GEOLOGICAL & MINING ENGINEERING AND SCIENCES

onTarget

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People... and change

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All about people

CHANGE: The theme of both parties in this presidential election is change, something that is present every day in everyone's life. This department is no exception. As many of our longtime faculty retire, they are, in some sense, replaced by new faculty. In another sense, of course, these retiring faculty can never be replaced. Who can claim the legacy of Lloyal Bacon, perhaps the most-loved professor I have ever met? Nobody.

And so we change, while maintaining our standards of high expectations for our students, and of great teaching and research by our faculty and staff. Profiles of the two new faculty hired last year, Greg Waite and Aleksey Smirnov, appear in this newsletter. Two other new faculty will be profiled in the next newsletter—Simon Carn (started in fall '08) and Shiliang Wu (starting in spring '09). In the meantime, Jimmy Diehl and Sue Beske-Diehl have started a three-year "transitional" retirement phase, teaching in the spring semesters only, and Gregg Bluth has left to begin a new career as a schoolteacher at a private school in Pennsylvania (while remaining an adjunct faculty member with us).

This issue of *On the Faultline* emphasizes the people in our department and what they do. I am often asked to provide a list of current faculty...this is available on our website, www.geo.mtu.edu, and would make very boring reading in a newsletter. But, in response to these requests, we are highlighting some of the faculty who are going through changes—whether they be new members of our department, have retired, or have started "transitional" retirement.

In addition, we describe our field courses...you can decide whether or not they have changed from the time you were enrolled. And we are pleased to tell you about a change in Houghton: a brewpub brought to you by an alumnus of GMES.

Other articles describe an award received by Ted Bornhorst, as well as competitive entries by undergraduates conducting research, some novel high-flying research done (with balloons) by two adjunct faculty, and more. I hope you like reading these articles.

Wayne D. Pennington, Professor and Chair

Wayne Pennington worked on Alaska's Bering Glacier last summer with GMES faculty and students and Michigan Tech Research Institute (MTRI) researchers. The GMES group concentrated on seismic and infrasound characterization of ice-calving and icequakes, and on geophysically mapping the fresh-to-salty groundwater transition along a transect to the Pacific Ocean. Access to some sites was provided by helicopter. This picture shows the MTRI crew tending one of their stations, measuring the vertical and lateral movement of the ice.

HONORS

Bornhorst receives award for contributions to Lake Superior geology

GMES PROFESSOR Ted Bornhorst, Seaman Mineral Museum director, was recently awarded the prestigious Goldich Award from the Institute on Lake Superior Geology.

This award, the institute's highest honor, is granted annually to one recipient for outstanding contributions to Lake Superior geology. The award is named after the late Sam Goldich, an internationally recognized geologist who worked extensively in the Lake Superior region.

The Institute on Lake Superior Geology is a nonprofit professional society with the objectives of providing a forum for exchange of geological ideas and scientific data and promoting better understanding of the geology of the Lake Superior region.

Bornhorst received the Goldich Medal for 2008 at the institute's 54th annual meeting. "As a token of the institute's appreciation, it is altogether fitting and appropriate that Ted join the ranks of other prominent Lake Superior geologists who have been honored with this prestigious award," said Jim Miller, professor at the University of Minnesota-Duluth. Miller cited Bornhorst for his "impressive resume of academic contributions" and for "his unparalleled service to the institute over the past 25 years."

On the cover: Assistant Professor Aleksey Smirnov in the Marble Bar area of Western Australia. The rocks behind him are the Late Archean (~2.7 billion year old) Hardey Formation. See page 6.

Peace Corps students return

In this newsletter, we profile three students who have obtained or will soon obtain a master's degree using the Peace Corps Master's International Program.

▶ R. ADAM BLANKENBICKER recently returned from serving two years in Guatemala, where he worked on assigned topics and developed new activities based on observed needs.

Blankenbicker maintained a blog detailing his activities for those back

home, using it to appeal for cash donations in order to buy a few books for local children. After receiving far more money than expected, he was able to buy an entire set of new books for a middle school, plus a speaker system that will be used by the middle school, a local elementary school, and for town meetings as well.

Where exactly was your Peace Corps Field location?
Aldea Las Marias (town), El Palmar (county), Quetzaltenango (department/state), Guatemala. On the Pacific Coast of Guatemala where the coastal plains hit the volcanic chain. Just south of Volcán Santa María.

What kind of problems are faced by the people living there?
Volcanic hazards include ash fall, lahars, and small pyroclastic flows. Pollution is everywhere in Guatemala; people will just toss anything anywhere if it doesn't serve them anymore. Most jobs in the area do not pay well (coffee and macadamia nuts) so it is difficult to provide for education, food, medicine, and to maintain a home. Luckily they do have electricity and plenty of water.

What type of research did you undertake?
I monitored the activity of Volcán Santiaguito. The focus of my research is the pattern of the activity of the volcano as it becomes less active, by analyzing the videos I recorded. As I was collecting data for my project, I was able to work with the observers and help them with their work.

What was the most challenging aspect of the research?
Obtaining equipment! The instrumentation I used was left by visiting scientists either from this university or others. Also, it was difficult to prepare stateside, because I did not know in advance where I would be stationed.

What was the best part of the experience?
The people. You really get to see things from a different perspective when you live in a completely different setting. The people I met don't worry themselves with the small problems like traffic when they have to worry about the bigger problems like food for the next day. It makes you appreciate what we take for granted. And they're so happy, I think, because of that. We let the small things get to us.

Did all the hard work pay off?
The project is still new, but my work has set the stage for the next Peace Corps volunteer. My research can be used by Guatemalan scientists because it does not involve a load of money and it can be taught. I think foreign scientists will be interested in the detail of the work since it involves a longer and detailed time scale than most investigations which are usually limited to one field season.

What next?
For now it's just getting all of my data processed and analyzed. After I'm done with my thesis, I'll be looking for a job. A PhD is also on my mind, but I think I need to get out in the world some more before I make that step.

▶ ESSA GROSS arrived home from a two-year Peace Corps assignment in Juigalpa, Nicaragua, and began work at Michigan Tech as a research scientist in the GMES department.

While in Nicaragua, Gross measured the productivity of drilled wells equipped with rope pumps. The idea came from work she had done with local ministries involved in resource management, as well as SNV, an international non-governmental development organization based in The Hague, Netherlands. In 2006, SNV advisors had tried to complete a water recourse inventory for a watershed near Juigalpa in order to help the local government develop a watershed protection plan. They found that taking surface

measurements was simple enough, but there was no quick, easy, or economical way to characterize the wells—which is

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Peace Corps students return *continued*

ESSA GROSS *continued from page 3*
where most of the population gets water for household use. They were unable to incorporate any groundwater data into the inventory.

From SNV's experience Gross's thesis project was born. She set out to develop a pumping test method that would use the existing infrastructure of the well and make it technologically appropriate (no motorized pumps and no computers for data analysis).

Gross performed over 100 pumping tests in the region over an eight-month period, and then analyzed the data several different ways to find the easiest and most accurate manner to determine well productivity.

Getting the project up and running was a challenge. Determining the logistics of locating the wells to study, getting the well users excited about the project, retrofitting and equipping the wells, and hiring local help for the test was what Gross described as her "introduction to project management." She describes it as stressful, but also exciting to see it all come together.

"I was very satisfied with the results of the work," adds Gross. "The course of the research was different than where we thought we'd go when we began, but I think that happens almost all the time. Peace Corps really helps you learn to be flexible and take the mishaps and stumbles in stride."

▶ LUKE BOWMAN hopes to better understand why certain links in the chain of communication malfunctioned during the 2005 Santa Ana volcanic eruption in El Salvador. It killed at least two people, injuring seven, and forced many people to flee their villages. The volcano spat rocks for over one mile—some the size of cars.

The GMES graduate student will start a six-month project with the Peace Corps Response team and a local Salvadorian NGO (non-governmental organization) in January. He will work on disaster preparedness and hazard awareness on the western flanks of the Santa Ana volcano.

Bowman's situation is a bit different than the other Master's International students. He joined the Peace Corps after earning his undergraduate degree at Hanover College, serving for two years in Honduras. Upon his return in 2006, he entered the graduate program in geology at Michigan Tech.

Bowman will be the first Tech master's student using the option of Peace Corps Response (formerly known as Crisis Corps; it deploys experienced Peace Corps volunteers on short-term, intense, assignments) as a method for conducting thesis research while working on a community development project.

Bowman has already conducted interviews in the community near the Santa Ana to assess current risk perception and to hear accounts of the events leading up to, during, and after the crisis event.

In addition, Bowman, along with GMES master's student Anna Colvin, worked with El Salvador's SNET agency (Servicio Nacional de Estudios Terrestres) to gather thermal camera data on El Salvador's volcanoes. They collaborated with a private geothermal energy company to assess the effectiveness of thermal cameras in locating potential thermal energy sources which could prove useful in hazard evaluation.

While serving in the Peace Corps the first time, Bowman lived in three small mountain villages in Honduras. His first project was stove-building. While eating meals with the community families, he noticed that there were no chimneys in their kitchen stoves, allowing smoke to roll off the wood-burning, clay stoves and fill the rest of the house.

Honduran families were asked to provide the raw materials, and were then "adopted" by a friend or family member of Bowman's in the US. Each sponsor donated $35 to buy the steel, hot plate, rebar, cement, tools, and all other non-local materials. Bowman tackled numerous other projects, as well. "My Peace Corps experience was a defining time in my life and guided me toward finding my passion," he adds.

"The opportunity to return under the auspices of Peace Corps working on a focused project in El Salvador will likely further shape my career goals and give me a chance to apply the many things I've learned at Tech throughout my first year."

Studying volcanoes with balloons: two adjunct faculty

PEOPLE DO ALL KINDS of crazy things in Hawaii, but flying balloons over a volcano usually isn't one of them. Unless you're Adam Durant, that is.

Durant, an adjunct geological sciences faculty member, took meteorological balloons to the Kilauea volcano this summer to make the first on-location measurements of volcanic gases as they actually

Durant launches a balloon to capture plumes emanating from Halema'uma'u crater of the Kilauea volcano, on the Big Island of Hawaii.

spew from the mouth of the volcano. The Kilauea volcano began erupting in March.

Durant and Matt Watson, also an adjunct faculty member at Michigan Tech, are working with Paul Voss of Smith College to measure the temperature, composition and water content of the volcanic gases. Durant received his PhD at Michigan Tech, and is doing postdoctoral work under Watson at the University of Bristol in the United Kingdom.

"The balloons are piloted remotely by satellite link," Durant says, "with flight visualization using Google Earth. We were looking at tropospheric volcanic emissions of sulfur dioxide, carbon dioxide, and water, which can be hazardous to human and animal health and degrade ecosystems."

The group released two balloons in July that rode the winds in and out of the plumes emanating from Halema'uma'u crater.

After the first balloon was released into strong winds left over from tropical storm Elida, it worked for a couple of hours, ascending to 2,500 meters around Mauna Loa mountain. The first flight lasted just under two hours before the balloon collided into Mauna Loa. Durant and Watson spent the following three hours scouring the jungle on steep mountain slopes before finally locating the balloon mostly intact.

The next day's launch was more successful. As the balloon remained airborne, they had to get approval from the Federal Aviation Administration to extend the flight beyond their approved window. They received permission to continue and had to terminate the flight themselves after five hours, so as to not exceed the new FAA window and interfere with Hilo or Kona airports.

This flight landed in a macadamia nut tree plantation, and the Google Earth images were so clear they could "count the rows to find the balloon," Durant laughs. They were able to land the balloon close to a major highway; "it sure beat slugging it out through a jungle," said Durant.

We were looking at tropospheric volcanic emissions of sulfur dioxide, carbon dioxide and water, which can be hazardous to human and animal health and degrade ecosystems.

~Adam Durant

The preliminary data is already interesting, Durant says. "We are fairly confident of three findings. First, this work is feasible for measuring SO_2 and CO_2 in volcanic emissions for several hours after eruptions. Second, there is a loss of SO_2 after one hour of flight away from the source, which could reflect conversion to sulfate aerosol. [Sulfate aerosols may lower the Earth's temperature by reflecting away solar radiation.] And third, there is a clear stratification of SO_2 above CO_2 within the plumes."

Adam Durant, Matt Watson, and Paul Voss (not pictured) have made the first in situ measurements of gases in a volcanic plume using meteorological balloons.

The stratification could represent separation of the gases through meteorological processes such as water droplet formation. This finding has implications for remote sensing studies that aim to measure volcanic gas emission rates.

There is immediate concern for this work, too. "One of the largest subdivisions in America is Ocean View, Hawaii, and it is downwind from the volcano on the west side of the island. We detected sulfur dioxide over the development, several hours after it was erupted into the atmosphere," Durant says. Although this is much less than the 500 ppm at the source, it's still high enough to warrant more monitoring.

Paleomagnetism: Shedding light on the young Earth

After being at Michigan Tech for a year, Dr. Aleksey Smirnov and Dr. Greg Waite have established their research programs and are teaching courses. The following articles (here and on page seven) describe their research.

ASSISTANT PROFESSOR Aleksey Smirnov came to Michigan Tech last fall to join the Department of Geological and Mining Engineering and Sciences. Smirnov hails from Russia, where he studied geophysics at Saint-Petersburg State University. He earned his doctorate degree at the University of Rochester, with post-doctoral experience at Yale University.

What drew Smirnov to Michigan Tech? First of all, "a renowned paleomagnetic laboratory established by professors Jimmy Diehl and Suzanne Beske-Diehl. Their research is well known around the world," Smirnov explains. Secondly, it was the location. "Michigan's Upper Peninsula and surrounding areas in the US and Canada are very important in terms of Precambrian geology and geomagnetic field studies," he adds.

Crystallization of the Earth's inner core may have resulted in a dramatic increase of the geomagnetic field strength. Paleomagnetic study of Precambrian rocks may give us a much better estimate of the inner core age.

~ Aleksey Smirnov

Smirnov is especially interested in applying paleomagnetism to study the Precambrian. Although it makes up about seven-eighths of the Earth's history, there are many unanswered questions about that time period. Paleomagnetism may be able to answer many of them.

Aleksey Smirnov samples rocks 2.7 to 3.5 billion years old from the Pilbara Craton in Western Australia

In particular, Smirnov says, "we hope to use paleomagnetic records to reconstruct the positions of continental blocks in the Archean—something which has never been done before. Such reconstructions may help us understand the Precambrian geology (for example, the early plate tectonics mechanisms)."

The study of paleomagnetism can provide a breakthrough in another important area—the age of Earth's inner core. The core consists of two parts: the outer core, which is liquid; and the solid inner core. However, the timing of this stratification is largely unknown. Current estimates based on geochemical and thermal history studies range somewhere between 1 to 3.5 billion years. "Crystallization of the inner core may have resulted in a dramatic increase of the geomagnetic field strength," explains Smirnov. "Paleomagnetic study of Precambrian rocks may give us a much better estimate of the inner core age."

Understanding the Precambrian geomagnetic field may also provide important insights into the atmospheric chemistry of the early Earth and the evolution of life. Today, the Earth's magnetic field protects the atmosphere and life from solar and cosmic radiation. "Before the geomagnetic field came along, there would have been a high level of radiation, which may have had some effect on early life and atmospheric evolution."

To answer these questions, Smirnov seeks to find well-preserved Precambrian rocks, which is not an easy task. This summer, Smirnov and undergraduate student Danford "Chad" Moore went to Western Australia and sampled rocks 2.7 to 3.5 billion years old, gathering about 900 samples from the Pilbara Craton. The two-year project is supported by the National Science Foundation.

"It was a tough but rewarding expedition," he says. They and two Yale colleagues spent a little more than a month gathering samples and attending a conference. They worked in remote, empty areas, and did not see many people, but did see dingo, kangaroo, lizards, emus, and one snake. "By next spring we ought to have our first results," he says.

Michigan's Upper Peninsula and surrounding areas in the US and Canada are very important in terms of Precambrian geology and geomagnetic field studies.

Smirnov will be returning to Australia again in the spring...and then? "There are many places to study Precambrian paleomagnetism including Australia, South America, South Africa, and Northern Europe," says Smirnov. "We are seeking funding to continue our research." He is also determined to continue his research right here in the UP. "People in other places are seeking NSF funding to come here. But we only need to grab our gear, hop in a car, and drive few hours to our sampling locations."

Seismic signals: Magma-mapping to forecast volcanic hazards

GREG WAITE, an assistant professor of geophysics, specializes in volcanic seismology, using earthquakes and surface deformation to understand volcanic eruption mechanisms.

Volcanic eruptions are capable of unleashing some of the most destructive forces on Earth. "Understanding volcanic earthquakes is paramount to determining the dynamics of a volcano's magmatic plumbing system—and ultimately forecasting volcanic hazards," Waite explains.

Waite studied mathematics at St. Norbert College, earned his master's and doctorate in geophysics at the University of Utah, and arrived at Michigan Tech last fall after a post-doc experience with the US Geological Survey.

"Volcanoes produce a rich variety of seismic signals in addition to those generated during normal earthquakes," he adds. "The signals that result from movement of magma or other volcanic fluids, or the resonance of fluid-filled cracks, have distinct characteristics. These characteristics make volcanoes difficult to analyze with the typical methods—the ones used to study earthquakes that occur in places like California's San Andreas Fault."

Waite uses syneruption volcanic earthquakes to map magma conduits by modeling high-fidelity recordings of the events. This is only possible from recordings made at close range. To collect these data, Waite, his students, and colleagues hike high onto the flanks of erupting volcanoes to place seismometers, which detect ground vibrations, and infrasonic microphones to detect low-frequency pressure waves in the air.

Waite currently has projects at Mount St. Helens, Yellowstone, and Newberry volcanoes in the US, and Fuego and Pacaya volcanoes in Guatemala—all which involve seismic investigations of crustal structure and volcanic processes.

His work at Mount St. Helens has led to a new model for the cause of shallow, repetitive earthquakes associated with the recent eruption. These "drumbeat" earthquakes are believed to be caused by the jerky movements of a solid plug of molten rock traveling up from the volcano's core, a process known as the stick-slip model. Modeling of seismic data collected by Waite and his colleagues dispute that explanation. "It suggests a source with a net volume change, such as a resonating fluid-filled crack," he says.

Waite has shown that the source of these earthquakes might consist of a shallow hydrothermal crack filled with a mixture of meteoric and juvenile steam that is pressurized by the magmatic activity. "Periodically a pressure threshold is reached and steam is forced from the crack, causing the crack to partially collapse and resonate," says Waite. "In addition to generating the earthquakes, this mechanism triggers a much lower-frequency response in the magmatic system, the source of which indicates a corner in the magma conduit where the pathway deviated from that which fed earlier eruptions."

More than 500 million people, or about 10 percent of the world's population, live within 100 kilometers of a historically active volcano.

"Greg collected a fantastic data set and produced a robust and intriguing model for the process responsible for those earthquakes," says Seth Moran, the principal USGS seismologist monitoring the current eruption on Mt. St. Helens. "We are adjusting our understanding of the mechanics underlying the eruption to incorporate his results."

Waite's research team is applying these techniques to study volcanic earthquakes in other areas—such as at the Pacaya and Fuego volcanoes in Guatemala—and integrating data from volcanic gas emissions to better understand the role of magmatically-derived gas in the generation of volcanic earthquakes. Ultimately, this work should lead to an improved eruption prediction at hazardous volcanoes worldwide.

Want to make a gift to the GMES department?

ALTHOUGH Michigan Tech is a state institution, it receives less than one-third of its funding from state appropriations. Your gift helps keep the GMES department on the cutting edge. There are three ways to give:

Use Michigan Tech's online gift form at www.mtf.mtu.edu/gift

Call the Michigan Tech Fund at 906-487-2310

Mail a gift to the Michigan Tech Fund using the enclosed envelope. In order to make sure 100 percent of your gift goes to the GMES department, please specify GMES account #1325AO. Many, many thanks!

Living the good life—in "transitional retirement"

JIMMY DIEHL AND SUZANNE BESKE DIEHL, both professors of geophysics, are officially transitioning into a well-deserved albeit somewhat early retirement after thirty years spent teaching and researching geophysics at Michigan Tech.

The two are enjoying what some might call a "reverse snowbird strategy"—spending summers traveling and hiking like fiends, arriving home in time to enjoy the fall colors and winter here in the UP, teaching courses at Michigan Tech during spring semester—and then heading out to do it all over again.

In June, the Diehls kicked off their journey with a river rafting trip down the Grand Canyon—"the trip of a lifetime," they said. They went with their son, Scott, and daughter, Barbara, to celebrate Scott's newly earned doctorate in computer science. He's now teaching at Siena College near Albany, New York. Barb is a career counselor at Colorado State University.

"Our goal is to enjoy the national parks while everyone else heads back to school," they explained in a hasty email dispatched from the road in Washington state over the summer. They were in Bellingham at the time, visiting Bob Mitchell, a former student of Jimmy's at Michigan Tech who is now a professor at Western Washington University.

On the way to Portland, they stopped at Beacon Rock, "a place that Lewis and Clark wrote about in their journals."

In Nevada, the two camped at 8,500 feet in the Humboldt range. From there it was southern Utah—Zion, Bryce, Capital Reef and other national parks. "Hiking on Angels Landing in Zion was especially memorable," Sue recalls. "A waterfall appeared right before our eyes after a squall." Later that day, a trio of California Condors soared past them.

One of their last stops was high up on the north rim of the Grand Canyon, where they looked down upon the very same Colorado river they'd rafted a few months before.

"We hiked two to three days at each of the national parks we visited—and looked at the geology, too, of course," notes Jimmy.

New book!

America:
A View from Above

Photos by Jim Wark
Text by Peter Skinner
230 pages
310 aerial photos
$25.00

Jim Wark, a GMES alumnus, has recently published a new book of stunning aerial photography. Featured here is Wark's favorite photo from the book. "For me it is a graphic and iconic image that represents the strength, integrity and beauty of America–and something of a nostalgic time gone by." Autographed books are available at www.airphotona.com, or contact Wark at 719-454-1051, airphotona@comcast.net

You call this retirement?

"WHEN YOU'RE FREE to do things, you're asked to do a lot of things," says Allan Johnson, professor emeritus of the Department of Geological and Mining Engineering and Sciences at Tech. "Now that I'm retired, though, I can linger a little longer over a cup of coffee," he adds.

Johnson retired from the GMES department in 1998, "but in truth I didn't really retire." He actually went on to complete an abandoned underground mine inventory for the Michigan State Department of Natural Resources. "It was an under-funded, three-year project, which I directed and participated in with others. It was a great way to wind up my career at Michigan Tech," he adds.

Today, Johnson is on the board of the Quincy Mine Hoist Association, which this year is celebrating the centennial of the #2 shaft and the founding of the Quincy Mining Company in 1848. In his spare time, Johnson also serves as the State of Michigan representative for the Advisory Commission of the Keweenaw National Historical Park. That's when he's not too busy serving as president and secretary/treasurer of the UP Section of the Society of Mining, Metallurgy and Exploration. "We're excited about our new environmental subsection," he notes. Johnson is also a member of the board of directors of the Portage Lake Sportsman's Club, and involved in the Copper Country Rock and Mineral Club.

One project dear to his heart—Johnson is transcribing the 1840 field notes of Douglass Houghton for publication by Wayne State University Press. "People always thought that Houghton's field notes had been lost when he drowned in Lake Superior. Then, one day back in the 1970s or 80s, they turned up in a New York auction."

Johnson heads up a committee seeking a commemorative bicentennial stamp honoring Houghton, who was born in 1809. The stamp has the support of Senator Carl Levin, a stamp collector himself. It also has the support of State Geologist, Hal Fitch, a Michigan Tech GMES graduate.

Johnson was born and raised in Muskegon in southwestern Michigan. "I came to the UP to attend Michigan Tech in 1962, and never left." He graduated with a BS in geological engineering in 1965, an MS in geological engineering in 1967, and a PhD in geology in 1971. "There are no rock exposures where I grew up. There are sand dunes and farming fields, but no bedrock exposed at the surface," he says. "I used to pick up fossils along the railroad tracks as a youngster. That was probably something that sparked my interest."

He met his wife, Mitzi, in a Hancock laundromat. "I married the secretary of former Michigan Tech President, Ray Smith, when he chaired the Metallurgical Engineering Department. He lost a secretary and I gained a wife." The two spent many happy hours rockhounding in the UP, looking for agates and copper. Mitzi recently had successful hip replacement surgery, which has given them both a new lease on life. "Right now I am cleaning out the garage so there's room for her to park her car. It's filled mostly with rocks."

Johnson fondly recalls one particular road sign located on the edge of campus. "The sign said: 'You are now breathing the purest most revitalizing air on Earth.'"

"I'm very supportive of Michigan Tech. It's the economic engine for much of the Keweenaw and is vital to this area. We're fortunate to have it, and I am thrilled that it's doing so well, thanks to the good stewardship of our present administration."

PASSING

Lloyal O. Bacon, "a phenomenal teacher," 1916–2008

Geophysicist Lloyal O. Bacon, of Houghton, who was on the Michigan Tech faculty from 1949 to 1978, passed away Tuesday, April 15, 2008. He was 92.

Originally with the physics department, Bacon moved to the GMES department as the University's geophysics program expanded. Allan Johnson, a professor emeritus in the GMES department, is one of his former students.

"Lloyal Bacon was an interesting guy," says Johnson, who enrolled at Tech in 1962. "You had to pay attention in class, and he made the students think.

"His tests were not easy, and you really had to know your stuff, but we learned a lot," said Johnson. "It was always a relief after a test. Fortunately, you didn't always have to get the right answer, but you did have to show how you attacked the problem. I thought he was a great teacher."

Among his undergraduate and graduate students Bacon was known as an excellent and demanding, but kind teacher. He gained students' respect because of his thoroughness and intellectual honesty, and this respect grew greater and greater during the students' professional careers, because the lessons kept coming back to them.

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PASSING *continued*

GMES chair, Wayne Pennington, came to Tech in 1994 and remembers Bacon attending his interview talk. "He sat in the front row with a microphone attached to his hearing aid so he could hear me," Pennington said. He quickly came to appreciate Bacon's lasting influence.

"He's the only professor I've known at Tech whose students would want to go see him at home when they came back to the area to visit," said Pennington. "Everybody asked about him at meetings, and he was frequently at seminars. He had a very active mind."

Bacon earned a BS in geological engineering in 1941 from the University of Minnesota and served in the US Navy during World War II. He later earned MS and PhD degrees in geophysics from Penn State before coming to Michigan Tech.

Bacon was an active researcher as well as a phenomenal teacher, said Johnson. "He did some work for C&H [Calumet and Hecla copper mining company], exploring for native copper." Because Keweenaw copper runs in nearly pure, narrow veins, it can be difficult to detect by exploratory drilling. "He developed a sensor, like a metal detector, that you could lower down the bore hole," said Johnson. "That was quite innovative."

Memorial gifts may be made to the Lloyal O. Bacon Geophysical Scholarship Fund of the Michigan Tech Fund, Michigan Technological University, 1400 Townsend Drive, Houghton, MI 49931-1295. For more information, call 906-487-2310. The fund supports scholarships for students majoring in geophysics.

Teaching field methods

Our curricula require field courses in both geology and field geophysics. Two other field courses are offered by our department as well. Taught in Utah, one is intended for high-school and middle-school science teachers. The other, developed by Dr. James Wood, takes place in Kenya. It will be detailed in our next newsletter.

EARTH SYSTEM SCIENCE

Jacqueline Huntoon, GMES professor and dean of the Michigan Tech graduate school, along with husband Christopher Wojick, a senior research engineer in environmental engineering, teach a summer field-based Earth System Science course to high school teachers in and around Utah's national parks.

"The course is designed to use the spectacular geology of southeastern Utah to teach basic geoscience content within an Earth System Science framework," Huntoon explains.

Scientific method is the basis for instruction. Each day, she and Wojick give teachers an overall problem to consider. Throughout the day the teachers collect data in the field, extract additional data from the course's field library, and develop one or more hypotheses. They must also recommend possible ways that

During their Utah summer field course for high school teachers, Huntoon and Wojick model a variety of methods for teaching students of differing learning styles.

their hypotheses could be tested using more data. At the end of each day the teachers self-evaluate their progress.

Most of the teachers who take the course are certified to teach in other disciplines. "We encourage them to use Earth Science examples to demonstrate how information from the other basic sciences as well as mathematics can be applied to real-world problems," Huntoon explains. "Earth System Science is unique in that it is inherently trans-disciplinary. It is the ideal venue to demonstrate how practicing scientists use scientific inquiry to generate new knowledge."

Earth System Science is unique in that it is inherently transdisciplinary. It is the ideal venue to demonstrate how practicing scientists use scientific inquiry to generate new knowledge.

~Jacqueline Huntoon

The course has a ripple effect. One teacher plans to take a group of at-risk students to Utah within the next two years. Six other teachers have started graduate school in order to earn an MS in applied science education at Michigan Tech.

SUMMER FIELD COURSE IN GEOPHYSICS

"WITH EVERY FIELD course there are expectations for the students," says GMES Adjunct Assistant Professor Jeremy Shannon. Field days can often be long, hot, and buggy, so a good attitude is important."

Shannon, who earned his PhD in geology at Michigan Tech, teaches the summer geophysics field course on top of his work as Assistant Professor of Earth Science at nearby Finlandia University.

"We want to see students worrying more about their data rather than what time it is," he notes. "We want to see students be respectful to other group members even when there is disagreement." Students are required to treat the equipment properly, especially when it becomes time to pack up at the end of a long day.

Field Geophysics takes place each year in June and July. Emphasis is focused on the collection of geophysical data with various instruments, data reduction, interpretation, and report writing. Gravity magnetic, electromagnetics, resistivity, and seismic are the main geophysical methods used. Survey sites include areas near McLain State Park, Taylor Mine, Rice Lake, Ahmeek, and Dollar Bay.

"The course is very practical," adds Shannon. "Students get to experience some of the challenges that inherently creep into fieldwork—i.e. dead batteries, anomalous data, cultural noise, equipment repair/maintenance, and working effectively with other people."

SUMMER FIELD COURSE IN GEOLOGY

"A FOCUS ON mapping in simple to complex Precambrian rocks is what makes this field course unique," notes Professor Ted Bornhorst, who has been teaching field geology with engineering applications for the past twenty-five years. "Some of the same field sites that were used more than fifty years ago are still used today because they are still great for teaching the principal of field mapping," he adds.

Field geology is an intensive five-week course. Students typically leave campus at 8 am and return at 6 pm. Except for one day in the lab and a three-day geologic excursion to Marquette, every day is spent completing mapping projects at field sites located in the Keweenaw Peninsula and L'Anse regions.

Determining the four dimensional relationship between rocks is one of the most important fundamental skills taught in the course, Bornhorst explains. "The field geology tradition remains a critical component of a geo degree and is one of the most memorable classes students take while attending Michigan Tech."

Joshua Shue sets the frequency on the horizontal loop transmitter during an electromagnetic survey near Taylor Mine. Students used electromagnetic techniques to detect and map the location of conductive slates.

The course requires integrating general geology, mineralogy, petrology, and structural geology. In addition to making maps, students take notes in the field to describe the rocks and geologic features. For three field sites, the students must complete a technical geologic report and a polished geologic map.

Some of the same field sites in the Keweenaw Peninsula and L'Anse regions that were used more than fifty years ago are still used today because they are still great for teaching the principal of field mapping.

~Ted Bornhorst

GMES students succeed at Undergraduate Expo

A GMES UNDERGRADUATE research team earned second place and a senior design team won an honorable mention at Michigan Tech's 7th annual Undergraduate Expo. More than 500 student participants of the University's Senior Design, Undergraduate Research, and Enterprise teams compete for prizes at the expo each spring. A distinguished panel of judges—made up of alumni, corporate representatives, and faculty members—critique the projects.

Second Place for Undergraduate Research

Groundwater Investigations Using Resistivity Surveys on a Terminal Moraine, Bering Glacier, Alaska

Sponsors United States Bureau of Land Management, Michigan Tech Research Institute

Student researchers Kevin Endsley, Silvia Espino, and Joshua Richardson, Applied Geophysics

Josh Richardson calibrates a newly-deployed geophone (part of the Michigan Tech seismic array) in the Grindle Hills, above the Bering Glacier.

Project overview Freshwater generated by the annual melting of the Bering Glacier, the largest glacier in North America, flows into Vitus Lake and is discharged into the Gulf of Alaska via the Seal River. Water budget analyses show that the annual freshwater discharge exceeds the river's capacity Our primary purpose was to map the interface between the freshwater aquifer and the inferred underlying saltwater wedge using electrical resistivity sounding.

Student perspective "The Bureau of Land Management representatives weren't accustomed to working with Michigan Tech students and were more comfortable talking to our faculty advisors, even though our faculty advisors naturally let students take the lead in their own projects. We did well, however, and we have a good working relationship with the BLM now. The most fun was working in the field, of course. I've never felt more fulfilled than that summer in Alaska, having the opportunity to work on a real scientific investigation, and be responsible for its achievements in a remote and largely untouched environment. That's something that isn't offered in the classroom." *–Kevin Endsley*

Honorable Mention for Senior Design

Slope Stability Analysis of the CD-III Pit at Cleveland Cliffs Michigan Operations

Sponsor Cleveland Cliffs Inc.

Team members Jason Kneibel, Benjamin Beard, Michaela Polster, and Walter Rathbun, Geological Engineering; Cody Suits, Geology

Project overview We were commissioned to perform a slope stability study on an open pit mine operated by Cleveland-Cliffs Inc. in Ishpeming, Michigan. This project is significant because it allows students to work alongside professionals at an actual work site while performing a task similar to that of a hired consultant. A GPS laser instrument was utilized by keying in on planar wall features to measure the structural geology of the wall. Field geology and geotechnical methods were used to determine the wall's slope stability.

GMES students Cody Suits and Walt Rathbun conduct field work at Cliffs Natural Resources' Tilden Mine near Marquette, Michigan.

Student perspective "The most difficult, challenging aspect of the project was dealing with the processing of our data. There was no clear cut answer, and using our engineering judgment in the timeframe we had was a learning experience. Our study area was relatively straightforward in the world of slope stability problems, but the great thing about working in the geosciences is that you very rarely see the same problems that another engineer in another field might encounter. Problems in the field have many different solutions and an equal number of possible pitfalls; there's not much room for an engineer to get too full of themselves. We have formulas and simulations that attach a number to the complexity of the problems but ultimately you're held at the mercy of Mother Nature." *–Walt Rathbun*

Explanation of the Buried Forest of Little Traverse Bay, Houghton County, Michigan

Student researchers Katie Schon, Alexander Michells, and Jeremy Loucks; graduate student/instructor/advisor Alexandria Guth

Alex Guth, Alex Michels, and Katie Schon at Little Traverse Bay. The research team counted 254 submerged stumps along the beach shoreline, with more located further inside the lake.

Project overview Along the shoreline of Little Traverse Bay lie the submerged remains of some tree stumps that appear to be standing in place. The immediate objectives for our research were to determine the age of the trees (using radiometric dating) and the type of tree. We hope to draw some conclusions in a continuing study about the paleo-environment for this area and what changes in relative lake level caused the submergence of the trees.

Student perspective "Learning what type of tree we were dealing with at our project site was challenging. The identification is made on the basis of characteristics that require a microscope to see. With the help of several people in the School of Forest Resources here at Michigan Tech, we identified the tree stumps as Tamarack (*Larix laricina*). We needed more information about lake level fluctuations during the time the trees were living, as well as the Tamarack growing environment. There is evidence of a lake level increase that occurred about 1600 years ago; we feel that this is what first caused the submergence of the trees.

–Katie Schon

Enterprise Team

Aqua Terra Tech

Sponsors National Science Foundation, Thrivent Financial for Lutherans Foundation

Team leaders Katelyn FitzGerald, Geological Engineering; and Briana Drake, Environmental Engineering

Project overview Aqua Terra Tech is comprised of Michigan Tech students in civil, geological, and environmental engineering who provide planning, analysis, and design services for community water resource needs.

Student perspective "It was really difficult stepping in as the president of Aqua Terra Tech last spring. There is a lot to do and a lot to keep organized. We always have new and inexperienced members as others graduate. It is a challenge to mentor the underclassmen and keep them motivated and busy with project work at their level. What makes it all worthwhile? Getting to work with other enthusiastic and hard working students is the best part of the job. They make everything a whole lot easier and a whole lot more fun. Most important lessons learned: It is crucial to communicate things clearly as a leader. If you don't know what's going on nobody else does either. Organization saves you time in the long run. It is important to share the workload."

–Katelyn FitzGerald

Aqua Terra Tech began as an environmental consulting student enterprise in 2002, initially focusing on a collaborative project with the Keweenaw Bay Indian Community to characterize the Silver River Watershed on the L'Anse Indian Reservation.

The largest meeting of volcanologists in the world

2008 IAVCEI in Reykjavik, Iceland

THREE GMES FACULTY—Greg Waite, Bill Rose, and Simon Carn (new this year to Michigan Tech)—along with four graduate students—Rudiger Escobar Wolf, Emily MacCarthy, Patricia Nadeau and Elisabet Head—went to Iceland to participate in the 2008 International Association of Volcanology and Chemistry of the Earth Interior (IAVCEI) General Assembly. It is perhaps the largest meeting of volcanologists in the world, and happens every four to five years.

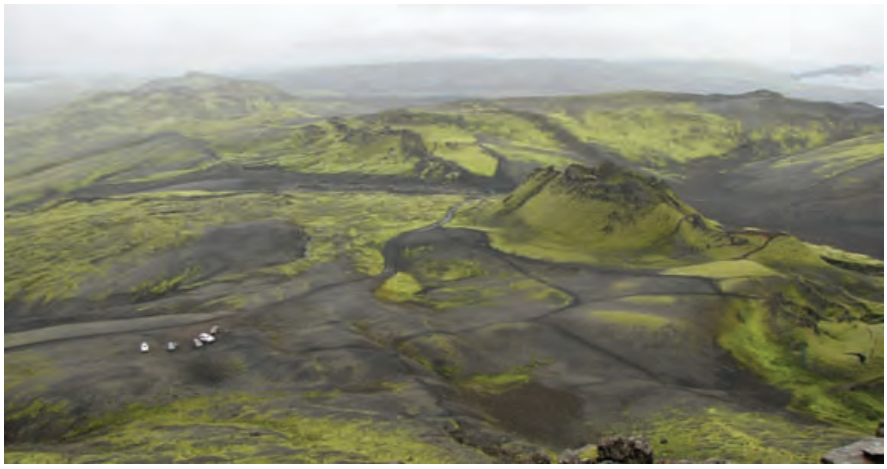
Simon Carn

Rudiger Escobar Wolf

Escobar presented two posters on his PhD research at Fuego and other active volcanoes in Guatemala as well as one on an updated geologic map for Santiaguito volcano.

"The meeting consisted mainly of talk sessions ordered according to topics," he explains. "Given the wide variety of topics and the large number of presentations, up to ten sessions happened simultaneously almost all of the time." Along with the assembly, there were several official field trips to Icelandic volcanoes.

Escobar passed on the official field trips, and instead organized a trip with some friends. "We climbed Hekla volcano, saw the 'original' Geysir geyser in the Haukadalur valley (from which the word geyser derives) and visited Þingvellir, where you can see the boundary of the North American and Eurasian tectonic plates."



Iceland's Laki craters are the site of one of the largest eruptions on Earth in historic times in 1783-1784.

Assistant Professor Simon Carn traveled independently in Iceland after the assembly. He visited the Laki craters, the site of one of the largest eruptions on Earth in historic times (1783-84), and then went to a beautiful spot called Jökulsárlón, where fragments of a large glacier drift across a lagoon and into the sea. "Iceland in general is spectacular because there are very few people, the volcanic landscape is striking and the interplay of sun, rain, ice, clouds, and clear air creates ever-changing vistas."

To top it all off, Carn ran the Reykjavik Half-marathon (13.1 miles), coming back 17th overall. "The race was challenging due to a headwind and lack of crowd support on much of the course," he says.

Jökulsárlón, Iceland—where fragments of a large glacier drift across a lagoon and into the sea.

From barrels of oil—to barrels of ale

AFTER SIXTEEN YEARS as a petroleum engineer and resource manager for Amoco, Dick Gray (class of 1982) ventured out on his own, forging a gas and oil exploration company, Presco Western LLC, in Colorado. He and Paul Boissevain, a senior geophysicist, liked to hang out

Dick Gray and his partner brew and sell KBC beer all across Michigan. KBC is also quickly gaining ground in Wisconsin.

at the Wynkoop Brewing Company in Denver. There they met brewer David Lawrence. Gray used to talk about opening a microbrewery someday and often kidded Lawrence about "buying him."

Ten years later, when Gray and his wife, Stasia (Chronowski '82), finally decided to come back to Houghton, the timing was right. It wasn't hard to convince Boissevain and Lawrence to come with them—and the Keweenaw Brewing Company was born.

Gray and Boissevain purchased a building in downtown Houghton in 2003. After five months of renovation, they were open for business. The "KBC," as it's referred to by the locals, consists of a sixteen barrel microbrewery and taproom, as well as a second production facility in nearby South Range. Beers change with the seasons, but they always offer five core ales: Pick Axe Blonde, Red Jacket Amber, Lift Bridge Brown, Widow Maker Black, and Full Gale Pale.

Growth has been steady, with sales increasing from 460 barrels in 2004 to a projected 3,350 barrels in 2008. KBC sold its 500,000th pint in the taproom a few months ago. "I'm an engineer, and engineers track everything," says Gray. "I've already estimated when we'll hit one million pints—in May 2011."

What is the secret to good beer? "A simple aspect like water can make a big difference," says Gray. "We get our water from the city of Houghton and the Village of South Range, and don't do anything to it. So many breweries add gypsum and other treatments to the water. Not us. In some parts of the country, such as Key West, Florida, they actually had to take sand out of the water with filtering equipment."

For Gray, knowing how to read an engineering drawing came in handy. "We were able to purchase some used tanks, but not all the jewelry that goes on them. All we had were drawings. We had to manufacture a lot of our own tubular apparatus," he recalls.

The KBC building in Houghton used to be a Christian bookstore and a men's clothing store. "It was basically a box inside a box. We tore out old wallboard and took it down to the base. We stripped off five different floors. In the past, people had burned coal downstairs to heat the place. Coal dust was everywhere during the renovation. We were covered with it."

Gray and Boissevain put up all the money to start KBC. "It's a business, as well as an investment, as well as the art of making the beer," he explains. "We've got the luxury of all three. If we had to draw a wage, though, we could never do it the way we're doing it."

The price of hops is up 500 percent. The cost of grain has more than doubled. Utilities have gone up. It has brought the price of beer significantly higher. For a long time, KBC charged $2 per pint; now it's $2.50—still a great deal.

KBC is also sold wholesale—in kegs and cans. Why cans? "It made sense," Gray explains. "There's lot of outdoor activity up here. It's easier to crush and empty a can and put it in your backpack than it is to lug around a bottle. No one wants glass out on a boat, either. Aluminum is recyclable, and it's also a little better for beer—no light, or oxygen. Shelf life is little longer. But canning and sealing cans is tricky," he says. The capital investment for glass and cans is similar. Gray orders 200,000 cans at a time—a semi load.

KBC doesn't filter its beer. "You lose some flavor with filtering. Instead we let gravity do the work as the beer sits in a tank for a week. We're left with a real clear beer," he adds. Lagers take even more time—fifty-plus days. "However if you make it, you must move it. We are constantly moving beer, whether from tank to cans or kegs. It's a vicious cycle,

continued on next page

Alumni often reminisce of the days spent in one pub or another while they were students at Michigan Tech. Today's students (of age) and their faculty and staff already wax philosophically and think fondly of their time at the Keweenaw Brewing Company. This brewpub, and Dick Gray's efforts at organizing the downtown retail merchants, have helped revive the downtown of Houghton in the face of competition from strip malls that surround the city. We are very glad to claim the KBC, in some sense, as our own.

Photo by Jimmy Diehl: Bryce Canyon Amphitheater as seen from Sunset Point along the Rim Trail. The sedimentary rocks that make such erosional features as hoodoos and fins belong to the Paleocene Claron Formation. Sinking Ship (dipping beds) is seen in the center of the photo just below the flat lying beds on the skyline.

BARRELS *continued*

just like any widget factory."

What is Gray's advice to GMES alumni who may want to follow in his footsteps? "It all depends...to each his own. I took up a hobby—though my wife likes to call it a 'hobby gone mad.' It was a good time to start KBC. Our kids were out of the nest."

Does he ever miss geological engineering? "I don't miss drilling—risking half a million at a whack. It's like grabbing a trash can and throwing money in it. It's a risky business, but then again, there's nothing quite like oil and gas."

Since opening the brewery, Gray's stress level is down. "I don't work 24/7 anymore, just 10 hours a day. Back in the day I had a cell phone long before there were cell phones. I had email long before there was email. Nowadays I don't even carry a cell phone."

Check out KBC online, at www.keweenawbrewing.com.

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