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Crowdsourcing Digital Maps Using Citizen Geologists

Crowdsourcing—“the act of taking a job traditionally performed by a designated agent [expert] and outsourcing it to an undefined, generally large group of people” [Howe, 2009]—has fundamentally changed and enhanced the collection and dissemination of data. Crowdsourcing has proven effective for rapid data collection, especially where in-depth knowledge of a topic or discipline is not a necessity.

But what if some basic knowledge were a necessity? Could the potential of crowdsourcing still be harnessed? Geoscientists, particularly those who create and use geological maps, are beginning to ask these questions.

Geological mapping has traditionally depended on labor-intensive field data collection by geoscience professionals. These professionals could benefit greatly from crowdsourcing—they could cover more area at finer scales. However, the crowd used to help with mapping would need some geological training.

Although the general public may lack the necessary level of geological expertise, the 2000-plus geoscience students who attend capstone field courses annually [Whitmeyer and Mogk, 2009] have the training and background to make crowdsourced field data collection a viable option.

Different Crowdsourcing Approaches

Several projects have successfully utilized crowdsourcing to generate and analyze data.

Examples include generating maps of the extent of wildfires [Goodchild and Glennon, 2010] and mapping the status of earthquake-impacted areas (as in the case of the 2011 Tohoku earthquake; see <http://www.sinsai.info>). The Google Earth™ for Onsite and Distance Education (GEODE) project is currently crowdsourcing instructional field locations (<http://geode.net/mgmt>). Crowdsourcing can also help scientists process mountains of data, including morphological classification of galaxies (the Galaxy Zoo project [Land et al., 2008]) and the collection of information on human genes (the Gene Wiki project [Huss et al., 2008]).

Geoscientists have begun to explore crowdsourcing as an effective (and inexpensive) way to collect and organize field data. For example, the U.S. Geological Survey employs geo-crowdsourcing with “Did You Feel It?” surveys for recent earthquakes and, from that information, creates community-sourced maps of earthquake shaking intensity (see <http://pubs.usgs.gov/fs/ts030-01/>).

Some crowdsourcing efforts have even directly targeted citizens with specific expertise.

In 2000, GoldCorp, a gold production company, issued a challenge: It would open up its wealth of geological data in a region and offer \$575,000 to whomever came up with the best locations and methods for finding gold. The GoldCorp Challenge resulted in successful gold targets utilizing a crowd consisting primarily of professional geologists and engineers (R. Tischer, He struck gold on the net (really), 2002, <http://www.fastcompany.com/44917/he-struck-gold-net-really>).

Case Study: A Field Mapping Exercise in Ireland

Building on the approach of tapping into a crowd with specific expertise, the James Madison University’s (JMU) field course in Ireland has developed a crowdsourcing exercise for geological mapping as a component of a digital mapping exercise [Johnston et al., 2005; De Paor and Whitmeyer, 2009]. Students collect outcrop data in the field using modern hardware (iPads) and software (iGIS). Later, in camp, students evaluate their field data in comparison with an aggregate of all student-collected data.

This approach makes the assumption that the majority of students will collect accurate data; deviations from the group norm will highlight field locations that students should revisit to reevaluate data they collected. Ultimately, the composite data set produced by the students is accurate and robust enough to function as a highly detailed geological map, with the added benefit that it is already in a modern, Geographic Information System (GIS) format.

Digital Mapping and Crowdsourcing Methodologies

Most modern digital mapping methodologies utilize handheld tablets with integrated global positioning system (GPS) receivers and iOS, Android, or Windows apps to collect field data in standard comma-separated values (.CSV) or GIS shape file (.SHP) formats. Base maps for field areas default to aerial imagery (e.g., Google Maps™ or Microsoft Bing Maps™) that is native to mobile devices.

Alternatively, users can tile (e.g., via MapTiler) and upload their own base maps—useful for field areas with limited cell tower access. Field data are typically exported to a host computer and then imported into GIS software to build a digital geological map.

The methodology used in the JMU case study derives from a 4-day digital mapping exercise that each year focuses on a previously unmapped section of a mountain ridge in western Ireland (for details, see the additional supporting information provided in the online version of this article). Students

use GPS-enabled iPads and the associated iGIS app to collect geological data in the field (Figure 1). Point data are collected using a basic template with input fields for unit, strike, dip, dip direction, and notes. In addition, the app includes an input field that color codes data points by unit (Figure 2a).

Students also record outcrop data and information in their field books to back up their digital data. However, with an active cell phone signal, the mappers could also periodically back up their field data to a cloud-based storage system.

Each evening, students export their iGIS data to a laptop computer running the mapping software ArcGIS. They “clean” their field data in ArcGIS to remove any spelling discrepancies and work on their maps by adding line-work for contacts and faults, and polygons for the areal extent of lithological units. Concurrently, students evaluate the day’s mapping and decide where to focus their efforts during the next day’s field session.

Advantages of the Case Study’s Approach

A distinct advantage of crowdsourced digital mapping over traditional independent mapping is the ability to centrally compile all student data into a composite master file. Field locations where students have conflicting outcrop data (Figure 1b)—often resulting from discrepancies in lithological

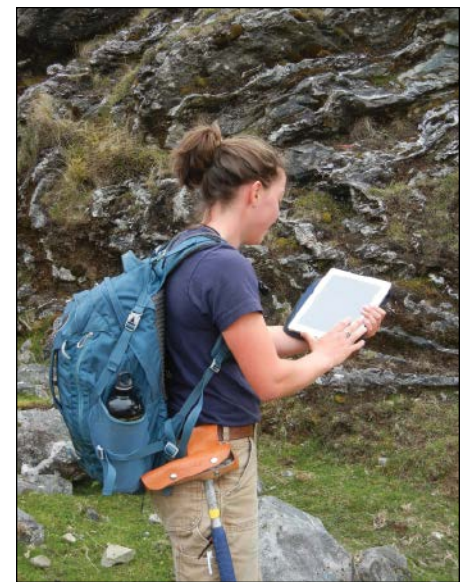


Fig. 1. A student uses a tablet to help create a digital geological map during the James Madison University field course to Ireland.

characterization and/or orientation measurements—become apparent during evening meetings.

Simple mistakes in compass readings or determination of dip direction are resolved

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ABOUT AGU

Eos: The Next Generation

On 9 December a dynamic, new, broadly inclusive, and freely accessible Earth and space science news website will launch: Eos.org. This new site is inspired by AGU’s vision to galvanize our community of Earth and space scientists to collaboratively advance and communicate our science.

We are building Eos.org on a strong foundation. Every week for 35 years, *Eos* has been a reliable source of Earth and space science news, research, and features and announcements for AGU members.

Eos will shift to an online-first publishing model, ensuring that we keep pace with science and that we respond to and anticipate changes in the ways our community acquires and shares knowledge. Readers will have more choices about how and when to engage with *Eos*, and toward that end we’ve made sure that Eos.org will be equally readable at a glance on your mobile device or at a more leisurely pace on your laptop or tablet.

One of the first things you will notice is that Eos.org will present new content every day. Popular content familiar to regular readers, including Research Spotlights, news, articles authored by scientists, news from AGU, and job listings will continue, but we won’t have to wait a full week or more to publish.

As we grow the site, we will gradually expand the selection of domestic and international news and features, including contributions from science journalists and bloggers. We will experiment with new content such as slide shows and special series. In-depth features that explore scientific trends, discoveries, and the impact of your science will be introduced, as well as a broader array of opinion pieces. As Eos.org evolves, we will strive to reflect the increasingly global, interdisciplinary, and transdisciplinary nature of your work.

Not all of this will happen overnight. More interactive features are planned for the spring and fall of 2015. Thereafter, Eos.org

will be improved iteratively, based on AGU’s growing digital and editorial capacity, and the learning drawn from Web analytics and reader feedback. Ideas for improvement will also come from the continued input of the *Eos* Online Advisory Panel and the *Eos* editors and Editorial Advisory Board, both of which have been key to informing content and design.

The advent of Eos.org also provides an exciting opportunity to launch a new print version. In early 2015, *Eos* will be delivered in the form of a bimonthly color print magazine, also digitized for viewing on a tablet. The *Eos* magazine will be delivered to all U.S. members who do not opt out at the time of membership renewal. Due to the high cost of mailing, the *Eos* magazine will be made available to international members upon request to memberservices@agu.org.

The various forms in which *Eos* will be available—the desktop- and mobile-friendly Eos.org, the new print magazine, and the downloadable magazine, combined with the power of social media—provide for a whole new level of reach and engagement for our science.

Eos.org is the first of three interrelated elements of an overall digital content strategy. Other elements include a re-envisioned AGU.org, slated for year-end 2015, and a yet-to-be-named site to inform and engage the non-science public, planned for 2016–2017. I am looking forward to sharing more with you about these developments as they take shape.

In the meantime, you need not wait until 9 December to connect with Eos.org. I invite you to join me in following *Eos* on Twitter (@AGU_Eos) as we gear up for this transition.

—CHRIS MCENTEE, Executive Director/CEO, AGU;
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BY S. J. WHITMEYER AND D. G. DE PAOR

EOS

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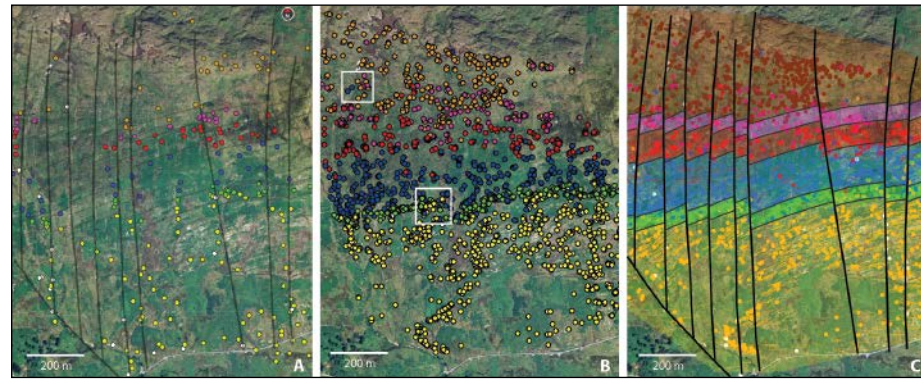


Fig. 2. (a) A tablet screen showing an aerial map view of the iGIS app. Dots colored by lithology represent data taken by a professional geologist at individual outcrops during the 4-day digital mapping exercise. (b) Aggregate data collected by students during a single year of the digital mapping exercise (see Figure S2 in the online supplement for a composite map of 6 years of field data). Compare the data density with that in Figure 2a. White boxes highlight areas of conflicting data. (c) Geological map interpretation of student field data. Bold black lines are normal or oblique faults; thinner black lines are interpreted lithological contacts.

by revisiting an outcrop and correcting the measurements. However, lithological variances often occur in areas of transitional contacts and thus require more thought on how best to define unit boundaries. Students are encouraged to resolve these conflicting interpretations through ongoing discussions with their peers.

Each year, the area for the digital mapping project progresses to new sections of a mountain ridge, such that the current year's digital data add to a growing database of outcrop-scale lithological and structural information. Over the course of several years, student data collection has facilitated the compilation of a new, data-rich geological map of the mountain ridge (see Figure S2 in the additional supporting information found in the online version of this article).

Existing geological maps of this region [Graham *et al.*, 1989] are at much less

detailed scales, and thus this exercise effectively equates to an authentic undergraduate research experience for the students [e.g., Burgin and Sadler, 2010].

Implications of Digital Mapping and Crowdsourcing

The concept of citizen science for field data collection is highly dependent on availability of mobile GPS- and GIS-enabled equipment. A key recent development is the near-ubiquity of iPhone, iPad, and Android mobile devices among the general public.

Previously, handheld pocket PCs (e.g., the Trimble GeoExplorer series) and ruggedized PCs with integrated GPS receivers (e.g., ToughBook® or xPlore®) were the optimal systems for field data collection [Pavlis *et al.*, 2010]. These systems have been rendered obsolete by smartphone and

tablet apps that facilitate data collection in the field using intuitive touch screen apps. These modern devices are lightweight; have excellent battery life, stable operating systems, and more intuitive interfaces; and can be protected from the elements with an OtterBox® or a Ziploc® bag.

GIS apps that use the industry standard formats for geospatial data facilitate seamless transfer of field data to a GIS-based digital map on the user's host computer. This approach is not dissimilar to traditional mapping techniques that use rough field slips for mapping in the field and clean office copies for final map preparation [e.g., De Paor and Whitmeyer, 2009].

Students who learned the rudiments of map creation in ArcGIS (or other GIS packages) had the most success with JMU's digital exercise. These formats can be frustrating to the uninitiated. However, because knowledge of GIS is a valuable tool for today's geoscientists, time invested in learning to use this software is likely well spent. Further, recent developments such as Google Maps Engine™ (<https://mapsengine.google.com>) may reduce the steepness of the GIS learning curve [Ryan *et al.*, 2013].

Perhaps the most significant advance in digital crowdsourcing methodologies for geological field mapping and data collection is the ability to pool data sets from many field geologists into a large aggregate database of outcrop information. Whereas field mapping by a single professional geologist (one of the authors) produced a field map defined by obvious cross-strike and along-strike traverses (Figure 1a), the aggregate map produced by less-experienced students during the same 4-day period is marked by a significant increase in data density (Figure 1b).

The professional's mapping strategy is efficient and presumably produced an accurate characterization of the outcrops visited. However, the data-rich aggregate student map arguably shows the stratigraphic arrangement and structure of the field area in significantly greater detail. The aggregate student map includes areas of conflicting data (boxes in Figure 1b), which can be used as teachable moments to encourage students to reevaluate their lithological characterizations and measurements.

In general, the accurate measurements overwhelm the errors, but when preparing a final geological map from aggregate data (Figure 1c), the less detailed—but perhaps more accurate—professional work can help resolve areas with conflicts in interpretation.

Crowdsourcing as an Educational Exercise

JMU's digital mapping exercise revealed that students can be challenged, and sometimes frustrated, by using digital hardware and software methods to create a geological map. Their initial impatience with learning how to use the equipment can be exacerbated by episodes of equipment failure that result in a loss of digital field data. Fortunately, the switch to using iPads for data collection virtually eliminated losses. Whereas most students with previous ArcGIS experience were comfortable with using the software to create their geological maps, the steep learning curve for ArcGIS often provoked frustration among students unfamiliar with this software.

In general, students appreciated the exposure to digital field equipment and GIS software and consistently reported improvements in skill level and knowledge as well as in their attitudes toward the nature of science, based on the summative survey of this exercise (see Table S1). They were typically quite impressed when they saw the results produced by incorporating student field data from several years into a collective geological map of the mountain (Table S2).

The discussions that ensued among students as they evaluated their field data in comparison to aggregate group data spurred the types of higher-order geological analyses that capstone field courses work to achieve [Mogk and Goodwin, 2012].

Future Possibilities

Emerging digital technologies are creating new opportunities for crowdsourced geological mapping beyond the JMU case study described here.

For example, citizen tourists are generating vast quantities of georeferenced cell phone imagery, and some advanced users are creating high-resolution interactive gigapixel panoramas (gigapans) and 360° "photo sphere" collections. Likewise, Google



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Instructors: David Battisti, Marin Clark, Inez Fung, Carmala Garzone, Jung-Eun Lee, Peter Molnar, Nathan Niemi, and Gerard Roe.

Graduate students with background in earth and/or atmospheric sciences and with training in geochemistry, continuum mechanics, and relevant mathematics are encouraged to apply.
Deadline for applications is December 10, 2014.

Visit <http://www.earth.lsa.umich.edu/summerschool2015> for more information.



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NEWS

Failed Rocket Payload Included Research Experiments

About an hour and a half before the launch of the Orbital Sciences Corporation's Antares rocket and Cygnus cargo spacecraft at 6:22 p.m. on 28 October, Jeff Goldstein arrived at his vantage point on Arbuckle Neck Road in Assawoman, Va. It was just 1.5 miles from launchpad 0A at NASA's Wallops Flight Facility. Goldstein, director of the National Center for Earth and Space Science Education (NCESSSE) had come with about 35 elementary school through college students, as well as some parents, teachers, and school administrators, to watch the liftoff that would deliver the students' microgravity experiments to the International Space Station (ISS).

With the crescent moon hanging in the sky, the sun setting, and the launchpad flooded in white light, the excited crowd listened, courtesy of NASA, to the audio output from mission control. They counted in unison from T minus 10 seconds to launch, Goldstein recalled.

However, when the rocket exploded 6 seconds after liftoff, their euphoria fizzled. The students, who recognize that they are participants in the dawn of the commercial spaceflight era, learned firsthand that space is a tough environment to operate in.

The payload for the unmanned ISS resupply mission included equipment and food for the astronauts as well as research projects. Among the projects were the Meteor Composition Determination investigation to learn about meteoroid dust, a "Drain Brain" human health study to understand blood flow in space, and a set of projects that are part of NCESSSE's Student Spaceflight Experiments Program (SSEP) initiative. SSEP's "Yankee Clipper" suite of experiments

included 18 microgravity mini-laboratory projects designed by teams of students on topics ranging from crystal formation to milk in gravity to the effects of microgravity on seeds and on composting.

Since NCESSSE's inception in 2010, nearly 49,000 students from 778 U.S. schools have been involved with the initiative, which includes a formal research competition to help prepare the next generation of scientists to be "job-force ready," Goldstein explained. Working with commercial launch service provider NanoRacks, LLC, SSEP experiments have flown onboard seven missions to ISS. Everything had gone smoothly until the late October launch attempt.

"I'm trying to turn this into a very powerful teachable moment," Goldstein said, noting that science, technology, engineering, and mathematics (STEM) curricula should include authentic immersive experiences in research. "We promised real spaceflight in this program. This is not a fluffy simulation. This is real spaceflight, but we didn't expect this."

"Failure is part of the equation," he said. "It's really important for students to understand that failures are the guideposts on the side of the road to success. And how they respond to failure is a characterization of what they are made of. I'm seeing that they are ready to step to the plate again."

Goldstein said that all of the student projects can be reconstituted within a month, if needed, and that NanoRacks is looking into when there might be another opportunity to fly the experiments.

—RANDY SHOWSTACK, Staff Writer

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has a vast trove of "Street View" images with geological value.

In many cases, professional geologists could simply highlight and annotate such imagery without having to visit the physical locations. This not only could help scientists identify locations for future fieldwork but also could allow scientists to cover more ground than they could otherwise.

In addition, augmented reality software (e.g., FreshAiR, <http://www.playfreshair.com/>), could create "realities" or virtual tours of landmarks that trigger content delivery on mobile devices based on physical proximity, similar to how museum visitors take tours by listening to information via headsets. Thus, field classes could become asynchronous. Professional geologists could use this technology to transmit requests to citizens when they visit locations of geological interest—citizens could then upload pictures specific to a researcher's area of study. During field exercises, teachers and professors also could give smartphone-based quizzes about mapping and landscape interpretation to students.

With careful planning, opportunities for a wide range of geoscientific crowdsourced projects will only grow. Share your stories through <http://geode.net/crowdsourcing>.

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Americans Unprepared for Natural Disasters

Americans are very worried about the threat of natural disasters—but don't seem to be prepared for one. This conclusion comes from Chapman University's recent Survey on American Fears, released on 21 October. The survey asked 1500 Americans to rank how worried they were about several types of natural disasters and then how prepared they were for each.

Tornadoes and hurricanes topped the list of fears, followed by earthquakes, floods, pandemics, and power outages. When asked if they were prepared for a disaster, however, an overwhelming majority of Americans responded "no."

The answer isn't surprising, according to Ann Gordon, associate dean at Chapman University's Wilkinson College of Humanities and Social Sciences, who headed up the natural disasters section of the survey. A 2013 poll by the Federal Emergency Management Agency (FEMA) found similar results: Americans are mostly unprepared for natural disasters, even those in the most vulnerable areas.

The biggest surprise, Gordon told *Eos*, was that "there's no relationship between how afraid you are and your likelihood of having a disaster preparedness kit."

Unprepared for Tornadoes and Hurricanes

Even in areas where natural disasters are a regular, yearly occurrence—such as in Tornado Alley, which stretches from northern Texas to South Dakota and experiences more than 1000 tornadoes per year—most of those surveyed said they weren't prepared. Specifically, most Americans don't have a disaster preparedness kit that includes such items as batteries, several days' worth of water, emergency blankets, and nonperishable food.

Gordon and her colleagues then conducted a follow-up survey, asking respondents why they weren't prepared. The majority of those polled (34%) said they thought that emergency services would help them. Gordon also found that those Americans with a higher income tended to be more prepared than those with lesser economic means.

Even those who can afford to be are not prepared for various reasons. Robert Meyer, co-director of the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania, did extensive research on communities affected by Hurricane Sandy in 2012. He found that even

though people were worried about their homes or livelihoods, they didn't think they would be affected personally. This is what psychologists call an "optimistic bias," Meyer explained.

"People tend to think that others are more likely to have bad things happen to them than themselves," he said.

Why Aren't People Prepared?

Another reason people weren't prepared was because they prepared for the wrong thing. During Hurricane Sandy, people thought the wind would be the most damaging aspect; in reality, flooding caused the most damage to homes and lives.

Even people living next to water think of hurricanes as wind storms, Meyer said. "People have poor mental models of hazards," he added.

Meyer also found that people who had already been through a hurricane and had suffered significant damage were the most likely to be prepared. Those least likely to be ready had experienced a natural disaster but had not suffered significant damage.

"As a consequence, when it comes down to 'next time,' people have the tendency to think they don't need to put out as much effort," Meyer said.

Motivating Preparedness

The next step will be to find out what messages about preparedness will motivate people to act. In September, which was National Preparedness Month, FEMA organized a prepare-a-thon, and 17 million people across the country pledged to prepare for a natural disaster, whether by buying a kit or practicing disaster responses. However, more needs to be done to ensure that more Americans are prepared, Gordon said.

"We're encouraging people to just get started," Gordon said, "[For example], every time you go to the supermarket, get something for your emergency kit."

To learn more about the Chapman University Survey on American Fears, see <http://bit.ly/AmericanFears2014>.

For a list of items recommended by FEMA for a complete emergency kit, see: <http://bit.ly/FEMAEmergencyKit>.

—JOANNA WENDEL, Staff Writer

Experts Examine Role Scientists Play in Oil Transportation Issues

U.S. hydrocarbon production is on the rise, meaning that transporting hydrocarbons—whether by pipelines, trucks, or trains—is as well. However, increasing environmental concerns, mixed with other issues such as energy independence and landowner rights, is making this transportation a hot-button issue.

One proposed project, for example, the Keystone XL pipeline, has become a lightning rod for issues related to oil and gas transportation. That pipeline, whose completion is dependent on action by politicians and the courts, would move oil from Canada to U.S. refineries.

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2015 CIDER SUMMER PROGRAM – June 30 – July 31, 2015

"Solid Earth and Climate: Dynamic Interactions with the Hydrosphere and Carbonsphere"

CIDER announces their annual summer program on behalf of the geosciences community (<http://www.deep-earth.org/>). Organizers: Meredith Nettles, Terry Plank, Louis Derry and Jeff Freymueller.

The purpose of CIDER 2015 is to bring together scientists from different disciplines to better understand how interactions between the mantle and the major surface reservoirs of water and carbon influence sea level, ice sheet dynamics, the volume of the ocean, magma production, the volcanic flux of CO₂ to the atmosphere, and the loss of carbon via subduction into the mantle. CIDER 2015 will involve cross-disciplinary discussions among geophysicists, geochemists, geodynamicists and paleoclimate scientists. *The program includes a 4 week tutorial program for about 35 advanced graduate students and post-docs (July 5-31, 2015), while more senior scientists are also welcome at any point in the program.*

A Deep Carbon Observatory Thematic Institute, "Carbon from the Mantle to the Surface" will be held in conjunction with the CIDER program on July 1-3, 2015.

The tutorial program will include lectures and hands-on tutorials. Concurrently, junior and senior scientists will engage in collaborative multidisciplinary research ventures defined on site.

This summer program will be held at the University of California, Berkeley. It is supported by the NSF/FESD program. Applications are invited for both senior and junior participants at:

<http://www.deep-earth.org/summer15.shtml>
Application deadline: February 1, 2015

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Experts examined issues related to transporting crude oil, including how science can inform these decisions, during a 20 October forum at the Geological Society of America annual meeting in Vancouver, Canada.

At the forum, Suzette Kimball, acting director of the U.S. Geological Survey (USGS), said, "In addition to understanding the quantity and the quality of potential resources, USGS and other science agencies are able to provide an integrated science perspective that can be used to address potential risks associated with the transport and movement of a resource."

Among potential risks from hazards nationwide, she said, are storm surges that can flood pipelines and other energy infrastructure along coastal areas, including key facilities such as Port Fourchon, La. Kimball said that flooding has become more common along Highway 1 to Port Fourchon, whose infrastructure facilitates 18% of the U.S. oil supply and more than 90% of the Gulf of Mexico's deepwater oil production.

Other risks include impacts from climate change (for example, melting permafrost, which can undermine pipeline infrastructure) and from road washouts due to intense rainfall from extreme weather. In addition, earthquakes can severely damage transportation routes and onshore and offshore pipelines. Pipeline routes can also fragment wildlife habitat and introduce other environmental changes.

An Integrated and Objective Science Approach

Kimball said that an integrated science approach to impacts, along with resource assessments, "is essential to inform the decision makers" about the potential risks in constructing pipelines and other means to move resources from production to consumption.

She said that a good example of a successful integrated science approach was the construction of the Trans-Alaska Oil Pipeline, which crosses the Denali Fault. The

pipeline, which survived the November 2002 M7.9 Denali earthquake, was designed to slide on horizontal steel beams. Careful engineering to stringent earthquake design specifications, based on geological studies done in the 1970s, paid off, Kimball said.

Kimball stressed the importance of being objective in discussions about energy resources and transport. "Those of us in the public sector very jealously guard our reputation for providing unbiased objective science in order for the decision makers to have geological information upon which they can base those decisions," she said.

"Once we get sucked into an advocacy role or anything that is perceived as an advocacy role, we lose that objectivity, and the products that we produce become, in these highly charged situations, used as ammunition for one side or the other's perspective," she added. "However that doesn't mean that we don't have a responsibility to educate the general public, lawmakers, [and] those who develop that public policy."

Sticking to Facts

Robert "Matt" Joeckel, Nebraska state geologist and a professor at the University of Nebraska-Lincoln, focused his remarks primarily on the Keystone XL pipeline. Joeckel said that although people might think that the chief argument against the pipeline extension is environmental concerns, another fundamental issue is landowner rights.

The debate about Keystone XL, which would be built through Nebraska, has been highly charged, with unusual coalitions coming together on different sides of the project and with neighbors pitted against neighbors, Joeckel said.

He noted that not only has the issue become highly politicized, but some debate participants have demonstrated "a preponderance of pedantry," and that "the geological truth is misrepresented by both sides, pro and anti, whether intentionally or not."

Joeckel said that what he has found most offensive in the debate about the pipeline



Trans-Alaska oil pipeline crossing the Denali Fault.

have been some wild claims and incorrect statements about Nebraska's geology. "That isn't a matter of opinion; that's a matter of fact." He said, "What I sought to do is stick with what I know best, and that is [to focus on] some aspect of regional geology and try at least to make sure that the appropriate points are communicated" to people who have questions about the geology.

Risks From Various Transport Systems

Discussion moderator Rex Buchanan, interim director of the Kansas Geological Survey, told *Eos*, "People are going to use energy. You've got to figure out what the best way to go about getting it to them will be. There is no absolutely perfect system."

Pipelines, however, may be the safest method to transport petroleum products, according to Chris Hunt, director of planning and public engagement at the Department of Energy for the government of Alberta. Oil that would be transported through the Keystone XL pipeline would originate in Alberta. Hunt, who focused his remarks on efforts by the Alberta government—working with other governments, regulators, industry, and others—to ensure that oil transportation systems are safe, said that improvements in

technology, standards for site selection, and monitoring combine to provide environmental protection and minimize incidents.

Buchanan told *Eos* that there are risks with any oil transportation system. "My guess is if you took a look at risk associated with trains and certainly with trucks, that you would see a greater impact on infrastructure—certainly with trucks—and accident levels, and particularly in terms of proximity to population centers, because those trains and trucks go through cities," he said.

Buchanan added that geologists have a lot to offer in terms of providing objective advice in public policy debates about transporting energy but that they don't always get heard. This could be because some geologists may not choose to engage in energy debates or that they may not know how to best engage in debates that can get highly polarized or emotional.

As a result, decisions can get made "without geologic input, and that's no good for anybody," he said. "If you don't get involved, those things take on a life of their own, and you never catch up."

—RANDY SHOWSTACK, Staff Writer

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Centenary of the Discovery of Earth's Magnetic Field Reversals

In the early years of the 20th century, physicist Bernard Brunhes, then director of the Geophysical Observatory of Puy de Dôme (now Observatoire de Physique du Globe de Clermont), measured for the first time reverse magnetization in samples from a basaltic lava flow and from the underlying backed argillaceous sediments from the village of Pontferein (now Pont Farin) in the Cantal volcanic district (Auvergne, France).

He correctly interpreted this observation as a consequence of the inversion of Earth's magnetic field in the past [Brunhes, 1905a, 1905b and 1906]. Subsequent observations by Mercanton [1926 a and b] and Matuyama [1929] have reinforced this assumption. This paradigm of periodic magnetic reversals resulted in the construction of a paleomagnetic scale that has been of great consequence for the understanding of Earth's dynamics.

Because of the importance of the discovery, Cox *et al.* [1963] gave the name *Brunhes* to the present-day normal magnetic epoch.

To commemorate the centenary of Brunhes's discovery, a monument was erected near the entrance of the present-day observatory. The panel was unveiled on 4 June 2014 by Vincent Courtillot, a former student of Allan Cox, and Etienne Leflaive, the grandson of Bernard Brunhes.

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Vincent Courtillot and Bernard Brunhes's grandson unveiling the Brunhes stela, made of enameled lava. The inscription reads "Bernard Brunhes (1867–1910). Director of the Puy de Dôme Observatory from 1900 to 1910. Bernard Brunhes discovered in 1906 the inversions of the Earth's magnetic field. This finding, of paramount importance for the Earth's history, has earned him a worldwide reputation: the present magnetic period bears his name." Stela designed by Jacques Kornprobst and manufactured by Patrice Brunel. Financial support provided by several French institutions.

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—JACQUES KORNPBST and JEAN-FRANÇOIS LÉNAT, Laboratoire Magmas et Volcans, Observatoire de Physique du Globe de Clermont, Clermont-Ferrand, France, email: j.f.lenat@opgc.univ-bpclermont.fr

In Brief

Methane-producing microbes important for studying greenhouse gas emissions Microbial communities in thawing permafrost contribute a significant amount to atmospheric methane, a greenhouse gas many times more potent than carbon dioxide. A new paper published in *Nature* on 23 October describes how a newly discovered microbe—*Methanoflorens stordalenmirensis*—adds another layer to the complicated relationship between the world's permafrost fields and greenhouse gas (GHG) emissions.

Lead author Carmody McCalley, postdoctoral research associate at the University of New Hampshire, explained that the question has always been whether these microbes matter for models of GHG emissions to the overall role of thawing wetlands in climate change.

After *Methanoflorens* was discovered in northern Sweden, McCalley and her colleagues found that microbes trapped in permafrost do have a significant role.

Scientists must think about which microbes are "making the methane [and] what does that say about the isotopic signature of the methane in the atmosphere," McCalley told *Eos*.

Researchers use the isotopic signature of methane to figure out its source. Methane produced by these microbial communities tends to have a lighter isotopic signature than that produced by other means, such as fossil fuel burning. What McCalley and her team found was that models have been overestimating the amount of methane originating from thawing permafrost and underestimating the methane coming from burning of fossil fuels.

"Now when people are looking at where the methane is coming from, it's such an important contributor to global warming and climate change, the ways that the source of that methane is calculated might change as a result of these findings," said John Leigh, professor of microbiology at the University of Washington, who was not involved in the study.

"If you don't take [microbes] into consideration in reconstructing where the methane came from, you can get the wrong answer," said McCalley, "and you end up assuming that more methane came from thawing permafrost than actually did."

Continuing Bardarbunga eruption fuels scientific research Lava from

Iceland's Bardarbunga volcano, which began erupting on 29 August, now covers 60 square kilometers of the Holuhraun lava field. Scientists have arrived in droves to study the ongoing fissure eruptions.

Morten Riishuus, a senior researcher in volcanology from the University of Iceland's Nordic Volcanological Research Center, has periodically visited the eruption site for the past month. "It is an incredible privilege and experience to be able to witness the activities at the eruption site," he told *Eos*. "We have never before been able to document such an event in such detail," he added.

The dike intrusion—which serves as a magma conduit for the eruption—is the main focus for scientists studying the volcano, Riishuus explained. Because the Holuhraun lava field is so flat, the fissure eruption provides a good analogue for volcanic activity in Iceland during the Neogene (23 million to 2 million years ago).

The main hazard scientists and the general Icelandic population face is toxic gases spewing from the eruption. At the eruption site, Riishuus and his colleagues must wear face masks, and if concentrations of gases such as sulfur dioxide become high enough, they will be forced to evacuate.

The Icelandic Meteorological Office (IMO) updates pollution readings daily and has advised that people who feel discomfort should stay indoors.

Riishuus said that that a name has already been suggested for the eruption: Nornahraun, which means "the witch's lava." The name was suggested because the eruption has produced "Pele's hair" (*Nornahár* in Icelandic), which is "melt droplets drawn into long glassy strands by the gas jet during degassing at the vent," Riishuus said.

As of 31 October, the eruption shows no signs of slowing or stopping. The future of Bardarbunga is uncertain, although IMO has predicted different scenarios: The eruption could gradually slow and then stop, or the caldera could collapse, inducing a stronger eruption, flash floods from melted glaciers, and ash plumes.

For background on the eruption, see "Field dispatch: Up close and personal with a volcanic eruption" (*Eos*, **95**(39), 352, doi:10.1002/2014EO390005) and <http://ow.ly/Dq8Km>.

Visit <http://bit.ly/IcelandMetOffice2014> to keep up to date with the Bardarbunga eruption via IMO.

—JOANNA WENDEL, Staff Writer

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Second Suomi NPP Applications Workshop November 18–20, 2014, Westin at Bridge Street, Huntsville, Alabama

Suomi-NPP is a NASA/NOAA mission launched on October 28, 2011. Suomi-NPP provides continuity between many of the NASA Eos instruments and those provided by NOAA by the JPSS program. Both NASA and NOAA have validated the S-NPP instruments' superior accuracy over their predecessors and have demonstrated their potential to support weather forecasting, disaster response and management, ecological forecasting, air quality, public health, and water resources management applications.

The workshop will

- present Suomi NPP instrument performance and data characteristics, and data and product access information from both NOAA and NASA,
- review current applications from all S-NPP instruments,
- provide an opportunity for community feedback to NASA and NOAA on data products, data access and other user needs.



There is no registration fee, but attendance is limited to 150 participants. See conference web site for logistics and registration information.

http://weather.msfc.nasa.gov/conference/npp_conference_home.html

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FORUM

Women Count

I am a counter by nature. I count things as an effective way to occupy my mind. How many people are in this room? How many are women? How many are wearing glasses? How many people are using a Mac versus a PC?

Once, sitting in a science team meeting as a graduate student, I noticed that I was the only woman in the group of about 15. At that time, it did not really bother me, but the scientist in me kicked into gear. I began gathering data. Was this situation unusual?

To learn more, I routinely calculated female to male ratios in various populations of scientists. At conferences, I counted the fraction of audience members who were female to establish a base statistic of the population of scientists. I compared that to the ratio of women giving oral presentations in that session, or the list of awardees, or the names of co-investigators listed on a mission overview talk.

This carried over to evaluating research groups. Which professors never seemed to have female graduate students in their labs? Which ones had multiple female students? I began looking for correlations. Were female to male ratios higher when the leadership was female? Yes, they were.

The scientist in you is probably curious about my sample size, my accuracy in distinguishing women from men in a crowd or in an author list. While important, they are likely minuscule compared to the trend I saw.

Over time, the trend bothered me. The gender imbalance that exists in science is easily perpetuated and is harmful to our community as a whole.

The Root of the Problem: Selectors Chose Candidates Most Like Them

The problem begins not when institutions select who will be faculty, or who gets what award, or who will be in the next cadre of graduate students. The problem begins well

before this, when there are plenty of qualified individuals for a small number of positions that aren't advertised but are instead assigned. In these cases, the person selecting candidates does not have an exhaustive list of who would be appropriate, nor does he or she have a set criteria of experience needed to fill that position.

Who will the selector choose? Psychology suggests that selectors focus on people who are most like them. This can happen deliberately—overt bias—but it can also happen subconsciously or unconsciously, a phenomenon called homophily [McPherson *et al.*, 2001].

By corollary, people who are less like us are not foremost in our minds. For example, if the selector is male, the list of qualified candidates might be front-loaded with males, although qualified female candidates exist. The failure here is that although a perfectly valid team could be assembled based on the people who spring to the selector's mind, an equally valid but more diverse team could also have been selected.

We all subconsciously or unconsciously prefer people who remind us of our self-identified characteristics—it's human nature. The only way to overcome this is if selectors make a deliberate attempt at establishing diversity.

Homogeneity Spawns Homogeneity—How to Break the Cycle?

"Like calling to like" perpetuates imbalance. In the example above, where the selector is seeking to quickly assign people to leadership positions, the resulting "formative group"—influenced by the same psychology of like craving like—may inadvertently filter future populations into one that mirrors them.

Formative groups may include science teams, assessment groups, society officers, conference organizing committees, search committees, review panels, etc. Search

committees identify candidates for faculty positions, and those faculty members select students and postdocs for their labs. Review panels influence who gets funding for their research and who does not. Science team members seek one another out for future science teams. Conference organizers assign who gives oral presentations; this affects how much exposure a person's research will get, which helps with future proposals, job applications, and collaborations. Assessment groups evaluate programs and prioritize objectives, which influence future directions for the field.

Each formative group has a role in shaping who is successful in our community. In science, so much opportunity comes from networking and from non-competed opportunities. Visibility is a key aspect to succeeding as a scientist. Thus, having diversity at the formative group level means that if the formative group just acts naturally, that is, thinking foremost of people like themselves, representatives will advocate for many different populations as a natural consequence.

In short, diversity in formative group membership perpetuates diversity.

An In-Depth Look at Space Missions

Spacecraft missions are the bread and butter of scientific work in space science and represent a great deal of opportunity. However, membership on the science team is often non-competed, and females are routinely underrepresented.

I saw this after conducting an informal survey of the science teams listed on the website of seven recent male-led NASA planetary science missions with fewer than 45 science team members (excluding participating scientists and guest investigators who are chosen through a competitive process). I found that only one had a ratio consistent with the female population of planetary scientists, which is 27%, according to the American Astronomical Society's Division of Planetary Sciences (see http://dps.aas.org/files/dps/publications/survey_2010/SurveyResultsBusinessMeeting.pdf).

Six of the seven missions had 5%–18% females on the non-competed science team. The statistical anomaly is demonstrated when you compile the data from all of the missions. The missions had a total of 28 women out of 193 listed science team members, or 14.5%, far less than 27%, which would be 52 women. In fact, randomly

selecting exactly 28 women from 193 planetary scientists is a far outlier—the value is 4 standard deviations away from the mean. This is clearly anomalous and demonstrates that women are routinely underrepresented on planetary mission science teams.

I believe the reason for this is that predominantly male leaders at the principle investigator (PI) and instrument PI levels select from a mental list that is front-loaded with men. There's a subtlety here in that the typical instrument team size is small enough that each instrument team would expect to have 0, 1, or 2 women if the selector chooses based on the DPS ratio of females. In-group bias appears to weight these numbers to the low side. So when a larger team is aggregated from smaller groups of 3, 4, or 5, the cumulative team will have fewer women than what is found in the entire population.

In this example, picking 3 men for a team of 3 is not a statistical anomaly. However, when the entire science team was assembled from several small instrument teams, it ended up with a clearly anomalous composition with less than 20% women.

So how can this underrepresentation be avoided? One idea is that all spacecraft missions include a competed participating scientist program, where selections are likely to be more proportional to the gender ratio in the community. Another is that NASA could move to a paradigm where a large fraction of science teams is competitively selected.

We Are All Susceptible to Propagating Homogeneity

I want to be clear that I am not condemning my male colleagues, nor am I accusing anyone of sexism. Sure, active discrimination exists and is intolerable. Fortunately, it is rare and usually pretty easy to spot. In general, we are good, fair-minded people with the best intentions. Instead, I'm calling for us all to be proactive on diversity issues.

Recently, I co-chaired the science organizing committee (SOC) for a conference. Interestingly, the director of sponsoring group is a woman, and it might not be a coincidence that the two co-chairs of the SOC are women. My co-chair and I chose a SOC with a mix of men and women. The distribution of women in each of the presentation categories was roughly equal to the proportion of woman-authored abstracts. The

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The International Continental Scientific Drilling Program (ICDP)

icdp |

Call for Proposals

The International Continental Scientific Drilling Program, ICDP coordinates and supports multinational endeavours in continental scientific drilling. The program focuses on challenging themes of global geoscientific and socio-economic relevance, including, but not limited to, active faulting, earthquake processes, heat and mass transport, global cycles, environmental change, and the hidden biosphere.

With this announcement, the ICDP invites Earth scientists to submit project proposals in which drilling is required to achieve critical research goals. This call is open to investigators from ICDP member countries (Austria, Belgium, Canada, China, Czech Republic, Finland, France, Germany, Iceland, India, Israel, Italy, Japan, New Zealand, Norway, Poland, South Africa, South Korea, Sweden, Switzerland, The Netherlands, United Kingdom, United States of America) as well as from countries considering membership in the ICDP. Please note that ICDP provides operational support and allocates co-funding for drilling-related costs only; research grants for the project should be sought from other funding agencies. This concept of commingled funding and international cost sharing, in addition to an exchange of technological capabilities and know-how, has proven very successful over the years.

PROPOSAL PREPARATION

The submission of proposals to the ICDP is normally handled in a 2-step procedure. The first step is the submission of a **pre-proposal** in which a request to hold an ICDP-funded workshop is submitted. The proposal should outline the main objectives, the scientific importance of the planned project, details of the proposed drill site, the expertise of the group of proponents and envisaged international collaboration. The workshop serves to bring together a competitive international research team which can develop a **full drilling proposal**. Principal Investigators should note that they are responsible for planning and running pre-site surveys needed to facilitate the choice of an appropriate drill site. Following a successful pre-proposal and workshop a full proposal can be submitted in a second step.

PROPOSAL EVALUATION

All proposals are evaluated by the Science Advisory Group (SAG) of the ICDP, which makes recommendations to the Executive Committee (EC) based on scientific quality and priority. The EC then reviews technical and financial issues in order to ensure that projects are feasible within the constraints of ICDP's annual and long-range plans. The EC informs the Principal Investigator(s) of the outcome of the evaluation, and states whether further development of the proposal is to be encouraged or not.

ICDP aims to foster joint projects with the International Ocean Discovery Program, IODP. We therefore cordially invite project proposals in which coordinated drilling on land and at sea is required or land-sea transect drilling series are planned ("amphibious projects"). Joint project proposal submission will be accepted by both programs and jointly evaluated.

The deadline for proposal submission to the ICDP, including those for amphibious projects, is **January 15, 2015**. Please submit a digital copy via email of the preliminary or full proposal to: Uli Harms, GFZ German Research Centre for Geosciences, Telegrafenberg, D-14473 Potsdam, Germany, phone +49-331-288-1085, fax: +49-331-288-1088, email: u.harms@icdp-online.org

Detailed information on the scope of the ICDP, the submission of proposals, proposal format, and the process for development of a successful proposal is available on the ICDP home page at: <http://www.icdp-online.org/proposals>.



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Forum

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categories of invited/plenary talks, contributed talks, and posters had ratios of 32%, 30%, and 29% women, respectively.

This shows that when selections were from a diverse formative group and based on a complete set of submitted abstracts, the results may be in proportion.

It takes a conscious act to assemble a diverse team. As attuned to gender issues as I am, I am not immune to neglecting diversity. In fact, although I was initially quite pleased that the program set up by the SOC was balanced, I failed at establishing a racial balance in this committee. As a white woman, it never crossed my mind, so the SOC had very little racial diversity. In retrospect I wish I had considered other types of diversity when selecting SOC members.

A Call to Action

Especially in our community of analytic thinkers, I suspect many of us analyze populations. So this is a notification to all of my colleagues in science. I count. Other women count, too. We will be counting and evaluating how many women you include in the team you are assembling. And we are going to ask you about it.

So I'm asking you to count, too, particularly when it comes to formative groups. As the leader of a formative group, please go the extra step of asking, "Are there candidates for this team who are female/early career/international/minority?" (Hint: the answer often is "yes.") If so, then bring them onto your team.

When you are a member of a formative group, look at the composition of the rest of your team. Ask your leadership, "Where are the minorities on this assessment group?" Then follow up by looking at diversity in your formative actions: "Are there female candidates on the short list for this faculty position?"

Even outside of a team, evaluate team composition when you see someone post the names of team members in a presentation or a website, or the list of invited speakers at a conference, or the list of award winners. If the list is homogeneous, ask those in charge, "Why are all of the co-investigators male? Why are there no minorities among the speakers on the agenda?" Don't do so in an accusatory manner. But do so to bring diversity up to the level of conscious thinking.

The Long Term Goal

As long as we follow our subconscious tendencies to pick people like ourselves, gender imbalance—or any imbalance, for that matter—will persist.

Nonetheless, I feel confident that most people, if consciously evaluating teams for diversity, will be able to assemble well-qualified, diverse teams. My hope is that eventually, by making a conscious effort to be more diverse in our selections, early-career women scientists will see a thriving community of established women scientists and feel included, and the population of women scientists will rally.

Then maybe, when you get that dreaded question from the audience, "Why are there no women on your team?" the answer will be, "They all turned me down because they are overcommitted."

Reference

McPherson, M., L. Smith-Lovin, and J. M. Cook (2001) Birds of a feather: Homophily in social networks, *Ann Rev. Sociol.* (27), 414–444, DOI:10.1146/annurev.soc.27.1.415.

—DANA M. HURLEY, Johns Hopkins University Applied Physics Laboratory, Laurel, Md.; email: dana.hurley@jhuapl.edu

MEETINGS

Crossing the Boundaries of Physical Limnology

17th International Workshop on Physical Processes in Natural Waters; Trento, Italy, 1–4 July 2014

Scientists who study the physics of inland and coastal water bodies met in Trento, Italy in July for the 17th in a series of workshops that seek to expand cooperation with researchers in related fields. The workshops aim to facilitate the dialogue among physical limnologists, modelers, and colleagues from other disciplines, such as biologists, chemists, and engineers. This year's workshop was attended by 47 participants from 17 different countries.

One major issue discussed was the increasing demand for a reliable modeling of ecological dynamics and their interaction with the classical transport processes (e.g., lakes' circulation, mixing, and sediment and particle transport). Several presentations focused on the capability to predict water temperature changes both at short and long time scales, also in order to develop realistic scenarios for climate change studies. With thermal stratification being a crucial aspect of lake dynamics, a hot topic was the mixing in deep lakes, which occurs through a wide range of processes (e.g., downwelling, increased turbulence and double diffusion) and drives the long-term response of deep water temperature.

Another issue that emerged from the works presented was the need to have reliable measurements both for an in-depth understanding of the processes—for supporting the increasingly complex numerical models—and for the growing trend of metadata analysis merging different lake systems. To this end, a special session on Standard Operation Protocol was organized, as a first step toward the establishment of suitable protocols for field measurements and data analysis. These protocols, which should address the specific difficulties of

measurements in lakes, may allow non-expert users to avoid basic errors and misinterpretations and experts to agree on use of instruments and data analysis in lakes.

The two keynote speakers embodied the interdisciplinary outlook characterizing the workshop. Andreas Lorke (physicist, University of Koblenz, Landau, Germany) and Nico Salmaso (ecologist, Fondazione E. Mach, Trento, Italy) have tackled the problem of managing lake ecosystems from different perspectives, always recognizing the strong interactions among physical, biogeochemical, and ecological processes.

Program details and extended abstracts are available at <http://events.unitn.it/en/ppnw2014>. To promote collaboration among researchers interested in physical limnology, a distribution list was set up after the workshop. This list is a particularly valuable resource for a scientific community that, although spread all over the world, is relatively small and divided into groups that often rely on a limited number of members. To subscribe to the "lakes list," send an email to sympa@list.dicam.unitn.it with "SUBSCRIBE lakes" in the subject line.

The next workshop will be held in Landau, Germany, in August 2015 (<http://www.ppnw.uni-landau.de>). For details, please contact the local organizing committee (Andreas Lorke, lorke@uni-landau.de).

—MARCO TOFFOLON, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy; email: marco.toffolon@unitn.it; and SEBASTIANO PICCOLROAZ, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Italy; and DAMIEN BOUFFARD, Physics of Aquatic Systems Laboratory, Margaretha Kamprad Chair, École Polytechnique Fédérale de Lausanne, Switzerland

What's on the Web?

Read the latest offerings from the AGU Blogosphere:

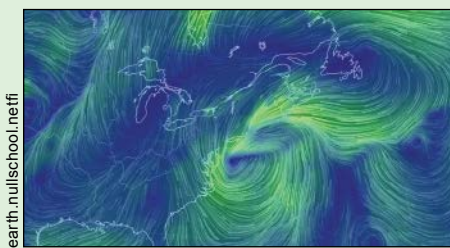
The Landslide Blog: "Riverbank collapse: A fascinating new video" (<http://ow.ly/DdAWo>)

Dan's Wild Wild Science Journal: "Forecasters and science writers knock Weather.com for hype" (<http://ow.ly/DdA6R>)

GeoSpace: "Hurricane Sandy restoration saves shorebirds, 'living fossils' they rely on" (<http://ow.ly/DhCXE>)

The Trembling Earth: "California quake aftermath seen from above" (<http://ow.ly/DhAPg>)

The Bridge: "Congress and me: A scientist in DC" (<http://ow.ly/Ddzoe>)



In Dan's Wild Wild Science Journal blog, meteorologist Dan Satterfield discusses a recent nor'easter, shown here as bright green in a wind field map off the Mid-Atlantic Coast. Many forecasters have heaped criticism onto Weather.com for what they consider sensationalism about the storm, which they say served as "click bait" and exaggerated the danger.

Developing Resources for Teaching Ethics in Geoscience

Teaching Geoehtics Across the Geoscience Curriculum; Chico Hot Springs, Montana, 10–13 June 2014

Ethics education is an increasingly important component of the pre-professional training of geoscientists. Geoehtics encompasses the values and professional standards required of geoscientists to work responsibly in any geoscience profession and in service to society. Funding agencies (e.g., the National Science Foundation, the National Institutes of Health) require training of graduate students in the responsible conduct of research; employers are increasingly expecting their workers to have basic training in ethics; and the public demands the highest

standards of ethical conduct by scientists. However, there is currently no formal course of instruction in ethics in the geoscience curriculum, and few faculty members have the experience, resources, and sometimes willingness required to teach ethics as a component of their geoscience courses.

To address this need, a group of about 25 participants gathered at a workshop in Chico Hot Springs, Mont., in mid-June to initiate action. The workshop, funded by the

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—Alden Adolph, AGU member since 2012

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Meetings

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National Science Foundation's Ethics Education in Science and Engineering program, drew individuals with a broad range of backgrounds and interests, including those outside of the geosciences (e.g., biology, engineering, history, and philosophy). The workshop program was organized around four themes: geothics and self, geothics and the geoscience profession, geothics and society, and geothics and stewardship of Earth.

The goals of the workshop were to identify, aggregate, organize, and disseminate the instructional resources currently available for teaching geothics; develop a collection of case studies that could be used in geoscience classes across the curriculum; begin to develop a community of scholars and expand the network of colleagues interested in teaching geothics; and consider ways that geothics can contribute to public science literacy.

Products of this workshop include a toolkit of best practices and strategies for teaching and assessing student understanding of geothics. Working groups made recommendations on how to introduce geothics topics in introductory courses, identified geothics topics that could be integrated into existing "core" courses required in the geoscience curriculum, and developed guidelines for creation of a new, dedicated course of study on geothics for majors. Participants contributed to a growing compilation of online

instructional resources to support teaching geothics (e.g., journal articles, reports, books, Web resources). Many participants presented case studies that focused on ethical issues confronting the geosciences, in general, and geoscientists in specific professions, in particular. These case studies were discussed and refined over the course of the meeting and are available for use in a wide array of classes and instructional settings.

The workshop was intended to be a catalytic event to promote greater awareness of the need for formal instruction in geothics in the undergraduate geoscience curriculum. A follow-on theme session on teaching geothics across the curriculum and a town hall meeting on geothics is scheduled for the 2014 AGU Fall Meeting. We encourage the geoscience community to become informed about initiatives to promote geothics education and to contribute to the collections of case studies and online resources. More information about teaching geothics can be found at <http://serc.carleton.edu/geothics/index.html>.

—DAVID W. MOGK, Department of Earth Sciences, Montana State University, Bozeman, Mont.; email: mogk@montana.edu; and JOHN W. GEISSMAN, Department of Earth and Planetary Sciences, University of New Mexico, and Department of Geosciences, University of Texas, Dallas

About AGU

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AGU Scholarship Fund Reaches Its Goal

The Edmond M. Dewan Young Scientist Scholarship fund has reached its goal of \$25,000. Those who donated to the fund share AGU's mission in taking an active role in educating and nurturing the next generation of scientists and ensuring a sustainable future for society. Thanks to the generosity of more than 100 members of the AGU and science community, a deserving graduate student of atmospheric or space physics will receive financial assistance to further his or her research and advance his or her research and future career.

The scholarship also serves as a memorial to Edmond Dewan, an AGU member, physicist, inventor, and explorer of a wide range of subjects. Dewan's son Brian said, "In the course of a conversation, my father once

said to me in an informal tone: 'Everything's a mystery—until you understand it.' Edmond was a natural at explaining things to people, even things that would normally require a great deal of prerequisite knowledge to understand. He would certainly be very glad to know that there is a scholarship bearing his name that will help students beyond his own time. Much thanks to everyone who contributed to this fund, and especially for bringing it into existence."

The first scholarship will be presented in 2015. More information on the scholarship can be found at <https://giving.agu.org/>.

—CLAIRE HOWARD, Development Coordinator, AGU; email: choward@agu.org

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POSITIONS AVAILABLE

Atmospheric Sciences

GEOPHYSICAL FLUID DYNAMICS/CLIMATE DYNAMICS

The Department of Earth and Planetary Sciences at Northwestern University invites applications for a tenure track, assistant professor position in geophysical fluid dynamics/climate dynamics, to begin as early as fall 2015.

Specifically, we seek a scientist who employs theoretical, observational, and/or numerical methods to study coupled geophysical fluid dynamical processes within the atmosphere, hydrosphere, cryosphere, and/or lithosphere. Candidates whose expertise complements that of existing faculty in solid earth geophysics, planetary science, and paleoclimate are particularly encouraged. The successful candidate is expected to teach both undergraduate and graduate courses and lead a vibrant externally funded research program. A Ph.D. is required at the time of appointment.

Deadline for applications is December 31, 2014. Applicants should visit www.earth.northwestern.edu for submission instructions.

AA/EOE. Northwestern University is an Equal Opportunity, Affirmative Action Employer of all protected classes including veterans and individuals with disabilities. Women and minorities are encouraged to apply. Hiring is contingent upon eligibility to work in the United States.

Biogeosciences

Environmental biogeochemistry/Geobiology-Dartmouth College.

The Department of Earth Sciences at Dartmouth College invites applications for a junior rank tenure-track position in the general areas of biogeochemistry and geobiology. We especially welcome applications from candidates with research interests that include microbially-mediated biogeochemical interactions in processes of mineralization, weathering, and sequestration of contaminants; hydrocarbon formation and degradation; biogeochemical cycling in fluvial and/or cold environments,

including river-channel, floodplain, and lacustrine ecosystem response to environmental change. Particular attention will be given to candidates who combine a focus on understanding fundamental processes with state-of-the-art laboratory and/or field research programs that complement and contribute to ongoing research activities in the Department as well as in Dartmouth's Geisel School of Medicine and Thayer School of Engineering. The successful candidate will continue Dartmouth's strong traditions in graduate and undergraduate research and teaching. Teaching responsibilities consist of three courses spread over three of four ten-week terms.

The Department of Earth Sciences is home to 11 tenured and tenure-track faculty members in the School of Arts and Sciences, and enjoys strong Ph.D. and M.S. programs and outstanding undergraduate majors. To create an atmosphere supportive of research, Dartmouth College offers new faculty members grants for research-related expenses, a quarter of sabbatical leave for each three academic years in residence, and flexible scheduling of teaching responsibilities.

Dartmouth College, a member of the Ivy League, is located in Hanover, New Hampshire (on the Vermont border). Dartmouth has a beautiful, historic campus located in a scenic area on the Connecticut River. Recreational opportunities abound all year round. To learn more about Dartmouth College and the Department of Earth Sciences, visit <http://www.dartmouth.edu/~earthsci>.

To submit an application, send curriculum vitae, statements of teaching and research interests and objectives, reprints or preprints of up to three of your most significant publications, and the name, address (including street address), e-mail address and fax/phone numbers of at least three references to:

Environmental Biogeochemistry/Geobiology Search Committee

Department of Earth Sciences
Dartmouth College 6105 Fairchild Hall
Hanover, NH 03755

e-mail: earth.sciences@dartmouth.edu

Applications received by November 7, 2014 will receive first consideration. The appointment will be effective July 1, 2015.

Dartmouth is an equal opportunity/affirmative action employer with a strong commitment to diversity. In that spirit, we are particularly interested in receiving applications from a broad spectrum of people, including women, persons of color, persons with disabilities, veterans or any other legally protected group.

Geochemistry

University of Kentucky Department of Earth and Environmental Sciences Tenure-Track Faculty Position in Stable Isotope Geochemistry / Paleoclimatology

The Department of Earth and Environmental Sciences (EES) at the University of Kentucky invites applications for this tenure-track faculty position with an anticipated start date of August 2015. Exceptional candidates at all ranks will be considered. We seek candidates with expertise in light, stable isotope geochemistry, in particular as applied to research questions in the field of paleoclimatology. The department maintains a fully equipped, state-of-the-art stable isotope geochemistry facility (three IRMS and full set of peripherals) for analysis of HCNO in virtually any substance. In addition to maintaining a productive, externally funded research program, the new faculty member will teach and mentor at the introductory, major, and graduate levels. Potential collaborative research opportunities exist with faculty in EES; staff of the Kentucky Geological Survey and the Center for Applied Energy Research; and faculty in the College of Arts and Sciences, the College of Agriculture, Food and Environment, and the College of Engineering. The successful individual will have a demonstrated publication record, and will have developed, or show the potential for developing, a nationally recognized research program; relevant experience beyond the Ph.D. is essential. Applications will be accepted electronically through Interfolio at: <http://apply.interfolio.com/27039> We will begin review of applications on January 15, 2015; however, applications will be accepted until the position is filled. The University of Kentucky is an Affirmative Action/Equal Opportunity university that values diversity and is located in an increasingly diverse geographical region. Women, persons with disabilities, and members of other under-represented groups are encouraged to apply. The University also supports family-friendly policies. Additional details of the Department of Earth and Environmental Sciences (faculty, research clusters, and facilities) and the University of Kentucky may be viewed at our web pages: www.as.uky.edu/ees and www.uky.edu.

Hydrology

Assistant Professor in Hydrogeology/Hydrology at Syracuse University

As part of an interdisciplinary water initiative, Syracuse University solicits applications for a tenure track joint faculty position in Earth Sciences (75%) and Civil & Environmental Engineering (25%) at the level of Assistant Professor. We seek applicants to expand our current interdisciplinary research program in water science and engineering and who apply quantitative methods to understand groundwater and surface water systems at a broad range of spatial and temporal scales. Research areas of specialization may include, but are not limited to: numerical modeling of complex systems including reactive flow and solute transport, hydrogeophysics, and the application of hydroinformatics to integrate observations and models. Candidates whose research expertise lends itself to interdisciplinary collaboration across Earth Sciences and Civil & Environmental Engineering and complement our existing strengths in field-based studies, surface water-groundwater interaction, environmental geochemistry, and watershed hydrology and biogeochemistry are encouraged to apply.

The new position will support the University's Water Science & Engineering Initiative, which is an interdisciplinary program to strengthen research

and graduate training related to water science and engineering across the Colleges of Arts & Sciences and Engineering & Computer Science at Syracuse (<http://water.syr.edu>). Syracuse has a nationally recognized legacy of scholarship advancing understanding of hydrologic systems and how they are impacted by earth processes and human activities. Successful candidates will develop a dynamic, internationally recognized and externally-funded research program and contribute to the instruction, research, and service efforts of the interdisciplinary water initiative, Earth Sciences, and Civil & Environmental Engineering.

Review of applications will begin December 1, 2014 and continue until the position is filled. To be considered, applicants should submit a cover letter, curriculum vitae, statement of research and teaching interests, copies of three relevant publications, and the names and contact information of three references. A Ph.D. in earth sciences, environmental engineering, or a related field is required. To apply, visit www.sjobopps.com.

Syracuse University is interested in candidates who have the communication skills and cross-cultural abilities to maximize their effectiveness with diverse groups of colleagues, students and community members. Women, military veterans, individuals with disabilities, and members of other traditionally underrepresented groups are encouraged to apply. Syracuse University is an equal opportunity employer, as well as a federal contractor required to take affirmative action on behalf of protected veterans.

Assistant Professor in Water Science Department of Geological Sciences Jackson School of Geosciences The University of Texas at Austin

The Department of Geological Sciences in the Jackson School of Geosciences at The University of Texas at Austin seeks to hire a tenure-track Assistant Professor in Water Science. We seek candidates at the forefront of their science who will contribute to leadership in research and teaching. Candidates interested in chemical, physical, and biological processes, or water resource sustainability, are encouraged to apply.

We are interested in a wide range of disciplines related to water including but not limited to: (1) physical hydrology, (2) low-temperature geochemistry, (3) remote sensing and geophysics, and (4) alpine and glacial hydrology.

As part of the Jackson School of Geosciences (www.jsg.utexas.edu), the Department (www.geo.utexas.edu) has over 50 faculty and a community of research staff with a broad range of specialization and access to outstanding research facilities and equipment.

Applicants should submit a letter of application, curriculum vitae, statements of research and teaching interests, and contact information for at least three references. Submit a compiled electronic copy to [water.search@jsg.utexas.edu] or send to: Water Science Search Committee, Department of Geological Sciences, University of Texas at Austin, Austin TX 78712. Review of applications will begin December 15, 2014 and continue until the position is filled.

Background check conducted on applicant selected.

The University of Texas at Austin is an Affirmative Action/Equal Opportunity Employer.

Ocean Sciences

Assistant/Associate Professor of Coastal and Marine Systems Science

The College of Science at Coastal Carolina University invites applications for a tenure-track position as Assistant/Associate Professor of Coastal and Marine Systems Science. Appointment will be at the rank of Assistant or Associate Professor depending on experience and will begin Fall 2015.

Applicants must have a Ph.D. in a relevant field. The successful candidate will be expected

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to develop a sustained externally funded research program in coastal biogeochemistry, partner cooperatively on interdisciplinary teams within the new School (<http://www.coastal.edu/scmss/>) and provide instruction and supervision of masters and doctoral students. Applicants are sought with research and graduate experience in coastal and marine eutrophication, particularly with respect to water quality degradations leading to hypoxia, with preference for individuals who use phytoplankton indicators to assess ecosystem-wide effects of eutrophication. The successful candidate will be expected to contribute to and complement existing strengths of the School. Prior experience with distance learning would be beneficial.

The School of Coastal and Marine Systems Science (SCMSS) houses the Center for Marine and Wetland Studies (<http://bcmw.coastal.edu/>), Waccamaw Watershed Academy, Environmental Quality Laboratory and related graduate programs. The School maintains a broad array of instrumentation and support staff well equipped for broad pursuits especially in geophysical seafloor and sub-bottom mapping, hydrodynamic observation and modeling, hydrogeology, and microbial and water quality analyses. A new 54' research vessel is available for coastal and marine systems sampling.

Coastal Carolina University is a public comprehensive liberal arts institution located just nine miles from the Atlantic coast resort of Myrtle Beach, South Carolina. Coastal enrolls more than 9,900 students from 45 states and 58 nations. The University is accredited by the Commission on Colleges of the Southern Association of Colleges and Schools to award the baccalaureate and selective master's degrees of national and/or regional significance in the arts and sciences, business, humanities, education, and health and human services, a specialist degree in educational leadership, and a Ph.D. degree in Marine Science.

Interested candidates should submit a letter of application, curriculum vitae, statement of research interest and contact information for at least three professional references, electronically at <http://jobs.coastal.edu>. Review of applications will begin November 12, 2014 and continue until the position is filled.

Coastal Carolina University is an EO/AA employer.

Interdisciplinary Climate Change Oceanographer The University of Southern Mississippi

The University of Southern Mississippi's Department of Marine Science at the Stennis Space Center is offering a tenure-track position in interdisciplinary climate change oceanography at the assistant professor level. Applicants must hold a Ph.D. in oceanography or a related field, with a minimum of 18 hours of graduate coursework in climate change

oceanography, and have demonstrated research experience. Postdoctoral experience is desirable. The successful candidate is expected to conduct an active research program and to teach and develop courses for an interdisciplinary academic program for graduate and undergraduate students. The successful candidate must also demonstrate a commitment to teaching and collaborative research. Information is available online about the department at <http://www.usm.edu/marine/>.

Applicants must submit a letter of interest outlining their qualifications for the position, including a research plan, teaching philosophy with a curricular plan, a curriculum vitae, and names and contact information of at least four references. Applications must be submitted online at <https://jobs.usm.edu> (Job Posting #0003293). For inquiries about the position, contact Dr. Donald Redalje, chair of the search committee, at Donald.Redalje@usm.edu or 228.688.1174. Applicant review will begin December 8, 2014, and continue until the position is filled. AA/EOE/ADA

Maine Maritime Academy is a co-educational, public college on the coast of Maine offering 18 degree programs in engineering, management, science, and transportation, ranked the #1 Best Public College, on Money magazine's Best Colleges list, August 2014. MMA currently seeks to fill the following position(s):

Assistant Professor of Marine Science
The Ocean Studies Department at Maine Maritime Academy invites applications for an Assistant Professor of Marine Science. Applicants must hold a Ph.D. in oceanography or other marine related field by August 2015. Teaching expectations include undergraduate courses in introductory chemistry for science and non-science majors, marine geochemistry, and additional courses and electives dependent on the successful candidate's area of expertise. Candidates with demonstrated teaching excellence, commitment to undergraduate education, and research cruise experience are particularly encouraged to apply. For full job description and application information see: <http://mainemaritime.edu/about-mma/employment-at-mma/>.

Women, minorities and veterans are particularly encouraged to apply. EOE.

Marine Chemistry The University of Southern Mississippi.

The University of Southern Mississippi Department of Marine Science at the Stennis Space Center is offering a tenure-track position in marine chemistry at the assistant professor level. Applicants must hold a Ph.D. in oceanography or a related field and have demonstrated field and laboratory research experience. Post-doctoral experience is desirable. The successful candidate is expected to conduct

an active research program and develop courses for an interdisciplinary academic program for graduate and undergraduate students. The successful candidate must also demonstrate a commitment to collaborative research and teaching. Information is available online about the department at <http://www.usm.edu/marine/>.

Applicants must submit a letter of interest outlining their qualifications for the position, including a research plan, teaching philosophy with a curricular plan, a curriculum vitae, and names and contact information of at least four references. Applications must be submitted online at <https://jobs.usm.edu> (Job Posting # 0003282). For inquiries about the position, contact Dr. Alan Shiller at alan.shiller@usm.edu or 228.688.1178. Applicant review will begin December 8, 2014, and continue until the position is filled. AA/EOE/ADA

Professor - Climate, Oceanography Massachusetts Institute of Technology (MIT).

MIT's Department of Earth, Atmospheric and Planetary Sciences seeks to expand its vibrant and interdisciplinary approach to research and education in climate science. We seek applications from outstanding candidates working in climate related fields. We particularly encourage applicants working in the fields of ocean dynamics, oceans and climate, and/or marine biogeochemical cycles.

Requirements: Applicants must hold a Ph.D. by the start of employment. We seek highly motivated candidates with a strong commitment to excellence in research, teaching and student advising. A keen interest in relating to complementary research in the Department and/or in the MIT/Woods Hole Joint Program in Oceanography is important.

Preference will be given to appointments at the rank of Assistant Professor but a more senior appointment can be considered for an individual with exceptional qualifications.

Review of applications will begin immediately. To receive consideration, a complete application must be received by 12/31/2014. Applicants should submit a curriculum vitae and two-page descriptions of research and teaching plans and arrange for three letters of reference to be submitted directly by professional referees.

Questions regarding the search may be addressed to Prof. Mick Follows, Search Committee Chair (mick@mit.edu).

Applications are being accepted at Academic Jobs Online at

<https://academicjobsonline.org/ajo/jobs/4822>
Questions regarding the application procedure can be addressed to Ms. Karen Foshier, HR Administrator, EAPS, 54-924 Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139; kfoshier@mit.edu; 617-253-2132

MIT is an equal opportunity/affirmative action employer. Applications from women, minorities, veterans, older workers, and individuals with disabilities are strongly encouraged.

Professor/Associate Professor/Lecturer Shanghai Jiao Tong University (SJTU) Shanghai, China.

- Ranks: Tenure-track Lecturer, and tenured Associate-Full Professor

- Salary: Based on the qualification and salary scale of SJTU

- Closing date: Open until all positions are filled
SJTU recently formed the Institute of Oceanography (IOO), and is seeking qualified candidates to fill positions at all ranks. The IOO will take the advantage of existing excellences in mathematics, engineering, computer sciences and the humanities at SJTU to develop strengths in areas of observational physical, chemical and biological oceanography, related ocean engineering and technologies and marine social science. Specific research areas include physical, chemical and biological oceanographic processes, biogeochemical cycling, ecosystem dynamics, climate change, deep sea life processes, underwater sensors, platforms, information systems, the policies for marine environment and resource protection and the law of the sea.

The IOO is recruiting 30-40 faculty members at all ranks in related areas of ocean science and technology. Individuals with strong background and skills in areas of observations, in situ experiments, field data analysis, in situ sensors, platforms, and data-model integration are preferred. Successful candidates are expected to develop internationally recognized, externally funded disciplinary and interdisciplinary research programs, and to actively participate in graduate teaching and advising.

Qualifications: A PhD is required and post-doctoral and/or work experience is preferred. The successful candidate must have a demonstrated capability to carry out an independent, externally funded research program, to supervise graduate students, and to collaborate with others in research and education. These positions are immediately available. The level of an appointment will be commensurate with the qualification and experience of a successful candidate, and the salary level will be based on the university salary scale.

An applicant should send his/her curriculum vitae, a statement of teaching and research interests and goals, not more than 5 representative publications, and the contact information of three referees to IOO_hyy@sjtu.edu.cn.

Solid Earth Geophysics**Faculty Positions in Geology, Geochemistry & Geophysics Massachusetts Institute of Technology (MIT).**

The Department of Earth, Atmospheric and Planetary Sciences at MIT seeks applications for faculty positions in geology, geochemistry, and geophysics. We particularly encourage applicants whose work crosses traditional disciplinary boundaries. The intent is to hire at the assistant

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Tenure-Track Faculty Position in Physical Oceanography

The College of Marine Science at the University of South Florida invites applications for a tenure-track, nine-month academic appointment in Physical Oceanography at the Assistant, Associate, or Professor level. Rank is dependent on qualifications and experience.

Qualified candidates will employ modern tools of multi-disciplinary science to understand global issues critical to the ocean system, including but not limited to: thermohaline and wind-driven circulation, ocean-cryosphere-atmosphere-biosphere interactions, small-scale processes, global climate change, and interactions between the deep and coastal ocean.

Candidates will be selected on the basis of their potential to conduct transformative research within their discipline, their prospects for peer reviewed publication and acquisition of external research funding, and potential for outstanding mentoring and teaching. The successful candidate will be expected to contribute to core courses in oceanography and teach specialty courses at the graduate level.

Minimum Requirements: Must have research experience in the field of Physical Oceanography, a firm grounding in geophysical fluid dynamics, and a PhD in a relevant scientific discipline at the time of hire.

Preferred qualifications: Applicants should be capable of interacting with colleagues in multi-disciplinary oceanographic research.

For the Assistant Professor rank, candidates should have a strong potential for scholarly publication, acquisition of extramural research funding, and a commitment to exemplary instruction and mentoring of graduate students.

For the Associate Professor rank, candidates should have an outstanding record in research, including a substantive publication record, evidence of success in attracting extramural research funding, and a commitment to exemplary instruction and mentoring of graduate students.

Contact: For information regarding the available position, please contact Dr. Don Chambers, donc@usf.edu or Tim Trowbridge, trowbridge@usf.edu (727-553-3375).

Application procedures: Apply online at Careers@USF. Please submit a cover letter stating qualifications, along with research and teaching goals, curriculum vitae, and contact information for at least three referees. Position is open until filled, however, priority review of applications will begin by November 3, 2014. Appointment is expected to commence August 7, 2015.

The College of Marine Science has 26 ranked faculty covering biological, chemical, geological, and physical oceanography and marine resource assessment, ~110 graduate students, ~\$15 million in annual research, a total endowment of ~\$18 million, ~80 full-time support personnel (including engineers, technical, and College administrative staff). The College of Marine Science is a member of the C.W. Bill Young Marine Science Complex, made up of six Federal and State environmental research and operational agencies in close proximity, including the USGS Coastal Geology division, the NOAA National Marine Fisheries Service Southeast Regional Office, the US Coastguard, the Florida Wildlife Research Institute (FWRI) of the Florida Fish and Wildlife Conservation Commission, the Florida Institute for Oceanography (FIO), and the Tampa Bay National Estuary Program. Several private research groups including SRI International are co-located in this research cluster. Together with the College, these agencies and institutions employ ~800 researchers, engineers, technicians and support staff, making St. Petersburg one of the largest marine-science research complexes in the southeastern US. Additional information is available at <http://www.marine.usf.edu/> and <http://www.usf.edu>.

The University of South Florida is a high-impact, global research university located in beautiful Tampa Bay on Florida's spectacular west coast. It is one of the largest public universities in the nation, and among the top 50 universities, public or private, for federal research expenditures. The university is one of only four Florida public universities classified by the Carnegie Foundation for the Advancement of Teaching in the top tier of research universities, a distinction attained by only 2.3 percent of all universities. At the heart of USF is a vibrant, diverse and engaged student body. More than 47,000 students are enrolled in the USF System, a system of three separately accredited institutions – USF Tampa, USF St. Petersburg and USF Sarasota-Manatee – with an annual budget of \$1.5 billion and an annual economic impact of \$3.7 billion.

The University of South Florida is an Equal Opportunity/Affirmative Action/Equal Access Institution. To request disability accommodations in the application and interview process call (813) 974-2970. According to Florida law, applications, and meetings regarding them, are open to the public.

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**GEOCHEMICAL AND ENVIRONMENTAL RESEARCH GROUP (GERG)****ASSISTANT RESEARCH SCIENTIST**

The Geochemical and Environmental Research Group (GERG) at Texas A&M University (TAMU) is looking for an Assistant Research Scientist to fill a soft-money position in petroleum geochemistry.

Applicants must have a Ph.D. in organic geochemistry or a related field with a strong background in analytical instrumentation including gas chromatographs, GC/MS, and laboratory QA/QC systems. Analytical experience in analyses and interpretation of aliphatic, aromatic and petroleum biomarker hydrocarbons data is desired; post-graduate experience is preferred.

Candidates are expected to develop proposals and carry out research in resource geosciences for local, state, federal and industrial clients, in association with other researchers at TAMU.

Publication of research results is expected. The position is funded for two years initially, with subsequent funding dependent on grant awards.

Applicants should send a letter of application, together with a CV and the names of three potential referees to

Ms. Sandy Dunham (dunham@geos.tamu.edu; 979-458-9325). The position will remain open until filled.

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professor level, but more senior appointments can be considered.

Applicants must hold a Ph.D. in geoscience or a related field by the start of employment and must demonstrate ability to excel in teaching at the graduate and undergraduate levels. A complete application must include a curriculum vitae, one- to two-page descriptions of research and teaching plans, and three letters of recommendation.

Applications are being accepted at Academic Jobs Online <https://academicjobsonline.org/ajob/jobs/4798>

To receive full consideration, a complete application must be received by December 1, 2014.

Search Contact: Ms. Karen Foshier, HR Administrator, EAPS, 54-924 Massachusetts Institute of Technology, 77 Massachusetts Avenue, Cambridge, MA 02139; kfoshier@mit.edu; 617-253-2132

MIT is an equal opportunity/affirmative action employer. Applications from women, minorities, veterans, older workers, and individuals with disabilities are strongly encouraged.

Preceptor (teaching/curriculum development) in Earth and Planetary Sciences Harvard University.

The Department of Earth and Planetary Sciences seeks applications for a preceptor. The successful applicant should be well versed on the issues of earth sciences, and have experience in developing, teaching, and supporting sections and labs. A graduate degree is required (Ph.D. preferred) along with evidence of successful prior teaching and administrative experience. Salary will be highly competitive and commensurate with experience. The position is renewable on a yearly basis for up to eight years, contingent upon performance and curricular needs. For greater detail about this position and to apply, visit: <https://academicpositions.harvard.edu/>. Applications should include: i) a cover letter that discusses how this position would fit into the applicant's career trajectory; ii) the names and addresses of three referees; iii) a CV; and iv) a statement of teaching experiences and philosophy. The three letters of recommendation should be submitted separately and at least one letter must discuss the applicant's experience with teaching, administration skills, and other educational work. Review of applications will begin on November 28; preferences will be given to applications received by this date.

TENURE TRACK ASSISTANT PROFESSOR: PALEOCLIMATE/PALEONTOLOGY CALIFORNIA STATE UNIVERSITY NORTHRIDGE.

The Department of Geological Sciences at California State University, Northridge invites applications for a full-time tenure-track faculty position at the level of Assistant Professor in Paleoclimatology/Paleontology. We offer B.S. and M.S. degrees

in Geology and in Geophysics. The successful candidate must have a PhD at the time of appointment. Experience in post-doctoral research and/or University-level lecture instruction is desirable. We seek an innovative paleoclimatologist/paleontologist with technical expertise in one or more of the following fields: paleontology, paleoecology, low-temperature geochemistry, paleo-oceanography, geochronology, dendrochronology, palynology, or other techniques. We particularly seek candidates who both complement our current research program and integrate across tectonics, sedimentology, and stratigraphy. The successful candidate is expected to develop a vigorous research program, which includes seeking extramural funding, publishing peer-reviewed papers, and involving undergraduate and M.S. students. Furthermore, the successful candidate is expected to demonstrate teaching excellence and provide effective instruction to students of diverse backgrounds. Potential classes to be taught by the new hire include: a new undergraduate core course in Earth Systems, a general education course in climate change, and elective offerings at the upper-division and/or graduate level in the candidate's research specialty.

Applicants should submit a cover letter, CV, three letters of recommendation, statement of teaching philosophy and experience, and statement of research interests. Electronic submissions are strongly encouraged and should be sent to: paleontology.search@csun.edu. Materials can also be sent to: Paleontology Search Committee, Department of Geological Sciences, California State University Northridge, 18111 Nordhoff Street, Northridge, CA 91330-8266. Review of applications will begin 1 January 2015. Priority will be given to applications received by this date, but the position remains open until filled. For additional information, see <http://www.csun.edu/geology>. The University is an EO/AA employer.

Interdisciplinary/Other**ENVIRONMENTAL GEOPHYSICIST & LOW TEMPERATURE GEOCHEMIST POSITIONS.**

The Dickinson College Department of Earth Sciences is expanding its faculty and invites applications for TWO tenure track positions at the Assistant Professor level, ABD or PhD (preferred). (1) Environmental Geophysicist: Teaching responsibilities for this position will include hydrogeology, an upper level course in environmental geophysics, a required introductory course and upper level electives in the candidate's field of expertise. (2) Low Temperature Geochemist: Teaching responsibilities include a required upper level low temperature Geochemistry course for the major, a required introductory course, upper level electives in the candidate's field of expertise

(e.g., climate change, critical zone studies, environmental geochemistry).

The successful candidates will be committed to teaching excellence in the liberal arts tradition and will have broad interests in geosciences beyond their specialty. Experience in student-faculty undergraduate research is highly desirable. Applicants must demonstrate a strong potential for interacting effectively with undergraduate students and an ability to collaborate effectively with students and colleagues from diverse backgrounds.

The Dickinson Earth Sciences curriculum emphasizes project-based learning with a strong field component, which is greatly facilitated by our location in the Great Valley, near the folded Appalachians, the northern terminus of the Blue Ridge, and the Triassic rift basins. The department has excellent analytical (AAS, SEM-EDS, CL, XRD, XRF, TOC), laser particle size analyzer, digital 3-component seismometer, a 5-well instrumented well field for hydrogeologic investigations) and computing facilities. More information can be found on the college (www.dickinson.edu) and department (www.dickinson.edu/homepage/96/earth_sciences) web pages. Dickinson College is a highly selective private liberal arts college in south-central PA within easy drive of the New York-Washington, DC metro corridor.

Applicants should apply on-line using jobs.dickinson.edu. Review of applications will begin November 17 and continue until each position is filled. Dickinson College, an EEO Employer, is committed to building a representative and diverse faculty, administrative staff, and student body. We encourage applications from all qualified persons. We value the ability to create an inclusive classroom for an increasingly diverse student body.

Faculty Fellow, University of Oregon.

The Department of Geological Sciences invites applications for a residential fellowship as a Meierjurgan Faculty Fellow for one term during academic year 2015-2016. Requirements are one term in residence and one departmental seminar. The recipient will receive a \$15,000 stipend. Selection criteria include academic merit, collaborative ties with faculty, and likely use of departmental facilities or regional field areas. PhD in geology or related field required. The Department and University house an array of modern instrumentation and we are located in a geologically active region. For details see our website <http://www.uoregon.edu/~dogsci/>. Applicant should submit a one-page letter of intent indicating the desired term of residence and a complete curriculum vitae to the Meierjurgan Fellowship Committee, posting # 14242, Department of Geological Sciences, 1272 University of Oregon, Eugene, Oregon 97403-1272, or you may submit application materials via email to arbeiter@uoregon.edu. To ensure consideration, please submit application materials by January 30, 2015. Position will remain open until filled.

The University of Oregon is an equal opportunity, affirmative action institution committed to cultural diversity and compliance with the ADA. The University encourages all qualified individuals to apply, and does not discriminate on the basis of any protected status, including veteran disability status.

FACULTY POSITION IN WATER and LAND RESOURCES

The Department of Environmental Earth System Science at Stanford University seeks an innovative scholar for a junior level, tenure-track, faculty appointment in the area of freshwater and land resources.

We seek a broad-thinking, multi-disciplinary scientist employing hydrological, ecological, and/or other appropriate approaches for the study and management of coupled freshwater and land systems. Preference will be given to an individual focusing on regional to large-system scales. We expect development of a vigorous research program employing strong analytical, computational, and/or measurement methods. The successful candidate will also be expected to teach classes in freshwater/land-system processes and resources as well as mentor students at the graduate and undergraduate levels.

Each applicant is asked to provide a cover letter describing research and teaching experience as well as future plans in these areas, curriculum vitae, and a list of three referees who may be contacted for letters of recommendation. Please submit the requested materials at: <https://academicjobsonline.org/ajob/jobs/4923>. Review of applications will begin on December 15, 2014, and will continue until the position is filled. Questions related to your submission may be directed to maslin@stanford.edu.

Stanford University is an equal opportunity employer and is committed to increasing the diversity of its faculty. It welcomes applications from women and minority groups, as well as others who would bring additional dimensions to the university's research and teaching missions.

Geophysicist, Department of Geology and Environmental Science, James Madison University - 0406253.

The Department of Geology and Environmental Science (<http://www.jmu.edu/geology/>) at James Madison University seeks applications for a Geophysicist at the Assistant Professor level for a tenure-track position beginning August 2015. A Ph.D. related to the geosciences is required at the time of employment. We seek a colleague who is committed to excellence in teaching and research involving undergraduates. Teaching responsibilities include introductory and upper level undergraduate geophysics courses, and general education science courses. Information on existing equipment housed in the department can be found at <http://www.jmu.edu/geology/facilities.shtml>. Collaborations are encouraged with faculty in other STEM fields. To apply go to JobLink.jmu.edu, reference posting number 0406253 and submit a faculty profile, cover letter, a detailed curriculum vitae, a statement of teaching philosophy, a statement of research interests, and the names and addresses

of three references. Questions regarding this position may be directed to Elizabeth Johnson, Search Committee Chair, at: geophysics@csu.jmu.edu. Screening of applicants will begin December 21, 2014; however, applications will continue to be accepted until the position is filled. Salary is commensurate with experience. JMU does not tolerate discrimination or harassment on the basis of age, color, disability, gender identity, genetic information, national origin, parental status, political affiliation, race, religion, sex, sexual orientation or veteran status.

Mineralogy/Petrology Western Washington University invites applications for a tenure-track Assistant Professor starting September 2015, with research and teaching specialties in mineralogy or petrology.

Western Washington University is a nationally recognized, public, masters-granting institution located in the Pacific Northwest at the base of the North Cascade Mountains. We seek a colleague whose research interests could include metamorphism and the dynamics of orogenic systems, low-temperature alteration processes, generation of ore deposits, or planetary geology. Required qualifications for the position include 1) a PhD in an appropriate Earth Science field at the time of appointment, 2) the ability to develop a high-quality undergraduate teaching program including courses in Mineralogy and Optical Petrography, and contribute to field courses such as Field Camp or Field Petrology, 3) the ability to establish an externally-supported research program, 4) the ability to involve students in research, 5) the ability to contribute to the graduate (MS) degree program, 6) ability to work with a diverse student body and 7) a demonstrated capacity to pursue important problems in the Earth sciences using field-based and quantitative techniques. Preferred qualifications include postdoctoral experience, college-level teaching experience in the courses listed above, ability to teach Introductory Geology, and potential to develop local field research projects. The ideal candidate will engage in collaboration within the Geology Department and the Advanced Materials Science and Engineering Center (AMSEC) and will enhance without duplicating existing departmental strengths in igneous petrology/volcanology, field geology, geomorphology, geophysics, tectonics, geoscience education, and planetary geology, as well as emerging directions in engineering geology and ore-forming systems. For more information see <http://geology.wvu.edu/dept/> and <http://www.wvu.edu/amsec/>.

Interested candidates must apply online. To see a full position description and log in to WWU's Electronic Application System for Employment (EASE), please go to <https://jobs.wvu.edu/JobPosting.aspx?PID=6211>. Applications must include a cover letter outlining teaching and research experience and accomplishments with specific reference made to the required and preferred qualifications described above. The application should also include a C.V., graduate school transcripts, as well as goals and plans for teaching and research at WWU. The names and contact information for letters of reference from four persons familiar with the candidate's research and teaching must be provided; one of these references must be from outside the applicant's current institution. Review of all application materials will begin on January 5, 2015; position is open until filled. Questions regarding this position should be directed to the search committee chair, Liz Schermer (Liz.Schermer@wvu.edu) or the Geology Department chair, Bernie Housen (Bernard.Housen@wvu.edu). WWU is an EO/AA employer and encourages applications from women, minorities, persons with disabilities, and veterans.

POSTDOCTORAL POSITION Meteor Fireball Modeling at Purdue University.


The Planetary Program at Purdue University is seeking an individual interested in joining a 3-year effort to model large meteor fireballs, such as that which devastated Chelyabinsk, Russia in 2013. The position is initially a one-year appointment with the possibility of extension for up to three years. We seek someone with strong quantitative and modeling skills that can apply hydrocode models and numerical equations of state to understand the formation of shock waves around an asteroid entering the Earth's atmosphere and follow its subsequent fragmentation and evaporation above the surface. A familiarity with UNIX is required and experience in FORTRAN programming is desirable.

Applicants must have a Ph.D. in a field related to Physics or Geophysics and appropriate computer and modeling skills. Salary and benefits are highly competitive. The appointment can begin as early as January 2015. Applications should include a CV, bibliography and names of at least three referees. We prefer electronic submission directly to jmelosh@purdue.edu. Applications completed by January 1, 2015 will be given full consideration, although the search will continue until the position is filled. A background check is required for employment in this position.

Purdue University is an EEO/AA employer fully committed to achieving a diverse workforce. All individuals, including minorities, women, individuals with disabilities, and protected veterans are encouraged to apply.

Rangeland Ecology and Management: The Department of Forest, Rangeland, and Fire Sciences at the University of Idaho invites applications for an academic-year, tenure-track Assistant Professor.

We are searching broadly for a candidate who will help advance our teaching, research, and outreach activities. The successful applicant will have a commitment to quality teaching at the graduate and undergraduate level, and will be expected to develop a research program focusing primarily on Idaho's extensive and diverse rangelands. The successful candidate will have the opportunity to



**THE UNIVERSITY OF TEXAS
AT DALLAS**
The Department of Geosciences

BASIN ANALYSIS, GEOPHYSICS, AND NEOTECTONICS

OPEN RANK FACULTY POSITIONS

The Department of Geosciences at The University of Texas at Dallas is searching to fill three open, tenure-track or tenured faculty positions in the fields of basin analysis, geophysics, and neotectonics. We are searching broadly. These positions aim at the Assistant Professor level, but highly qualified candidates will be considered for Associate Professor or Professor level appointments. The institution entertains the possibility of a team consisting of one senior scientist and two junior scientists to fill the positions. The positions are to be filled during the 2014-2015 academic year.

For the basin analysis position(s), the successful candidate should have principal interests in fundamental processes of sedimentary basin architecture and evolution, and in the application of basin analysis to energy and environmental issues.

The geophysics position(s) is/are broadly defined to include expertise in any facet of geophysics applied to the study of Earth's interior. Candidates for the neotectonics position(s) is/are expected to have research interests in geomorphology, structural geology, near surface geophysics, and/or geochronology as applied to solving neotectonic problems.

We seek individuals with the potential to develop vibrant, sustained, externally funded research programs that complement existing departmental strengths and who will contribute effectively to the Department's educational programs at the BS, BA, MS and Ph.D. levels. We especially encourage geoscientists interested in field studies and helping to strengthen the Ellison Miles Center for Geological Field Studies. We also very much want to increase the diversity of the Department and especially encourage women and minorities to apply.

These positions are part of a departmental expansion and all of them will play a pivotal role in the University's strategic emphasis on energy and the environment. We are seeking individuals who will complement and expand departmental concentrations in structural geology, active and ancient tectonics, geophysics, geospatial science, and computational geoscience. Successful candidates may build upon our traditional collaboration with the petroleum and minerals industry in areas that encompass carbon dioxide sequestration and the exploration and development of petroleum and mineral resources. The Department of Geosciences has strong and expanding undergraduate and graduate programs. UTD is a relatively young and rapidly growing institution. It attracts very talented students (mean freshman SAT > 1200) with great diversity and is situated in a metropolitan area that is undergoing rapid growth.

Applications will be reviewed beginning October 15, 2014, but will be considered until the positions are filled. Indication of gender and ethnicity for affirmative action statistical purposes is requested as part of the application.

Questions about the positions should be directed to the Department Head, **Professor John W. Geissman**, geissman@utdallas.edu. Applicants should submit a complete resume, a statement of research interest and the names and contact information of five professional references via online applications available at:

<http://go.utdallas.edu/pnr141001>
<http://go.utdallas.edu/pns141001>
<http://go.utdallas.edu/pnt141001>

The University of Texas at Dallas is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, national origin, disability, pregnancy, age, veteran status, genetic information or sexual orientation.

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contribute to the research and outreach efforts of the UI Idaho Rangeland Center.

For a complete description and to apply online, <http://apptrk.com/532931>

First consideration will be given to applicants who apply by November 14, 2014. The University of Idaho is an Affirmative Action/Equal Employment Opportunity Employer and is committed to a diverse faculty, staff and student body.

TEMPLE UNIVERSITY TENURE TRACK POSITIONS IN REMOTE SENSING AND GEOMATERIALS.

The Department of Earth and Environmental Science is entering a period of growth with a newly launched Ph.D. program. To achieve this growth, the department seeks to fill two tenure-track faculty positions to begin in August 2015. One of the positions will be in the area of REMOTE SENSING. A second position will be in the area of GEOMATERIALS. Exceptional candidates holding a Ph.D. are encouraged to apply at any level (assistant, associate, or full professor). Mentoring of undergraduate and graduate students and securing external funding are expected. Applicants must have a Ph.D. in a relevant science discipline.

REMOTE SENSING: We especially encourage applicants with a focus on the analysis of Earth using airborne or satellite remote sensing platforms, expertise in digital signal processing for geoscience applications, and the use satellite data for understanding climate change. This appointment will complement existing expertise in geophysics, hydrogeology, structural geology, geomorphology, and planetary geology, and make use of the new high-performance computing cluster. Applicants should be able to teach undergraduate and graduate courses including Remote Sensing and Physical Geology.

GEOMATERIALS: Of particular interest are applicants with a focus on energy as well as earth science, and with expertise in mineralogy and petrology that crossover to material science. The candidate should investigate crystalline, glassy, or melt geomaterials with a goal of understanding the atomic-scale characteristics that lead to macroscopic properties in earth sciences. The individual is expected to use a combination of field or experimental based data collection and modeling approaches. This appointment will complement existing expertise on the properties of nanominerals and geochemistry within EES as well as materials research conducted through supercomputing, engineering, chemistry, and physics utilizing a variety of in place instrumentation and the newly formed Temple University Energy Frontier Research Center. Applicants should be able to teach undergraduate and graduate courses including Mineralogy and Petrology.

Applications should first email a letter of intent to the appropriate Search Committee Chair. REMOTE SENSING applicants should send a letter of intention to apply and any inquiries to Alexandra Davatzes, Chair, Search Committee, alix@temple.edu, whereas GEOMATERIALS applicants should email Nick Davatzes, Chair, Search Committee, davatzes@temple.edu. Applicants should upload a CV, statement of teaching goals, a research plan, names and addresses of at least three references, and selected reprints via the following website: <http://ees.cst.temple.edu/>. We request application material be submitted by December 1, 2014. Temple University is a state-related research-intensive institution with an undergraduate enrollment of more than 27,000 and nearly 10,000 graduate and professional students. More information about our department is available at <http://www.temple.edu/geology/>. Temple University is an equal opportunity, equal access, affirmative action employer committed to achieving a diverse community (AA, EOE, M/F/D/V). The department specifically encourages applications from women and minorities.

Tenure-Track Faculty Position Sedimentology The University of Alabama Department of Geological Sciences.

The Department of Geological Sciences at The University of Alabama invites applications for an Assistant Professor tenure-track faculty position in sedimentology beginning August 2015. Candidates must have a strong record of research and teaching, and must have received their Ph.D. in Geosciences at the time of appointment. The successful candidate will be expected to establish an externally-funded research program, attract and supervise graduate students, and teach undergraduate and graduate courses in sedimentology/stratigraphy, and introductory geology. The department has a broad range of isotopic, geochemical and modeling research facilities available, in addition to University-shared instrumentation at the Central Analytical Facility (www.caf.ua.edu). Details regarding existing research programs, equipment, facilities, and departmental activities are at www.geo.ua.edu. Questions should be directed to Dr. Delores Robinson (dmr@ua.edu). Go to <http://facultyjobs.ua.edu/postings/35994> to electronically apply. When submitting an application, candidates must provide a cover letter, CV, research and teaching statements, and a list with the contact information for at least three referees. Review of applications will begin November 17, 2014. The University of Alabama is an Equal Opportunity Affirmative Action Employer and actively seeks diversity in its employees.

Tenure-Track Faculty Position Seismic Stratigraphy The University of Alabama Department of Geological Sciences.

The Department of Geological Sciences at The University of Alabama invites applications for a tenure-track faculty position in seismic stratigraphy, beginning August 2015. The position will be filled at the Assistant Professor level. Candidates are invited to apply who have specialties within the broad field of seismic stratigraphy. Energy

industry experience is a plus. It is expected that this position will enhance our existing faculty research areas in geophysics, sedimentology, basin analysis, and petroleum geology. Candidates must have a strong record of research and teaching, and must have received a Ph.D. in geology, geophysics, or a related field, at the time of appointment. The successful candidate will be expected to establish a vigorous, externally funded research program and attract and advise high-quality graduate students. Teaching responsibilities will include undergraduate and graduate courses in her/his specialty and introductory geology. The department has a broad range of geophysical, geochemical, and computational facilities, in addition to University shared facilities, including the Dauphin Island Sea Lab. Departmental software includes industry standards such as ProMAX, Petrel, IHS Kingdom, Geosoft, ArcGIS, and Matlab. Details regarding existing research programs, equipment and facilities, and departmental activities can be found at <http://www.geo.ua.edu>. Questions should be directed to Dr. Ibrahim Çemen (icemen@as.ua.edu). Applicants should go to <http://facultyjobs.ua.edu/postings/36000> to electronically apply for this position. When submitting an application, candidates must provide a cover letter, CV, research and teaching statements, and a list with the contact information for at least three referees. Applications will be reviewed beginning November 17, 2014. The University of Alabama is an Equal Opportunity Affirmative Action Employer and actively seeks diversity in its employees.

Faculty position: Space Technology

The Department of Mechanical Engineering (ME) at Boston University invites applicants for a tenure track faculty position at the Assistant Professor level in Space Technology, and its commercial, scientific, and societal applications. Possible areas of focus include small satellites, spaceflight control, sensors and instrumentation, robotics, and space communications. The university seeks to build upon its traditional strengths in Space Science through the development of a synergistic technology program in the College of Engineering. The selected candidate will have the opportunity to work with a diverse group of faculty through BU's interdisciplinary Center for Space Physics (CSP). A joint appointment with the department of Electrical and Computer Engineering is possible depending on background and interests. Interested candidates should have a Ph.D. degree in a relevant field of engineering or applied science, and should have the ability to develop and sustain a funded research program. The applicant should be able to teach courses in the graduate and undergraduate programs in Mechanical Engineering or related courses in the College of Engineering. Salary is competitive and commensurate with experience. Boston University is an equal opportunity employer, and all qualified applicants will receive consideration without regard to race, color, religion, sex, national origin, disability status, protected veteran status, or any other characteristic protected by law. Additional information and application instructions can be found at <http://www.bu.edu/me>. Inquiries may be addressed to Joshua Seme-ter at jls@bu.edu.

The Geosciences Department at Hamilton College seeks applicants for a tenure-track Assistant Professor of Geosciences to begin in July 2015.

The successful candidate for the position must have a Ph.D. in the geosciences with a broad background in sedimentary geology and related field experience. Candidates will be expected to establish a strong scholarly record in sedimentary geology and to advise undergraduate research projects. Teaching responsibilities include: a required course in sedimentary geology, a topical introductory course in geology, and one or more electives in the candidate's specialty.

Visit <http://careers.agu.org/jobs/6523812/> tenure-track-assistant-professor-of-geosciences to learn more and to apply

Turner Postdoctoral Fellowship University of Michigan

This highly competitive fellowship is open to candidates who have obtained a PhD in any field within Earth and environmental sciences.

The Department seeks qualified applicants who are interested in collaborating with one or more faculty members. Applicants are encouraged to contact prospective faculty host(s) prior to the application deadline to discuss areas of common interest and to develop innovative research proposals.

Turner Postdoctoral Fellows receive an annual salary of \$55,000, discretionary research funds of \$5,000 per year, and a generous benefits package. The fellowship is awarded for a one-year period, with an anticipated extension for a second year.

Application: Applicants must have a PhD. To apply please go to: <http://www.earth.lsa.umich.edu/turner2015/newapplicant>. Complete the online application, including the names and addresses of at least three references, and upload (as a single PDF) the required application documents, which should include a curriculum vitae and a research proposal (5 pages maximum excluding references).

Deadline: Applications and reference letters for the 2015 competition are due January 15, 2015.

Inquiries should be sent to Michigan-Earth-Search@umich.edu. Women and minorities are encouraged to apply. The University of Michigan is an equal opportunity/affirmative action employer.

Student Opportunities**PhD in Cryosphere Geophysics**

Boise State University, Department of Geosciences, is seeking a highly motivated student to

work on an NSF funded project that is focused on studying firn on the Greenland Ice Sheet (GrIS). The student will work on advanced georadar imaging techniques to characterize the firn column. The project will require the student to participate in extended field campaigns on the GrIS. A solid background in field geophysics is preferred. For additional information contact John Bradford (jbradfor@boisestate.edu) or HP Marshall (hpmarshall@boisestate.edu).

NC State CyberSEES Project - Graduate Research Assistants

We are looking for exceptional graduate students to work on an NSF award (<http://goo.gl/Bw15b>) on climate-water-energy nexus that utilizes hydroclimate forecasts for improved management of water and energy systems. Ideal candidates should have background in one/more of the following areas: Hydroclimatology and water and/or energy management, Strong programming skills, Optimization and Statistical modeling. Interested candidates are requested to submit their profile at <http://goo.gl/2NFIMn>.

Ph.D Positions: Passive Seismology Applied to Mineral Exploration

We seek motivated individuals with experience in seismology for at least one fully funded Ph.D position at The University of Western Australia.

The research involves the analysis of broadband seismic data from Western Australia to determine crustal structure in this economically significant area. The research will use techniques adapted from exploration seismology, including:

- 2D and 3D full-wavefield elastic modelling;
- Imaging and waveform inversion of 2D seismic data from local mine blasts;
- 2D teleseismic migration and image-domain adjoint-state; and
- Ambient noise tomography.

Full details at <http://www.cet.edu.au/about-us/careers-and-research-opportunities/research-opportunities>.

PhD opening in Geomicrobiology, University of Melbourne

PhD scholarship available for qualified and highly motivated applicant in School of Earth Sciences, University of Melbourne, to conduct research in geomicrobiology. Potential projects include (but not limited to) investigation of the deep subsurface biosphere, evolution of microbial metal resistance, bioremediation of mine contaminants, mineral/isotopic biosignatures. Prospective students should email CV and brief statement of research interest to jmoreau@unimelb.edu.au. Admission deadline rolling.

PhD Student Opportunity, Geophysics Joint Doctoral Program.

San Diego State University and University of California San Diego are

accepting applications for the Joint Doctoral Program in Geophysics. The SDSU/UCSD Joint Program provides full access to the Geophysics curriculum of UCSD's Scripps Institution of Oceanography, with additional specialized courses and research opportunities offered by SDSU faculty. Assistantships for Fall 2015 are available for research in earthquake physics and strong motion, fault zone structure and dynamics, quantitative paleoseismology, applied seismic imaging, and computational seismology. Successful candidates must meet doctoral admissions requirements of both universities. Apply, by December 15, 2014, at www.csumentor.edu. For further information, see www.geology.sdsu.edu/jdp, or send inquiries to Professor Steven Day (sdlay@mail.sdsu.edu).

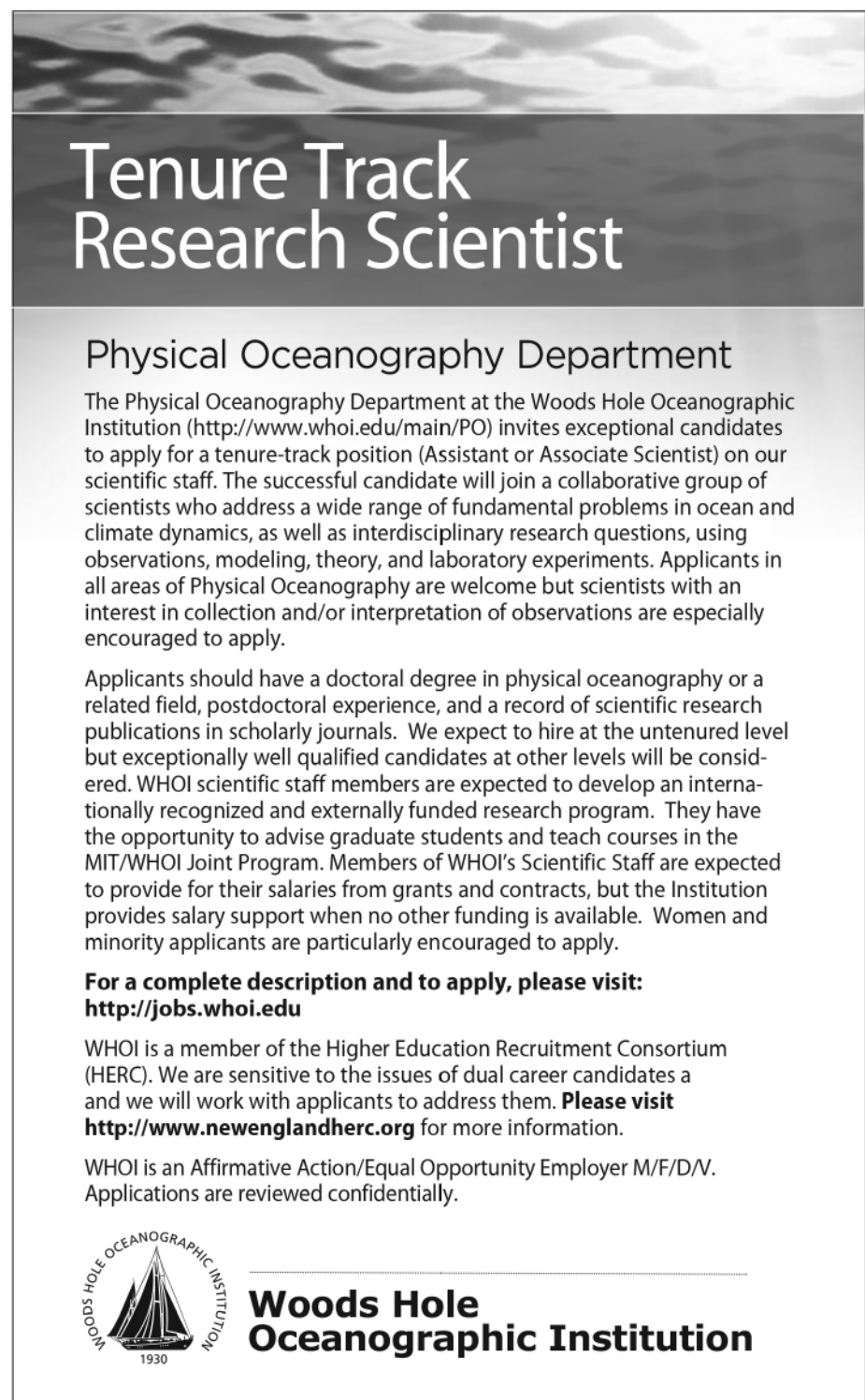
Student positions in computational math and geophysics

The Departments of Geosciences and Mathematics at Boise State University are seeking well-qualified students to work on an NSF funded project in computational mathematics. The project is focused on developing new techniques for joint inversion of multiple types of geophysical data. Funding is available at both the Masters and PhD levels. A solid background in computational mathematics is required. For additional information contact John Bradford (jbradfor@boisestate.edu), or Jodi Mead (jmead@boisestate.edu).

The Department of Earth and Environmental Sciences at Lehigh University will have several varied support packages available for students starting in our research-intensive M.S. and Ph.D. programs in AY2015-2016. We encourage applications from students with interests aligned with the broad range of research areas in which our faculty are engaged. Interested students should visit our website (www.ees.lehigh.edu) and directly contact any faculty who might serve as potential advisors. Lehigh University is an equal opportunity employer and promotes excellence through diversity.

The Jonathan O. Davis Scholarship supports graduate students working on the Quaternary geology of the Great Basin.

The national scholarship is \$5,000 and the University of Nevada, Reno stipend is \$1,500. The national scholarship is open to graduate students enrolled in an M.S. or Ph.D. program at any university in the United States. The Nevada stipend is open to graduate students enrolled in an M.S. or Ph.D. program at the University of Nevada, Reno. Details on application requirements can be found at: <http://www.dri.edu/GradPrograms/Opportunities/JonathanDavis>. Applications must be post-marked by February 17, 2015. Proposal reviews will not be returned. Applications should be addressed to: Executive Director Division of Earth and Ecosystem Sciences Desert Research Institute 2215 Raggio Parkway Reno NV 89512



Tenure Track Research Scientist

Physical Oceanography Department


The Physical Oceanography Department at the Woods Hole Oceanographic Institution (<http://www.whoi.edu/main/PO>) invites exceptional candidates to apply for a tenure-track position (Assistant or Associate Scientist) on our scientific staff. The successful candidate will join a collaborative group of scientists who address a wide range of fundamental problems in ocean and climate dynamics, as well as interdisciplinary research questions, using observations, modeling, theory, and laboratory experiments. Applicants in all areas of Physical Oceanography are welcome but scientists with an interest in collection and/or interpretation of observations are especially encouraged to apply.

Applicants should have a doctoral degree in physical oceanography or a related field, postdoctoral experience, and a record of scientific research publications in scholarly journals. We expect to hire at the untenured level but exceptionally well qualified candidates at other levels will be considered. WHOI scientific staff members are expected to develop an internationally recognized and externally funded research program. They have the opportunity to advise graduate students and teach courses in the MIT/WHOI Joint Program. Members of WHOI's Scientific Staff are expected to provide for their salaries from grants and contracts, but the Institution provides salary support when no other funding is available. Women and minority applicants are particularly encouraged to apply.

For a complete description and to apply, please visit: <http://jobs.whoi.edu>

WHOI is a member of the Higher Education Recruitment Consortium (HERC). We are sensitive to the issues of dual career candidates and we will work with applicants to address them. **Please visit <http://www.newenglandherc.org>** for more information.

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 **Woods Hole Oceanographic Institution**

RESEARCH SPOTLIGHT

Highlighting exciting new research from AGU journals

Global trade network affects availability of food

Because the Earth's population is slated to hit 9 billion in the next century, food scarcity has become an increasingly important topic of study. Food availability is widely examined, but *D'Odorico et al.* point out that reliance on trade to distribute food has not been sufficiently quantified.

The authors used world trade statistics from 153 countries for 251 food commodities to construct a global network of food trade in terms of calorie transfer. They found that many countries, especially in Africa and the Middle East, depend on trade to provide enough food and that the countries that suffer the most from chronic food scarcity are limited by climate, the availability of water, and other factors.

The authors report that although today there is enough food being produced to feed the world's growing population, factors such as water shortages and dependence on trade may exacerbate food scarcity in many regions around the world. Given this information, trade patterns and potential trade disruptions need to be considered when studying food scarcity. (*Earth's Future*, doi:10.1002/2014EF000250, 2014) —JW

What happens to minerals as they get squeezed in the mantle?

The motion of the Earth's mantle is controlled in part by how mantle minerals respond to changes in temperature and pressure. The chemical and physical shifts that minerals undergo as they are heated and squeezed cause some to sink down toward the core and others to rise up toward the surface. This buoyant pressure and gravitational sinking, in turn, affect the convection of the mantle and the large-scale cycling of the Earth.

In the lower mantle, starting around 650 kilometers depth, the most common minerals are silicon oxides that include iron, magnesium, or calcium. The proportion of iron, magnesium, or calcium bound up in the mineral affects its density. At the same time, the chemical structure of the mineral also changes with pressure and temperature. The result is that researchers are not really sure how these minerals behave in the mantle.

Using a combination of a diamond anvil press and laser heating, *Tateno et al.* measured how these common minerals changed under the conditions found in the lower mantle. They tested pressures from 34 to 179 gigapascals and temperatures from 2900 to 5000 Kelvin.

The authors found that as the pressure increases and the mineral starts to melt, at around 34 gigapascals, it changes to preferentially include more iron and magnesium. This change causes its density to increase. With a high proportion of iron and magnesium, the partial melt is actually denser than the original solid, and the melt sinks farther toward the core.



Diamond anvil cells (shown above) and laser heating were used to simulate the conditions of the lower mantle.

The proportion of iron and magnesium in the authors' samples increased with pressure up to around 80 gigapascals before leveling off. This pressure is roughly equivalent to a depth of 2000 kilometers below the Earth's surface. (*Journal of Geophysical Research: Solid Earth*, doi:10.1002/2013JB010616, 2014) —CS

Vortices in Saturn's upper atmosphere

Saturn's magnetosphere exhibits phenomena with 10.7-hour periodicity that scientists do not fully understand. One proposed explanation is that twin vortices in the upper atmosphere at Saturn's north and south poles generate currents that drive the magnetosphere periodicity.

Smith analyzed the vortex model and the problems with it, considering the possible mechanisms by which atmospheric vortices could drive currents that generate the observed periodicity. He noted that the model has two problems: First, there is no physical material in the upper atmosphere that rotates at close to the 10.7-hour period, and second, vortices in the upper atmosphere would be unlikely to remain coherent long enough to generate the necessary currents.

The author then proposed a model that could overcome those difficulties. In the new model, the twin vortices originate not in the planet's upper atmosphere but in the stratosphere, at around 750 kilometers in altitude. He showed that the necessary wind patterns could exist and are consistent with observations of Saturn's upper atmosphere. (*Journal of Geophysical Research: Space Physics*, doi:10.1002/2014JA019934, 2014) —EB

Different types of ice propagate waves differently

Surface ice on oceans and lakes can cause major problems onshore and offshore. Specifically, surface waves interacting with ice can create hazardous conditions for cargo ships, damage coastal structures, and carry important nutrients away from the shore.

Previous attempts to study the interaction between surface waves and ice have

been burdened by bulky, inefficient, and low-resolution technology. To overcome this problem, *Campbell et al.* used a new technique to accurately observe at high resolution how surface waves are affected by different types of ice.

In a Wisconsin lake, the authors used stereo imaging—taking multiple images of one area to create a three-dimensional view—to observe waves interacting with three distinct types of ice. The authors found that frazil ice, which is made up of tiny needlelike structures in random orientations, and pancake ice, which consists of round, flat pieces of ice made up of ice that results from collisions among pieces of frazil ice, propagate wave energy differently than brash ice, which consists of large chunks of ice left over from wreckage.

The authors are currently investigating which types of ice pose the worst hazards when they are hit by waves and how these interactions are influenced by topography, bathymetry, and wave speed. (*Journal of Geophysical Research: Oceans*, doi:10.1002/2014JC009894, 2014) —CS

Oregon earthquakes increase local landslide risk

Coastal Oregon is home to a number of slow, recurrent landslides. During bouts of heavy rain, water gets into the soil, reducing friction and causing the ground to slip. Often, these landslides creep along at a barely perceptible rate—less than a centimeter per day. Yet the landslides are a lurking threat, as past events that have damaged infrastructure and cut communities off for months at a time have demonstrated.

Of particular concern is how these landslide regions would respond to the more potent shaking of an earthquake, a process that is not well understood. Based on new laboratory experiments, *Schulz and Wang* suggest that many of Oregon's slow creeping coastal areas would fail catastrophically during an earthquake, an added threat in the seismically active region.

Between the smaller recurrent landslide events, the hillslopes are propped up by the constant friction that develops in the soil during the slow movements, known as its "residual shear strength." A small amount of jostling, however, can actually change the strength of a hillslope, as soil particles are rearranged into either a more shear-resistant or shear-compliant state.

The authors assessed how the soil from two of Oregon's landslide regions would respond to different kinds of pressure. They tested soil samples from two recurrent landslides under constant and increasing displacement rate and under loading forces that mimicked historical earthquakes.

The researchers found that a small rapid displacement caused a pronounced drop in shear strength. However, if the displacement rate was increasing, rather than constant, the shear strength actually increased—up to a point. Under shaking conditions drawn from historical earthquakes, however, the



U.S. Highway 101 was moved in 2001 after it was damaged by the Carmell Knoll landslide in Oregon.

soils' residual strength could not hold up. (*Journal of Geophysical Research: Earth Surface*, doi:10.1002/2014JF003088, 2014) —CS

Glaciers in west Antarctic retreating rapidly

As a glacier slides slowly into the sea, buoyancy eventually trumps gravity, and the sheet of ice floats. The place where the ice starts leaving the ground is called the grounding line, and this line can shift as the mass of the glacier shifts with precipitation or climate. Studying the movement of the grounding line through time helps scientists determine the stability of the glacier and its mass budget—the balance of how much mass the glacier is gaining or losing.

Rignot et al. set out to describe the changes in several glaciers that empty into the West Antarctic's Amundsen Sea. The researchers used satellite data that tracked the motion of the glaciers and were able to measure precisely how far their grounding lines retreated between 1992 and 2011 and what the glacier bed topography looked like along the way. The grounding lines of all four glaciers studied retreated between 10 and 35 kilometers during that time, and because the authors could not find any topography factor upstream of the grounding lines that could interrupt this retreat, they have deemed that the glaciers' retreat started more than 20 years ago and is now unstoppable.

The Amundsen Sea sector of West Antarctica is already the largest contributor to Antarctic ice loss and contains enough ice to raise the global sea level by 1.2 meters. In the coming centuries, the authors note, these glaciers will significantly contribute to sea level rise. (*Geophysical Research Letters*, doi:10.1002/2014GL060140, 2014) —JW

Rain projected to dominate western U.S. precipitation

Throughout the western United States, scientists have noticed that warming has reduced snow accumulation and led to earlier snowmelt, a change that could have dire consequences for the region's ecology and industries. Specifically, previous research has found that the rain-snow transition zone—the area where precipitation is dominated by rain versus snow in the winter—has shifted significantly in the past few decades.

Klos et al. present projections of the change in the rain-snow transition period over the next half-century, based on climate projections from several climate models. The authors constrained their projections under the Representative Concentration Pathway 8.5 scenario, which assumes that greenhouse gas emissions will continue to rise at current rates (e.g., "business as usual").

Under this scenario, the authors found that the rain-snow transition zone will move up in altitude and latitude and that, in the western United States, the land area with wintertime conditions conducive to snowfall will shift from a current ~53% of the West to only ~24% of the West by mid-century. The authors note that these projections will be valuable to regional water resource managers as they develop strategies to prepare the agricultural industry and municipal water suppliers for the coming shift toward more rainfall and less snow. (*Geophysical Research Letters*, doi:10.1002/2014GL060500, 2014) —JW

—ERNIE BALCERAK, Staff Writer; COLIN SCHULTZ, Writer; and JOANNA WENDEL, Staff Writer

Peruvian Andes helped to cool eastern equatorial Pacific

During the latter half of the Cenozoic, starting during the Pliocene, the eastern equatorial Pacific (EEP) underwent a change from warm, wet climate conditions—which scientists refer to as "permanent El Niño"—to more moderate conditions like those observed today. Although scientists can track this change using marine proxy records, they are still puzzled as to why the sudden shift occurred.

Feng and Poulsen, however, note that the shift coincides with uplifting in the Peruvian Andes. To test whether this uplift could have influenced climate conditions in the EEP, the authors ran experiments using a complicated climate model, quantifying the changes seen in the EEP as a function of Andean elevation.

The authors found that the Andes, which rose from 1 to 3 kilometers during the Pliocene, caused a net cooling effect that can account for about one half of the cooling observed along the coast of Peru in the late Cenozoic. Uplift also enhanced low-cloud formation in the EEP, which accounts for most of the net cooling.



The late Cenozoic uplift of the Andes could have altered the tropical Pacific climate state.

The authors note that although their results show that the Andes were indeed one of the factors contributing to the climate shift in the EEP, more research is needed to pin down other contributing

variables. Understanding the relationship between the Andes and the EEP, they add, will further inform research on modern-day climate variability. (*Paleoceanography*, doi:10.1002/2014PA002640, 2014) —JW