Washington University in St. Louis

Department of Earth and Planetary Sciences

Newsletter

Fall 2003 Issue 7

IN THIS ISSUE…

The grand staircase and meeting area.

New Earth and Planetary Sciences Building

Above: Depiction of the new building (on right) as seen from Hoyt Drive.

Construction is scheduled to be completed by the summer of 2004 for our new Earth and Planetary Sciences Building, located to the northeast of Brookings Hall. McDonnell and Wilson Halls will be taken over by the Biology Department after we move to the new building. We will have state-of-the-art facilities that will enable us to considerably enhance our teaching and research programs, while providing space for public display of the department's interesting and valuable collection.

Aside from the laboratories and offices, the building will also house one medium classroom, one small classroom, a computer lab, and several teaching laboratories. The Earth and Planetary Sciences Library will also be housed in the new building. The lower level will be for use of the College of Arts and Sciences as a temporary space for other departments when older buildings go through the process of renovation.

The architectural firm of Tsoi/Kobus & Associates of Boston designed the four-leveled 150,000-square-foot structure. Keeping with the classic Collegiate Gothic Style of most other buildings on campus, the new structure will feature Missouri red granite, limestone facing, and a green slate roof (see more pictures on page 27).

STEPHEN ZATMAN

Department Mourns the Loss of Professor Zatman *by Michael Wysession*

Stephen Zatman, Ph.D., assistant professor of Earth and Planetary Sciences in Arts & Sciences, died in a car accident on Delmar Boulevard in University City, Missouri, Tuesday July 9, 2002. He had just completed his first year in our department and was 30 years old. Stephen is survived by his wife, Dana, and his daughter, Molly, both of University City, his father, Merton, and mother, Carol, of Great Britain, and a brother, Michael.

Stephen was universally liked in the department, and was an ideal scientist, teacher, and mentor. Stephen was full of exciting ideas for research, as evidenced by the countless napkins and envelopes on which he hastily scribbled geophysical equations as new ideas came to him. In addition, his excellent teaching revealed his keen ability to communicate his ideas with others.

"Stephen Zatman was one of the premier young geodynamicists in the country, who had tremendous potential to be an outstanding teacher and mentor," said Department Chairman Raymond E. Arvidson. "In spite of his brief time with us, he was very highly regarded and made an outstanding impact in our department. He will be greatly missed by his family, his colleagues, and the university at large." Stephen grew up in England and received his bachelor's degree from Cambridge University in 1993. He received his Ph.D. from Harvard University in 1997, studying the dynamics of Earth's magnetic field, one of the most quantitatively challenging areas of research in the geosciences. He later extended his work to planetary geodynamos during a postdoctoral research position at NASA Goddard Space Flight Center. At his subsequent postdoctoral research position at the University of California-Berkeley, Stephen extended his analytical skills to the research problem of intraplate deformation, establishing a clever formulation for predicting which intraplate regions would be susceptible to internal deformation. Stephen came to our department in July 2001. He had so many ideas for new research projects that at the graduate student recruitment weekend faculty presentations, where each faculty member was given roughly 5 minutes to talk about their research, it took him 15 minutes to simply list the new projects he was excited about (and he still left several out!).

Stephen died during a car accident not far from his home. He was driving Rabbi Hyim Shafner, of the Washington University Hillel House, home after a class held at the home of a member of his synagogue, Bais Avraham. Rabbi Shafner was severely injured in the accident and was treated at Barnes-Jewish Hospital. He was released July 17, 2002. The grief of Stephen's loss was felt throughout the University and the global geophysical community, with many people expressing their deep sadness over Stephen's death. Administrators, faculty, and students pulled together to provide support for Stephen's family. After sitting Shiva at the Zatman residence following Stephen's death, Stephen's family traveled to Oak Park, Michigan, where a funeral was held on July 12 at Hebrew Memorial Chapel.

The Department of Earth and Planetary Sciences has established the Stephen Zatman Memorial Lecture Fund for young geophysicists in Stephen's honor. We will all miss him greatly.

If you would like to make contributions to the Stephen Zatman Memorial Lecture Fund, please contact the Director of Development at:

Stephen Zatman Memorial Lecture Fund
C/o Director of Development – Arts & Sciences
Washington University
One Brookings Drive
Campus Box 1210
St. Louis, Missouri 63130-9989

Message from the Chair

The past year has been one of very mixed emotions. We were all very deeply affected by the tragic death of assistant professor Stephen Zatman last summer. He was a brilliant young geodynamicist who was very well matched to our departmental and university missions. We still miss him very much.

On a brighter note, we hired three assistant professors in the area of geobiology: Carrine Blank, in astrobiology, Jennifer Smith in geoarcheology, and Joshua Smith in vertebrate paleontology and paleoecology. These three new faculty and assistant professor Jan Amend form the nucleus of a geobiology cluster within the department and university, including the development of a new certificate in geobiology for majors in Earth and Planetary Sciences. Professor Hal Levin is retiring this summer, but we expect to see him frequently in his office next fall. He continues to work on new books and revisions of his existing books, solidifying his reputation as an outstanding and prolific author. We have had the good fortune to enroll a number of outstanding undergraduates in our classes. We profile four of them in this issue of the newsletter, including a Rhodes Scholar and two Fulbright Scholars. Finally, our new building is progressing well and we expect to move in during the summer of 2004. We are very much looking forward to this move because the new facility will provide the quality space needed to allow us to expand and improve our missions in teaching and research. Please, stay in touch with us and drop in if and when you visit St. Louis.

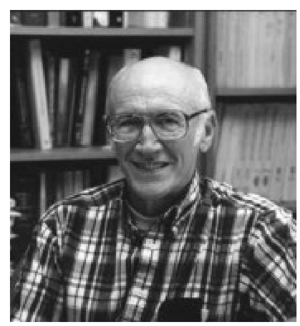
Current Research

Why Geochemists Care About Big Lunar Craters *by Larry Haskin*

Ever wonder about the giant craters on the Moon? The really big ones that are covered with dark mare basalt? Consider the Imbrium basin, a prominent, dark, circular feature of the Moon's northwest quadrant, within a region dominated by Oceanus Procellarum. The Imbrium basin formed during a large impact ~3.9 billion years ago. Filling with mare basalt began shortly after. The discussion below is broadly concerned with the earlier igneous crust of the Moon and ignores volcanic flooding.

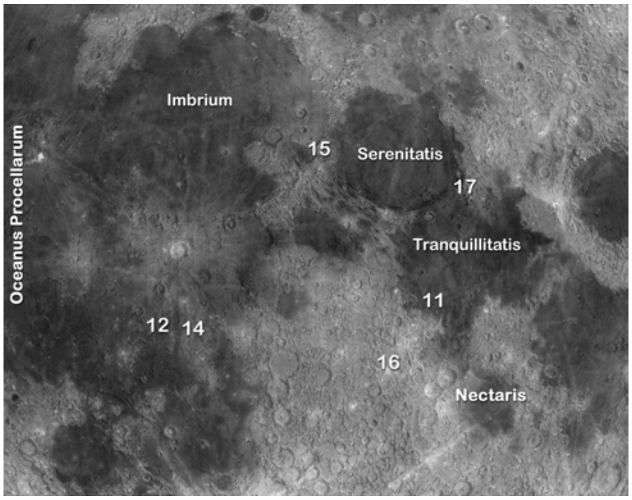
Assuming the Imbrium basin formed in accord with crater-scaling equations, the impactor was ~60 km in diameter and struck the Moon's surface at a velocity of tens of km/sec. The resulting explosion created a paraboloidal excavation cavity ~740 km in diameter and ~70 km deep. Mantle rebound and slumping occurred. The final diameter of the Imbrium crater is ~1100 km.

Ejecta from the Imbrium basin dominates the non-volcanic part of the samples from the Apollos 12 and 14 sites and is present at the Apollo 15 site. More than 14 billion cubic km of ejecta shot out of the crater, enough to cover the Moon to a depth of ~300 m if spread uniformly. The bulk of the ejecta fell within about 1000 km of the basin, however. The remainder is spread unevenly across the Moon. The Imbrium ejecta fragments did not merely produce a layer of Imbrium material where they fell. Ejected at high velocities, they fell back at high velocities, creating secondary craters and a surge of material that moved radially outward from the basin. Ejecta deposits are complex mixtures of material from the primary and secondary craters. The upper portion of the Imbrium ejecta deposit was further shattered and mixed over geologic time as small impactors struck it.



We have long known that the Moon's surface was blasted into a kilometers-deep "megaregolith" by basin-forming craters. Why, then, are we geochemists now particularly interested in ejecta deposits? Most lunar samples are breccias. To understand the igneous development of the Moon's crust, we must identify the igneous precursors of those breccias *and* determine where on the Moon they originated. Most regolith materials have lost all petrographic trace of their igneous precursors. We can partly unscramble the compositions of the precursors geochemically using inter-element trends. Thus, we know the main types of the early lunar igneous rock, but less about just where those rocks originated. Ejecta deposit modeling provides clues.

Consider first the breccias collected at the Apollo 16 site for example. The nearest basin is Nectaris to the southeast. The Nectaris impact sculpted the major features of the region (e.g., the Descartes Mountains), so it seemed reasonable that the material collected there came out of the Nectaris basin. Ejecta modeling and photogeologic evidence show, however, that the up-



Apollo landing sites and large basins on the lunar nearside

permost, ~1.5 km thick deposit at the Apollo 16 site was produced by the Imbrium cratering event some 1600 km to the northwest. It was the Imbrium deposit that the astronauts sampled.

Now consider the chemistry of the Apollo 16 breccias, as an example. To a first approximation, their chemical compositions are binary mixtures. One end member is highly feldspathic, like that of lunar meteorites believed to come from highland regions distant from the Apollo and Luna sampling sites. The other is trace element-rich mafic material loosely called KREEP (for potassium, rare-earths, and phosphorus). According to the "magma ocean" hypothesis of the Moon's early differentiation, the feldspathic materials accumulated upward late in the crystallization of a global magma ocean, and KREEP is (or derives from) very late-stage melt. It was thought that the Moon had a global feldspathic crust with a layer of KREEP beneath it.

Ejecta deposit modeling indicates that 20% of the material in the Imbrium ejecta deposit would be Imbrium ejecta and 80% would be material already present at the site, including ejecta from the Nectaris and perhaps the Serenitatis basins. The 20% matches the average proportion of KREEP-bearing rock we find in Apollo 16 soils and breccias, and it appears to be the Imbrium fraction of the deposit. Imbrium ejecta thus contributed the KREEP at the Apollo 16 site. Materials rich in KREEP are detected from orbit owing to gamma rays from radioactive thorium and potassium; deep basins outside the Imbrium-Procellarum region did not excavate detectible amounts of KREEP.

Ejecta modeling, among other studies, has made us rethink the evolution of the magma ocean. Instead of occurring as a global layer, KREEP-forming elements somehow migrated to the Imbrium-Procellarum region of the Moon, and that region may never have had a thick feldspathic upper crustal layer. Instead of a simple highland-mare dichotomy for the Moon, we now think in terms of terranes: the Feldspathic Highlands Terrane (the source of the feldspathic lunar meteorites), the Procellarum KREEP Terrane (the source of KREEP-rich materials), and the South Pole-Aitken Terrane, which we believe exposes lower crust (Jolliff et al., 1999, Major lunar crustal terranes: Surface expressions and crust-mantle origins, *J. Geophys. Res.,* 105,4197-4216).

We are working toward an automated mission to the South Pole-Aitken basin that, about 2008, would bring us samples of this third major terrane. From them, we will learn more about the chemical evolution of the global magma ocean. We will also learn the age of the South Pole-Aitken basin, the largest and most ancient of the Moon's basins. That basin is so large it contains several smaller basins, whose frozen melt fragments will also be among the samples and will give their ages, too. This will clarify the timing and duration of the heaviest period of impact cratering on the Moon. From ages of Apollo and Luna samples, it is suspected that the Moon (and Earth) underwent a cataclysmic bombardment ~3.9 Ga ago. If so, was the South Pole-Aitken basin created during that cataclysm, or is it substantially older?

The crater ejecta studies originated with former graduate student Billy Moss as a response to the challenge of seeking time-and-provenance indicators for materials from specific regions of the Moon. They are being continued by Larry Haskin in collaboration with Bill McKinnon. Bright ideas from graduate students and interactions among faculty with different areas of interest (geochemistry and planetary physics, in this case) lead to new directions in research!

You Think the Weather in St. Louis is Hot in the Summertime? *By Katharina Lodders and David Ullman*

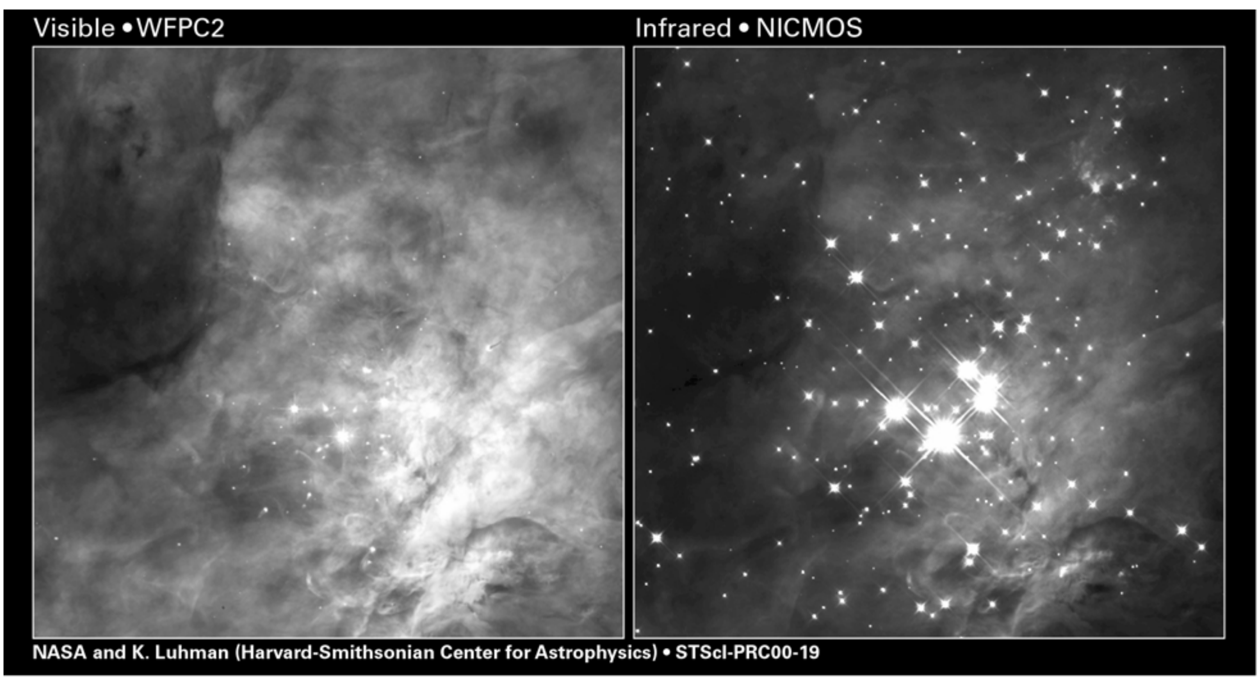
If you've ever spent a summer in St. Louis, you know that it is hot, oppressively hot. But imagine a climate that sustains clouds and rain of liquid iron. That's right, we are not talking about our friendly H_2O molecule anymore, we are talking about iron…

Katharina Lodders of the Planetary Chemistry Lab and collaborators published an article in the June 1, 2002 issue of Astrophysical Journal Letters reporting the evidence of weather on celestial bodies called brown dwarfs. Brown dwarfs are essentially "failed stars," bodies more massive than planets but not large enough to sustain the thermonuclear reactions of a star. Brown dwarfs are much cooler than stars, and usually they are faint in visible light. They radiate off energy as an infrared glow that fades away over millions of years. The nearest such dwarf to earth is about 19 light years away.

The first brown dwarf was discovered just eight years ago, so there is still much to learn how atmospheres of brown dwarfs change as they age and cool. The research team was particularly interested in the coolest brown dwarfs. Using absorption spectra, the researchers determined the makeup of the atmospheres in several dwarfs by analyzing light absorbed by different chemical compounds.

Using chemical thermodynamics, Lodders' work involved finding what chemical compounds exist and whether they are solid, liquid or gaseous at the temperatures and pressures exhibited in brown dwarfs. The atmospheres of brown dwarfs are still very hot by comparison to the Earth's atmosphere. Instead of water, brown dwarfs have "snow" made of rock and liquid iron "rain" and "fog" which is settling into clouds.

The exciting result from the study was that clouds made of liquid iron are clearing and changing so that light from below the clouds is seen, which is the first evidence of changing weather patterns on these celestial bodies. Brown dwarfs are the first non-planetary bodies to exhibit such weather phenomena.



Probing deep within a neighborhood stellar nursery, NASA's Hubble Space Telescope uncovered a swarm of newborn brown dwarfs. The orbiting observatory's near-infrared camera revealed about 50 of these objects throughout the Orion Nebula's Trapezium cluster, about 1,500 light years from Earth [image at right]. Appearing like glistening precious stones surrounding a setting of sparkling diamonds, more than 300 fledgling stars and brown dwarfs surround the brightest, most massive stars [center of picture] in Hubble's view of the Trapezium cluster's central region. The brown dwarfs are too dim to be seen in an image taken by the Hubble telescope's visible-light camera [picture at left]. (used by permission, STScI)

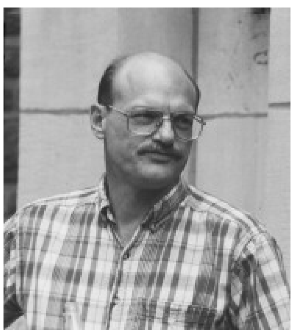
One diagnostic compound observed in cool dwarfs is iron hydride gas. However, in cool brown dwarfs liquid iron metal can condense. Then iron hydride gas decomposes, and its iron condenses, leaving the hydrogen gas behind. This means that less iron hydride gas should be present in cooler dwarfs above the liquid iron clouds. Indeed, the researchers found that the absorption band of iron hydride faded in spectra of cooler dwarfs. The group expected that as the temperature decreased into the coolest dwarfs, the iron hydride band would continue to fade and eventually become nonexistent. However, the group found that the signal did not die. Equally puzzling was the finding that as the brown dwarfs age and cool, they fade, except for a brief period where the dwarfs actually appear brighter.

Lodders and her collaborators hypothesized that there was something in between conditions of clear and cloudy. They used the idea of partial cloud clearing in their models to accurately describe the characteristics of brown dwarfs with a broad range in temperatures. The group suggested that the cooler brown dwarfs have different degrees of cloud clearings so that one can see into the hotter atmosphere below the clouds. This hypothesis accounts for the brightening effect seen in cooler brown dwarfs as they age. It also explains the existence of the iron hydride absorption band, because below the iron clouds iron hydride gas is still present.

In reference to the iron hydride findings, Lodders said, "If it's condensed it cannot be in the gas. This means if it shows up in the spectrum, the only way you are seeing it is by looking through the clouds. And if you have cloud-clearings, that means you have weather."

The group's findings about the weather in brown dwarfs were also described in the science section of the August 6, 2002 edition of the New York Times.

Flow Modifications and Floods on the Missouri River *by Robert Criss*



In the last decade, the Midwestern United States experienced floods of such severity that they would not, under normal circumstances, have been expected to have all occurred in a period less than several centuries. In a series of papers and in a new book, "At the Confluence: Rivers, Floods, and Water Quality in the St. Louis Region," Robert Criss and his associates David Wilson, William Winston, and Everett Shock have developed new mathematical theories of flooding, established remarkable new isotopic and geochemical data sets for floods, and shown that engineering modifications of waterways have increased the frequency and severity of floods on large Midwestern rivers. While all these and several other water quality and supply issues are discussed by the many authorities who contributed to this new book, the phenomenon of huge regional floods most captures the imagination.

Man-made changes to the lower Missouri River are profound, yet few of these are evident to a causal observer. Today the lower Missouri River has a nearly invariant, 1000 to 1500 foot-wide channel that meanders through a bluff-bounded floodplain with a typical width of 2 to 3 miles. This form differs greatly from that described by early explorers such as Lewis and Clark, and accurately portrayed on 19th century maps. The natural river had a braided channel filled with small islands, sand bars, hazardous snags and sawyers, all confined within unstable, caving banks.

The profound changes in the form and function of the river result from engineering projects that have optimized navigation but not recognized their negative impacts on wildlife and catastrophic flooding. These projects were first prompted by frequent losses during the steamboat era that compelled the federal

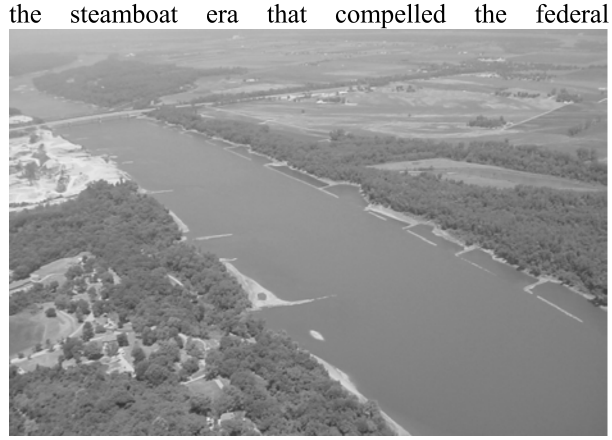


Figure 1: Photograph of the Missouri River north of St. Louis, looking northwest from a position near Mile 6.5 at an altitude of 1500 feet, during the low flow conditions of July 31, 2002. Lewis Bridge on US 67 is in the middle background (Mile 8.2). Note the prominent wing dams located every 600 to 1200 feet along both sides of the river; the tree line on the north side marks the approximate position of a levee. The site of Fort Bellefontaine is located in the left foreground and is proximal to the first and last campsites of the Lewis and Clark expedition (May 14, 1804 and Sept. 22, 1806). Photo by author.

government to initiate snag removal and other navigational improvements. By the 1930s, the lower Missouri River was engineered from its braided form to a single channel with a 9 foot minimum depth by dredging (see figure 3) and by construction of levees, wing dams, meander cut offs, and bank stabilization works. These efforts shortened the lower Missouri River by 46 miles and reduced the water surface area by fully 50%. Crucial nesting and spawning habitat was all but eliminated by the removal of 20,000 snags (one every 100 feet), and by the destruction of all but 2% of the former acreage of unconnected islands and bars. Further upstream, six huge reservoirs in Montana and the Dakotas were constructed between 1933 and 1964. To all this was added the detachment of the river from its natural floodplain by levees, the transformation of the floodplain from riparian forests and wetlands to cultivated fields, and the profound conversion of the entire watershed from forests and prairies to cultivated fields and urban areas.

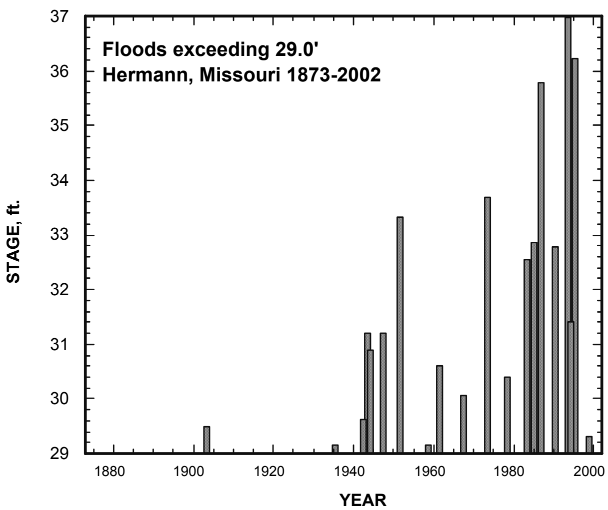


Figure 2: Flood stages of the Missouri River at Hermann have risen markedly over the last 130 years. The flood of 1903 had the highest stage (29.5 ft.) recorded within an interval exceeding 60 years, but stages over 30 feet are now commonplace and occur every 3 years or so. Data from Jarvis et al. (1936) and USGS (2002). From Criss (2002), "Rising Flood Stages on the Lower Missouri River," *East-West Gateway Blueprint Paper.*

All the above changes have relevance to floods, but the combination of levees and wing dams along the lower Missouri River has the greatest effects. Wing dams are jetties of rock intended to stabilize channels and to keep water levels high in mid-river for barge traffic. Along the lower Missouri River many thousands of wing dams have been constructed by the U.S. Army Corps of Engineers, typically 4 to 10 per mile (figure 1). During periods of low flow, these structures maintain a navigational channel for barge traffic and increase midstream water velocity to create a stable,

Figure 3: Dredge boat maintaining Missouri River channel lined with wing dams during low flow conditions near Washington, Missouri, July 23, 2002. No commercial traffic was seen during the flight. Photo by author.

self-scouring channel. Under flood conditions, however, the structures act like scale in a pipe, constricting the channel and lowering the velocity of the water.

This impedance of the flow and the constriction of the channel forces flood levels to rise. In particular, to accommodate a given flow, the depth of water in a narrow channel must necessarily be greater than for a wide one, and this effect is exacerbated when the water velocity is lowered. At all but two gauging stations on the lower Missouri River for which long term records are available, flood waters are 4 to 10 feet higher for a given flow than they were 75 to 100 years ago (Figure 2). For comparison, no historical increases in flood levels are observed for any of the stations in the Meramec River basin, which is devoid of wing dams, large reservoirs, and extensive levee systems. In other words, where minimal river engineering occurred, the gauging station records of today look just like the records of 100 years ago.

Considered separately, these reductions in channel conveyance have significantly increased the flood stages that arise for a given meteorological condition. The ramifications are many. High flood stages are commonplace now, and recurrence intervals for high stages are much shorter than assumed because recurrence calculations have been traditionally based on river discharge rather than on river stage. Flood stages as high as those in the Great Flood of '93 will likely recur in a few tens of years rather than centuries from now. Secondly, when those high stages recur, the great energies that are released when levees are overtopped will cause catastrophic and unnatural erosion and deposition of sediments.

Whether severe flooding has also worsened due to land use changes, global warming, or climate change are separate issues. Such changes affect the meteorological delivery of water to river basins and the subsequent delivery of that water to the river channel. Increases in the intensity and frequency of severe storms would result in an increased frequency of high river discharges. Furthermore, deforestation, destruction of wetlands and prairies, detachment of floodplains from river channels, and urbanization severely reduce the water retention characteristics of basins and impede infiltration. Such changes to the natural hydrograph harm ecosystems and hasten the delivery of rainfall to river channels, promoting flash flooding and destabilizing the natural channel, while increasing erosion and flood frequency. However, all such effects are separate from the dependent relationship of river stage to river discharge discussed above, which is a function of channel conveyance and a direct result of the river structures we build. Several chapters in "At the Confluence" document these effects and outline innovative ways we can do better.

Ocean Drilling Program Installs Two Long-Term Observatories in the Seafloor off Costa Rica *by Julie Morris and Dawn Cardace*

Department of Earth and Planetary Sciences research faculty member Julie Morris, graduate student Dawn Cardace, and a team of international scientists, aboard the JOIDES Resolution drillship, recently finished the two-month Ocean Drilling Program's Leg 205 expedition off the Pacific coast of Costa Rica, dedicated to the installation of long-term observatories in deep boreholes in the seafloor. Installed along an active part of the Pacific Ring of Fire, the instruments will collect vital data to better understand processes leading to hazardous earthquakes and explosive volcanism along the Middle America convergent margin. Using a submersible, scientists will re-visit the two observatories several times over the next decade to retrieve data and samples and to deploy second and third generation instruments.

One primary goal of Leg 205 was to investigate and sample subsurface fluid flow along faults discovered previously by the Ocean Drilling Program (ODP). Deep coring beneath 4.3 km of water recovered samples from the sedimentary prism formed above the shallow subducting plate and revealed the pathways that are used by fluids to escape partially from the subducted sediments. They mainly migrate along faults, planes where rock units move against each other and due to the movement, crush rock and create pathways for fluid and gas migration. The chemical analyses of the small quantities of pore water, extracted from the rock by squeezing them under high pressure in the laboratory, reveal that they originate from depths of >4 km (and perhaps as deep as 8-10 km), as they contain components which require temperatures around 100 C. These fluids are thus messengers from the depths and temperatures along the plate boundary where earthquakes become common, the so-called seismogenic zone.

Researchers analyze samples on the "catwalk"

Leg 205 installed a new type of seafloor observatory into this plate boundary fault zone. Called CORKs (Circulation Obviation Retrofit Kits), these observatories have already been installed in quite a number of ODP boreholes to monitor pressure and temperature or to collect fluids. The ones installed during Leg 205 will collect fluids and gases over a multi-year period, while also monitoring pressure and temperature changes as fluids flow along the fault zone. The fluid samples will contain a record of temporal changes in fluid chemistry, and will be used to infer rates of fluid flow. It may be possible to investigate changes in pressure, temperature and fluid flow and composition in the wake of an earthquake.

Another major goal was to determine the history of the uppermost part of the down-going oceanic plate, drilled at the deepest part of the Middle America trench. The seafloor in this region is very unusual, with heat flow that is only 10-15% of that expected for the age of the oceanic crust. Scientists believe the ocean crust is so anomalously cool because fluids, perhaps seawater, are flowing deep in the crust and carrying away its heat. Pore fluid chemistry shows anomalies in deep sediments that are consistent with this idea. Leg 205 cored 170 meters into the igneous part of the oceanic plate and identified regions of high fracture density and greater rock alteration. A CORK was also installed in this fractured rock to monitor pressure and temperature and collect fluid and gas samples to better understand why this oceanic plate is so unusual. Because this plate continues into the subduction zone, its thermal and fault structure may be very important for earthquake processes and for the reactions that release fluids and gases. Coring results in this plate surprised the science party because we encountered less altered rock than expected, with larger minerals indicating slower cooling. This may be either gabbroic rocks from Galapagos hot spot activity or thick and slowly cooled lava flows from the East Pacific Rise.

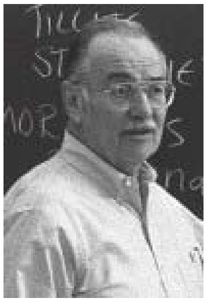
This work was done aboard the Ocean Drilling Program (ODP) drillship "JOIDES Resolution," which left Victoria (Canada) in early September and returned to shore in Panama in early November. The shipboard scientific party was led by co-chiefs Julie Morris (Washington Univ., St. Louis, USA), Heinrich Villinger (Univ. Bremen, Bremen, Germany) and staff scientist Adam Klaus (Texas A & M University, USA). The installation of observatories (so called CORKs) in deep boreholes in the ocean floor is a key objective for the international geoscience community and plays an important role in planning for a successor to the Ocean Drilling Program. They will help to better understand temporal variations of processes in the subsurface of the ocean floor and will also allow insight into the basic physical properties of the sediments and the oceanic crust making up 70% of the Earth's surface.

The installation of the two long-term observatories into the boreholes was a true success, which can only be appreciated by realizing that every instrument has to fit through a 5-inch diameter drillstring for deployment and survive a long, rough trip of more than 4 km through the pipe into the sub-seafloor. In addition, the instruments have to withstand the high ambient pressures in the borehole, ~6000 pounds per square inch. It took all the skill and dedication of the complete crew of drilling professionals on the rig floor to make this success possible.

EPSc in Action

Hal Levin Retires After 41 Years

After 41 years with the University, Professor Harold "Hal" Levin is retiring from his position as a well-liked and respected professor. Hal received a B.A. in Geology in 1951 and an M.A. a year later, both from the University of Missouri. He then enlisted in the army. Afterwards, Hal was accepted into the graduate program here at Washington University and in 1956 received a Ph.D. He then worked for Standard Oil of California as a micropaleontologist and sedimentologist. The former position involved biostratigraphic correlation of Tertiary sequences using foraminifera and coccolithophorids. The sedimentologic studies involved petrographic analyses of reservoir rocks and provenance and correlation studies employing heavy mineral suites. In 1962, Hal left Standard Oil and accepted a position in the Geology Department at Washington University where he has taught courses in physical and historical geology, invertebrate paleontology, micropaleontology, sedimentology and stratigraphy, and life of the geologic past. During his time at Washington University, Hal has received the Faculty Award for Excellence in Teaching from the Washington University Alumni Association, an Excellence in Teaching Award from the Council of Students in Arts and Sciences, and two Outstanding Teaching Awards in the Natural Sciences from the Arts and Sciences Council of Students. He served as the Department of Earth and Planetary Sciences chairman from 1972 to 1975. In the years between 1976 and 1993, he also served as Associate Dean and Coordinator of Preprofessional Studies in the College of Arts and Sciences. Writing efforts include seven editions of *The Earth Through Time*, four editions of *Contemporary Physical Geology*, *Earth Past and Present* (with coauthors), eight editions of *Laboratory Studies in Earth History* (with Michael Smith who received his doctorate in our department), an introduction to paleontology text titled *Life Through Time*, and an invertebrate text titled *Invertebrates and Their Living Relatives.* Hal plans to continue with his textbook writing with regular revisions, and he wants to begin a new physical geology textbook sometime in the summer of 2003.



Aside from writing, Hal is also looking forward to traveling west to visit various geologic sites that he has always avoided because of the summer tourist rush. The department wishes Hal the best of luck and looks forward to seeing him frequently in the future as he works on his publications. (His email address is levin@levee.wustl.edu).

Katharina Lodders Promoted to New Position

Katharina Lodders has been promoted from Senior Research Scientist to Research Associate Professor in the Department of Earth and Planetary Sciences. Katharina has been with us for over 10 years and has research interests in experimental and theoretical studies in planetary science and cosmochemistry, modeling of chemical processes in the solar nebula, the formation of meteorite parent bodies, planetary accretion and differentiation processes, and the formation of presolar dust grains in cool star atmospheres. The department congratulates Katharina for her new position. (See Brown Dwarfs article on page 5 of this newsletter)

Department Welcomes New Faculty

Carrine Blank, Ph.D. – Assistant Professor

Carrine comes to the department from the University of California, Berkeley, from which she received her Ph.D. in 2002. Carrine has interests in molecular geomicrobiology, and her research involves using geochemical and molecular biological approaches to study microbial populations in the boiling springs and geysers of Yellowstone National Park. While little is known about the microbial populations in these ecosystems or how the chemistry of the environment influences population structure, all of these organisms branch deep in the tree of life. Therefore, study of these organisms, their gene content, and their metabolic capabilities, has the potential to help us better understand the early evolution of life. She studies population structure in the ecosystems by isolating the DNA from hot spring sediments and sinters, followed by the cloning and sequencing of the small subunit and large subunit ribosomal RNA genes, as well as the internal transcribed space region. Evolutionary relationships between organisms are calculated using molecular phylogenetic techniques, and the influence of geochemistry and geography on population structure is determined using phylogeographic techniques. Carrine is originally from the Seattle area.

Jennifer Smith, Ph. D. – Assistant Professor

After receiving her Bachelor's degree in Geology from Harvard in 1996, Jen went on to complete her Sc.M. and Ph.D. in Geology from University of Pennsylvania in 2001. She comes to the Department of Earth and Planetary Sciences with research interests in quaternary geology, geoarchaeology, and paleoenvironmental reconstruction. For the last few years, Jen has been working on climate change and human occupation of the Egyptian desert over the last few hundred thousand years, towards understanding how people have adapted to changing environments in the past. Through reconstructing climate change across the Sahara, Jen hopes to better understand how climate changes happen (which will improve the ability to predict climate change) and to understand how and when hominids may have been able to migrate "out of Africa." She is interested both in how natural (non-anthropogenic) climate change has affected human/hominid societies and how human land use prior to the Industrial Revolution affected the landscape. This summer, Jen worked on a project on the island of Ithaka (Greece) with Washington University professor of Art History and Archaeology Sarantis Symeonoglou, who is excavating the Cave of the Nymphs. Jen comes from Connecticut and is married to Assistant Professor Josh Smith.

Joshua Smith, Ph. D. – Assistant Professor

Josh Smith joined the department in September of 2002 as an Assistant Professor. He studies the interactions between ancient organisms and their environments, particularly terrestrial and coastal ecosystems in the Cretaceous of Gondwana. Josh can trace his interest in geology and paleontology to the age of six, when his parents gave him his first dinosaur book as a gift as the first strike in what was to become a concerted campaign to bury him in telescopes, microscopes, chemistry sets, and all things science (well actually, they did lay off the chemistry sets after he blew up the bathroom). He grew up on the edge of the Connecticut River Valley in Massachusetts and it was partly the curious red sandstones cropping out in the valley that nudged him toward geology. He began his quest to figure out those red rocks right at the source, at the University of Massachusetts at Amherst (B.S. 1994), and continued his studies at the University of Pennsylvania (Sc.M. 1997, Ph.D. 2002). Back in the days before graduate school when he actually had hobbies, Josh was an avid drummer, skier, painter, and writer of bad fiction. Josh is married to Assistant Professor Jennifer Smith.

Department Welcomes New Arts and Sciences Curriculum with New Courses

After several years of deliberation among faculty, administration, and students, the College of Arts and Sciences has approved a new curriculum with new Bachelor of Arts degree requirements. These new requirements were first introduced to the class of 2005.

Designed to help students develop a more coherent undergraduate program in which required courses reinforce and enhance each other, the new curriculum develops a system of "clusters" within the distribution areas of Natural Sciences and Mathematics, Social Sciences, Textual and Historical Studies, and Language and the Arts. These "clusters" bring together two or three courses to provide a coherent grouping in an area of study. Students must also complete one writing-intensive course, one quantitative analysis course, one cultural diversity course, and one social differentiation course. Also, as a way to integrate coursework, students must also complete a "capstone experience" which involves independent research and work within their major.

In order to keep current with the new Arts and Sciences curriculum, the Department of Earth and Planetary Sciences has added some new courses to its curriculum to accommodate students and their new requirements. For instance, the department has put together five new Natural Sciences and Mathematics clusters in the earth sciences titled Earth in Perspective, Impact of Life on Earth, Measuring the Environment, The Surface of Planets, and Evolution of Planets. The Pathfinder Program in Environmental Sustainability under Professor Ray Arvidson also has two clusters, one in the Natural Sciences and one in the Social Sciences distribution areas.

The department has also redeveloped an existing course to fulfill the writing-intensive requirement. Professor Roger Phillips and Professor Michael Wysession are co-teaching the course, entitled Undergraduate Research Seminar, this fall. While the professors and topics covered will rotate each fall, the basic format of the course will remain constant, requiring advanced students to study topics in the diverse subdisciplines within Earth and Planetary Sciences while making written reports and oral presentations. Finally, the department has opened the door for students to complete their capstone experiences with field camp, independent study, and honors research opportunities. These learning opportunities have been developed and improved in order to enhance the learning experience of students under the new curriculum.

Environmental Studies Program Appoints New Director

Since its beginning in 1991, the Environmental Studies Program office and director have been located within the Department of Earth and Planetary Sciences. Effective July 1, 2003, Professor Jonathan Losos, Biology, took over for Professor Ray Arvidson as the new director of the program. Professor Losos conducts his research on the behavioral and evolutionary ecology of Caribbean *Anolis* lizards. He has also been the director of the Tyson Research Center since 2000. We expect that Jonathan's appointment will further strengthen the ties between Earth and Planetary Sciences and Biology. We look forward to continued growth of the Environmental Studies Program and implementation of a revised curriculum that includes introductory courses well suited for students who plan on majoring in environmental studies.

Department Develops New Certificate Program in Geobiology

The Department of Earth and Planetary Sciences is excited to be one of the few departments in the country to offer a certificate program in Geobiology to its students. Geobiology is a new interdisciplinary field melding the earth sciences with Microbiology, Evolution, Molecular Biology, Population Genetics, Anthropology, and Paleontology, and thus is an excellent fit to the wide-ranging strengths of our campus. In order to receive the certificate, students should complete all courses necessary for the major plus five upper-division level courses in an approved theme area such as Geoarchaeology, Geomicrobiology, or Paleobiology. The certificate is designed for students whose prime focus is in the earth sciences but also have interests in the biological sciences. Department faculty members Jan Amend, Carrine Blank, Jill Pasteris, Jen Smith, Josh Smith, and Bill Smith will comprise the Geobiology faculty committee. This committee will approve all theme areas and courses requested for credit in the certificate. The certificate differs from a minor in that the classes in each theme are targeted to the students' specific areas of interest, giving the student the flexibility of taking courses in a variety of departments. The department hopes to attract more undergraduate students, with a wider range of career interests, with the development of this program. Interested students should consult a Geobiology faculty member for more information.

Student News

What I did on my Winter Vacation *by Brian Dreyer*

Subduction zone systems are areas of massive material and energy transfer between the Earth's crust and mantle. Therefore, understanding subduction zone processes is critical to understanding the material balance between the crust and mantle through time. In addition, convergent margins are areas of catastrophic seismic and volcanic activity, and increasing the working knowledge of these processes may help lessen the potential for disaster.

The role of fluids in generating volcanic arc magmas is thought to be significant. In contrast to decompression melting beneath mid-ocean ridges, melting beneath volcanic arcs is largely generated through fluid input into hot mantle materials. In this process, fluids are released during dehydration reactions occurring in materials of the subducting slab in response to increasing temperature and pressure conditions. These fluids percolate into the overlying mantle "wedge," a process that usually causes the mantle to partially melt. This buoyant melt ascends through the mantle wedge and, if conditions are favorable, into and sometimes onto the crust. Therefore, the nature of the ocean-floor materials can have a significant role in the production of melt-generating fluids. Fluids are well known to alter the mechanical properties of materials, including rocks, and

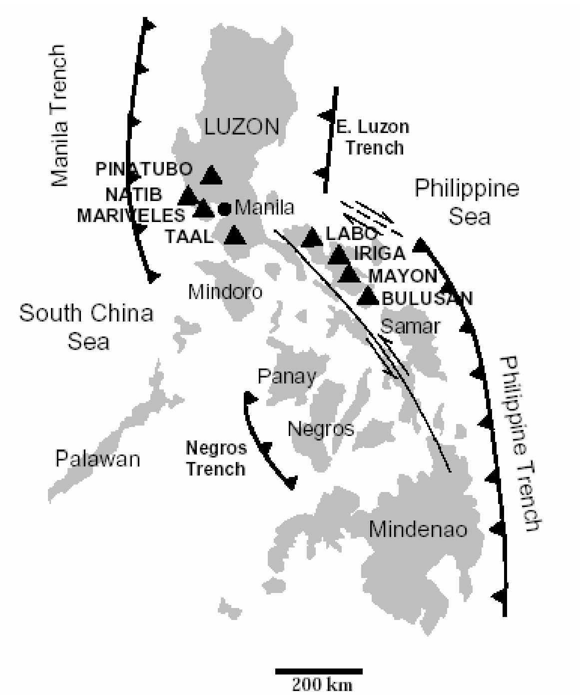


Figure 1: Luzon Island is the northernmost and most populated in the Philippines. Note the western and eastern arcs.

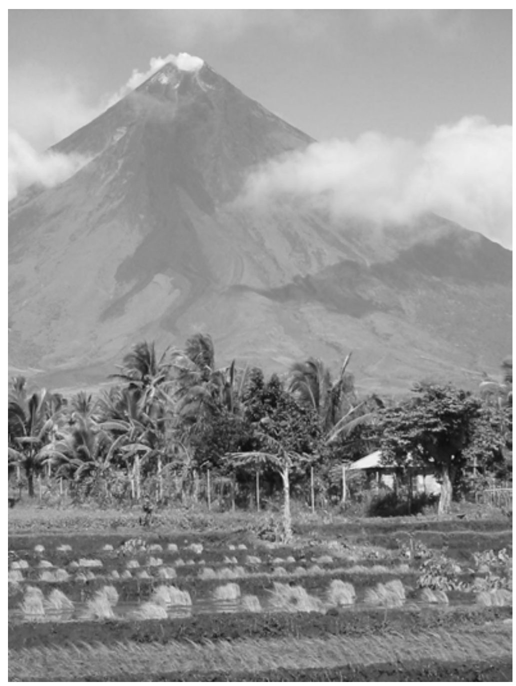
Figure 2: Mount Pinatubo, ~1600m, site of the June 1991 cataclysmic eruption, now the home of a crater lake.

the role of fluids in modulating or intensifying subduction zone seismicity may be substantial.

In January 2003, I had the opportunity to go to the Philippines, along with Prof. Yemane Asmerom and graduate student Andy Dufrane of the University of New Mexico and Prof. Samuel Mukasa of the University of Michigan, to investigate how changes in subducting sediment and derivative fluids may alter the style and timing of magma generation as well as the composition of eruptive materials. The northern Philippine island of Luzon is distinguished as having a double island arc setting; that is, the Philippine Sea plate is subducting beneath the eastern side of Luzon, while the South China Sea plate is subducting beneath the western side (figure 1). Furthermore, the sediments atop these are considerably different in composition and volume: a thick pile of sediments derived from weathering of Continental Asia exists on the western side of Luzon Island, while a comparatively thin section of deep-sea sediments from the western Pacific Ocean are on the eastern side. A previous pilot study strongly suggested that differences in sediment and fluid involvement in these subduction zones has led to important differences in mechanisms of element transfer from the subducting slab. Differences in transfer mechanism can have implications on many other processes, including material recycling and efficiency, mantle residence times, and subduction modification of the mantle. Further questions that our group (working closely with Dr. Julie Morris) will address include the style of mantle melting, whether it is a single- or multi-stage process, and the timing of magma differentiation and eruption through geochemical analysis of major and selected trace elements, Be-, Nd-, Sr-, U-series- isotopes.

Fieldwork in the Philippines, sometimes in remote locations, required a great deal of organization. We were grateful to have the generosity and assistance of the Philippine Institute of Volcanology and Seismology (PHIVOLCS) in Quezon City, who provided places to stay, skilled field knowledge, logistics and advice, valuable discussion, and camaraderie. The opportunity to collaborate with scientists in the Philippines was both professionally and personally satisfying.

Fieldwork on the volcanic arcs of the Philippines also required a lot of travel time. Thankfully, the destinations were well worth it. We ventured onto the volcanoes of Taal and Mount Pinatubo (figure 2) on the western arc and Iriga, Mayon (figure 3), and Bulusan on the eastern arc. The hikes and views were spectacular, even when the fieldwork was arduous. The nature of our geochemical analyses requires the freshest, driest, youngest volcanic rocks we could locate, and this was often more difficult than a quick glance at a geologic map would suggest. One of the most valuable lessons I learned was field sampling when the map is wrong! Escaping the chilly St. Louis winter for fieldwork in the tropical Philippines proved to be an experience in many respects.



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Geodyssey, the Washington University Geology Club *by Will Koeppen and Gillian Galford*

Geodyssey was created during the 2002 spring semester by a group of students interested in taking geology beyond the classroom. The mission of Geodyssey is to promote interaction of all individuals interested in geology and other natural sciences, provide an informal forum for undergraduates, graduates, and faculty members, and to expand opportunities for extracurricular learning and experiences in geology.

The first excursion of Geodyssey was a foray into the St. Francis Mountains of Southern Missouri to study petrology. This trip was quickly followed by the first ever end-of-the semester, Geodyssey road trip. Ten people from our department braved damp and cold weather, sickness, and conflicting schedules to discuss the *in situ* geology, environmental issues, and history of "South Dakota and Beyond" during an eight day field trip. The first leg of the trip fell into the "Beyond" at Pipestone National Monument in southwestern Minnesota, home to deep red, pliable sandstone used by Native Americans for peace pipes. Large, well-formed cross-bedding and other evidence of fluvial settings mingled with stories of Indian bravery and oracles throughout the short hike around the quarry. Inside the visitor's center younger generations of Indians raised on their ancestral homelands worked the sacred sandstone into pipes and discussed the styles and characters gracing their work, as well as their fathers and uncles from whom they learned the trade.

Nearby, Badlands National Park and a late spring sunset over the eroded towers and cliffs left nothing to be desired. Two days spent exploring the differentially eroded layers by van and on foot turned up everything from herds of wild buffalo and prairie dog towns to large, well-preserved fault lines, and

Geodyssey at Badlands National Park

stepped prairies to jaw, skull, and shin bones of Tertiary and Quaternary animals. The brilliant and typically underestimated ecostructure of the Great Plains, both past and present, proved to be interesting and surprising to nearly all of the students, and discussions ensued about the validity of park preservation techniques such as controlled burnings, public access, and infrastructure.

After quick stops at the South Dakota School of Mines Geological Museum, Wall Drug, and the Corn Palace (items on every geologist's itinerary), the vans made the long haul to one of the greatest natural wonders of North America – Devil's Tower. Immense in its columnar beauty, the monument still baffles geologists, and trip members enjoyed arguing over different modes of emplacement both with each other and innocent bystanders who were only as informed as the monument's

Geodyssey at Mt. Rushmore

minimally educational signboards. The debate still rages among theories of gigantic bears, volcanic necks, and capped vs. uncapped lava lakes. Recognizing that many of our most well known geologic features are, as of yet, unexplained brought a sense of simultaneous unease and excitement to more than one person standing at the base of the massive testament to nature.

Turning slightly southward, participants explored the pegmatites and namesake of the Harney Peak granite. Giant trigonal prisms of tourmaline, books of mica, feldspar and quartz crystals made everyone wish they didn't leave behind the 80 lb sample. Mount Rushmore had us looking both at the visages of our greatest political figures as well as the thick band under Jefferson representing hot politics of the Precambrian. Thick ice ribbons due to fog on the long pine needles adorned all of the trees by the end of the day reminding us that May is almost like winter to the northern Midwest.

Finally, the trip treated us to Wind Cave and the Mammoth Site, two beautiful sites offering insight into both public and private research. Cave naturalist and storyteller extraordinaire Mike Laycock informed us not only about cave formations but also cave management such as limited access, "smart" parking lots which do not alter groundwater flow, and delicate pH balances affected by a history of human interactions. The director of the Mammoth Site, Dr. Larry

Agenbroad, was similarly gracious in giving us a personal tour through the bellows of his research/business enterprise. He emphasized the necessity of outreach and the economics of being a privately affiliated researcher at one of the most productive (or destructive if you're a mammoth) fossil sites in the world. He even showed us the alleyway behind the Mammoth Site where another, perhaps even larger, sinkhole harboring mammoth fossils resides – the Mammoth Site II of the future. "Anyone interested in working here?" asked Dr. Agenbroad.

This semester has Geodyssey thinking about caves once again, as we are in the midst of planning a weekend trip to Mammoth Caves in 2003. The club is also participating in a field trip to Zion National Park and Bryce Canyon National Park with the Geodyssey's faculty advisor, Bob Dymek, and his Development of the North American Landscape class. Other efforts include fundraising (t-shirt sales!) to support our activities and participating in field trips led by various professors to further our geologic education.

Student Profiles

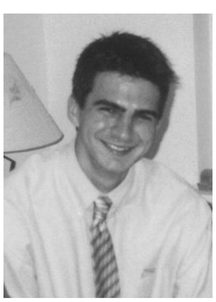
Sarah Johnson, Class of 2001

Sarah graduated summa cum laude in 2001. A member of the Hewlett Program in Environmental Sustainability, Sarah graduated with majors in Environmental Studies and Mathematics along with a large number of Earth and Planetary Sciences courses. Near the end of her senior year, Sarah was selected to be a Rhodes scholar. Before heading off to Oxford to begin graduate work, Sarah spent a summer working in the Mars Program at NASA headquarters. At Oxford, Sarah has been studying Philosophy, Politics, and Economics. When not in school, she has also spent some time in Madagascar doing biodiversity surveys for Frontier London and the World Wildlife Fund, received an international certification in expedition management, worked for an aid organization in Ugunja, Kenya, taught environmental studies class to high school students, went to Costa Rica to present a paper on botany biodiversity along the Fiherenana River Valley, and even found time to summit Kilimanjaro last January.

Sarah will be entering MIT this fall to complete her graduate studies in planetary sciences.

While at Washington University, Sarah also worked in the mission control center during Steve Fossett's 1999 attempt to circumnavigate the globe by balloon. Sarah was the recipient of the Truman Scholarship, the Goldwater Scholarship in Science and Engineering, the Washington University Compton Scholarship, the Society of Exploration Geophysics Scholarship, the National Merit Scholarship, and the Universities Space Research Association Willett Memorial Prize.

Sean Rovito, Class of 2002



Sean graduated in 2002 summa cum laude with a degree in Environmental Studies. He was the recipient of a Fulbright Scholarship to study in South America. His project dealt with the biogeography and conservation of Chilean plants using two genera (Senecio and Calceolaria) that grow all over Chile. The idea was to create a database with all existing collections of these plants from various sources within Chile. He looked at the database to find areas that needed more collecting, and went to these places to do fieldwork. After adding these to the database, he began his analysis to figure out how different areas of Chile are related to each other in terms of the plant species they contain. The data divides Chile into different biogeographic units and tells how they are related to one another. Once he finished the analysis, Sean worked to determine which of the biogeographic units are already well represented in the Chilean natural reserve system and which need more reserves to protect plant species diversity.

After completing this independent research, Sean returned to the states this fall to begin graduate school in the Integrative Biology Department at University of California, Berkeley to study molecular phylogenetics.

Laurel Griggs, Class of 2003

Over her past 4 years at Washington University, Laurel has been studying toward a B.S. with majors in Systems Science and Mathematics and Environmental Studies and an A.M. in Earth and Planetary Sciences. She graduated summa cum laude in May. The research for her master's degree focused on the development and testing of a model to determine moisture gradients in subsurface soil from temperature fluctuations at the surface of the soil. This model was tested in the Kau Desert, Hawaii, and has applications in agriculture, meteorology, and water resource management. Now that she has graduated, Laurel will be starting graduate school at the University of Colorado-Boulder in the fall where she will be in the division of water resource engineering. She anticipates that her research will focus on an exploration of the turbulence that occurs around coral reefs to elucidate coral reef regeneration. After taking a semester of graduate classes there, she will be going to South Africa in January of 2004 on a Fulbright Scholarship. In South Africa, Laurel will work with researchers at the University of Natal in Pietermaritzburg to explore the science behind wetland and river management during dry periods. Following a year in South Africa, she will return to Colorado to finish her Ph.D. research. In addition to the Fulbright, Laurel is also the recipient of the Hertz Fellowship, the National Science Foundation Fellowship, Washington University Women's Society Leadership Award, the engineering school's Sullivan Professional Achievement Award, and the Morris K. Udall Fellowship.

Bethany Ehlmann, Class of 2004

Bethany is a senior with double major pursuits in Earth and Planetary Sciences and Environmental Studies. She was introduced to both of these fields as a member of the Pathfinder Program in Environmental Sustainability and through her various research experiences in the lab of Professor Ray Arvidson. Along with a team of other researchers, Bethany recently completed a hydrologic model of Lake Waiau, a small pond on the summit of Mauna Kea, Hawaii. She has also worked on deriving properties of the Mars soil using data collected by the Sojourner Rover. This summer, Bethany will be doing senior thesis work in the Kau Desert, Hawaii, simulating a Mars Rover trenching experiment. As part of the 2002 NASA Astrobiology Academy at Ames Research Center, she conducted research on the Remote Sensing of Axel Heiberg Springs in the Canadian Arctic and worked on a group study of the political feasibility of a human Mars mission, which was recently presented at the 14th International Academy of Astronautics Conference. During Fall 2003, Bethany was abroad in Panama, studying marine biology, rainforest ecology, and conservation and development in Central America. This summer she worked in Washington DC on a space policy internship through the Space Studies Board of the National Research Council. And in the Spring 2004, Bethany will be working at the NASA Jet Propulsion Laboratory in mission control during the upcoming Mars Exploration Rover mission.

Bethany is the recipient of two national fellowships in 2002, the Goldwater Scholarship in Science and Engineering and the Morris K. Udall Scholarship in Environmental Studies. After her senior year, Bethany plans to travel abroad and return to the U.S. to pursue a graduate program in planetary sciences.

EPSc Faculty

Jan Amend
Assistant Professor, University of California-Berkeley, 1995, Microbial Geochemistry.

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

Carrine Blank
Assistant Professor, University of California-Berkeley, 2002, Molecular geomicrobiology.

Robert Criss
Professor, California Institute of Technology, 1981, Stable isotope geochemistry, fluid-rock interactions, groundwater hydrology.

Ghislaine Crozaz
Professor, University of Brussels, 1967, Trace elements in extraterrestrial and terrestrial rocks.

Robert F. Dymek
Professor, California Institute of Technology, 1977, Igneous and metamorphic processes, Pre-Cambrian geology.

M. Bruce Fegley, Jr.
Professor, Massachusetts Institute of Technology, 1977, Chemical processes on planetary surfaces, in planetary atmospheres, and in the early solar system.

Larry A. Haskin
Professor, University of Kansas, 1960, Trace-element geochemistry, terrestrial and lunar materials.

Anne Hofmeister
Research Professor, California Institute of Technology, 1984, Physical and thermodynamic properties of minerals, infrared spectroscopy.

Bradley L. Jolliff
Research Associate Professor, South Dakota School of Mines and Technology, 1987, Geology, Petrology, and Geochemistry of the Earth, Moon, and Mars.

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

Harold L. Levin
Professor emeritus, Washington University, 1956, Invertebrate paleontology, micropaleontology, stratigraphy.

Katharina Lodders
Research Associate Professor, Johannes Gutenberg-Universität and Max-Planck-Institut für Chemie, 1991, Planetary Chemistry.

William B. McKinnon
Professor, California Institute of Technology, 1981, Origins of icy satellites of the outer solar system, Pluto, and impact craters.

Julie Morris
Research Associate Professor, Massachusetts Institute of Technology, 1984, Isotope geochemistry, magmatism and tectonics.

Jill Dill Pasteris
Professor, Yale University, 1980, Ore deposits associated with igneous rocks, geological applications of Raman spectroscopy.

Roger J. Phillips
Professor, University of California-Berkeley, 1968, Interior evolution of the terrestrial planets and relationship to tectonic deformation.

Frank A. Podosek
Professor, University of California-Berkeley, 1969, Isotopic compositions and elemental abundances in terrestrial, lunar, and meteoritic materials.

Jennifer R. Smith
Assistant Professor, University of Pennsylvania, 2001, Quaternary Geology, Geoarchaeology, and Paleoenvironmental Reconstruction.

Joshua B. Smith
Assistant Professor, University of Pennsylvania, 2002, Vertebrate Paleontology and Paleoenvironment Reconstruction, Sedimentology

William Hayden Smith
Professor, Princeton, 1966, Development and application of high-reliability instruments for space, airborne, and ground-based environmental remote sensing.

Robert D. Tucker
Associate Professor, Yale, 1985, High-precision U-Pb dating techniques and their application to the study of Pre-Cambrian and Phanerozoic orogenic belts.

Douglas A. Wiens
Professor, Northwestern University, 1985, Earthquake source processes, structure of the mantle and crust, plate tectonic processes.

Michael E. Wysession
Associate Professor, Northwestern University, 1991, Seismology and geophysics, structure of the Earth from the inner core, core-mantle boundary.

Ernst Zinner
Research Professor, Washington University, 1972, Astrophysics, cosmochemistry, extraterrestrial materials.

Recent Faculty Publications

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Department Welcomes New Employees

Andrea Amend – Staff Research Associate

Andrea began working for the department as a staff research associate in September of 2002. After growing up in Ann Arbor, MI, Andrea graduated in 1991 from the University of California-Berkeley with a B.S. in Chemistry. She went on to work for 10 years in environmental consulting before coming to Washington University. Andrea is married to Jan Amend of the department. They have two children, Finn and Emma, ages 4 and 5. When she is not working for the department, Andrea teaches pre-school science and enjoys spending time outdoors and digging up worms with her kids.

Gretchen Benedix – Research Scientist

Gretchen grew up all over, but spent most of her childhood in California and Idaho. She graduated from the University of Hawaii, Manoa with a Ph.D. in Geology and Geophysics. In December of 2002, Gretchen came to the department as an Electron Microprobe and X-ray Diffraction Specialist and Research Scientist. She really enjoys working with the great people of the department and looks forward getting to know St. Louis a little better.

Hugh Chou – Systems and Network Administrator

Hugh was born in Madison, WI and later grew up in Morgantown, West Virginia. He went on to receive his bachelor's degree from Cornell University and his master's degree from Washington University in Electrical Engineering. After working for Washington University for about 6 years in the Biology Department, Hugh moved on to a biotech company. He has now found his way back to Washington University and started work in April of 2002 with the "interesting and unique folks" of the Department of Earth and Planetary Sciences as the systems and network administrator. He is married to Penny and has two children, Mary and David, ages 12 and 6. Hugh's idea of fun includes writing web-based programs for mortgage, financial, and real estate web sites (hey, at least he thinks it's fun!). He also enjoys fixing up the house and tinkering with/breaking any computer related or electronic gadgets he finds.

Andrew Dombard – Postdoctoral Research Assistant

After growing up in Battle Creek, MI, Andrew attended Haverford College where he attained a double major in Physics and Astronomy. Andrew received his Ph.D. from Washington University in Earth and Planetary Sciences in 2000. He took a post-doc position at Carnegie Institute in Washington D.C. until July 2002 when he returned to the department in July 2002 as a Postdoctoral Research Assistant for Roger Phillips. He enjoys St. Louis because his wife, D'Arcy Meyer-Dombard, is in St. Louis as a graduate student in the department. He likes to chase his cat around the apartment and walk dogs at the Humane Society with D'Arcy on the weekends.

Anthony Egan – Computer Systems Coordinator

Anthony came to the department in December of 2001 as a computer systems coordinator for Roger Phillips. After growing up in Vermillion, South Dakota, Anthony received his B.S. in Chemistry and Math from the University of South Dakota. He later went on to complete his M.S. in Chemical Engineering with an emphasis in Thermodynamics from the South Dakota School of Mines. Anthony actually likes the weather of St. Louis and being close to his Midwestern roots. He lives with his wife, Michelle, and he enjoys cooking indoors and hiking outdoors. Anthony also attends Washington University Engineering night school to stay current with his programming skills.

Aida Kadunic – Administrative Assistant

Aida was born in Zenica, Bosnia. After two years of law college in Bosnia, she had to leave the country in 1990 with her husband and her son because of the war. They moved to Nuernberg, Germany where they lived for seven and one-half years and then came to the United States. Aida began working for the department in February of 2003. She works as an administrative assistant for the *Geochimica et Cosmochimica Acta* research journal under Frank Podosek. Currently, Aida lives in St. Louis with her husband of 15 years and her 13-year-old son and 6-year-old daughter.

Kathy Kitts – Postdoctoral Research Assistant

Although not exactly new to the department and the school, Kathy took on a new position in the fall of 2002 as a postdoctoral research assistant for Frank Podosek. Kathy completed her bachelor's degree from Washington University in 1985. After a master's degree in French from St. Louis University, she came back to Washington University to complete a master's degree in Geochemistry in 1998 and a Ph.D. in Cosmochemistry in 2002. Kathy grew up in Arizona and consequently enjoys that there are four seasons in St. Louis. Married to David Eisert, Kathy also serves as the director of the Pattonville Observatory and Planetarium in St Louis (http://nightsky.psdr3.org).

Lou Lucas – Administrative Assistant

Lou Lucas, Assistant to the Director of the McDonnell Space Sciences Center, grew up in Southern Virginia in the small town of Chatham, and, later, in rural Brunswick County (home of the stew). She attended undergraduate school at Mary Washington College of the University of Virginia, former women's division of Mr. Jefferson's Academic Village. Before coming to our department, she taught U.S. Government and World Cultures in high school, worked as a paralegal in Texas and Missouri, edited curriculum at the University of Texas, and reviewed research proposals for the Human Studies Committee at the Washington University Medical Center. Her husband, Art, is a chaplain and Director of Spiritual Care Services at Barnes Jewish Hospital. They have two children, Kate, a recent graduate of Duke University, and Martin, a student at Stanford University. In her off hours, Lou likes to research genealogy and is presently collecting and editing family stories. She enjoys writing fact-based fiction and recently began a Master's program here in American Culture Studies.

Rory Roberts – Staff Research Associate

Rory began work as a Staff Research Associate for Julie Morris in June of 2002. A son of a United States Naval Officer, Rory spent his childhood in various places across the U.S. Rory is himself a U.S. Navy submarine veteran. He currently lives in St. Louis with his wife, Lucy, and his daughter, Jessica. When he is not working towards his engineering degree, Rory spends time with his wife and daughter, and he also enjoys four-wheeling in his Hummer, hunting, working with computers, and making websites.

Antje Rusch – Postdoctoral Research Assistant

In July of 2002, Antje began work in Postdoctoral research for Professor Jan Amend. Dr Rusch is an ecologist broadly interested in environmental studies on biological, geochemical and physical processes and their interactions. While attracted to a variety of ecosystems on Earth, her current focus is on the microbial ecology of hydrothermal vent systems. Antje grew up in various mid-sized towns in Germany and received a degree in biology from the University of Oldenburg and her Ph.D. in marine biogeochemistry from the University of Bremen. When she is not out enjoying the many parks that St. Louis has to offer, Antje also takes pleasure in tennis, water polo, judo, sailing, bicycling, dances of the 1950s, and singing in a gospel choir.

Laura Schaefer – Laboratory Assistant

Laura continues her ties with the department as a Laboratory Assistant for Bruce Fegley. She graduated in May 2002 from Washington University with a B.A. in Earth and Planetary Sciences and began work in this full-time position in June of 2002. After moving around until high school, Laura's family finally settled in Freeburg, IL to be close to other relatives in St. Louis. In her spare time, Laura enjoys spending time with family and friends, going to concerts, and watching movies.

Rigobert Tibi – Postdoctoral Research Assistant

Before arriving at the department as a Postdoctoral Research Assistant for Doug Wiens in October 2000, Rigobert spent his childhood in Cameroon and received his education at the University of Mining and Technology in Freiberg, Germany and also at GeoForschungsZentrum in Potsdam, Germany. He enjoys the great work environment here in the department with the interaction with his colleagues within the Seismology Group. Rigobert also enjoys playing soccer, following politics, and traveling. He is happy to be in St. Louis with its many attractive places such as the Galleria, the Arch, and Forest Park.

Dave Ullman – Administrative Assistant

Dave (a.k.a. "Mountain Dave" in the Hewlett/Pathfinder world) graduated from Washington University in May 2002 with a B.A. in Environmental Studies. After working on the Continental Divide Trail for a few months, Dave returned to St. Louis. In December of 2002, he found work with the department as an administrative assistant for the Environmental Studies Program. He enjoys working with the fun people in the department and likes many things about St. Louis including the community, the great music, Cardinal's baseball, wonderful food, and the various hidden gems of camping opportunities surrounding the city. He also enjoys backpacking, running, playing frisbee, and riding his bike to work every day. Dave comes from Milwaukee, WI.

Bill Winston – Stable Isotope Research Specialist

Bill was born in North Carolina but grew up in Virginia and Florida. He graduated from Washington University in 1996 with a major in Environmental Studies and a minor in Biology. In January 2002, he completed a master's degree in Earth and Planetary Sciences. Now working with the department as of March 1, 2002, Bill contributes as a Stable Isotope Research Specialist where he enjoys the variety of tasks such as lab work, writing, and fieldwork. Bill recently celebrated his 20^{th} wedding anniversary with his wife Barb, and he enjoys floating on the many rivers near St. Louis, camping, fishing, and playing racquetball.

Credits

Editors

David Ullman   Margo Mueller

Layout

David Ullman

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Ray Arvidson   Carrine Blank   Dawn Cardace   Robert Criss   Brian Dreyer   Gillian Galford   Larry Haskin   Will Koeppen

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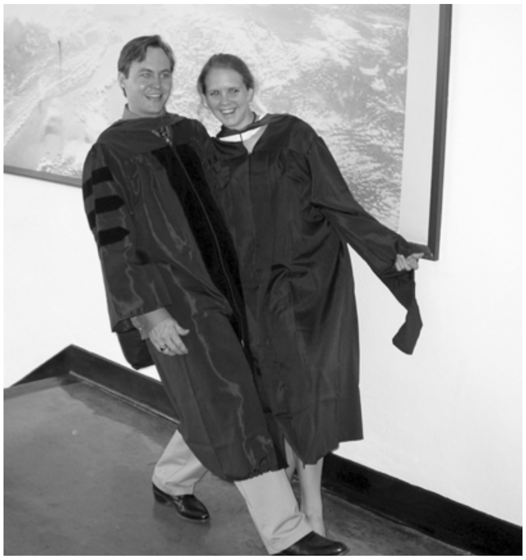
Spring 2003 Photos

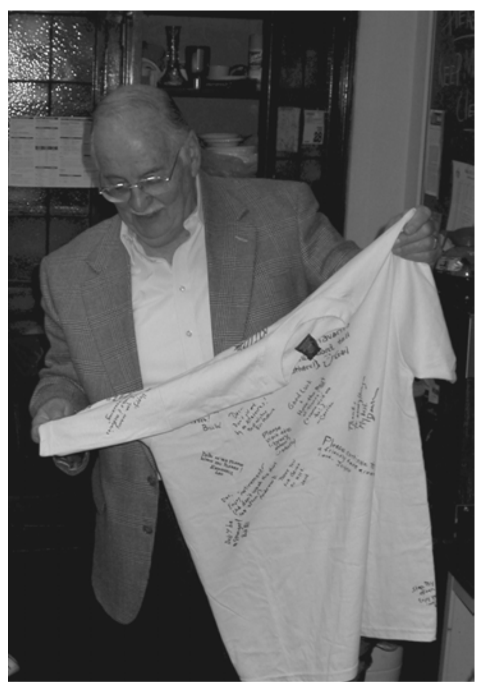


Ph.D. recipient Kris Larsen and A.M. graduate Laurel Griggs celebrate their graduation.

A.M. recipient Samantha Fernandez and Professor Bob Dymek enjoy conversation after graduation.

Faculty, students, and staff enjoy an afternoon of graduation celebration.

Professor Emeritus Hal Levin proudly displays a cake commemorating his retirement.



Hal Levin examines a t-shirt signed by various members of the department wishing him well in his retirement.

Faculty and staff enjoy some cake at Hal’s farewell after 41 years with the University.

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Construction photo looking W. Taken 4/30/03.

Construction photo looking SW. Taken 5/14/03.

Construction photo looking N. Taken 5/14/03.

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