University of Wisconsin-Madison • Department of
GEOSCIENCE
Another face of *The Outcrop* Winter 2012/2013

She sees sea tales in the sea core

In the past year, three members of Harold Tobin's research group have found themselves at sea—not in oceans of data, but off the coast of Japan.

Two graduate students, Tamara Jeppson and Susanna Webb, and post-doc Joanne Tudge, have spent a cumulative six months living and working as logging scientists on the drilling vessel Chikyu. Jeppson sailed as a logging physical-properties specialist on the Japan Trench Fast Drilling Project (JFAST) which targeted the fault zone that ruptured during the M 9.0 Tohoku-Oki tsunami earthquake of March 2011. JFAST took place one year after the initial fault rupture, and involved collecting logging data, coring the fault zone, and installing a downhole observatory. Webb and Tudge sailed as logging-structural and logging-lithology specialists on Expedition 338, which is part of the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE).

Expedition 338 involved logging a riser drilling hole that penetrated the Miocene inner accretionary prism of the Nankai Trough. Several other riserless holes were also logged and cored at key sites in the Nankai Trough study area over the course of the expedition. Both expeditions experienced adverse weather conditions, with gale-force winds and wave swells reaching over 9 m (!), but overcame these challenges and collected "groundbreaking" data. Both expeditions even managed to break records:

The drill ship Chikyu

Expedition 338 drilled the deepest hole into an accretionary prism (2km) and JFAST set a record for the deepest scientific ocean drilling depth, over 7 kilometers! Scientists aboard the vessel all worked 12 hour shifts on the laboratory decks of the ship, analyzing incoming data. The Chikyu is equipped with four stories of laboratory decks, allowing immediate core and log analysis onboard. Scientists also present daily progress reports of data analysis to other members of the scientific party and lab staff, which encourages discussion. "Seeing the core come up on deck and the anticipation of what it would show us was a thrilling moment for the science party," Jeppson recalls. Webb enjoyed the night shift, being able to monitor and analyze the logging data as it came in, and finishing each shift off by watching the sunrise over the ocean from the helideck.

Life on the Chikyu is not all toil, however—friendly inter-science party ping-pong championships were held on each expedition, as well as Japanese tea ceremonies, calligraphy lessons, and birthday celebrations. The Expedition 338 science party celebrated a slew of holidays onboard; Halloween, Guy Fawkes, Thanksgiving, Christmas, and New Year's. For Thanksgiving, the American scientists were presented with excellent pumpkin pie by the kitchen staff, which was greeted with a standing ovation. Perhaps most valuable to the graduate students, however, were the four daily meals, and the free laundry services. Tellingly, when asked if they would like to return for another expedition, all three answer with a resounding "Yes!"

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From the Chair

March 20, 2013

This letter reaches you in place of the usual Spring edition of the Outcrop. We will continue to publish the Outcrop, but will mail it to you each November, before Thanksgiving. I'd like to briefly highlight a few of the exciting things going on in Weeks Hall.

Assistant Professor Mike Cardiff arrived in Madison and began teaching hydrogeology courses last Fall. In January, Mike learned that he will receive the Lorenz G. Straub award. This award is based on an international competition that recognizes annually the outstanding PhD dissertation in hydraulic engineering. What a great start to Mike's career!

Professor Clark Johnson was just selected by Provost Paul DeLuca to become a Vilas Distinguished Achievement Professor. This is among the most prestigious awards available to faculty at UW-Madison and comes with a substantial financial contribution toward Clark's research program over the next five years. Clark will hold the title for the remainder of his career.

Keeping with the Department's strategic plan: http://geoscience.wisc.edu/geoscience/about/department-of-geoscience-five-year-strategic-plan-2013-2018/, we have requested permission from Dean Sandefur to search for a new faculty member in the area of Surface Processes and Landform Development.

Professor Brad Singer.

On a very sad note, the Department has lost one of our most energetic and effective off-campus supporters with the passing of Jay Nania this week. A memorial will grace the next Outcrop.

The remainder of this newsletter highlights undergraduate and graduate student research, the Geology Museum, and the Wasatch-Uinta field camp. I hope you enjoy this short communication and urge you to please take the opportunity to update us with your email address so that you may regularly receive the Department's new quarterly e-newsletter, in addition to the Outcrop.

Sincerely,

Brad Singer
Professor and Chair

Stay connected!

Please continue sending us your professional and personal news!
We have received many updates from alumni and friends and we will be sure to include them in the Outcrop this fall. Please send any additional 2012 or 2013 updates by August 30, 2013 for inclusion the 2013 Outcrop.

Do you receive email from the department?
Send us your email address so we can alert you about alumni receptions and other important department news and so you can receive the new e-newsletter that comes out quarterly. We do try keep the email to a minimum! Send us address/email updates.

Send your updates to:
By email to diman@geology.wisc.edu
By US Mail to Mary Diman
Department of Geoscience, 1215 West Dayton Street, Madison, Wisconsin 53706

Addressing a critical need for Field Camp scholarships

We face the major financial challenge of keeping Summer Field Camp affordable for our students.

In the past we have offered a limited number of Field Camp scholarships for our undergraduate students from unrestricted gift funds and industry support, but with the large increase in the number of our majors, and simultaneous increases in Field Camp costs, we cannot help all of our students in need. We therefore solicit your help in creating a Field Camp Scholarship fund. We hope to achieve a sustained giving level of $30,000 annually for Field Camp scholarships.

Summer 2013 will mark the 42nd year of UW-Madison's participation in the Wasatch-Uinta field camp based in Park City, Utah. Since 1967 the Chateau Apres has been the 6-week home to more than 2600 students including ~650 from Madison. The remarkably diverse geology available within a 50 mile radius of the Chateau provides our students with a special place for the capstone course rounding out all the lectures and labs they had in Weeks Hall (and Science Hall before that). The Wasatch-Uinta camp has been successful in helping launch the careers of many academic and industry geologists–most recently the camp has been traveling to NE Nevada to spend 2-3 days looking at real gold mines–at least 15 graduates from the the consortium schools in the last five years have found seasonal or permanent employment in the mining industry in the western U.S.

A Field Camp group in front of Chateau Apres in 1986. Photo taken by Bob Dott.

Some of the field projects will be familiar to many of you–we still map at Chalk Creek, Deer Creek reservoir trying to avoid the Heber Creeper, and spend four days on Bonanza Ridge. Final projects include two days on Jupiter Ridge (and the mosquito swamp in the lowlands below Guardsman Pass) and in Albion Basin–two years ago we had to walk in because the snow still had not melted by the end of July! Many readers will have favorite memories of Field Camp–most of them good. It is a unique opportunity for students to practice what our faculty have been preaching for years–the chance to really BE a geologist in the field. Please consider helping keep this experience available to our students.


Getting organized in the field. This the first stop on day one of the four days at Bonanza Ridge, 2012.

NOTE: A link for the customized on-line giving form for the College of Letters and Science Geoscience Field Camp Fund is http://www.supportuw.org/giving?seq=16809

Student Research

Undergrads
Cole Christiansen
Dana Peterson

Cole-fired

Under the direction of Professor Craig Benson, Cole Christiansen, a senior in Geological Engineering and Geology, spent eight months on a project testing the hydraulic conductivity of geosynthetic clay liner (GCL) permeated with municipal solid waste (MSW) leachate. The project examined the effect of MSW leachate on the chemistry and the hydraulic conductivity of GCLs under different confining pressures.

In addition to research with Benson, Cole received funding from the Shell Undergraduate Research Fund in January of 2011 to pursue a research project of his own titled the Effectiveness of Bentonite as an Annular Seal in Wells. Cole worked collaboratively with Dave Hart (WGNHS) and Dave Johnson (Wisconsin DNR) to develop and construct scale models and a dye system to illustrate failure paths in bentonite seals under different hydrogeologic conditions.

Cole Christiansen in Grand Teton National Park, at the summer 2012 Field Camp.

Cole's research was put on hold for a chance to gain experience in the world of consulting while he worked for Golder Associates as a Geotechnical Engineering Intern in Denver. During his 6-month term he worked with Golder's Geo-Engineering, Mining, Groundwater and Power groups. A project that was especially relevant to Cole and his research was a site investigation of a coal-fired power plant in which he and his supervisors tracked the movement of contaminants through groundwater via monitoring wells.

The site investigation provided Cole with a better understanding of how wells are installed in the field. This insight motivated him to devise an improved testing procedure for his independent research project, and as a result, the project received additional funding in 2012. The second phase of testing is underway and Cole aims to have the project completed by summer 2013.

Cole will graduate this spring and will pursue an MS and PhD at the University of California, Berkeley.

In the zone

Tectonic tremor is arguably one of the most exciting and enigmatic seismological discoveries of the last decade. Tectonic tremor is a weak but persistent shaking of the Earth that was first discovered in subduction zones and later beneath the San Andreas Fault (SAF). Tremor events represent spasmodic slip on the deep extension of the SAF, occurring at a depth of about 20-25 km. Tremor occurs deeper than the nearby regular earthquakes, which can be found at maximum depths of only 12-13 km. These episodic events are characterized by bursts of low frequency earthquakes (LFE's) with energy in the 1-10 Hz range. Tremor tells us about fault slip at depth in both space and time by illuminating the fault close to the base of the crust.

Since the summer of 2011 I have been working in Cliff Thurber's seismology lab, researching tectonic tremor below the San Andreas Fault. We began by analyzing several periods of continuous data from the Parkfield Area Seismic Observatory (PASO) temporary array, operated in 2000-2006.

We started the identification process by correlating templates of known LFE's from a nearby station array based on a catalog of events from Shelly et al. (2010). Using the dense PASO array and various correlation methods, including autocorrelation (Brown et. al. 2008), a scanning algorithm (Rowe, 2005), a cross correlation of templates (Shelly et al., 2007), and finally a stacking algorithm which aligned and amplified LFE arrivals, we were able to refine the locations of these known events.

We used data from the 59 stations comprising the PASO array, combined with data from Shelly and Hardebeck (2010), to provide strong constrains on the locations of LFE's relative to nearby earthquakes using double-difference location in a 3-D model.

The fine-scale seismic velocity structure around zones of tectonic tremor and LFE's has been imaged successfully in subduction zones. This success is due in part to the occurrence of earthquakes in the subducting slab beneath the zone of tremor and LFE's. For the San Andreas fault, the observed tremor and LFE's in the Parkfield region occur at depths greater than 15 km, which is below the deepest normal earthquakes in the region. This makes tomographic imaging of the tremor zone more challenging. In the summer of 2012 we used a combination of P and S arrival times and corresponding differential times from stacked seismograms of LFE's (Shelly and Hardebeck, 2010) along with absolute and differential times from shallower microearthquakes to image the

Peterson research continued, next page

three-dimensional P- and S-wave velocity structure to ~20 km depth. Our results indicate the LFE's near SAFOD lie within or adjacent to zones with slightly reduced P-wave velocity and more sharply reduced S- wave velocity. The estimated Vp/Vs values are approximately 1.85 to 1.95 in these zones. The elevated Vp/Vs values are interpreted to reflect high pore fluid pressure and low effective stress. This is consistent with results from subduction zones and with observations of triggering and tidal modulation of LFE's and tremor on this deep extension of the SAF. Figure 1 shows our tomography results, which are deeper than ever imaged before at Parkfield via body wave tomography, providing information on the physical conditions in the tremor zone.

–Dana Peterson

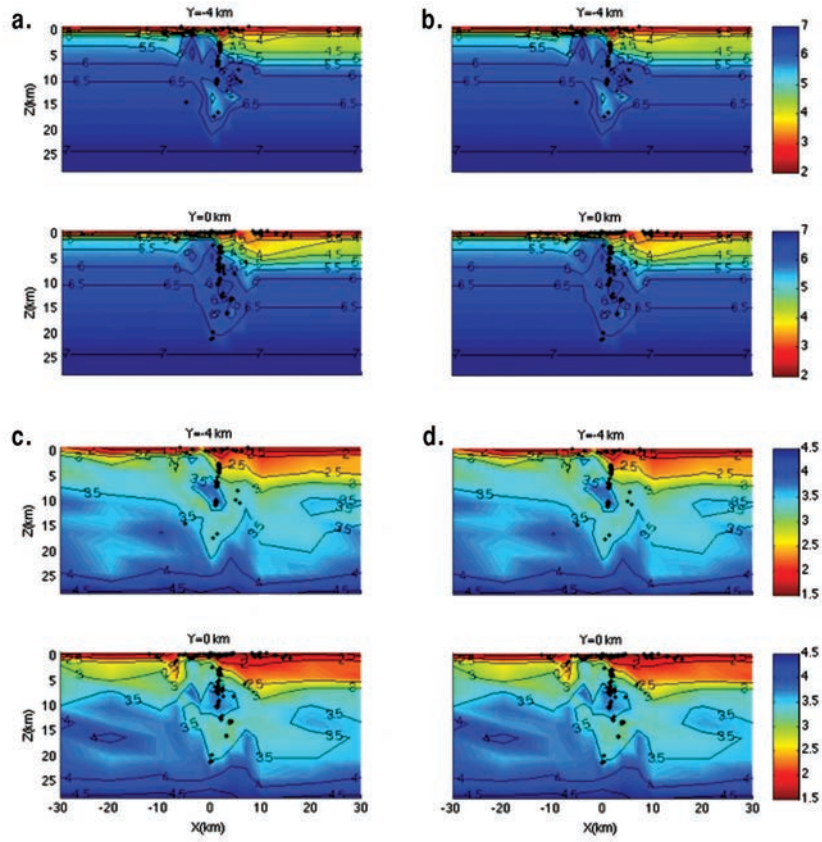


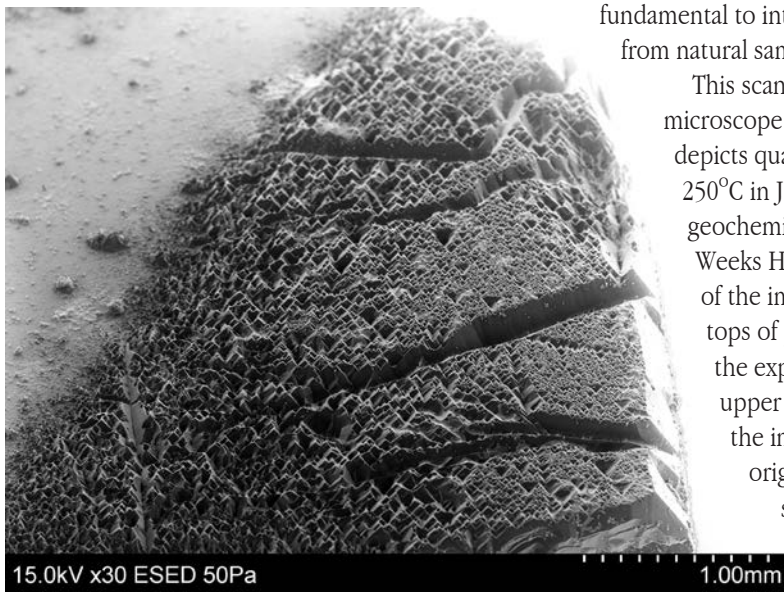
Figure 1. Tomographic fault normal cross-sections from Y=-4 (northwest) to Y=8 (southeast). The San Andreas Fault is oriented vertically at X=0. P-wave (a-b) and S-wave (c-d) velocity are shown by black contours (labeled with km/sec) and colors from red (slow) to blue (fast). Black diamonds above 15 km are relocated earthquakes and black diamonds below 15 km are relocated LFE's. Note the zone of slightly reduced velocity centered around 15 km depth in the Y = -4 and 0 km panels, where the LFE's are concentrated.

Grad Students
Anthony Pollington
Liz Percak-Dennett

Home-grown

Quartz is one of the most abundant minerals on Earth, and an understanding of the factors controlling its growth is fundamental to interpreting data from natural samples.

This scanning electron microscope image (left) depicts quartz grown at 250°C in John Valley's geochemistry lab at Weeks Hall. The center of the image shows the tops of peaks grown in the experiment; the upper left corner of the image shows the original polished surface on which the experimental quartz grew. Each peak is an individual quartz crystal; they all have the same orientation. The canyons are formed above scratches in the original surface. The largest peaks (center right in image) are ~250 microns tall – smaller than three human hairs!



SEM image of quartz grown experimentally at 250°C. Photo, Anthony Pollington

Using the WiscSIMS ion microprobe, our group will measure the isotope chemistry of this experimentally grown quartz to understand how the chemistry of quartz changes with temperature, which will help understand how quartz grows in nature. This is the first time scientists have carried out these experiments to measure the equilibrium silicon isotope fractionation of quartz. **–Anthony Pollington**

Grad student research continued, page 6

Grad student research, continued

Iron goes round and round

Bacteria are everywhere!

They've had billions of years to evolve on earth and now thrive in some of the most extreme environments. As a geomicrobiologist, I study how these microbes interact with minerals in modern environments, and how these small-scale changes can lead to massive system-wide signatures.

Iron (Fe) is the most abundant redox-sensitive element on Earth, and bacteria can gain energy through both oxidizing and reducing Fe. My dissertation research couples field explorations with lab-based experiments to investigate microbial iron cycling in modern environments. Studying modern analogues helps us to understand the evolution and behavior of elemental cycling on Earth, while allowing us to look into the geologic record with biological insight.

As part of the NASA Astrobiology Institute, I'm examining modern magnetite formation in Lake Geneva, Switzerland. This is the only modern environment where primary magnetite production is linked to microbial iron reduction. Studying the site geochemistry and iron isotope behavior of this modern analogue has allowed us to better understand the potential for microbial involvement in magnetite akin to that seen in Precambrian Iron Formations.

Microbial Fe-oxidation can also cause subsurface contaminants, like uranium, to become mobile leading to migration of these harmful elements. I've investigated the ability of native subsurface microbes to oxide Fe in contaminated systems, allowing better understanding of the role bacteria have in controlling elemental mobility. My research tracking mineralogical, microbiological, and geochemical changes accompanying microbial pyrite oxidation helps us to comprehend the role microbes played in controlling sulfur cycling on ancient Earth.

–Elizabeth Percak-Dennett

What's news is what's old in the Geology Museum

From legs to antennae, this pyritized trilobite has it all! Normally only the exoskeleton remains, but here we get to see the preserved soft parts on its underside.

The museum's collections were boosted in the past year with a number of generous specimen donations. The Friends of the Geology Museum purchased four pyritized trilobites (photo, left) that hail from New York's Beecher Beds. These Ordovician fossils preserve spectacular detail of soft tissues, including legs, gills and antennae.

In addition, a slice of lunar meteorite and a collection of Pleisocene fossils (including an unerupted baby mammoth tooth) came from Maury Bramson, 47 invertebrate fossils from Gerald Gunderson (including soft-bodied remains from the Silurian Scotch Grove Formation in Iowa), and oil-filled Illinois geodes from Tom Fey.

Staff news: The UW Geology Museum's family is growing! We are happy and proud to announce we have hired Dr. David Lovelace as the museum's scientist. Dave's job includes leading field expeditions, managing our fossil preparation lab, and doing research on museum specimens. Dave earned his PhD here at the UW-Madison studying Triassic rocks and fossils from Wyoming. His research and field photos were selected for the cover of PALAIOS this past September.

Before coming to Madison, Dave was the director of the Big Horn Basin Foundation, the non-profit educational foundation for the Wyoming Dinosaur Center in Thermopolis. Most notably in his tenure there he was responsible for the construction of a skeletal mount of Supersaurus—the longest dinosaur discovered to date. The Friends of the Geology Museum Board is helping to financially support this position for which we are very grateful.

Our curator Carrie Eaton received a National Endowment for the Humanities grant to preserve and digitize the museum's historical archives and geological equipment which cover over a century's worth of museum and UW history.

Assistant Director Brooke Norsted collaborated on Clark Johnson's latest NASA Astrobiology Institute grant and will be heading those outreach efforts for the next five years.

To keep up with all the latest news from the Geology Museum, follow us on Facebook at www.facebook.com/uwgeologymuseum

Graduate student honored for excellence in teaching, research

UW-Madison annually employs over 1,700 teaching assistants, and each year our most accomplished TA's are recognized across campus.

L&S Teaching Assistant Instructional Development Program Committee has just announced it will honor Department of Geoscience PhD candidate Elizabeth Percak-Dennett as an L&S Teaching Fellow for the year 2013. This is one of the highest forms of teacher recognition that the College awards.

Earlier this year, on February 28, 2013, Elizabeth Percak-Dennett was one of the 15 TA's honored by UW-Madison for exceptional service.

Positive student comments include "Liz was an excellent TA. Extremely enthusiastic and smart, she engages everyone and creates an open learning environment."

Faculty supervisors: "Liz has not only been superb, but has ventured well beyond Weeks Hall to participate actively in the Delta Program and bring to our Department leadership in TA training that we simply have not had." (Professor Brad Singer, Department Chair); and "Liz has a long history of involvement and leadership in teaching issues beyond the classroom. . . . This is typical of Liz's efforts: they engage and benefit not only her students but also her colleagues and the community as a whole." (Professor Dana Geary).

And in addition, Liz received an Outstanding Student Research Paper Award for 2012 by the Department of Geoscience. Read a brief description of her research interests on page 6.

Elizabeth Percak-Dennett, winner of UW, L&S, teaching awards, and a Geoscience research paper award.

Professor John Valley, Chloë Bonamici, and Ian Orland at the 2012 spring banquet.

Department annual awards to students

Each year, at the department's traditional spring awards banquet, our graduate and undergrad students are honored for academic excellence. The awards are drawn from several department named gift funds generously supported by our alumni.

Pictured left with Professor John Valley at the April 2012 spring banquet in Madison, are graduate students Chloë Bonamici, who received of the Kenneth and Linda Ciriacks Distinguished Graduate Fellowship, and Ian Orland recipient of the Board of Visitors' Distinguished Graduate Student Award.

Chloë and Ian were two of 34 geoscience students who received awards at the banquet.

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Please join fellow GeoBadgers
at the following conferences
venues/times TBD

- **AAPG in Pittsburgh**
  Monday, 20 May 2013
- **GSA in Denver**
  Monday, 28 October 2013
- **AGU in San Francisco**
  Tuesday, 10 December 2013

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The Department of Geoscience, fall 2012, in the Weeks Hall courtyard