sup> century. Since then sea level has risen by more than 2 millimeters per year on average, which is the steepest rate for more than 2100 years.

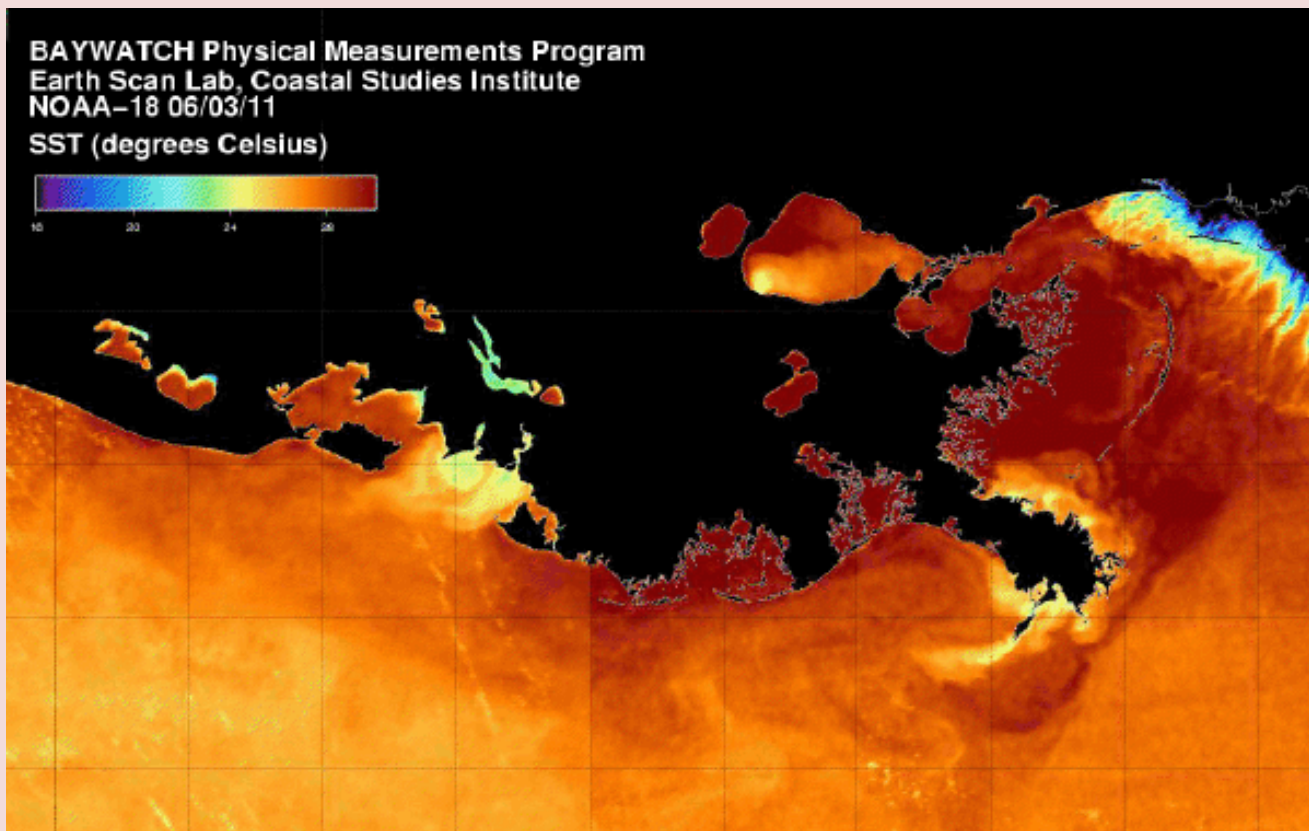
## Research Spotlight: Studies spy on a river's rage

The historic floods of Spring 2011 devastated residents living along the Mississippi River, but may result in a net benefit for fragile marshes of the Louisiana coast. Postdoctoral researcher Federico Falcini and Assistant Professor Doug Jerolmack used satellite data and mathematical modeling to study how sediment pouring from the mouth of the swollen Mississippi made its way onto surrounding wetlands, which are rapidly disappearing due to flood control structures and sea level rise. A boat survey by University of Mississippi colleagues confirmed model predictions. The survey earlier in June is part of an ongoing interdisciplinary effort

led by Penn's Sediment Dynamics Laboratory to learn how the flooding river discharges water and where it deposits its sediment load. Those muds could have a role in restoring the diminishing marshes along the Louisiana coast. The flood "is a catastrophic event, but it's a rare opportunity to understand the physics of the Mississippi delta," Fede explained. He and Doug hope to validate a model in which the faster water is moving as it exits a river, the farther into the sea it will carry sediment. This relationship would be especially important during floods, which carry unusually heavy loads of sediment that contribute to marsh-building along the coast. "We're going to

learn a whole lot that we'll use to inform and expand our model," Doug said.

The Mississippi story build upon Fede and Doug's 2010 publication in the *Journal of Geophysical Research* (A potential vorticity theory for the formation of elongate channels in river deltas and lakes, *Journal of Geophysical Research*, Vol. 115, f04038), where they developed a novel theory to understand the different patterns that river channels form as they built into oceans and lakes. Results help to explain the unusual shape of the Mississippi Delta, and may aid the design of artificial diversions in order to restore wetlands there.



*Sea surface temperature map of coastal Louisiana. Cold plumes of water can be seen emanating from the Atchafalaya (left-center) and Mississippi (right-center) channels during flooding on June 3<sup>rd</sup>, 2011.*

## Research Spotlight: The Carbon Collective



*The Carbon collective: Back row (left to right): Hao , Wenting Feng, Jose Fernandez, Claire-Marie Gherardi, Estelle Ancelet, Alain Plante. Front row (left to right): Anarmaa Sharkhuu, Maddie Stone, Aurora MacRae-Crerar.*

Assistant Professor Alain Plante's lab in Hayden 155 has been a hive of activity in 2010-2011, and was recently nicknamed "The United Nations of Soil Carbon Biogeochemistry" (or "The Carbon Collective" for short). Led by a Canadian national, the lab includes Chinese, Mongolian and American grad students, two visiting students from France, a Spanish postdoctoral researcher and visiting collaborators from Germany and New Zealand. Several undergrads have also been active in researching aspects of the terrestrial carbon cycle. Elizabeth Wordell (ENVS major, '11) recently presented her senior

thesis on reclamation progress in soils from Palmerton, PA, and had worked as an undergraduate research assistant contributing to our research program exploring how organic matter and minerals interact to make soils a potential sink for greenhouse gases.

Alain's research has made a big impact. Of the 724 articles the journal *Global Change Biology* (ranked 3rd in the list of most-cited journals in *Climate Change Research*, after *Nature* and *Science*) has published since January 2008, Alain Plante's 2008 paper with colleagues from the Natural Resource Ecology Laboratory (Sensitivity of organic

matter decomposition to warming varies with its quality. *Glob. Change Biol.* Vol. 14, 868-877) is one of the 25 most-cited. The article reports results from new laboratory soil incubations and reanalysis of data from other soil and litter decomposition studies that show that with higher temperature, decomposition and the release of CO<sub>2</sub> from soils is greater for more stable forms of organic matter compared to easily decomposable material. The results indicate that future emissions of CO<sub>2</sub> from soils may be even greater than previously supposed.

## Research Spotlight: Luquillo Critical Zone

In 2009 the Department received a \$5 million grant to lead the Luquillo Critical Zone Observatory in Northeastern Puerto Rico. This is the largest grant ever received by EES. The Observatory is one of six environmental laboratories that were established by the US National Science Foundation to study the chemical, physical and biological processes that shape the Earth's surface in the zone where "rock meets life" (<http://criticalzone.org/index.html>). These observatories are supported by the Earth Science Division of the Geoscience Directorate, and are centers of interdisciplinary studies of hydrology, geology, soil science, biology, ecology, and

geochemistry.

The principal investigator of the grant is Professor Fred Scatena, our Department and Undergraduate Chair. "The overarching goal of the Luquillo Critical Zone Observatory (LCZO) is to develop the infrastructure platform and information base that will allow geoscientists to address the question of how critical zone processes differ in landscapes with contrasting lithology but similar climatic and environmental histories" Fred explained. LCZO research is conducted in paired and nested sampling areas and is guided by seven interrelated hypotheses and a unified data management system that are designed to

quantify how granodiorite, volcanoclastic, and hornfels lithologies are coupled and decoupled to hydrologic and geochemical cycles (<http://www.sas.upenn.edu/lczo/overview.html>). Since the start of the LCZO, over 55 individuals have directly contributed to the Observatory's research. These include 6 EES Faculty, 10 undergraduate students, 13 graduate students, 5 post-doctoral researchers, and 5 professional staff. These collaborators are based at the University of Pennsylvania, Penn State University, University of California, Berkeley, University of New Hampshire, University of Puerto Rico, the US Geological Survey and the US Forest Service.

### Penn's Year of Water

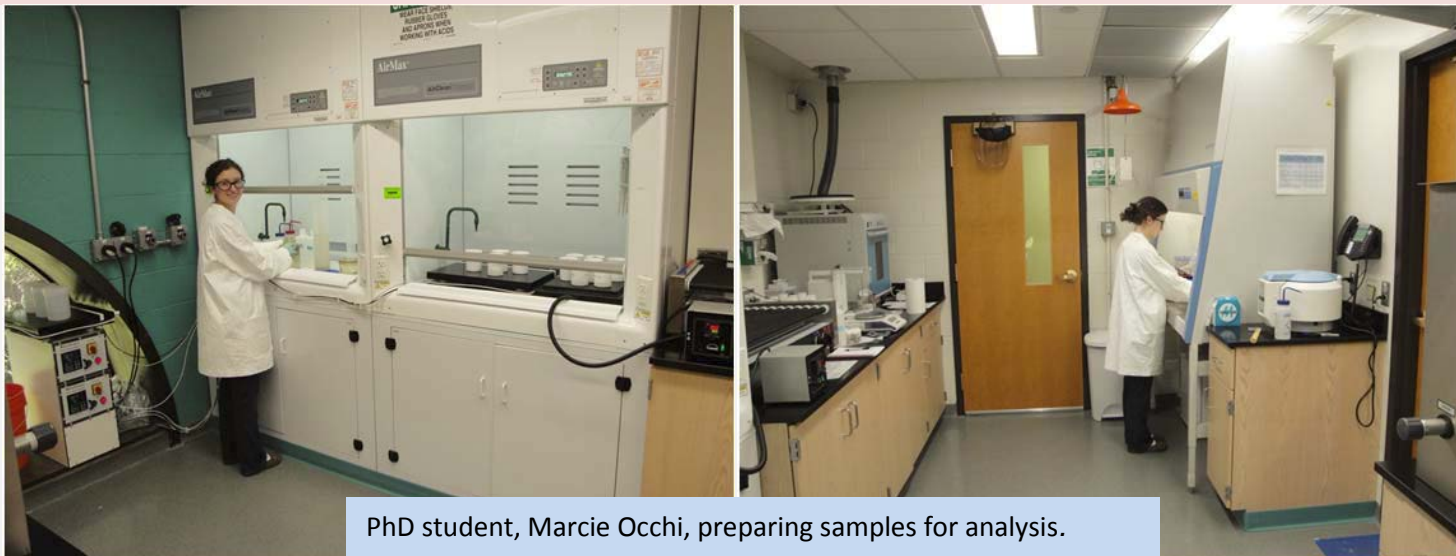
Each year, the Penn Provost's office sponsors a series of events around a theme chosen by faculty, staff and students. The 2010-2011 academic year was devoted to an exploration of water, and EES faculty were instrumental in the planning and design of many activities. Fred Scatena and Alain Plante sat on the Year of Water Steering Committee to select the Penn Reading Project book (Rose George's "The Big Necessity: The Unmentionable World of Human Waste and Why It Matters"), and to promote several interdisciplinary conferences, symposia, exhibits, performances, etc., including the Philadelphia Global Water Initiative's 4th Annual Conference, led by Stan Laskowski. The Penn Women's Alumni Group awarded a grant to two of our MES students to begin an electronic journal titled WH20 with a theme of Women and Water: Caroline D'Angelo and Dakota Dobyn. As part of the department's outreach, Irina Marinov gave a 60 Second Lecture titled "Why Water Matters for Climate."



Irina Marinov giving her 60 second lecture on Locust Walk.

[Watch Irina's 60 second lecture!](#)

## New Analytical Facility: Penn-Cosmogenic Isotope Laboratory



PhD student, Marcie Occhi, preparing samples for analysis.

Bringing Assistant Professor Jane Willenbring to Penn involved a substantial rearranging of departmental laboratory resources by **Dr David Vann**, our Research Associate and Laboratory Manager. “This restricted our options, as the historic nature of Hayden Hall limits what modifications are allowed” David explained. **Professor Art Johnson’s** biogeochemistry labs were relocated, allowing, in the end, a better and more efficient organization. Most of the Department’s advanced instruments, such as the inductively coupled plasma spectrograph (ICP-OES) and isotope-ratio mass spectrometer (IRMS), are now located in a climate-controlled room, a much better environment for the stability and longevity of the

machines. Our large central lab is now organized for better work flow and access to necessary machines, such as centrifuges and ovens, as well as fume hoods. This central lab is our main ‘wet chemistry’ lab, where samples are prepared for analysis for a broad range of projects, from forest nutrient cycling to sediment core reconstructions. In the end, creating space for a new faculty member resulted in changes involving nine different lab/office spaces within the Department.

EES now hosts a new facility for extracting in-situ produced and meteoric cosmogenic nuclides from rocks and sediment for analysis by accelerator mass spectrometry (AMS) for Jane Willenbring’s research. The new Penn Cosmogenic Isotope Lab (CIL) has a computer-controlled air-handling system to

automatically adjust temperature, air-flow rate and hot-plate temperature, two laminar-flow, fume-exhaust hoods and clean bench workstations, as well as a clean Beryllium-oxide target packing station. There is a production lab that includes hoods and a high-pressure, high-temperature microwave mineral digestion unit designed to dissolve rocks, quartz, fine-grained sediments and organics. The lab also contains ion-exchange columns for separation of rare elements and nuclides that comprise soil, ice, water and air particles. There is a hood dedicated to all phases of low-level sample preparation. Jane will use this facility to investigate problems in geology, environmental sciences, and hydrology and climate science.

## Undergraduate Program



*For the third year in a row, Doug Jerolmack led his “Earth Surface Processes” class on a spring break field trip to White Sands National Monument, home to the world’s largest gypsum dune field. Students used portable weather stations, sediment traps, and geophysical techniques in the field, and analyzed sediment, water and plant samples back at Penn, to understand how wind, water and vegetation interact to sculpt this bizarre landscape.*

The Earth and Environmental Science Undergraduate Program continues to thrive and provide an excellent education for our students, as well as a “home” within the College under the expert tutelage of **Dr Jane Dmochowski**. Our students are engaged in environmental policy and geologic fieldwork, and nearly everything in between. We have new courses in climate change, energy, sea-level rise and one offered this fall called “Rates and Dates” on the applications and methods of modern geochronology that will be taught by Jane Willenbring. Our recent changes to the curriculum—the Environmental Studies major now has several directed concentrations and we have added an Environmental Science track to the Earth Science major—continue to attract a lot of interest from students.

Board. This group continues to keep the faculty informed about student issues and has planned very interesting academic and social events, including field trips and three faculty discussion panels, the latest on the Marcellus Shale. This spring, 26 undergraduate students earned their bachelors degrees from the Department (19 Environmental Studies and 7 Earth Science), as well as 7 minors, with many earning awards and honors and going onto exciting post-graduate endeavors. Approximately 35% are going on to a masters program in a related field, 12% to Ph.D. programs, approximately 35% found employment in a related field, and one student is going directly into the Peace Corps.

We again had a very successful senior research conference this May, with 22 of our 26 graduating seniors presenting their senior research in written, oral and poster form. These projects ranged from modeling the potential for urban agriculture in Philadelphia using multispectral analysis in Geographical Information Systems (GIS), to using stable carbon isotopes to reconstruct Late-Holocene sea-level changes in the state of Georgia, and understanding the effect of fluid mechanics on river delta patterns.

As a continuation of our revised curriculum, the Department has updated and refined our curriculum objectives and is currently working to incorporate these objectives into all our course syllabi and other documentation so that students better understand how each class fits into their Earth and Environmental Science education. Toward this effort, we are updating our student handbook, website, and connecting more students to alumni through Twitter, Facebook and LinkedIn.

Our courses continue to teach the fundamentals of Earth and Environmental Science, while keeping up with the students' interests and needs. As an example, the undergraduate program has received funding from Penn's Environmental Sustainability Advisory Committee (ESAC) to incorporate more Sustainability-related themes into our undergraduate courses. Jane Dmochowski is attending a meeting this summer on

"Sustainability Across the Curriculum" and has engaged two students to help update many of our undergraduate course assignments to incorporate these themes, as well as updating the quantitative data analysis done in our introductory courses.

As an indication of the independent nature of our undergraduates, many have received grants this year to pursue their research:

Charles Kasserman, and Claire Masteller: Kelson Family College Alumni Society Undergraduate Research Grant.

Hyejung Lee and Marguerite Leone: Penn Undergraduate Research Mentoring program (PURM) grant.

Shirley Leung, Claire Masteller, Joanna Karaman and Douglas Miller: Penn Undergraduate Climate Action Grants.

Paul Mitchell: Benjamin Franklin Society grant.

Cassandra Turcotte: College Alumni Society Board of Managers and Presidents Undergraduate Research Grant.

Claire Masteller: Penn's Environmental Sustainability Advisory Committee (ESAC) Teaching Assistant grant.

*EES graduating seniors: Top Row (left to right): Sarah Fackler, Michael Paci, Raleigh Davis, Jason Goodman, Christiana Dietzen, Elizabeth Wordell, Kendra McKoy, Naomi Delphin, Hannah Cummons, Kirsten Washington. Bottom Row (left to right): Anastasia Piliouras, Nanneke Jansen, Jessica Renny, Jenny Gai, Meredith Perry, Jenna Stahl, and Will Van Eaton. There are a few missing: Cornelia Colijn, Andy Huang, Adrian Thomas, William Cooper, Kristina Koutsarova and Andreas Schreiber.*



## The PhD Program

As always our graduate group, led by the **Graduate Chair, Professor Art Johnson** and assisted by **Joan Buccilli**, is a center of excellence. This year two students defended their dissertations and both are happily heading for worthy employment. **Dr John Clark** has a job with the New Jersey Department of Environmental Protection as a wetlands analyst. **Dr Candace Grand Pre** has a 2-year Visiting Assistant Professor position at Franklin and Marshall College, with potential for a tenure track appointment thereafter.

In 2010 four new students were enrolled in the doctoral program: Tina Dura (Adviser - Ben Horton); Kimberly Litwin (Adviser - Doug Jerolmack); Marcie Occhi (Adviser - Jane Willenbring) and Maddie Stone (Adviser - Alain Plante). This fall we welcome three more: Hao Xing (Adviser - Art Johnson); Vanessa Boschi (Advisers Jane Willenbring and Alain Plante) and Bing Xu (Adviser Fred Scatena).

This year the graduate students have continued to produce excellent papers, be awarded prestigious grants and appear in national and international media outlets:

- Vera Aldeias appeared on a National Geographic TV show about the human fossil (that they named Bouchra) discovered at her PhD study site in Morocco. The show was called "World's oldest child".
- Maddie Stone was awarded a 2011 National Science Foundation Graduate Research Fellowship. The award comes with three years of support, international research and professional development opportunities and TeraGrid Supercomputer access. Congratulation to Maddie, whose selection was based on her "outstanding abilities and accomplishments, as well as her potential to contribute to strengthening the vitality of the US science and engineering enterprise".
- Tina Dura, another of our intake from Fall 2010, also received an NSF award. The NSF Office of International Science and Engineering (OISE) selected Tina into the 2011 East Asia and Pacific Summer Institutes Program for Singapore.
- Nicole Kahn has been awarded one of the three National Ocean Science AMS Graduate Internships.
- Eric Morschhauser received a grant from Evolving Earth Foundation for his proposal entitled, "Phylogenetic placement of Auroraceratops and a revision of Basal Neoceratopsia". Eric also received a young explorers grant from the National Geographic Society's Committee for Research and Exploration. Not to be outdone by his paleontology friend, Andrew McDonald has described a new species of dinosaur originally found at the site in 1996. Called *Jeyawati rugoculus* (pronounced HEY-a-WHAT-ee) the herbivore dinosaur comes from rocks that also preserve a swampy forest ecosystem that thrived near the shore of a vast inland sea 91 million years ago.
- Always the explorer, Roman Shor participated in a 2010 expedition examining the accumulation of plastic debris in the North Atlantic Ocean, and is presently participating in a Woods Hole Oceanographic cruise in the North Atlantic.



This is an artist's rendering of the new species, *Jeyawati rugoculus*, described by Andrew.

## Graduate Spotlight: Anarmaa Sharkhuu

Our graduate students go to the far reaches of the planet to pursue their academic curiosity. For example, Anarmaa Sharkhuu's research site is located at the southern boundary of Siberian continuous permafrost zone, as well as the transition zone from Siberian taiga to Eurasian steppe. If you didn't think that was enough, she also visited Antarctica!

Anarmaa's PhD is part of PIRE (Partnerships in International Research and Education)-Mongolia project, whose goal is to study ecological and evolutionary consequences of climate change in Northern Mongolia. Her advisor is Alain Plante. Anarmaa has come to Penn from Ulaanbaatar, the capital city of Mongolia. She graduated from the Ecology Department of the National University of Mongolia. "Within this project I am focused on studying stored carbon in different ecosystems, soil responses to potential climate warming, and its controlling mechanisms" Anarmaa explained.

Anarmaa used passive warming chambers to simulate potential warming in three ecosystems. Air and soil temperature, soil moisture, decomposition, soil CO<sub>2</sub> production and active layer thickness are monitored in the chambers and control plots. In addition, above- and belowground carbon is being quantified in steppe and forest.

"Traditionally this area had minimal human impact except nomadic grazing which is a part of the system. However, there has been an increase in overgrazing, poaching, and timber production in this region" Anarmaa said.

To support her research, Anarmaa has received a variety of awards, including a University Research Foundation grant to Dr Plante, the ACMS-Enkhbaatar Demchig Field Research Fellowship, and a Greg and Susan Walker Endowment.



*Anarmaa standing in front of a calving ice sheet in Antarctica.*

## Masters Program

### Masters in Environmental Studies (MES)

Students in the Master of Environmental Studies Program were very active this year. Under the guidance of **Dr Yvette Bordeaux** 38 students graduated from the program. Similar to the PhD students, they have won awards; attended, presented, and organized conferences; and published papers. For example, Tanya Dapkey, a recent graduate of the MES program published work from her Capstone entitled, "Can DNA barcodes of stream macroinvertebrates improve descriptions of community structure and habitat interactions and water quality?" in the Journal of the North American Benthological Society (2011, Vol. 30(1):195–216). In addition, our first Issue of PennElements (<http://www.pennelements.com/>), an environmental electronic journal, was published this spring. All articles in the journal were written by MES students. We also have an active Graduate Advisory Board consisting of 6 MES students that has organized programs such as a Mentor Program for incoming students, social events, and an Alumni Career Panel. We held the 5<sup>th</sup> Annual Graduate Research Conference on April 6th, 2011. Three MES students (Elizabeth Haegele, Steven Gillard and Sarra-Zoe Reich) presented their capstone research and 35 students displayed posters at the event, which was attended by nearly 100 students, faculty, alumni and prospective students.



*Master of Environmental Studies students Joanne Lee, Lindsey Walker and Christina Tierno attending the Wind and Wildlife Conference in Denver, Colorado in Fall 2010.*

### Masters of Science in Applied Geosciences (MSAG)

The program graduated a total of 9 students this year. This year's winner of the Institute for Environmental Studies Award for Excellence in Applied Geosciences was Faye Edmund. Faye also presented her research on "Petrographic and XRD investigation of volcanic rocks in Sabah, Malaysia" at the 5<sup>th</sup> Annual Graduate Research Conference, and plans to present it to colleagues in Malaysia this summer.

Carl Mastropaolo has developed an online version of Geocomputations I. This course is a pre-requisite for the majority of other MSAG courses and has had to be taken concurrently with other MSAG courses in the past. Geocomputations I will be offered in Summer Session II online from now on, so that incoming students may take the course before arriving on the Penn campus. This will better prepare these students for the rest of the curriculum. J Anthony Sauder, a Lecturer in the MSAG program, received the "Open Mind Africa" award in May for his work in bringing clean water to many African communities. Whenever possible, Mr Sauder has included Penn students in these projects.

## Awards and Honors

Douglas J. Jerolmack received the 2010 Luna B. Leopold Young Scientist Award at the 2010 American Geophysical Union (AGU) Fall Meeting, held 13–17 December in San Francisco. The award recognizes “a young scientist for making a significant and outstanding contribution that advances the field of Earth and planetary surface processes.” In addition, Doug was selected to present the Robert P. Sharp lecture at the 2010 AGU Fall meeting, the capstone lecture for the Earth and planetary surface processes focus group.

Peter Dodson received the Christian R. and Mary F. Lindback Foundation Award which honors faculty for excellence in undergraduate, graduate and professional teaching.

Ben Horton received a Medal for Research Excellence by the Commanding General of the North Atlantic Division of the United States Army Corps of Engineers (USACE). Ben was also selected to be an author of the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (5AR) and a committee member for the National Research Council.

Eric Morschhauser received the 2010 Paul Bond award from the Delaware Valley Paleontological Society

Caroline D’Angelo received the Society for Women Environmental Professionals of Greater Philadelphia Scholarship for the outstanding Graduate student in the Environmental field.

Vivian Futran received the Institute for Environmental

Studies Award for Excellence in Environmental Studies.

Faye Edmund received the Institute for Environmental Studies Award for Excellence in Applied Geosciences.

Cornelia Colijn received EES outstanding undergraduate “Teaching Assistant”, in recognition of her contribution to undergraduate teaching.

Anastasia Piliouras received the Henry Darwin Rogers Award, For Excellence in the Study of Earth Science for her study “Effect of Potential Vorticity on Delta Channel Bifurcation and Elongation”.

Nanneke Jansen received the Ferdinand Vandiveer Hayden Award, For the Outstanding Senior in Environmental Studies for her research on “Echinodiscus: Phylogenetics of Indo-Pacific, Holey Sand Dollars”.

William Cooper received Elaine B. Wright Award, For Excellence in Applying Environmental Studies to Community Service.

Jenna Stahl and Jessica Renny: Phi Beta Kappa Inductees.

Meredith Perry received a whole host of awards: the NASA Pennsylvania Space Grant Consortium Award; the PennVention Grand Prize Award; Tapper Innovation Connect Award; QVC Consumer Innovation Award; and Design Circle Inc., and Design for Manufacture Award.

### Paleontology summer stipends

More than 100 paleontology summer stipends have been awarded to undergraduate and graduate students over the last 15 years from the funds given by an anonymous donor for 20 years. The stipends give the students the opportunity to work over the summer with a professor at Penn or another institution, in the lab, a museum, or in the field. The stipends are intended by the donor to encourage undergraduate and graduate students in the study of paleontology. Seven stipends were awarded this year supporting outstanding research projects. They include work on the sediments surrounding a sensational discovery of the skull of a 100,000 year old human child in Morocco, the paleobiology of dinosaurs in China, New Mexico, Wyoming, and South Dakota, and microfossils that indicate sea level rise in Florida and Chile

## Events

EES sponsored 54 seminars and was involved in 11 special campus events or symposium. The logistics for all these events (and much more besides) are orchestrated by **Arlene Mand**. EES continues to be actively involved in a variety of SAS and University missions including Academically Based Service Courses, the University Sustainability initiatives and the Institute for Environmental Studies.

This year's Henry Darwin Rogers Lecture & Award Ceremony was given by Christopher Wnuk, Consulting Geologist, Reston, VA. His lecture was titled: "Field Geology in Afghanistan: Developing Economic Opportunities to Build Social Stability".

The 19th Paleontology-Paleobiology-**GEOBIOLOGY SYMPOSIUM** was held on the last Friday in February, as usual. Ten presentations by colleagues and students from 6 institutions covered topics ranging from synchrotron imaging of fossilized soft tissues, to the preservation of soft body Precambrian fossils, vertebrate Paleobiology, and a Permian flora preserved

by a volcanic ash fall. This annual symposium continues to serve as a center for the exchange of ideas in the field for the Mid-Atlantic region.



*Potluck dinner after the Henry Darwin Rogers Lecture 2011. Alumni and guests in the lobby of Hayden Hall after a fascinating talk of the Henry Darwin Rogers Lecture on April 28, 2011, looking forward to the traditional potluck and pig roast dinner. The speaker, Chris Wnuk in blue shirt with white collar is smiling into the camera.*



### Greg and Susan Walker Endowment

The Greg and Susan Walker Endowment was established in 2006 to provide resources to enable students in programs of EES to pursue independent research projects as part of their undergraduate and graduate curricula. Professor Emeritus Robert Giegengack oversees the Endowment. This year, the evaluation committee awarded the following grants:

Christiana Dietzen: Response of Mongolian Plant Communities to Experimental Micro-Environments.

Sarah Fackler: Holocene Sea-Level Reconstruction from the Thames Estuary, United Kingdom.

Jenny Gai: Using Stable Carbon Isotopes to Reconstruct Sea-Level changes in Georgia, USA, for Late Holocene Time.

Nanneke Jansen: The Atricypeidae: Phylogenetics of Indo-Pacific, Super-Flat, Holey Sand Dollars.

Meredith Perry: Atypical Growth Patterns in Proterozoic Carbonate Stromatolites: Analogs for Microbial Life on Mars?

Brandon Hedrick: Dinosaur Fieldwork in Northern Coahuila, Mexico.

Wenting Feng: Attendance at the Annual Meeting of the Ecological Society of America, Pittsburgh.

Mishra Chakrabarti: The Nutritional Environment of West Philadelphia.

Razvan Zarzu: Attendance at Ocean Science Conference, Portland, OR.