



## Overview

### IN THIS ISSUE...

#### Overview

Colorado Plateau Trip  
Arvidson Steps Down  
Wiens New Chairman

#### Current Research

Virtual Reality Lab  
Mineral-Water Interface

Phoenix Mission

#### EPSc In Action

Department News  
New Faculty

#### E & PS Faculty

#### Recent Publications

#### New Employees

#### Alumni Updates

Department of Earth and Planetary Sciences  
Washington University  
in St. Louis  
St. Louis, MO 63130



Greetings from the Department of Earth and Planetary Sciences at Washington University! These are exciting times in the department, as the recent influx of new faculty members and their laboratory equipment are rapidly filling up the new building that we began to occupy in 2004. For the first time since at least 1991, we have four assistant professors in the department (Jeff Catalano, Fred Moynier, David Fike, and Phil Skemer). Fred and Phil are profiled in this issue, and Jeff and David were profiled in the 2007 issue. All of the junior faculty are making excellent progress, as evidenced by the fact that all have already obtained NSF and/or NASA

funding for their research. Further good news is that Jennifer Smith is no longer an assistant professor, as she was promoted to associate professor with tenure this summer. Finally, we have also been joined by lecturer Vali Memeti (also profiled inside), who is providing much-needed help in teaching several geology courses.

As you can see, the department also has a new chairman. Ray Arvidson stepped down last summer after 17 very successful years leading the department. I agreed to become the new chair, and while it will be impossible to truly replace Ray, I am highly optimistic that we can continue our upward trajectory in the years ahead. Our department will remain at the center of one of the most exciting adventures, the exploration of space, as well as many of the important issues facing civilization, including environmental degradation, climate change, resources, and natural disasters.

Unfortunately we also needed to say goodbye to some of our long-time associates during the last two years. Roger Phillips retired from the active faculty in December 2007, and although he continues his research from his new hometown in Boulder, Colorado, is no longer with us on a day-to-day basis. Julie Morris has gone on to

*Continued on page 2.*



### Department Spring Trip to the Colorado Plateau

In May of 2009, the department participated in a field trip visiting the southwest United States. Led by Professor Bob Dymek, the group visited 8 different national and state parks or monuments which showcased the great denudation of the Colorado Plateau from the high elevation point of Bryce Canyon to the low point of the Colorado River in the Grand Canyon.

## Arvidson Steps Down

On June 30, 2008 Ray Arvidson stepped down from the Chairman position in Earth and Planetary Sciences after 17 years in the position. The department gave a thank you “celebRAYtion” on November 14, 2008 which featured a skit/video by the graduate students and a play/roast written by Jill Pasteris featuring department members. The Dean of Arts and Sciences, Ed Macias came and shared a few words as did former Chancellor Jack Danforth. During his tenure as chairman, Ray oversaw many changes in the department, chief among them was the building of McDonnell Hall to house the increasing number of faculty and their laboratories and then the construction and move to the current Earth and Planetary Sciences building on Hoyt drive in 2004. Ray succeeded Larry Haskin in 1991 and set about hiring several faculty and staff members to increase the department’s stature in research and teaching. Now that he has stepped down, he is devoting more time to research and working with grad students and in particular strengthening the highly successful Pathfinder Program in Environmental Sustainability. “I look forward to continuing the growth and excellence in reputation of our department,” he replied when asked about what he wanted for the future. Thanks, Ray, for an excellent and successful tenure as Chair.



*Ray and Eloise Arvidson enjoy the skits at the CelebRAYtion*

*Continued from page 1.*

be Director of the Division of Ocean Sciences at the National Science Foundation, and Bob Tucker has moved to a position with the US Geological Survey in Reston, VA. We also held a “retirement lunch” for longtime colleague Hal Levin. Hal officially retired from the faculty 7 years ago, but came back out of retirement to teach a highly successful 100-level course on dinosaurs for the last couple of years. I’ve heard that Hal is compiling some information about the history of the department, which I will be excited to see, as Hal is the only faculty member still around from the pre-1973 years.

I also encourage you as alumni to renew your involve-

## Wiens Appointed New Chairman

Professor Douglas A Wiens, seismologist, was appointed the new Chairman of Earth and Planetary Sciences on July 1, 2008. Doug has been with the department for 25 years and first came to Washington University as an assistant professor in 1984. He received his undergraduate degree in Physics from Wheaton College and his master’s and doctoral degree in Geological Sciences from Northwestern University in Chicago, IL. Doug was elected a American Geophysical Union Fellow in 2007. His research consists of using seismic imaging to investigate tectonic processes in the crust and upper mantle. He is particularly interested in studying mantle flow and the processes of melt generation in island arc and back arc spreading centers, the source properties of deep earthquakes in subduction zones, and the seismological structure of Antarctica. Doug has been the principal investigator or co-investigator for 10 different seismology field programs in the Western Pacific, Antarctica, and Africa and has published more than 85 papers in refereed journals. He has also been the major advisor for nine Washington University PhD degree students. He has served on numerous national committees, including NSF visiting committees and review committees, the National Academy International Polar Year Planning Committee, the Incorporated Research Institutions in Seismology (IRIS) Executive Committee, and the NSF Margins and RIDGE2000 program steering committees. During his time as chairman he would like to focus on increasing the strength of both our undergraduate and graduate programs, as well as increasing our research standing in key areas so Washington University will be increasingly recognized as a leader in the Earth & Planetary Sciences.

ment with the department. We enjoy hearing from you, and inside you will find a list of news items we compiled from notes that you sent us. We will have an alumni reception at the 2009 Fall AGU meeting in San Francisco. There is even a Facebook E&PS alumni group to help you keep in touch with each other. Alumni giving is an important part of our success, and there are special fund categories to help support things like teaching equipment purchases and student field trips such as the May 2009 Canyonlands and Grand Canyon field trip pictured on the cover. Above all, please stop by and tour our new building and talk to us if you are in St. Louis. –Doug Wiens

## Fossett Laboratory for Virtual Planetary Exploration

The amount of scientific data collected has increased exponentially over the past decade. Today's scientists and students face the challenge of understanding the universe, not by isolated exploration and analysis of a small number of observations, but by sifting through large volumes of information. This problem is evident in the world of planetary exploration including the exploration of Earth. Recent years have seen a wide range of spacecraft carrying a large number of instruments, all generating terabytes worth of data. Making sense of these data is what visualization is all about.

The Fossett Laboratory for Virtual Planetary Exploration allows scientists and students at Washington University's Department of Earth and Planetary Science, to use the wide range of data from these spacecraft to explore and understand remote places.

This "virtual exploration" not only provides scientists new ways to understand data, but allows the next generation to better understand the universe. Although it focuses on planetary science, the Fossett Laboratory also supports science and education in earth science and, in the future, other science and educational efforts from other parts of the Washington University community.

The Fossett Laboratory is a generous gift from the late Steve Fossett, Washington University alumni and former Board of Trustees member. The Fossett Laboratory is located in Dr. Ray Arvidson's Earth and Planetary Remote Sensing Laboratory.

The Fossett Laboratory is a generous gift from the late Steve Fossett, Washington University alumni and former Board of Trustees member. The Fossett Laboratory is located in Dr. Ray Arvidson's Earth and Planetary Remote Sensing Laboratory.

### Vision

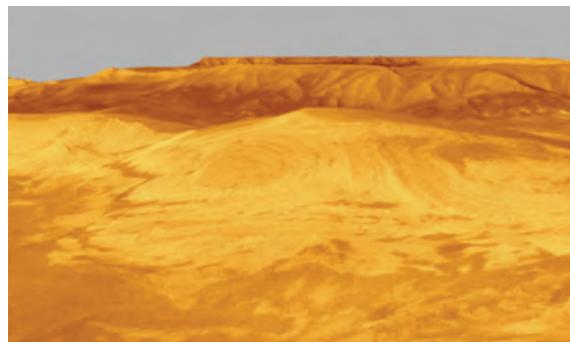
The core vision of the Fossett Laboratory is virtual exploration, i.e., the ability of scientists and students to "enter" the data and experience the place that the data describe. Using data from current Mars spacecraft such as the Mars Reconnaissance Orbiter and the Mars Phoenix Lander, the Fossett Laboratory puts people on

the surface of Mars, allowing them to see and understand an environment as a field geologist would. But virtual exploration goes beyond visible recreation of an environment; the Fossett Laboratory allows users to see beyond the visible spectrum by overlaying data such as thermal emissions, multi-spectral images, and high-energy electromagnetic radiation.

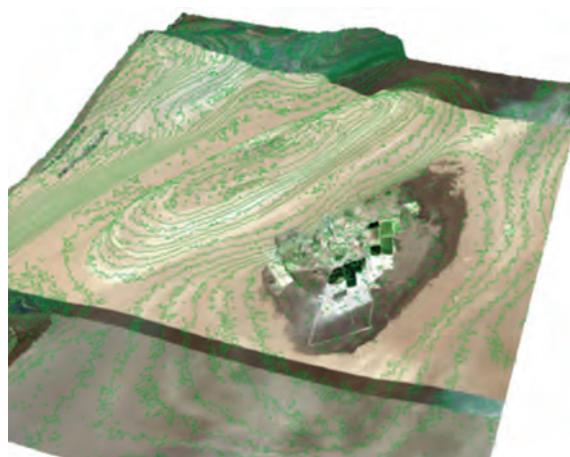
### Projects

The Fossett Laboratory supports the virtual exploration of planetary data through its immersive CAVE virtual reality system coupled with the extensive planetary data holdings in NASA's Planetary Data System's Geosciences Node also located in the Earth and Planetary Remote Sensing Laboratory.

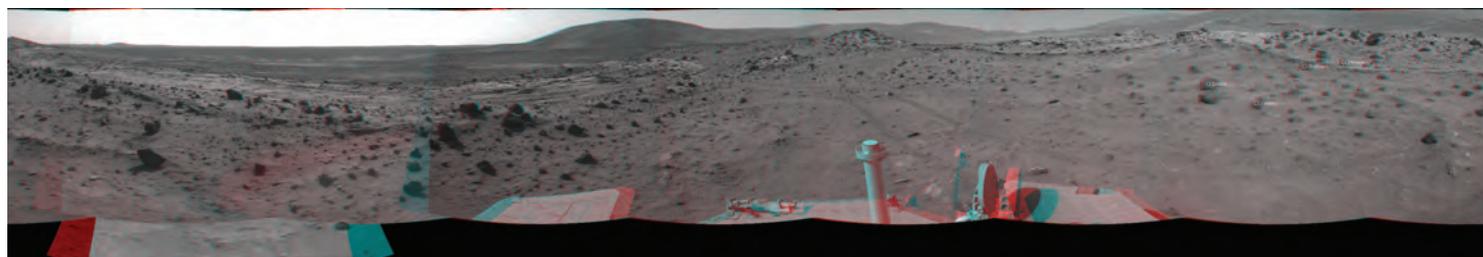
The Fossett Laboratory supports a wide range of research and education activities with the primary focus on planetary science. Recent examples include:



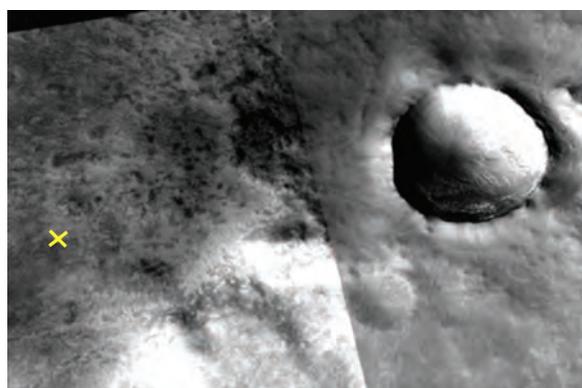
*Exploring 3D models generated with data from the Mars Reconnaissance Orbiter's HiRISE instrument and the European Space Agency's Mars Express HRSC instrument*



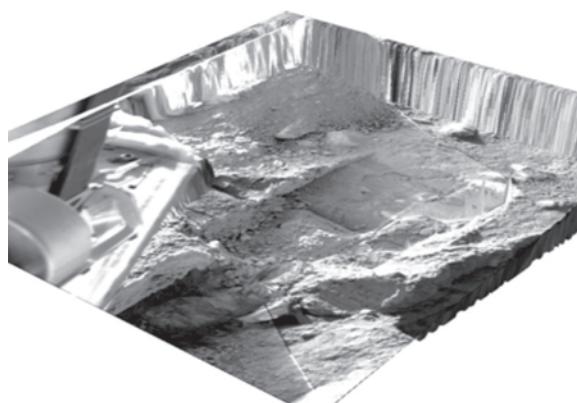
*Using earth satellite data to plan a geological field trip to China.*



3D anaglyph stereo image of the Spirit Rover landing site.



Exploration of Mars Phoenix Lander data - 3D perspective view of Phoenix landing site (This view was generated with CTX mosaics draped on MOLA DTM. Yellow cross is the Phoenix Lander position. The big crater is the Heimdall crater.)



Analysis of Mars Phoenix Lander data - 3D view of the Dodo-Goldilocks Trench dug by the robotic arm on NASA's Phoenix Mars Lander on Sol 116 (This view gives people a better understanding of the slope stability experiment.)

## FACULTY RESEARCH

### How Minerals React with Natural Waters *Jeffrey G. Catalano*

Many earth processes that affect human health and the sustainability of aquatic systems are controlled by chemical reactions between minerals and natural waters. These reactions impact important processes such as contaminant fate and transport, water filtration, biogeochemical element cycling, weathering and soil formation, nutrient bioavailability, biomineralization, ore deposit formation, acid mine drainage, and nuclear waste disposal. In addition, reactions between minerals and water are responsible for the mineralogical signatures of the evolution of Mars that have been identified by the Mars Exploration Rovers and the Phoenix Land-

er. Such reactions may also have played a critical role in the origin and development of life on Earth.

An important mineral that often reacts with natural waters is hematite,  $\text{Fe}_2\text{O}_3$  (Figure 1). Typically thought of as rust, hematite is actually a common iron oxide mineral in soils and sediments that is known for its ability to take up contaminant and nutrient ions from water. In the absence of oxygen, microorganisms can use hematite to breathe, driving iron cycling and affecting the fate of other elements in many aquatic environments. In addition, hematite has recently been observed on Mars and has been suggested to be an indicator of past water on the surface. Reactions between hematite and natural waters are thus frequent and affect many earth and planetary processes.



Figure 1. Occurrences and interactions of hematite: (left) Hematite occurs in many soils, controlling the availability of the nutrient phosphate and the fate of contaminants; (middle) Microorganisms such as *Shewanella oneidensis* MR-1 may breathe using hematite instead of oxygen; (right) Hematite occurs as spherules in sedimentary deposits on Mars (Photo credits: USDA-NRCS; PNNL; NASA/JPL/Cornell)

Research over the last few decades has sought to establish how such reactions operate and to develop models that allow prediction of their effects in diverse systems. Attaining these goals requires a fundamental understanding of how minerals react with natural waters. These reactions take place in a region called the mineral-water interface. In this region water is thought to behave differently than in normal bulk solution, being oriented and highly polarized, and dissolved ion concentrations may be elevated or reduced here compared to the neighboring “normal” water. Even though the mineral-water interface is the critical zone where all of these reactions occur little is known about the structure of this region and how reactions occur there.

Professor Jeff Catalano is working to understand how water is arranged at the interface between water and hematite and how this affects reactions that control water quality, nutrient availability, and biogeochemical element cycling. To accomplish this Prof. Catalano uses the Advanced Photon Source, a national synchrotron X-ray facility that produces the brightest man-made X-ray beams in the western hemisphere. By reflecting an X-ray beam off of a surface of a hematite crystal in water and measuring how the intensity of the reflected beam changes with angle, Prof. Catalano can solve the structure of the interface between hematite and water (an example is shown in Figure 2), just like a crystallographer solves the structure of a mineral using X-ray diffraction.

These measurements demonstrate that the structure of a hematite surface is similar to that of the bulk mineral, with the top layers displaying minor relaxations. In addition, multiple layers of water near the surface take on an ordered arrangement. A first layer of water adsorbs to and fully coats the surface, following the atomic-scale topography present. Water further from the surface shows signs of layering, indicating a continued effect of the surface on the structure of water. This ordering disappears about one nanometer from the surface,

at which point water appears to be fully disordered like the bulk fluid. A hematite-water interface is thus a one to two nanometer-thick transition zone that serves to bridge between a highly ordered mineral phase and a disordered fluid phase.

Prof. Catalano and his group are currently working on a number of additional projects investigating the reaction of hematite with natural waters. These include: (1) Investigating how contaminant ions adsorb to hematite and how this process is affected by the structure of interfacial water; (2) Characterizing how hematite surfaces change during biogeochemical iron cycling; and (3) Determining how structural transformations that occur during such cycling affect the fate of strongly-sorbing nutrients and contaminants. These studies explore the myriad ways in which a mineral, hematite, reacts with natural waters.

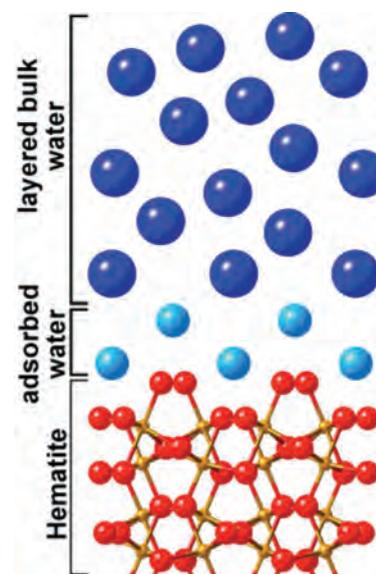


Figure 2. Schematic structural model of the hematite (012) surface in the presence of water. The blue spheres represent the positions of water molecules.

## Frank Podosek Honored

Frank Podosek of the Earth and Planetary Sciences department has been named the recipient of the 2009 Geochemical Society Distinguished Service Award. The award was established in 2002 and it recognizes outstanding service to the Geochemical Society and or the geochemical community that greatly exceeds the normal expectations of voluntary service. Frank has served as the Executive Editor of *Geochimica et Cosmochimica Acta* since 1999. According to Marty Goldhaber, Geochemical Society President, "Under Frank's leadership, the staff of the journal is fanatically dedicated to its smooth and timely operation. Overall, Frank has not only maintained, but also increased the quality and impact of our journal immeasurably."

## AGU's Whipple Award, 2007 and 2008

AGU Fellows Raymond Arvidson and Roger Phillips were awarded the 2007 and 2008 American Geophysical Union's Whipple Award, respectively. This award is given by the AGU Planetary Sciences Section at the Fall AGU meeting in San Francisco to the individual who has made an outstanding contribution in the field of planetary sciences. Ray has participated in all Mars missions since Viking and also in the Magellan Mission to Venus. His career has resulted in nearly 200 peer-reviewed publications on Earth, Mars, and Venus and the Moon, many of which are considered pivotal to our understanding of planetary surface processes. Roger Phillips is a renowned planetary scientist who has participated in missions to the Moon, Venus, Mercury and Mars. Roger was Director of the McDonnell Center for Space Sciences from 1999-2007. He is the author of more than 160 publications and recipient of many NASA awards. His research in planetary geodynamics is held in the highest esteem throughout the planetary sciences community.

## Korotev named Fellow in Meteorological Society

Randy Korotev, research professor at Washington University was named a Fellow in the Meteorological Society at their 71st annual meeting in Japan, 2008. Randy currently is the associate editor of the *Meteoritics and Planetary Science* journal and has authored over 80 peer-reviewed papers on planetary meteorites and the surface of the Earth's moon. His fascination with lunar rocks has kept him busy for the last forty years and shows no sign of stopping. He maintains the most comprehensive website on lunar meteorites ([http://meteorites.wustl.edu/lunar/moon\\_meteorites.htm](http://meteorites.wustl.edu/lunar/moon_meteorites.htm)) and is expert at differentiating between meteorites and earth rocks.

## Klein received Outstanding Staff Award

Lisa Klein, in the Earth and Planetary Sciences administrative offices was one of six Arts and Sciences staff members to receive the 2009 Outstanding Staff Award. Each year the staff award recognizes non-teaching personnel who have contributed significantly to the effectiveness of teaching, advising, counseling, and research efforts in the School of Arts and Sciences. Lisa, the department bookkeeper, is responsible for approving the financial transactions in the department.

## Crater on Moon named after Haskin

On January 22, 2009, the International Astronomical Union (IAU) named a crater close to the Moon's north pole after Larry Haskin (1935-2005), former professor of Earth & Planetary Sciences. Haskin devoted much of his career to studying the moon and impact cratering. In fact he was one of the first space scientists to analyze moon rocks brought back from the Apollo missions.

## Arvidson and Phoenix Team receive 4 NASA Awards

Ray Arvidson received four NASA Group Achievement Awards due to his efforts on the NASA Phoenix Scout Mission to Mars. The groups which Ray and his team members were awarded include: the Phoenix Development and Mission Team, the Phoenix Project Science Development Team, the Phoenix Project Entry, Descent,

and Landing Team, and the Phoenix Project Surface Operations Development team. The Phoenix mission was launched in August, 2007 and landed on Mars in May of 2008. It survived five months of the harsh Martian climate and produced approximately 100 GB of data before the mission concluded at the onset of Mars winter.

## **Pasteris gets Teaching Award**

In 2008, Jill Pasteris received a Faculty Teaching Award from the Arts and Sciences Council of Students. This award is given annually to teachers who have positively and profoundly influenced the undergraduate educational experiences at Washington University. The Council solicits nominations from all Arts and Sciences students, and the 6-10 winners are honored at a Faculty Awards Recognition Ceremony.

## **Distinguished Lectureship for Wysession**

Michael Wysession has been designated as one of the 2009-2010 National Association of Geoscience Teachers Distinguished Lecturers. He is one of their featured researchers on the cutting edge of geoscience education, research and teaching who visit other institutions to deliver seminars, workshops, and consultations with researchers and geoscience departments. Michael's specialty is geosciences education and working towards an Earth science literate public.

## **Wiens selected as NSF RIDGE Lecturer**

In 2008, Doug Wiens was selected as an NSF-RIDGE program distinguished lecturer. The NSF RIDGE program brings recent mid-ocean ridge research to colleges and universities, concentrating on those without existing ocean-science programs. Doug gave lectures on geophysical imaging of melt production and transport beneath spreading centers and volcanic arcs.

## **Graduate Students win Carl Tolman TA Excellence Awards**

Four graduate students have been honored for their excellent work as teaching assistants by receiving the Carl Tolman TA awards. Stephanie Novak was named the outstanding TA for 2007. In 2008 there were two students recognized: Cynthia Fadem and Erica Emry. Chris Orth won the 2009 honor. Each student was awarded \$500 in recognition of their outstanding service.

## **Garrett Euler wins Outstanding Student Paper Award at the Fall 2008 AGU meeting**

Graduate student Garrett Euler was awarded the Outstanding Student Paper award by the Seismology section of the American Geophysical Union in December, 2008 for his poster "Shear Velocity Structure of the Cameroon Volcanic Line region from Rayleigh Wave Phase Velocities."

## **Kelsi Singer wins top award at the Washington University GIS Symposium**

Graduate student Kelsi Singer was awarded the first prize at the Washington University GIS symposium for her poster "Spatial Analysis of Pits, Uplifts, and Lenticulae on Jupiter's Moon Europa." Graduate student David Mayer was the runner-up, completing a sweep by the E&PS department!

## **Graduate Students Awarded Fellowships and Grants**

Abigail Fraeman was awarded a National Science Foundation Research Fellowship, and Andrew Frierdich obtained a Cave Research Foundation Graduate Student Research Grant. Both awards are being used to support graduate research leading to their PhD theses.

## Department Welcomes New Faculty

### Frederic Moynier Assistant Professor



Frederic joined the department after completing a post doc at the University of California-Davis under Qing-Zhu Yin. He is originally from the southern area of France, specifically Manosque, Provence. He studied at the École Normale Supérieure de Lyon where he received his graduate degree in isotope geochemistry in 2006. While there he worked under Pr. F. Albarede and J. Blichard-Toft studying isotope geochemistry of transition metals. His research encompasses using isotopic compositions of terrestrial, lunar and meteoritic materials to understand the chronology of the Solar system, the physical and chemical process which modified those materials and the nucleosynthesis at the birth of our Solar system. Frederic uses a high precision mass spectrometer to determine isotopes of these materials in an ultra-clean laboratory. When he is not engaged in research and teaching he and his significant other, Marie, like to cook traditional French foods and watch movies at their home in University City. On occasion he's been known to play basketball with some of the department post docs.

### Philip Skemer Assistant Professor



Phil joined the department this August after coming from a post doctoral fellowship at Brown University where he worked with Greg Hirth. He received his undergraduate degree from Pomona College in California and then on to Yale University for his graduate degree in geology and geophysics in 2007. His researches micro structural evolution of peridotites and the behavior of both naturally and experimentally deformed rocks. Currently, Phil is busy setting up his lab to conduct high temperature and high pressure deformation experiments on a wide variety of planetary materials in order to better understand the processes that contribute to the large scale dynamics of Earth and other planets. When he is not working in his lab, he is at home with his wife, Mary Politi, redecorating a lovely eighty-nine year old house in University City. They like to snow ski, hike and climb mountains, especially with their dog, Riley. Phil is looking forward to when his lab and home are in place so that he will have time next year to watch his beloved NY Mets humiliate the home town favorites. However not being a fan of Provel cheese, he will not be eating Imo's pizza while catching the Cards vs. Mets games.

### Vali Memeti Lecturer



Vali grew up in Darmstadt, Germany and attended undergraduate school at the University of Technology in Darmstadt. For her diploma in geology, she studied a metamorphic gneiss dome in Southern France, where she spent several months doing field work. Wanting to perfect her English she decided to do graduate work in an English speaking country and ended up at the University of Southern California where she just recently completed her doctorate in Geology under the guidance of Lawford Anderson and Scott Paterson. Her specialty is structural geology and the study of pluton emplacement mechanisms in transpressive tectonic regimes, pluton-host rock interaction, and the geochemical evolution of plutons through time. She has recently started to pursue single mineral analyses to decipher magma chamber processes and growth. In our department she is teaching an undergraduate course, "Natural disasters" and a graduate course, "Advanced physical geology." When Vali finally finishes planning lectures she will have more time to pursue movies, jogging, hiking, camping and tennis. She spends most of her summers traveling and backpacking in Yosemite, where she spends several weeks at a time doing field work for her research.

## Seasons and Ice at the Mars Phoenix Landing Site *Selby Cull and Ray Arvidson*

The Mars Phoenix mission landed on the northern plains of Mars on 25 May 2008. It was tasked with studying the arctic environment of Mars: to search for subsurface water ice, probe the soil, track seasonal changes, and monitor the seasonal ice cycle. Phoenix only survived on the surface from late Martian-spring to late Martian-summer – after that, the days were too short and sunlight too scarce to keep the robot powered. But during that brief time, Phoenix made significant discoveries about the Martian arctic: it confirmed the presence of subsurface water ice, measured soil properties, and observed weather changes as the Martian summer drew to a close.

We have been using Phoenix surface observations to chart the seasonal ice cycle in the Martian arctic. By combining Phoenix's on-the-ground observations with remote observations from the orbiting instrument Compact Reconnaissance Imaging Spectrometer for Mars (CRISM) onboard the Mars Reconnaissance Orbiter (MRO) spacecraft, we have assembled a nearly-complete view of the seasonal ice cycle at the Phoenix landing site.

### Summer on the Northern Plains

Like most of Mars, the Phoenix landing site is ice-free for most of the summer. We did observe, using CRISM, small patches of water ice that last through the summer by hiding in the shadows of craters. The 5-mile-wide Heimdal Crater, directly to the east of the landing site, shelters small patches of water ice throughout the summer, hiding on its cold north-facing slopes. Interestingly, we also observed summer-time ice in one crater chase a crater-wall shadow throughout the day: the ice sublimates when the sun hits it; then recondenses on the shady parts of the crater wall, over and over again, all summer. (We called this “Runaround Crater,” as we watched the ice run around the interior of the crater all summer, chasing its shadow).

But, with the exception of Runaround Crater and the small patches on the north-facing slopes of Heimdal Crater, the area around the Phoenix landing site is ice-free for most of the summer.

Starting a few weeks after the summer equinox, CRISM started observing tiny amounts of water ice



*The Phoenix spacecraft landed on Mars in May 2008 to study the arctic environment.*

on the surface at nighttime. (Of course, “nighttime” in the summertime Martian arctic is like “nighttime” in Earth’s summer arctic – the Sun never sets, it just stays low to the horizon). The nighttime water ice traces quickly sublimated during the day, but recondensed on the surface at night.

A few sols (Martian days) after CRISM observed this phenomenon, the Phoenix spacecraft woke up one morning at 6 a.m. local time, and saw white frost spread across the surface. A few sols after that, the spacecraft awoke to see frost on some of its instruments. As summer drew to a close and the Sun drew closer to the horizon, more water ice formed on the surface during the “nights.”

### The Onset of Autumn

Phoenix didn’t survive long enough to see daytime frost form on the surface though it did make measurements of water ice clouds floating by. However, with CRISM, we see water ice form on the surface in a growing layer by late summer.

*Continued on page 10.*

*Continued from page 9.*

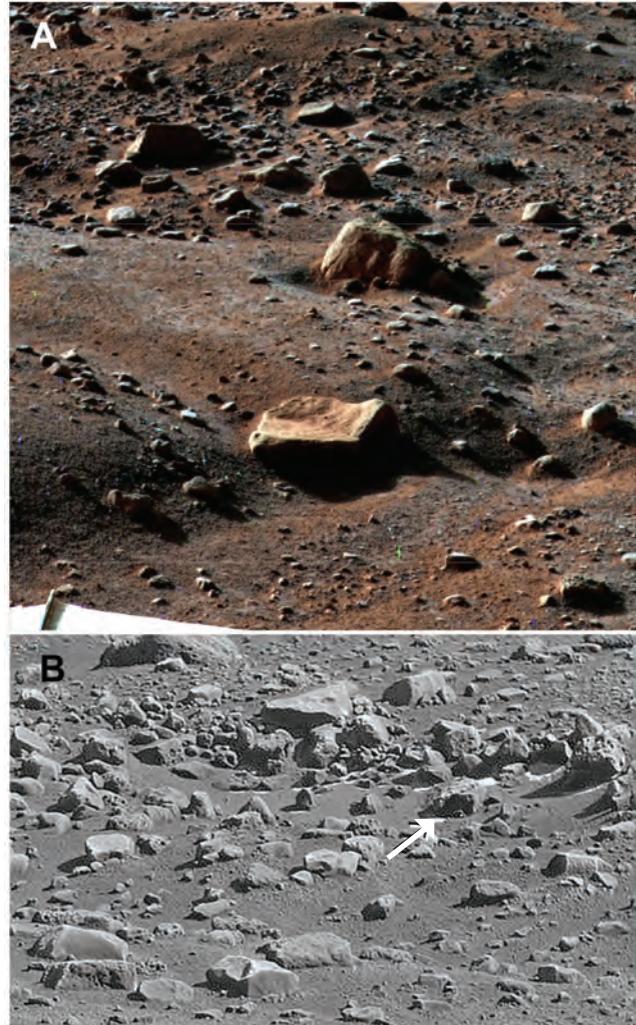
Sometime after the fall equinox, the surface temperatures at the Phoenix landing site have cooled to the point where carbon dioxide freezes onto the surface. Most of this is probably CO<sub>2</sub> frost, but it's possible that there are also small flurries of CO<sub>2</sub> snow falling on the Phoenix landing site throughout the fall.

Unfortunately, this is a difficult season for us to observe the landing site from above. Around the fall equinox, a thick layer of clouds cloaks most of the northern hemisphere – an effect called the “polar hood” – and effectively hides most of the surface. Even if Phoenix had survived the end of the summer, it would have run out of solar power with the onset of the polar hood.

### **Winter at the Phoenix Landing Site**

By winter, we see the Phoenix landing site covered by a thick slab of CO<sub>2</sub> ice – probably 12 inches thick. This slab starts to break up in spring, sublimating away and leaving behind smaller and smaller chunks of CO<sub>2</sub> ice. By mid-spring, the slab is almost completely gone, and we see rocks re-emerge from beneath the snow layer.

As of this writing, in October of 2009, the Martian northern plains are experiencing late winter. Based on our studies of the ice cycles at the Phoenix landing site, we predict that the Phoenix spacecraft is currently buried under about a foot of CO<sub>2</sub> ice. Given the extremely cold temperatures and the structural damage it will probably sustain due to that huge pile of ice, it's unlikely that the spacecraft will “wake up” again in the spring.



*The Phoenix spacecraft saw water frost form on the surface in late summer, and, near the end of the mission, it observed small patches of water ice lingering in the shadows of large rocks during the day.*

## CREDITS

### Editors

Margo Mueller, Doug Wiens

### Contributors

Selby Cull, Keith Bennett, Doug Wiens,  
Ray Arvidson, Jeff Catalano, Bob Dymek

**Jan Amend**, Associate Professor, University of California-Berkeley, 1995, Microbial geochemistry

**Raymond. E. Arvidson**, James S. McDonnell Distinguished University Professor, Brown University, 1974, Remote sensing, surficial geology

**Jeffrey Catalano**, Assistant Professor, Stanford University, 2004, Environmental geochemistry and mineralogy

**Robert Criss**, Professor, California Institute of Technology, 1981, Stable isotopes and hydrology

**Robert F. Dymek**, Professor, California Institute of Technology, 1977, Metamorphic and igneous petrology

**M. Bruce Fegley, Jr.**, Professor, Massachusetts Institute of Technology, 1977, Planetary chemistry and cosmochemistry

**David A. Fike**, Assistant Professor, Massachusetts Institute of Technology, 2007, Isotope geochemistry

**Daniel Giammar\***, Associate Professor, California Institute of Technology, 2001, Aquatic chemistry, water treatment, environmental biogeochemistry and nanotechnology

**Anne M. Hofmeister**, Research Professor, California Institute of Technology, 1984, Mineral physics

**Bradley L. Jolliff**, Research Professor, South Dakota School of Mines and Technology, 1987, Geology, petrology, and geochemistry of the Earth, Moon, and Mars

**Randy L. Korotev**, Research Professor, University of Wisconsin, Madison, 1976, Lunar geochemistry

**Katharina Lodders**, Research Professor, Johannes Gutenberg-Universität and Max-Planck-Institut für Chemie, 1991, Cosmochemistry, planetary chemistry, and astronomy

**William B. McKinnon**, Professor, California Institute of Technology, 1981, Planetary geophysics and dynamics

**Frederic Moynier**, Assistant Professor, Elève a L'Ecole Normale Supérieure de Lyon, 2006, Isotope geochemistry

**Richard V. Morris**, Adjunct Professor, University of Wisconsin, 1973, Planetary spectroscopy and mineralogy

**Jill D. Pasteris**, Professor, Yale University, 1980, Biomineralization and fluid-rock interactions

**Frank A. Podosek**, Professor, University of California-Berkeley, 1968, Isotope geochemistry

**Philip Skemer**, Assistant Professor, Yale, 2007, Experimental rock deformation and structural geology

**Jennifer R. Smith**, Associate Professor, University of Pennsylvania, 2001, Quaternary geology, geoarchaeology, and paleoenvironmental reconstruction

**William H. Smith**, Professor, Princeton University, 1966, Observational astronomy, planetary physics

**Slava Solomatov**, Professor, Moscow Institute of Physics and Technology, 1990, Geodynamics and planetary evolution

**Douglas A. Wiens**, Professor and Department Chairman, Northwestern University, 1985, Seismology and geophysics

**Michael Wyession**, Associate Professor, Northwestern University, 1991, Seismology and geophysics

**Ernst K. Zinner\***, Research Professor, Washington University, 1972, Astrophysics and space physics

\*Primary appointment in another department

- Amend, J.P. and T.M. McCollom, (2009) Energetics of biomolecule synthesis on early Earth. In: Chemical Evolution II: From Origins of Life to Modern Society. *American Chemical Society* (L. Zaikowski *et al.*, eds.) (in press).
- Arvidson, R. E., R. Bonitz, M. Robinson, J. Carsten, R. A. Volpe, et al, (2009) Results from the Mars Phoenix Lander Robotic Arm Experiment, *J. Geophys. Res.*, doi:10.1029/2009JE003408, in press.
- Arvidson, R.E., S. Ruff, R.V. Morris, D.W. Ming, L. Crumpler, A. Yen, S.W. Squyres, et al, (2008) Spirit Mars Rover Mission to the Columbia Hills, Gusev Crater: Mission Overview and Selected Results from the Cumberland Ridge to Home Plate, *J. Geophys. Res.*, 113, E12S33, doi:10.1029/2008JE003183.
- Barklage, M.E., D.A. Wiens, A. Nyblade, and S. Anandkrishnan, (2009) Upper mantle seismic anisotropy of South Victoria Land and the Ross Sea coast, Antarctica from SKS and SKKS splitting analysis. *Geophysical Journal International*, Vol. 128, Issue 2, pp 729-741.
- Catalano, J.G., P.A. Fenter and C. Park, (2009) Water ordering and relaxations at the hematite (110)-water interface. *Geochimica et Cosmochimica Acta* 73, 2242-2251.
- Catalano, J.G., C. Park, P. Fenter and Z. Zhang (2008) Simultaneous inner- and outer-sphere arsenate adsorption on corundum and hematite. *Geochimica et Cosmochimica Acta* 72.
- Criss, R. E., and J. Farquhar, (2008) Abundance, notation, and fractionation of light stable isotopes. *Rev. Mineral.*, **68**, ch. 3, p. 15-30.
- Criss, R.E. and W. E. Winston, (2008) Discharge predictions of a rainfall-driven theoretical hydrograph compared to common models and observed data. *Water Resources Research*, vol. **44**, W10407, 9 p. doi:10.1029/2007WR006415.
- Fegley, B. Jr., and L. Schaefer, (2009) Cosmochemistry, in Proceedings of the Kodai School on Synthesis of Elements in Stars, A. Goswami, (ed.) in press.
- Fegley, B. Jr., (2009) Atmospheric Evolution of Venus, in *Encyclopedia of Paleoclimatology and Ancient Environments*, pp. 75-83, (V. Gornitz, Ed.), Springer.
- Fike, D. A., C. L. Gammon, W. Ziebig, and V. J. Orphan, (2008) Micron-scale mapping of sulfur cycling across the oxycline of a cyanobacterial mat: a combined nanoSIMS and CARD-FISH approach, *ISME Journal*, 2: 749 – 759.
- Fike, D. A., N. Finke, J. Zha, G. Blake, T. Hoehler, and V. J. Orphan, (2009) The effect of sulfate concentration on (sub)millimeter-scale sulfide  $\delta^{34}\text{S}$  in hypersaline cyanobacterial mats over the diel cycle, *Geochimica et Cosmochimica Acta*, 73: 6187 – 6204.
- Hofmeister, A. M., (2008) Inference of high thermal transport in the lower mantle from laser-flash experiments and the damped harmonic oscillator model. *PEPI special issue “Frontiers and Grand Challenges in Mineral physics of the Deep Mantle”* 170, 201-206.
- Hofmeister, A.M., K.M. Pitman, A.F. Goncharov, and A.K. Speck, (2009) Optical constants of silicon carbide for astrophysical applications. II. Extending optical functions from IR to UV using single-crystal absorption spectra. *Astrophysical Journal* 696, 1502-1511.
- Jadhav, M., S. Amari, K. K. Marhas, E. Zinner, T. Maruoka and R. Gallino, (2008) New stellar sources for high-density, presolar graphite grains. *Astrophys. J.*, 682, 1479-1485.
- Ke, Y., and V. S. Solomatov, (2009) Coupled core-mantle thermal evolution of early Mars, *J. Geophys. Res.*, 114, doi: 10.1029/2008JE003291.

- Kirchoff, M.R., and W.B. McKinnon, (2009) Formation of mountains on Io: Variable volcanism and thermal stresses. *Icarus* 201, 598614.
- Korotev, R. L., R. A. Zeigler, B. L. Jolliff, A. J. Irving, and T. E. Bunch, (2009) Compositional and lithological diversity among brecciated lunar meteorites of intermediate iron composition. *Meteoritics & Planetary Science*, in press.
- Lodders, K., H. Palme, and H.P. Gail, (2009) Abundances of the elements in the solar system, in: Landolt-Börnstein, New Series, Vol. VI/4B, Chap. 4.4, J.E. Trümper (ed.), Berlin, Heidelberg, New York: Springer-Verlag, p. 560-630.
- Lodders, K., (2009) Exoplanet Chemistry, in Formation and Evolution of Exoplanets, R. Barnes (ed.), Wiley, Berlin, in press.
- Marhas, K. K., S. Amari, F. Gyngard, E. Zinner, and R. Gallino, (2008) Iron and nickel isotopic ratios in presolar SiC grains. *Astrophys. J.*, 689, 622-645.
- McKinnon, W.B., D. Prialnik, S.A. Stern, and A. Coradini, (2008) Structure and evolution of Kuiper belt objects and dwarf planets. In The Solar System Beyond Neptune, M.A. Barucci, H. Boehnhardt, D. Cruikshank, and A. Morbidelli, (eds.) Tucson, Univ. Arizona Press, 213241.
- Moynier, F., P. Beck, F. Jourdan, Q-Z Yin, U.W. Reimold, and C. Koeberl, (2009) Isotopic fractionation of Zn in tektites. *Earth and Planetary Science Letters*, 277, 482-489.
- Moynier, F., N. Dauphas and F. A. Podosek, (2009) Search for  $^{70}\text{Zn}$  anomalies in meteorites. *Astrophysical Journal Letters* 700, L92-L95.
- Pasteris, J.D., B. Wopenka, and E. Valsami-Jones, (2008) Bone and tooth mineralization: Why apatite?, *Elements*, 4, 97-104.
- Pasteris, J.D. and D.Y. Ding, (2009) Experimental fluoridation of nanocrystalline apatite, *American Mineralogist*, 94, 53-63.
- Reese, C. C., V. S. Solomatov, and C. P. Orth, (2007) Interaction between local magma ocean evolution and mantle dynamics on Mars, in Plates, Plumes, and Planetary Processes, edited by G. R. Foulger and D. M. Jurdy, Geological Society of America, pp. 913-932.
- Reese, C. C., V. S. Solomatov, and C. P. Orth, (2007) Mechanisms for cessation of magmatic resurfacing on Venus, *J. Geophys. Res.*, 112, doi: 10.1029/2006JE002782.
- Rusch, A. and J.P. Amend, (2008) Functional characterization of the microbial community in geothermally heated marine sediments. *Microbial Ecology*, 55, 723-736.
- Skemer, P., J.M. Warren, P.B. Kelemen, J.G. Hirth, (2009) Microstructural and rheological evolution of a mantle shear zone, *Journal of Petrology* (in press).
- Skemer, P., S-I. Karato, (2008) Sheared lherzolite xenoliths revisited, *J. Geophys. Res.*, 113, B07205, doi:10.1029/2007JB005286.
- Solomatov, V. S., and C. C. Reese, (2008) Grain size variations in the Earth's mantle and the evolution of primordial chemical heterogeneities, *J. Geophys. Res.*, 113, doi: 10.1029/2007JB005319.
- Wang, A., J. J. Freeman, and B. L. Jolliff, (2009) Phase Transition Pathways of the Hydrates of Magnesium Sulfate in the Temperature Range 50 °C to 5 °C: Implication for Sulfates on Mars, *J. Geophys. Res.*, 114, doi:10.1029/2008JE003266.
- Wang, A., J. F. Bell III, R. Li, J. R. Johnson, W. Farrand, E. A. Cloutis, R. E. Arvidson, et al., (2008) Light-Toned Salty Soils and Co-existing Si-rich Species Discovered by the Mars Exploration Rover Spirit in Columbia Hills, *J. Geophys. Res.*, 113, E12S40, doi:10.1029/2008JE003126.

**Michael Bland - Postdoctoral Research Associate**

Michael Bland, a post doc for Bill McKinnon, grew up in Minnesota, outside of St. Paul. He attended Gustavus Adolphus College in St. Peter, MN and dual-majored in geology and physics. Mike then went to a warmer climate and completed his PhD in planetary sciences at the University of Arizona. He likes working in our department as he is exposed to people who have a broad range of academic interests. He is married to Jennifer and has one 18 month old son, Alex, with whom he does all the free venues he can find. Mike especially likes our frozen custard and our weather. While some of us may question his judgment, he says it is warmer than Minnesota and cooler than Arizona so one cannot argue his logic. In his spare time he likes hiking, camping and traveling.

**Kathryn Hall- Office Assistant Geochemica et Cosmochimica**

Kathryn Hall grew up in Michigan and summered at one of the great lakes but eventually found her way to Colorado where she graduated with an associate degree in accounting from the Colorado Mountain College, Leadville. Kathryn has lived in Colorado for about 20 years. She started work here in April, 2007 assisting Seth Davis with the business of operating Geochemica et Cosmochimica Acta. She moved to St. Louis to be close to her daughter and her family. Being an original Midwesterner, she is glad to come back after being away. When she is not taking care of duties at work, she is taking care of two grandchildren and one grand puppy (Monte). Kathryn loves to read and crochet if she can find the time but most of all she enjoys all her time with her grandchildren.

**Stephen Hernandez - Laboratory Assistant**

Stephen Hernandez was born and raised in the west Texas town of El Paso. He recently received his bachelor's degree in pure mathematics from the University of Texas in El Paso. Stephen came to St. Louis to work under Doug Wiens as part of an internship program and has now been added to the research staff. What he likes best about his job is that it is like being in graduate school and constantly doing research. He has the freedom from classes to conduct research full time and he also has travel opportunities working on doing field work in Fiji and Antarctica. What Stephen likes best about St. Louis is that it is so green and seems to have an abundant amount of foliage which is vastly different from the desert environment.

He also likes all the entertainment venues available in St. Louis. When he gets a break from the seismic data, he likes to paint or play the guitar and lately has been experimenting with how to cook vegetarian/vegan dishes.

**Davey Jones - Postdoctoral Research Associate**

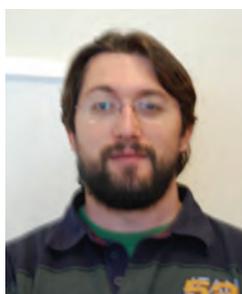
Davey Jones grew up in Baltimore, Maryland and graduated from Carleton College in Northfield, Minnesota with a major in geology. He started working in David Fike's lab at the beginning of June, 2009. His favorite part of working at Washington University is working with interesting colleagues. The things that Davey likes the most about St. Louis are all the good restaurants and going to the excellent farmers markets. He and his wife, Heather, have a two year old dog named Tobey who they adopted from Stray Rescue of St. Louis. Outside of the lab Davey's favorite things to partake of are reading, cooking, and hiking. Sounds like a perfect match for most members of our department.

### Dwight McCay - Laboratory Assistant



Dwight McCay grew up in many towns in Western United States and spent 13 years in the Army so he is a well traveled guy. He recently was a full time student at Maryville University and in May of 2009 he received a degree in environmental science. He also works in David Fike's Isotope Biogeochemistry lab prepping samples and isolating Sulfur isotopes for analysis. After graduation he married Donna Hodgins. When the two of them are not working or taking care of their blended family of 4 children, they are working in their 100% organic garden. Dwight is crazy about St. Louis because it is such a sports-nuts town. Since we have had a successful Redbird season I think he's happy. Note to Dwight, watch the Missouri Tigers, not the Rams this football season!

### Pablo Sobron-Sanchez - Postdoctoral Research Associate



Pablo is working in Alian Wang's Laser Induced Breakdown Spectroscopy laboratory and gaining knowledge of the Chinese language as a byproduct. He hails from Valladolid, Spain where he received his doctorate in physics at the University of Valladolid. Currently he is developing a Mars simulation chamber to test instruments for planetary exploration under Martian atmospheric conditions. What he likes best about his job is the opportunity to work with cutting edge researchers and renowned scientists. His favorite things about St. Louis include Forest Park, the nightlife and St. Louisans themselves. Pablo's off work time activities include playing sports, photography, travelling and going out with friends.

### Xinlei Sun - Postdoctoral Research Associate



Xinlei grew up in Licheng, in the Shandong Province of China and received her bachelor's degree in geophysics from the University of Science and Technology of China. She earned her doctorate at the University of Illinois, Champaign in seismology. She is working in the seismology lab for Doug Wiens. Xinlei is married and has a lovely one year old daughter named Grace. She is happy about moving to St. Louis because the weather is warmer than in Champaign and she can share more of the outside activities with her family. She likes to read, listen to music and travel when she is not pouring over seismology data in the hopes of finding interesting signals.

### Jue Wang - Postdoctoral Research Associate



Jue Wang hales from the Zhejuang province of China. She lived in 3 different cities in Zhejuang, due to her father's position. She received her undergraduate and master's degree from Tongji University in Shanghai, China. Then she applied to The Ohio State University and received her PhD. in geodetic and geo-information science, August 2008. Jue is working with Keith Bennett on organizing and archiving planetary mission data for the PDS Geosciences node. In her free time she is taking care of her son and brand new baby daughter or reading novels. She likes to travel and visit Forest Park and she especially likes the spring season in St. Louis. Congratulations Jue on the arrival of new daughter Jessica.

Continued from page 13.

- Wiens, D. A., J. A. Conder, and U. H. Faul, (2008) The seismic structure and dynamics of the mantle wedge, *Ann. Rev. Earth. Planet. Sci.*, 36, 421-455.
- Wiens, D. A., S. Anandakrishnan, J. P. Winberry, and M. King, (2008) Simultaneous teleseismic and geodetic observations of the stick-slip motion of an Antarctic ice stream, *Nature*, 453, 770-774.
- Wopenka, B., A. Kent, J.D. Pasteris, and S. Thomopoulos (2008) The tendon-to-bone transition of the rotator cuff: A Raman spectroscopic study documenting changes in organic and inorganic components. *Applied Spectroscopy*, 62, 1285-1294.
- Wyssession, M. E., N. LaDue, D. A. Budd, K. Campbell, M. Conklin, E. Kappel, G. Lewis, R. Reynolds, R. W. Ridky, R. M. Ross, J. Taber, B. Tewksbury, and P. Tuddenham, (2009) The Earth Science Literacy Initiative, *J. Geoscience Education*, in press.
- Wyssession, M. E., (2008) "How the Earth Works," *The Teaching Company*, 277 pp., and 48 accompanying half-hour video lectures.

## PhD Degrees Awarded

### 2007

#### **Johanna Kieniewicz**

Pleistocene Pluvial Lakes of the Western Desert of Egypt: paleoclimate, paleohydrology, and paleo-landscape reconstruction

#### **Pundit Mohit**

Relaxation, Contraction, and Polar Wander: A study of the viscoelastic evolution of crustal and lithospheric thickness variations on the Moon, Mars, Mercury and Ganymede

#### **Brian Dreyer**

Geochemical investigation of the Costa Rican and Kurile convergent margins

#### **Sara Pozgay**

Seismic investigations of the Mariana subduction system: anisotropy, attenuation, and volcano seismology

### 2008

#### **Joy Branlund**

Towards an understanding of heat transfer in the continental crust: Controls on thermal diffusivity and their influence on continental geotherms

#### **Katherine Adelsberger**

Geoarchaeology, geomorphology and sedimentology of paleolithic landscapes in Egypt

### 2009

#### **Moira Pyle**

Seismic surface wave studies of the Mariana Mantle Wedge and the Transantarctic Mountains

#### **Nancy Forsberg Taylor**

Erosion and deposition within Hellas Basin, Mars

#### **Cynthia Fadem**

The Geoarchaeology of the Danilo Bitinj and Pokrovnik sites, Dalmatia, Croatia

#### **Yun Ke**

Plume formation in strongly temperature-dependent viscosity fluids: application to early Mars

#### **Stephanie Kuster**

A new quantitative method for Tetrapod taxonomic identification

#### **Sandra Wiseman**

Spectral and stratigraphic mapping of hydrated sulfate and phyllosilicate-bearing deposits: Implications for the aqueous history of Sinus Meridiani, Mars

#### **Manavi Jadhav**

Multi-element isotopic analyses of presolar graphite grains from Orgueil

#### **Nancy Hsia Ackerman**

Microbial diversity and geochemical energy sources of Tutum Bay, Ambitle Island, Pupua New Guinea, an arsenic-rich shallow-sea hydrothermal system

**Ruth Defries**, (BA '76) is the Denning Professor of Sustainable Development in the department of Ecology, Evolution and Environmental Biology at Columbia University, New York. She recently was honored with a 2007 MacArthur Fellow Program Award, an unrestricted fellowship to talented individuals who have shown extraordinary originality and dedication in their creative pursuits.

**Paterno Castillo** (PhD '87) is a professor of geology at the Scripps Institution of Oceanography, the University of California at San Diego. His nephew (Wash U alum '09) and niece (Wash U alum '06) both graduated Summa Cum laude.

**Bob Brackett** (PhD '95) works for Hess Corporation in Manhattan, NY as their Director of Corporate Strategy. He and Joyce's daughter, Chloe, just turned two.

**Dante Lauretta** (PhD '97) and **Kate Crombie** (PhD '97) are living in Tucson, AZ where he is an associate professor at the University of Arizona. Kate has her own company Indigo Information Services that works with spacecraft Instrument teams. They have 2 boys, Xander and Griffin and recently celebrated their 10th anniversary.

**Laura Reiser Wetzel** (PhD '97) has been at Eckerd College for 12 years, currently as Associate Professor of Marine Science and Natural Sciences Collegial Chair. She and husband, Jim (also a Wash U alum) have a daughter, Anna, who is just finishing first grade.

**Jahandar Ramezani** (PhD '97) has returned to MIT after a stint overseas and will be joining the geochronology group as a postdoctoral fellow. You can find his new contact info on the department web site.

**Erik Melchiorre** (PhD '98) has been working as an associate professor of geology at California State University, San Bernardino. He and his wife Becky have 2 daughters Darwin and Bagabriella. They recently completed a sabbatical and traveled/worked in Puerto Rico, Vermont, Chile and Hawaii.

**Andrew Dombard** (PhD '00) and **D'Arcy Meyer-Dombard** (PhD '04) are both professors in the Department of Earth and Environmental Sciences at the University of Illinois at Chicago.

**Colin Enssle** (AM '00) graduated from Columbia University with an MBA and will be working for a consulting company on New York City Department of Environmental Protection contracts. He and his wife, Roberta, love NYC but still miss St. Louis and Washington University.

*Alumni: Join the alumni facebook page and communicate with old friends. Go to Facebook and search for Washington University Earth & Planetary Sciences.*

**Allan Telio** (BA '00) is working for EnerNOC, an alternative energy/smart grid company located in Boston, MA. He and his wife, Katie, also a Washington University alum, bought a house eleven months ago in Boston.

**Nicole Lovenduski** (BA '01) received her doctorate in Atmospheric and Oceanic Sciences from UCLA in 2007 and is currently

a NOAA postdoc research fellow at Colorado State University. Her research focuses on the ocean's role in the global carbon cycle. In January of 2010 she will be an Assistant Professor at the University of Colorado in Boulder with a dual appointment in the Institute of Arctic and Alpine Research and the Department of Atmospheric and Oceanic Sciences.

*Continued from page 17.*

**Brian Shiro** (AM '02) has been working as a geophysicist at the NOAA Pacific Tsunami Warning Center in Hawaii since 2005. He is involved in all aspects of the warning center's operations. In the summer of '05 he attended the International Space University and earned a certificate in Space Studies. In July of this year Brian was one of six crewmembers in a four-week simulated Mars mission at the FMARS station on Devon Island in the Canadian arctic. His son, Henry, was born in November 2007.

**Paul Giesting** (AM '02) got his doctorate degree from Notre Dame in 2006 and has been working as a geologist for the Indiana Dept. of Environmental Management. He reviews reports on geologically contaminated sites and occasionally visit them. He married in Rushville, IN in April, 2008.

**Natasha Johnson** (PhD '02) recently accepted a civil servant position at Goddard Space Flight Center as a Space Research Scientist in the Astrochemistry Laboratory. Previously she finished a two-year NPP Associateship at NASA Headquarters in Washington DC.

**Brian Hynek** (PhD '03) is an assistant professor in the Department of Geological Sciences and Laboratory for Atmospheric and Space Physics at the University of Colorado. His main research interests are the geologic, hydrologic, and climatic histories of Mars. He enjoys exploring the mountains of Colorado and rafting the great rivers of the western US.

**Frank Seelos** (PhD '05) and **Kim (Deal) Seelos** (PhD '06) are both employed at Johns Hopkins Applied Physics Lab as research scientists, primarily doing CRISM tactical operations and science analysis. They are expanding their research interests to include other parts of the solar system. Their daughter, Gwen was born in November, 2008.

**Bethany Ehlmann** (BA '04) is a graduate student at Brown University who recently was the winner of the 2009 Pellas-Ryder Best Student Paper Award given at the Meteoritical Society annual meeting in July, 2009. Bethany completed her masters at Oxford University in Environmental Change and Management where she was a Rhodes Scholar.

## ALUMNI, VISIT US THIS DECEMBER

**Fall AGU Meeting  
San Francisco  
Department and Alumni Reception  
Jillian's@Metreon**

101 Fourth Street  
San Francisco  
Tuesday  
Dec. 15, 2009  
5:30 to 7:30 PM

**Dawn Cardace** (PhD '06) is a NASA Postdoctoral Fellow at Ames Research Center working on serpentinization as a geologic process that interfaces with the deep biosphere. She and Jason have 2 children.

**Jeff Andrews-Hanna** (PhD '06) first took a post-doc position at MIT working with Maria Zuber. In August of 2008, he was accepted as an assistant professor in the Geophysics Department at the Colorado School of Mines in Golden, CO. He and his wife, Jessica were married while living in Massachusetts.

**Michelle Kirchoff** (PhD '06) lives in Houston, TX and works as a post doc researcher at the Lunar and Planetary Institute. She is focusing on impact crater distributions on Saturn's mid-sized satellites. She and husband, Tim, have a four year old named Lyle.

**Maggie Osburn** (AB '07) is a graduate student at California Institute of Technology who received her master's degree this summer and is continuing there for her doctorate. She received an NSF graduate research fellowship this year.

## ALUMNI UPDATE CARD

Let us know what you are doing now. Either send an email to [mueller@wunder.wustl.edu](mailto:mueller@wunder.wustl.edu) or fill out this card and send it to: Washington University in St. Louis, Department of Earth & Planetary Sciences, Margo Mueller, Campus Box 1169, One Brookings Drive, St. Louis, MO 63130.

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Phone: \_\_\_\_\_ Email: \_\_\_\_\_

Year graduated/degree: \_\_\_\_\_

Advanced degree(s): \_\_\_\_\_

Current employer: \_\_\_\_\_

Other news for next newsletter: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



**Department of Earth & Planetary Sciences**  
Campus Box 1169  
One Brookings Drive  
St. Louis, Missouri 63130

Nonprofit Org.  
U.S. Postage  
PAID  
Permit No. 2535  
St. Louis, Missouri