Promise and Perils of Oil Shale

Origins of Cosmic Rays

The "STEM" Crisis

Winter 2007-08 Volume 97 Number 4

Mines

Colorado School of Mines Magazine

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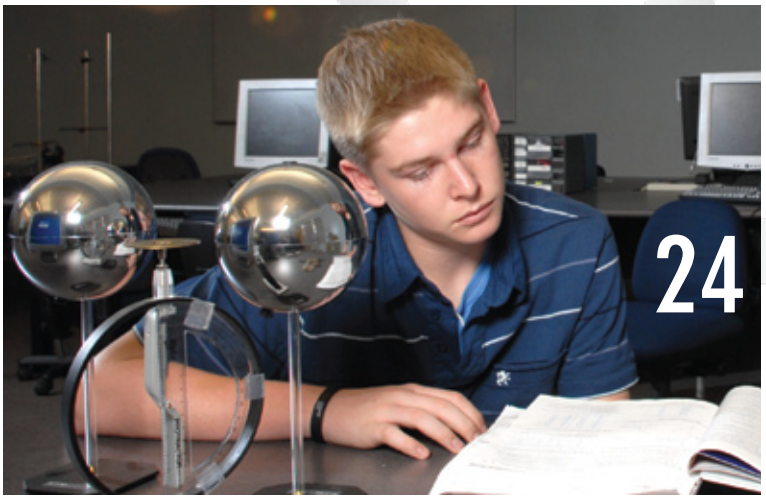

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Fossils and Fossil Fuels

I noted in Passings the death of Dr. DeVoto, "the Rabbit." I was at Mines when he arrived and the next summer we attended Geology Field Camp. He never walked anywhere, he ran. He ran up dip slopes and scarp slopes alike. He ran up and down ridges, he ran across valleys to get to the next ridge. He ran from outcrop to outcrop. He nearly killed us all. We called him the Rabbit ever since.

During field camp, I found a near perfect leaf fossil that I still have. I brought it into camp that evening, showed it to Dr. DeVoto and told him the formation from which it came. He immediately wanted to go back to where I had found it—not tomorrow, but now. We only had a couple of hours of daylight left. When we arrived at the place, he looked around, then took off with me in tow. Showing me how to walk outcrops, drop down one formation and walk again. He made it clear that I was not in the stratigraphic horizon that I thought I was. Therefore, the find became normal instead of extraordinary.

The graduate students loved him. When I came back for my master's after serving for three years in the military, I found out why. He was always available, always interested, always helpful and always positive.

James L. Evans '69, MS '73

It was heartening to read Larry Borowski's article in the Fall issue of *Mines* magazine. The "cradle to grave" vision that he describes is necessary and overdue in its emphasis. I commend the School's leadership for this foresight and will be cheering them on. Historically, Mines has dealt with financial realities of the present, while never failing to see the future.

At my "advanced" age I have an enviable box seat in the stadium of energy development. While involved in research for a company that is developing new ways to utilize our nation's coal resources with minimal environmental impact, I am on the advisory board of another company that is developing uranium reserves. Our country and others will rely largely on fossil fuels while the nuclear option returns to the scene.

Dr. Bisque, Professor Emeritus, Geochemistry

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Comments and suggestions are welcome. Contact us by writing to *Mines* Magazine, P.O. Box 1410, Golden, CO 80402; or call 303-273-3294 or 800-446-9488, ext. 3294 between 8 a.m. and 5 p.m. M-F, MST; or email magazine@mines.edu.

Dear Readers,

Happy new year! I hope you have enjoyed a restful time with family and friends over the holidays and are optimistic about the year ahead.

In spite of the many political and economic uncertainties around the country and the world, there is a strong mood of optimism at Mines. Perhaps it is fueled by all the good news: sponsored research is up, several major new initiatives are being funded, ongoing energy research of all kinds is being followed closely and student enrollment statistics are strong. Or maybe it can be explained more generally: With the world's appetite for energy and other natural resources skyrocketing, the School and its alumni are in high demand. Whatever the reason, Mines is a particularly dynamic and exciting place to be right now, and I look forward to covering new developments on campus in the coming year.

I'm particularly pleased with the feature stories in this issue. Illustrated on the cover, Millicent Schmidt's '03 story, "Expanding Educational Frontiers," describes how a volunteer group of students created a remarkable teaching technology—in signature Mines style, resourcefulness and creative problem-solving featured large. "Staying in the Game," by Jack Sommars, addresses the country's looming shortfall in qualified engineers and scientists, detailing what Mines is doing to tackle the issue. In "Oil from Stone," Paul Roberts provides an informative survey of oil shale, giving us a window into this colossal energy resource that is burdened by so many environmental concerns. And the story I wrote on cosmic ray detection, "Messengers from the Extreme Universe," illustrates the remarkable reach of modern science as it hints at the nature of the universe's most extreme environments.

I hope you enjoy this issue. We've accomplished a lot with *Mines* magazine in 2007—a fresh design, a brand new website and a revised editorial focus—and we have plenty in store for 2008. Keep the feedback coming.

Best wishes for a constructive start to the year,

Nick Sutcliffe
Editor and Director of Communications, CSMAA

Campus News

Mines Cycling Club Wins National Title

The Colorado School of Mines Cycling Club rode away with the Division II title at the 2007 USA Cycling Collegiate National Championship held in October in Banner Elk, NC.

Despite extremely muddy conditions, 12 Mines athletes trounced the nation's strongest Division II teams, claiming 14 top-10 finishes in eight events. Races included men's and women's downhill, dual slalom, cross country and short track.

Prior to the national win, Mines dominated the Division II competition at the Rocky Mountain Collegiate Cycling Conference Finals in Gunnison, CO. Mines riders won all of the individual A-category titles as well as the overall team title.

"Brandon Turman has done an outstanding job leading this team since he took over as president in 2005-06," said John Howard, director of intramural and club sports. "Almost overnight it became one of the best run clubs at Mines. He's got amazing dedication and passion."

Loaded with bikes and gear, the team drove 25 hours to compete in North Carolina. "It was a personal goal of mine to establish a team with a strong presence in the collegiate cycling world," said Turman. "Placing fifth last year gave us momentum to capture the title this year. Mines has always had the potential to be at the top of the collegiate ranks. The caliber of cyclists at this school is impressive—maybe it's a Colorado thing."

Team member Melissa Marts relished the opportunity to compete in North Carolina. "Nationals this year was so exciting. I really liked how we all came together. We needed every member of the team to win—everyone had to make sacrifices," said Marts. "We were blessed to have a team that was so cohesive and supportive. Everyone pitched in—from fix-

ing bikes to washing each other's mud-soaked clothes so we could ride again the next day."

While enjoying a family vacation in the North Carolina mountains, alumnus John "Tree" Scheve '66 was delighted to stumble across the event. Scheve said, "It was great to watch them. I became their unofficial photographer... I was so impressed with the team. They reminded me very much of my contemporaries when I was at Mines over 40 years ago."

Turman is optimistic about the future of collegiate cycling. "It is becoming a much more respected sport," he says. "It can play a big role in the development of future professional athletes—similar to many football and basketball programs."

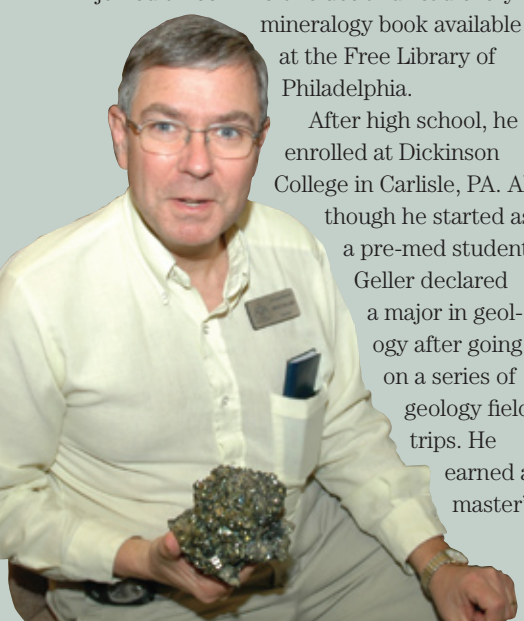
Mines Cycling is a coed club sport that races competitively throughout the region. The club has approximately 70 members, with nearly 35 active racers who compete in mountain, road, collegiate track and cyclocross.

For more information, visit www.csmcycling.com.

Geller Takes Helm at Geology Museum

Bruce Geller, the new director of the Colorado School of Mines Geology Museum, adores rocks and minerals. And this is only fitting, given that he is now responsible for the School's collection of more than 50,000 minerals, fossils, gemstones and artifacts housed at the museum.

"I've collected rocks since I was six years old in Philadelphia," he recounted. "When I was 14, my parents started taking me to mineral club meetings and into quarries on collecting trips. I remember installing a temporary mineral showcase for our high school library." During those years, Geller joined three mineral clubs and read every mineralogy book available at the Free Library of Philadelphia.



After high school, he enrolled at Dickinson College in Carlisle, PA. Although he started as a pre-med student, Geller declared a major in geology after going on a series of geology field trips. He earned a master's degree at Binghamton University in New York and went on to Harvard where he focused on zeolites.

In 1981, Geller came to Denver with Asarco, a silver and base metal mining and smelting company started by the Guggenheims. Shortly after arriving, he compiled a thorough summary of Colorado metal and non-metal mining—"everything from alabaster to zinc," he says. "I learned a lot about the history of Colorado mining in those nine months writing the book. Places like Cripple Creek, Leadville and Silverton have classic geology and fabulous mining legacies." After this compilation, he authored a weekly article known as "Rock Rhetoric" for a mining weekly, *The Mining Record*.

He went on to earn his doctorate at the University of Colorado in Boulder, where he wrote his dissertation on telluride-bearing ore deposits. For most of his 26-year career since graduating, he has worked as an independent mineralogist, primarily for mining companies.

Geller was thrilled when he was chosen to be the director of the Geology Museum. "I love sharing my knowledge about rocks and minerals," says Geller. "People come in with questions about samples all the time. I enjoy interpreting for them—what they are, where they are from, and what geologic conditions might have formed them."

Geller was formally welcomed to the School at an open house in September, attended by well-known geologists and mineral collectors from Colorado, other states and several foreign countries. The international turnout set the stage for a much larger event at the museum slated for September 2008: the sixth International Conference on Mineralogy and Museums. "It will be the first time it has been held in the U.S.," says Geller, who will organize the event that only occurs every four years.

In Geller's first few months at the museum he has formed a Museum Advisory Council and is developing plans for a gift shop. To augment his staff of 12 students, he hopes to build up an active group of knowledgeable volunteers.

Geller's future plans for the museum are ambitious. "I've inherited a great facility and an outstanding collection. Now I'd like to take it to an even higher level, so even more people can enjoy this resource. To that end, I hope to shift our emphasis from the beauty of minerals to the science behind them by introducing more text into our exhibits. I hope to establish our museum as one of the finest in the country," says Geller.

Work Hard, Play Hard

After opening its doors in August, the new Student Recreation Center is getting a strong thumbs-up from students. Brandon Leimbach, director of Recreational Sports, said, "After the initial excitement, you often see a dip in the number of people using a facility like this. We've been seeing our numbers improve as we offer more opportunities to the community." At present, about 800 students and members use the facility Monday through Thursday, with traffic on Friday and over the weekend slowing a bit.

John Howard, director of Intramural and Club Sports, has seen participation in his programs go up across the board. "We had 26 teams sign up for dodgeball this semester. That took us by surprise and we had to juggle the scheduling around. Last year we only had 12 teams," Howard said. He also remarked that indoor soccer was so popular this semester that he is considering running a league in the spring. The IM swim meet in November had approximately 90 participants. And this fall about 900 students made up 60 flag football teams, compared to 55 last year.

With winter approaching, Howard expects to see an even more pronounced growth in IM sports. "Basketball is going to be huge. I'm expecting about 400 students to make up about 50 teams—we had 30 teams last year," he said, adding that he has plans to launch a brand new floor hockey league this spring.

Howard is also pleased to see the increase in spontaneous group activities. "There are pick-up games going on all the time in the evening. Even with club sport practices and intramural leagues/tournaments, we keep at least one court open for drop-in play," he said.

Sophomore Lynlee Gerk found a new sport thanks to the Student Recreation Center. "I took a climbing class this fall," she says. "I probably wouldn't have ever started climbing if it weren't for the new Rec Center. I love the sport. I've learned a lot and met new friends along the way."

Beyond organized sports, there is a wide range of activities available to students. Fitness classes such as yoga, kickboxing, step aerobics and circuit training are offered every weekday. The climbing wall is open every evening except Saturday, and the pool is available for lap swimming several times each day. Cardio and weight training equipment can be accessed whenever the facility is open.

Thomas Cooper, lightboximages.com

During the fall semester, the Student Recreation Center hosted several varsity sports events, including volleyball games and swim meets. More than 30 men's and women's basketball games are scheduled in Lockridge Arena during the winter. And later in the spring, the 2008 Colorado State High School Athletics Association state regional basketball tournament will be held in the facility—an event that will bring thousands of high school students, coaches and families to campus.

The center is also in demand for non-sporting events. Career Day, which this fall included a record 180 companies, was held in the facility. And the School's annual donor recognition event, the Mines Century Society Dinner, took place in Lockridge Arena.

Leimbach notes, "This facility adds an important dimension to student life at Mines. The payoff is huge. We all know that Mines students work hard in the classroom. Now that they have this facility, they have more opportunities to play hard as well, and that's exactly what they are doing."

EPICS Team Competes in Hawaii

Armed with a model for a lunar habitat what does it say on page , an eight-member Mines EPICS team traveled to Hawaii this fall to participate in a challenge issued by the Pacific International Space Center for Exploration System (PISCES) to develop a strategic plan influencing construction and operation of an outpost on the moon.

In fall 2006, an original 14-member team had preceded them with a design that was ultimately selected for this year's final round of only three plans. This year's team, consisting of four women and four men from the original team, had refined the original design in preparation for this year's competition in Hilo, HI. The team competed against peers from the University of Colorado and Hawaii Community College.

The PISCES Program was initiated through the leadership program, sponsored by EPICS, which offers students the opportunity to explore leadership skills in an engineering design environment. The projects focus on strategic planning and community planning for upper-level management.

The Mines team addressed design issues for a lunar habitat involving in-situ resource utilization. The team divided the project into three systems: habitation (human support), resource extraction and utilization, and power.

EPICS Director Bob Knecht said the group from Mines caught the attention of the audience with its controversial use of lava tubes for the structure of the lunar habitat. "You could have heard a pin drop as Josh and Cassie discussed the advantages of their habitat and the integration of resource utilization to support construction of the habitat. They fielded some contentious questions following the presentation in the true Mines spirit," he said.

In the end, Hawaii Community College won the bid with a detailed architectural design of a surface habitat. Mines moved the project forward, developing a network with the CU and Hawaiian teams to collaborate on an integrated research strategy for future PISCES competitions.

Although they didn't win, the Mines team achieved its objective to promote research for its unique design and was invited to co-author a paper for the International Conference on Environmental Sustainability in the spring. Additionally, the group was invited to refine its strategic plan for resources utilization for a NASA competition.

Following the competition, Mines students took a field trip to observe the simulated lunar surface created by the volcanic craters located on the Big Island. When they toured the Thurston lava tube, the team was more convinced than ever that its design was feasible.

In Brief...

Dendy Sloan and **Carolyn Koh** were featured in the October 2007 edition of *Physics Today* with an article titled "Clathrate Hydrates Under Pressure."

Neal Sullivan was named director of the Colorado Fuel Cell Center. Sullivan has served as a faculty member of the CFCC and is an assistant professor of mechanical engineering who specializes in solid-oxide fuel cells and experimental diagnostics.

Jorg Drewes was awarded the Outstanding Research Award by the Rocky Mountain Section of the American Water Works Association for his exceptional performance and dedication to improving water quality and treatment processes.

Arthur Lakes Library Director **Joanne V. Lerud-Heck** was selected for the Arthur Gray Leonard Service Award by the Geology Department at the University of North Dakota. The award recognizes outstanding achievement in the geosciences in research, teaching studies and projects applied to societal needs, teaching, educational development and leadership in conservation of the Earth's resources and environment.

George Saunders '81, a MacArthur Fellow, read from and signed his latest book, *The Braindead Megaphone,* on campus in October as part of the LAIS Hennebach Lecture Series. Saunders received a bachelor's degree in geophysical engineering from Mines and is currently a professor of creative writing at Syracuse University.

Sustainability expert **Hunter Lovins** presented "Drivers of Change: The Business Case for Sustainability and Protecting the Climate," as part of the Hennebach Lecture Series. Lovins is the president and founder of Natural Capitalism Solutions and co-creator of the Natural Capitalism concept.

The 2008 award recipients of the American Association of Petroleum Geologists include the following Mines awardees and honorees: **Fred F. Meisner**—Sidney Powers Memorial Award, **Stephen A. Sonnenberg**—Honorary Member Award, **Douglas C. Peters**—Distinguished Service Award, **Cathy L. Farmer** and **Brian W. Horn**—George C. Matson Award.

Paul Sava of the Center for Wave Phenomena and Department of Geophysics was recognized by the Society of Exploration Geophysicists with the Reginald Fessenden Award for his work on wave-equation angle-domain imaging.

High-Tech Rock Abuse

Geophysicists are masters of uncertainty. Armed only with theories, algorithms, and a few snippets of information about the rock they are studying, they interpret sound-wave data and formulate highly detailed predictions about the subsurface. By and large, these predications are remarkably accurate, but geophysicists are rarely 100 percent certain until a hole is bored into the ground and samples are brought up for analysis. More often than not, there is a degree of guesswork that goes into interpreting seismic data.

Mike Batzle, who heads up Mines' Center for Rock Abuse (CRA) explains: "Predictions from seismic data are based on theories," he says. "But theories have adjustable knobs. If you don't know where the right settings are, then you have to make a guess."

The CRA is helping provide the right "settings" for geophysicists by analyzing rock samples in the lab. Taking a fist-sized column of rock, they can calibrate changes in seismic signature under a variety of different conditions—this is where the "abuse" comes in. "We will often squeeze the rock, exerting pressures that mimic the sample's native environment. Then we might inject either a liquid or a gas and calibrate the speed that sound moves through the sample under those conditions," says Batzle. "Then we'll inject a different gas or liquid and test again. We might do this with methane, carbon dioxide, water, oil or a mixture of two or more of these, each time registering the change in seismic signature."

With the CRA's results in hand, geophysicists can be much more certain of their interpretations. "They can point to a given signature and be pretty sure of what that signal means—whether the rock transitions from natural gas to water, or natural gas to oil, or oil to water, or even water to a mixture of carbon dioxide and petroleum."

The lab's results are not only useful for interpreting seismic surveys from the region where the sample originated. They can also be used to interpret seismic data from any area where a similar rock is found. Manika Prasad, the lab's co-director, points out that with each new kind of rock they test, they add to their database. "With some rocks we get in, we can simply go to data from previous tests of similar rock. As our database of seismic signatures grows, we can extrapolate more and more," she says.

In addition to seismic analysis, the lab also tests porosity, permeability and strength of samples. This can provide valuable baseline information for predicting how fast fluids and gas will flow under certain conditions, how much gas or oil is contained in a given formation and how best to fracture rock to increase flow rates.

Thomas Cooper, lightboximages.com

Manika Prasad and Marisa Rydzy.

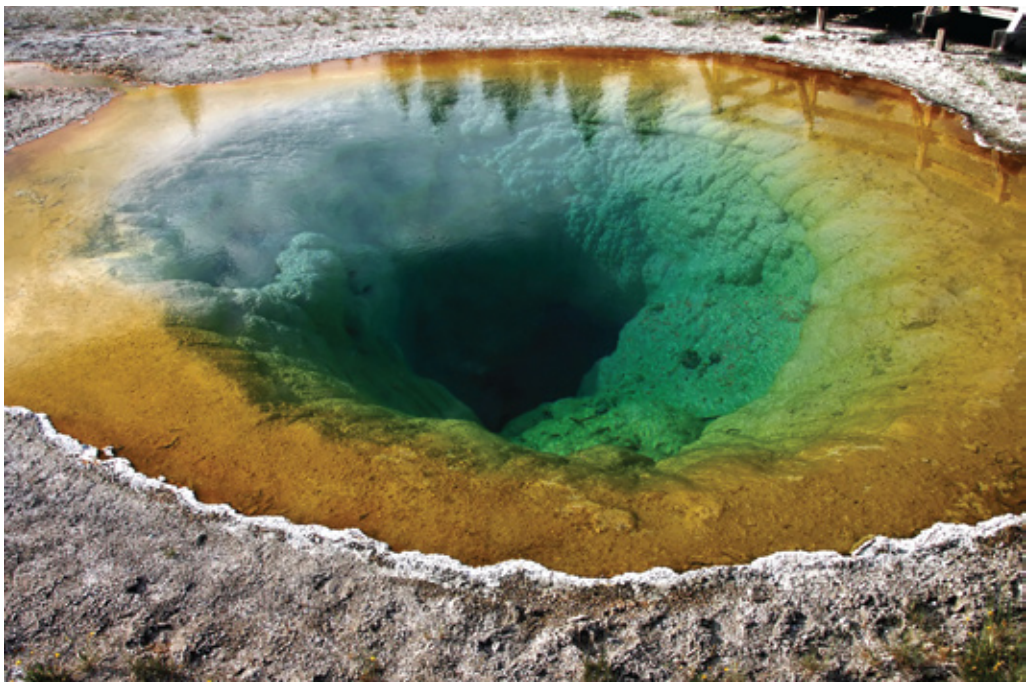
In addition to calibrating rocks, the lab also analyzes liquid and gaseous hydrocarbons in isolation. "There is a lot of interest in heavy oils right now because they are so plentiful," says Batzle. "But they are thick and hard to extract. Heating the oil-bearing strata can lower its viscosity, allowing oil to flow more easily. When this is done, seismic imaging can be used to monitor the production process remotely, but to do this accurately—to translate seismic wiggles into materials and conditions—the seismic signatures of the various materials must be known. That's what we can provide."

The laboratory is home to eight graduate students, one full-time technician and several visiting scholars. Much of the work is done in collaboration with other departments and universities, particularly the Rock Physics Lab at the University of Houston.

Indicative of their high profile, the CRA client list includes a raft of blue chip oil and gas corporations and service companies from around the world, including Anadarko, BP, British Gas, Chevron, EnCana, Shell, Petrobras, StatoilHydro, ExxonMobil, Devon, Japan Oil and Minerals, Chinese National Oil, Schlumberger, CggVeritas, Paradigm, and others. Batzle says, "There aren't many other labs doing what we do. We've got a lot of toys and can recreate just about any kind of underground condition. It's fun. We get paid to play, and we're building up a very valuable database of information."

Bio-Prospecting for a Hydrogen Economy

When the "hydrogen economy" was first presented to the public as a "green" alternative to hydrocarbons, most scientists and engineers scoffed—knowing that the vast majority of hydrogen was manufactured from natural gas made it a sham. On the other hand, the same group would sit up and take note if a way were found to manufacture hydrogen on an industrial scale by harnessing nature's ability to split water molecules using only the sun's energy. The industrial application of such an approach remains only a theoretical possibility, but rapid progress in bioengineering is advancing the science, and Colorado School of Mines is making some important contributions.



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Particularly robust microorganisms found in the hot pools within and around Yellowstone National Park may offer valuable biological traits for renewable hydrogen production.

Photosynthesis typically involves two discrete steps. First, light powers the oxidation of water in the presence of chlorophyll, stripping electrons and hydrogen ions from oxygen. In the second step, the liberated electrons are combined with carbon dioxide to create a simple carbohydrate. The challenge for molecular biologists is to intercept the energy generated after the water-splitting step of this process, before it is chemically bound up with carbon, channeling that energy toward the manufacture of hydrogen gas instead.

And there are organisms that have naturally evolved the ability to do this. Mathew Posewitz, a research professor at Mines who works in collaboration with the National Renewable Energy Laboratory, describes how certain algae, when deprived of oxygen or exposed to other unusual conditions, will switch from fixing carbon dioxide to manufacturing hydrogen gas. The problem is that for industrial-scale production of hydrogen, they need an organism that will do this under normal conditions, and none has yet been found. "We would prefer to use a naturally occurring organism. We've been looking for a while, and the search will go on," says Posewitz. "But it may not be out there. We may be looking at bioengineering."

To this end, the Mines-NREL collaboration made an important contribution in 2004 when they published a paper on how the enzyme hydrogenase can be transferred from one species to another. Hydrogenase is the catalyst that enables the creation of hydrogen gas from the electrons and protons freed by water oxidation. In labs around the world, numerous previous attempts to transfer active hydrogenase into other organisms had been unsuccessful, so the group's findings represented a major breakthrough.

With this bioengineering roadblock removed, the Mines-NREL research group is now focusing on what they call "bio-prospecting." They are continuing to search for an organism that will generate hydrogen naturally, but they are also looking for robust biological traits that they can genetically engineer. "We want to find the right photosynthetic organism that can efficiently harvest

photons of light and oxidize water, and then find the right hydrogenase that can reduce the protons to hydrogen gas, and get those traits into the same critter," says Posewitz. "We want the best photo system and the best hydrogenase combined into a single organism."

Their hunt for appropriate biological traits is focused on some quite extreme environments, including the Great Salt Lake and the hot pools in and around Yellowstone National Park. Posewitz explains, "If bio-energy production is ever going to be a reality, we are talking about very large-scale production, and we aren't going to have adequate freshwater resources or arable land to devote to it. Algae in the Great Salt Lake have evolved to tolerate extremely saline water, and we have plenty of that."

The reason for sampling high-temperature environments is to find the most stable hydrogenase. "When we transfer traits to our organism of choice, we want to impart robust qualities that aren't going to breakdown," says Posewitz, who points out that organisms adapted to high-temperature environments tend to have more stable enzymes and proteins.

Although great strides have been made in recent years, there is much left to be done. Posewitz estimates that if they are lucky, in 10 or 15 years they may have an organism that can do everything they are aiming for. After that, rolling out production in a way that makes economic sense will be incremental and could take many forms.

Jon Meuser, a graduate student at Mines who works with Posewitz, believes that biological hydrogen production may be just one component of a larger industrial operation. "The same infrastructure created to farm algae for hydrogen could also support algae that produce other useful products, such as lipids for biodiesel, or lactate for bioplastics," he says. "The 'biorefinery' of the future could one day produce many products we currently get from oil."

For now, Posewitz and his colleagues continue to work on the biochemistry of hydrogen production: "There are many obstacles to overcome. We are working upstream against billions of years of evolution—photosynthetic organisms want to use the energy they capture for themselves. We have to tinker with those systems and make them do what we want them to do. It's sort of like trying to get your children in line—it's not always easy to get biology to do what you want."

"Chaos Tamed"— Extraction signal from noise

For the geophysicist, noise and randomness are usually undesirable. But in an essay published last summer in *Nature* (vol. 447, p.643), entitled, "Chaos Tamed," Geophysics Professor Roel Snieder, along with his colleague Kees Wapenaar at Delft University of Technology, Netherlands, demonstrate that randomness can actually help in a new technology used for imaging. In normal imaging, as used for example with radar or seismic exploration, a source excites waves that bounce back from a target. These reflected waves are used to locate and characterize the target. However, in previous theoretical research it was discovered that an active source is not really needed, and that random noise can be used for imaging. For seismic imaging this noise can have cultural sources, such as traffic, or it may be natural, such as waves breaking. According to the underlying theory, the noise sources must be distributed everywhere, but in practice one can violate this to a remarkable degree. Snieder carries out an active research program on the extraction of information from noise with colleagues at Shell Research in Houston and with Kees Wapenaar at Delft University of Technology in the Netherlands.

Spiral Form in Nature and Engineering

The utility of wine openers rests on a familiar principle, the coupling between twist and translation. The form that sets the function is the handedness of the cork-screw, or the sign of the coupling. A recent study by Engineering Division student Dr. Hailong Wang and Professor Moneesh Upmanyu published in the *Journal of the Royal Society Interface* (available online: http://dx.doi.org/doi:10.1098/rsif.2007.1145) shows that the coupling in more flexible slender rods such as DNA can change sign, a combination of how the stretch is accommodated and handedness. The study settles the rather curious puzzle as to why DNA overwinds when stretched, with implications in nature and technology. Unsurprisingly, this is not news to Mother Nature, with examples ranging from spiral growth in fungi to propulsion of rod-like bacteria. An easily observable example is the change in spiral grain structure in certain pine trees. The study was sponsored by National Science Foundation and was also featured in the October 2007 Materials Research Society newsletter.

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Pollution Prevention—Bio-based Materials and Energy

Chemical Engineering Professor John Dorgan and former faculty member Dr. Dianne Ahmann have coauthored a new EPA report entitled *Bioengineering for Pollution Prevention Through Development of Biobased Materials and Energy*. The 173-page document examines scientists' understanding of plant matter and other bio-based alternatives to petroleum for materials and energy. The report examines progress made towards using plants, plant oils and microbes for plastics and fuels, as well as the challenges for using these alternatives on scales large enough to meet society's needs and still protect the environment. The report documents the extent to which economies around the world are dependent on petroleum. As demand for petroleum increases and supplies diminish, petroleum-based economies need to move to plastics and fuels that are renewable, domestically available and more environmentally friendly. Scientists and engineers are exploring many options through the field of industrial biotechnology, and results of some of their research are reviewed in this report. With recommendations for further action, the report encourages scientific discussion and identifies potential opportunities for interdisciplinary research. The report is now available at the EPA's research homepage: http://es.epa.gov/ncer/events/news/2007/07_18_07_feature.html.

Mines Football Plays in 2007 Dixie Rotary Bowl

After finishing with a 6-2 mark in the Rocky Mountain Athletic Conference (RMAC) in 2007, the Colorado School of Mines football team accepted an invitation to compete against Western Oregon University in the 22nd Annual Dixie Rotary Bowl on December 1, in St. George, UT.

Mines appearance in the 2007 Dixie Rotary Bowl, which was played at Hansen Stadium on the Dixie State College campus, marked the second time in four years that the Orediggers had advanced into the post-season, and the third time in program history that Mines had competed in a post-season bowl game. Despite a 26-12 loss in the Dixie Rotary Bowl, the Orediggers finished at 7-5 overall to secure their sixth winning season in the past seven years.

The top schools from the RMAC and the newly formed football league of the Great Northwest Athletic Conference that did not qualify for NCAA Division II playoffs this fall received the invitations to play in the 2007 Dixie Rotary Bowl.

"We were very excited about our opportunity to compete in the 2007 Dixie Rotary Bowl," said Bob Stitt, head football coach at Colorado School of Mines. "We were proud to represent the RMAC and we truly enjoyed our trip to St. George, Utah."

A.J. Montalvo

A.J. Montalvo, a junior linebacker from Houston, TX, was selected as the Orediggers' Most Outstanding Player in the bowl game.

The Dixie Rotary Bowl, which began inviting NCAA Division II schools in 2006, is one of two sanctioned NCAA Division II bowl games. Prior to 2006, the Dixie Rotary Bowl was the premiere junior college bowl game in the country for 20 years.

Thompson Named RMAC & Academic All-RMAC Player of the Year

Craig Thompson, a senior on the Colorado School of Mines men's soccer team, was one of three Orediggers to earn a spot on the First Team Academic All-RMAC squad this fall. One of five unanimous selections on the First Team, Thompson also earned RMAC Men's Soccer Academic Player of the Year accolades. Thompson, who also earned Academic All-RMAC recognition in 2006, has maintained a 3.74 cumulative grade point average while majoring in chemical engineering.

Craig Thompson

Mines' Nick Kubala and Jeff Nelson also qualified for First Team Academic All-RMAC laurels, while John Moseley earned Second Team honors. Matt Zachman, Kenan Bisic and Drew Werth all earned recognition on the Academic All-RMAC Honor Roll.

Thompson also went on to earn RMAC Player of the Year and First Team All-RMAC honors in 2007. For Thompson, who garnered All-Midwest Region accolades as a junior, 2007 marked the second time in as many seasons that he brought home First Team All-RMAC laurels. Joining Thompson on the All-RMAC team were Kubala (First Team) and Ross Davis (Honorable Mention). Kubala also earned ESPN The Magazine / CoSIDA First Team Academic All-District recognition.

The Orediggers, who qualified as the number 4 seed in the RMAC Tournament and advanced into the league's championship match, finished the 2007 season with an 11-9-2 overall record (7-6-1 in the RMAC).

Orediggers Retire Jerseys

Harry D. Campbell '42

During halftime at its October 13 game against Western New Mexico University, Mines forever retired the jersey (#48) of 1942 petroleum engineering graduate and member of Mines' undefeated football team of 1939 Harry D. Campbell. By establishing endowments and making major gifts to support scholarships, faculty, facilities and athletics, Harry has helped the School to make great strides in both athletics and academics. Recently, he funded the development of a new football field— the Harry D. Campbell Field—with a major gift, and was inducted into the Platinum Level of the Mines Century Society in recognition of six decades of tremendous generosity.

"It is with great pleasure and gratitude that we retire the jersey of Mr. Campbell and recognize his support," said Tom Spicer, director of Athletics. Campbell was inducted into the Athletics Hall of Fame in 2004 as an outstanding supporter.

John P. Lockridge '52

On November 16, Colorado School of Mines retired the men's basketball jersey (#16) of John Lockridge, a 1952 geological engineering graduate and one of the School's most loyal supporters. The jersey was retired prior to the Orediggers' first-ever regular-season Mines basketball game at Lockridge Arena in the Student Recreation Center. John and his wife, Erika, were instrumental in making the 2,500-seat arena a reality, and the couple has generously contributed to numerous scholarships and academic programs at Mines over the years.

John was awarded Mines' Distinguished Achievement Medal in 1982 and was selected as an Honorary Member of the Colorado School of Mines Alumni Association in 1997. John and Erika were inducted into the Mines Athletics Hall of Fame in 2003 as outstanding supporters, and they are members of the Platinum Level of the Mines Century Society, which honors alumni and friends who have distinguished themselves through extraordinary lifetime giving to the School.

Orediggers News & Notes…

Clifton Oertli

• The Colorado School of Mines men's cross country team finished seventh in the nation at the NCAA Division II National Cross Country Championships on November 17, in Joplin, MO. Almost a month earlier, the team placed third in the October 20 RMAC Championships in Durango, CO. The Oredigger men, who were ranked as high as fifth in the country this fall, also posted first-place finishes at the Woody Greeno Invitational and the Fort Hays State University Invitational.

• Twelve student-athletes from the Oredigger football team, as well as three from the Mines volleyball squad, earned Academic All-RMAC recognition in the fall of 2007. Volleyball's Kaity Edmiston, a sophomore from Clifton, CO, was a First Team Academic All-RMAC performer.

For complete schedules, rosters, results and statistics, please visit the Colorado School of Mines Athletics website at http://athletics.mines.edu.

Mines Women's Soccer Nets Success on the Field and in the Classroom

In the fall of 2005, Colorado School of Mines added women's soccer as an intercollegiate varsity sport for the first time in school history. After finishing with a respectable 7-8-0 overall record during their inaugural season, the 2006 Orediggers recorded just five victories and missed out on the annual Rocky Mountain Athletic Conference (RMAC) Tournament. Now, in just its third year of existence, the Mines women's soccer program has become a legitimate contender in a conference that has sent a host of teams to the NCAA Division II Tournament in recent years.

After concluding the 2007 regular season with an 8-3-1 record in conference play, Colorado School of Mines (12-8-1 overall) qualified as the #3 seed in the RMAC Tournament. Following a 3-0 Quarterfinal victory over the #6 seed New Mexico Highlands University at the friendly confines of Brooks Field, the Orediggers' season came to an end with a 3-1 setback to #2 seed Colorado State University—Pueblo in the RMAC Semifinals at Auraria Field in Denver.

At the end of the year, four Orediggers earned all-conference accolades, including Kayla Mitchell, who garnered First Team All-RMAC recognition. Elizabeth Oba was a Second Team All-RMAC pick, while Diane Wetzel and Corinne Johnson were both Honorable Mention All-RMAC selections.

"The success of the third-year women's soccer program is a tribute to the hard work of the student-athletes and a reinforcement of the belief that the Mines administration had in starting the program," said Frank Kohlenstein, who serves as the head coach for both the men's and women's soccer teams. "The RMAC is a great soccer conference, and we hope to continue to build our women's team to be a part of that greatness."

Kayla Mitchell

Just as impressive, however, was the fact that the women's soccer team produced five Academic All-RMAC performers during the fall of 2007. Mitchell, Wetzel and Adrea Johnson each garnered First Team Academic All-RMAC laurels while Corinne Johnson and Alyson Burchardt were Second Team Academic All-RMAC performers. In order to be nominated for this honor, a student-athlete must carry a 3.20-or-better cumulative grade point average, be a starter or key reserve and must have completed at least two consecutive semesters at her current institution.

Additionally, five other student-athletes—Ashley Wagener, Stefanie Frelinger, Erin Neil, Erin Doherty and Marissa Burson—earned recognition on the Academic All-RMAC Honor Roll in the fall of 2007.

"We are very proud of our women's soccer program," exclaimed Tom Spicer, Mines director of athletics. "Coach Kohlenstein, his staff and his players have represented Colorado School of Mines admirably on the field, as well as in the classroom."

Winter Athletics Home Schedules

MEN'S & WOMEN'S BASKETBALL

Jan. 4	Mesa State	6:00 pm & 8:00 pm
Jan. 5	Fort Lewis	6:00 pm & 8:00 pm
Jan. 18	Colorado Christian University	6:00 pm & 8:00 pm
Jan. 19	Metro State	6:00 pm & 8:00 pm
Feb. 8	Nebraska – Kearney	6:00 pm & 8:00 pm
Feb. 9	Chadron State	6:00 pm & 8:00 pm
Feb. 15	UC – Colorado Springs	6:00 pm & 8:00 pm
Feb. 16	Regis University	6:00 pm & 8:00 pm

SWIMMING & DIVING

Jan. 12	Metro State	10:00 am
Jan. 18	California State – East Bay	5:00 pm
Feb. 2	Univ. of Denver (swimming only)	11:00 am
Feb. 14-16	Rocky Mountain Invitational	TBA

WRESTLING

Feb. 8	Adams State	7:00 pm
Feb. 15	Western State	7:00 pm
Feb. 16	N.M. Highlands University	7:00 pm
Feb. 20	Mesa State	7:00 pm

INDOOR TRACK & FIELD

Jan. 26	Joe Davies Open	8:30 am
Feb. 16	Mines All-Comers	8:30 am
Feb. 22	Mines Twilight Open	3:00 pm

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An investment in knowledge always pays the best interest.
—*Benjamin Franklin*

Music and Mingling at the Mines Century Society Dinner

Alumni and friends celebrated the School's philanthropic spirit at the Mines Century Society Dinner in the new Student Recreation Center on October 12. President's Council, Heritage Society and Mines Century Society members mingled with department heads, board members and administration in Lockridge Arena, which was transformed into a festive venue. President Scoggins paid special recognition on behalf of the School to 2006-2007 members of the Simon Guggenheim Society of the President's Council, listed by class year in the Annual Report of Giving enclosed in this magazine, and new and rising members of the Mines Century Society, listed below.

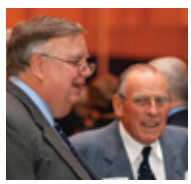
The Mines Century Society honors individuals at Copper, Silver, Gold, Platinum and Diamond levels, whose cumulative gifts to the School total $100,000 or more.

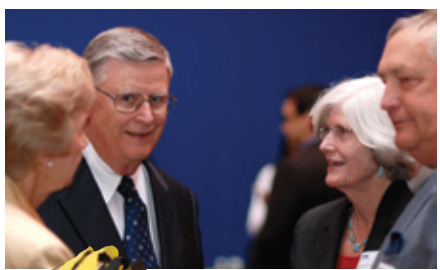
Platinum Level $3,000,000 to $4,999,999
Harry D. Campbell *

Silver Level $500,000 to $999,999
Stanley and Judy Dempsey #
Alfred T. Ireson #
Harold M. and Patricia M. Korell #
Rob and Ann McKee #
Thomas C. Snedeker #

Copper Level $100,000 to $499,999
Frank J. Adler
LaVerna K. Anderson
John H. and Margaret S. Barney
Michael E. Carr
James S. and Jacqueline Classen
Irwin M. and Wilda Glasser
Charles S. and Judy A. McNeil
F. H. Merelli
Jack W. and Cherri M. Musser
Daniel Pavone
John S. and Danielle R. Phillips
Charles J. and Kathy E. Vasilius
James R. Weber

* Previously a Gold MCS member
\# Previously a Copper MCS member





BP Strengthens Critical Partnership with $750,000 Gift

Sandy Stash '81 named Executive Sponsor for Mines

BP has pledged $750,000 toward scholarship and fellowship support for Mines students, strengthening the School as a key source of talent for its global operations. Additionally, the company has named Sandy Stash '81, vice president for regulatory affairs and compliance for BP Exploration Alaska, as BP Executive Sponsor for Mines.

Top students in chemical engineering, geology, geophysics, economics and business, mechanical engineering and petroleum engineering will be eligible for financial support through the new BP program. In addition, recipients will have the opportunity to apply for internships and full-time positions with the company.

As BP's executive sponsor, Stash has begun working with the School and the company to identify additional areas of collaboration and mutual benefit. In September, she met with academic and program leaders at Mines to discuss BP's role in educational enhancement as well as potential research and commercial projects.

Stash plans to launch a series of activities to raise the company's profile as an employer of choice on campus. "Clearly, the biggest challenge for BP and the global energy business is to find people with the right skills to lead the industry into the next several decades and beyond," said Stash. As "tenacious problem solvers" with excellent technical and critical thinking skills, she noted that Mines graduates are among BP's most valuable employees. Many recent Mines graduates who have joined the company are poised to take future leadership positions with BP, she added.

From a personal standpoint, Stash relishes the opportunity to reconnect with the Mines community. "I feel very fortunate to have had a Mines education," she said, "and am thrilled to have the opportunity to further strengthen and deepen the relationship with BP and Mines."

Mines Receives $309,599 from the Estate of LaVerna K. Anderson; Other Recent Gifts

Colorado School of Mines recently received seven large gifts:

Bequest distributions of $309,599 were received from the estate of **LaVerna K. Anderson** for The Mines Fund, in memory of E. Bernard Klunker.

A bequest of $247,570 from the estate **Emil J. Bruderlin** '10 will provide unrestricted support for The Mines Fund.

Harry D. Campbell '42 made gifts totaling $78,035 to the Harry D. Campbell Football Field Fund. He also made gifts of $103,560 to the Harry Campbell Endowed Scholarship Fund, which supports varsity football players.

Gerald '68 and **Tina Grandey** gave $100,000 in support of the McBride Honors Program, the student-initiated Washington Internship Fund, The Mines Fund, and the Grandey Curriculum Mini-Grant Fund.

The Henry Luce Foundation contributed $108,870 to support Dr. Kathryn Johnson, the Clare Boothe Luce Assistant Professor in Electrical Engineering.

William F. Oline '52 made a gift of $100,410 to the Harry C. Kent Petroleum Geology Graduate Scholarship Fund, established in 1991 to support graduate students in petroleum geology. Harry Kent, a former Mines geology professor, was Bill's college roommate when they attended Mines.

Tom Snedeker '36 established two charitable gift annuities with $120,000 and $30,000 gifts in support of the Petroleum Engineering Department.

Other recent gifts over $25,000 from individuals, corporations and foundations:

Jerome T. '64 and **Rebecca Broussard** continued their support of the Broussard Family Engineering and Technology Management Scholarship Fund with a $50,000 gift.

Margaret Campbell and her husband, **Edward Johnson**, made a $50,000 gift to the Harry Campbell Endowed Scholarship Fund in honor of Harry's recent birthday.

Paul D. Chamberlin, a friend of Mines, established the Chamberlin Endowed Scholarship Fund with a gift of $53,218 to support undergraduates studying extractive metallurgical engineering.

Chesapeake Energy Corporation contributed $25,000 toward the Chesapeake Scholars program.

Johanna P. Collester contributed $33,030 in continued support of the Stewart M. and Johanna P. Collester Fund.

Marshall C. III '67 and **Jane Crouch** gave $40,000 to support student workers at the Geology Museum and Geology Department activities, and to make a payment on their $250,000 commitment to Marquez Hall.

The Daniels Fund contributed $50,000 to support the Mobile Science Show.

Stan and **Judy Dempsey** contributed $25,000 in continued support of Arthur Lakes Library, the Dempsey Endowment for Special Collections, and the Dempsey Endowed Scholarship Fund.

Devon Energy Corporation contributed gifts totaling $70,000 in support of the Petroleum Engineering Department and the Devon Energy Corporation Scholarship.

The Energy Cup contributed $25,000 to support the Energy Cup Scholarship Fund.

ExxonMobil contributed gifts totaling $26,300 in support of the Departments of Chemical Engineering, Engineering, Geology, Geophysics and Petroleum Engineering.

Edward F. Gallegos '92 gave $50,000 to support the Jack Hancock Endowed Scholarship Fund.

Richard J. Gardner '70 made a $25,000 gift in continued support of the Gardner Endowed Scholarship Fund in Athletics and The Mines Fund.

Infiltrator Systems, Inc. continued its support of Dr. Robert L. Siegrist's work in the area of on-site and alternate wastewater technologies with recent gifts totaling $48,000.

Bob Irelan '68 made an additional $25,000 payment toward his $100,000 gift for the Darden Baseball Field Project.

John '52 and **Erika Lockridge** continued their support of the new Recreation Center with a $60,000 gift.

Marathon Oil Company contributed gifts totaling $140,000 toward the Marathon Center of Excellence for Reservoir Studies and the Marathon Oil Company Scholarship Fund.

Charlie McNeil '71 gave $1,000 to The Mines Fund and $25,000 to continue his support of the Recreation Center.

A bequest distribution of $85,000 was received from the estate of **Daniel Pavone** '48, MS '51 in support of The Mines Fund.

Alan G. Provost '62 made a $25,000 gift in continued support of The Mines Fund and the Niles E. Grosvenor Scholarship in Underground Mining Engineering, which he established last year to honor the late Mines professor.

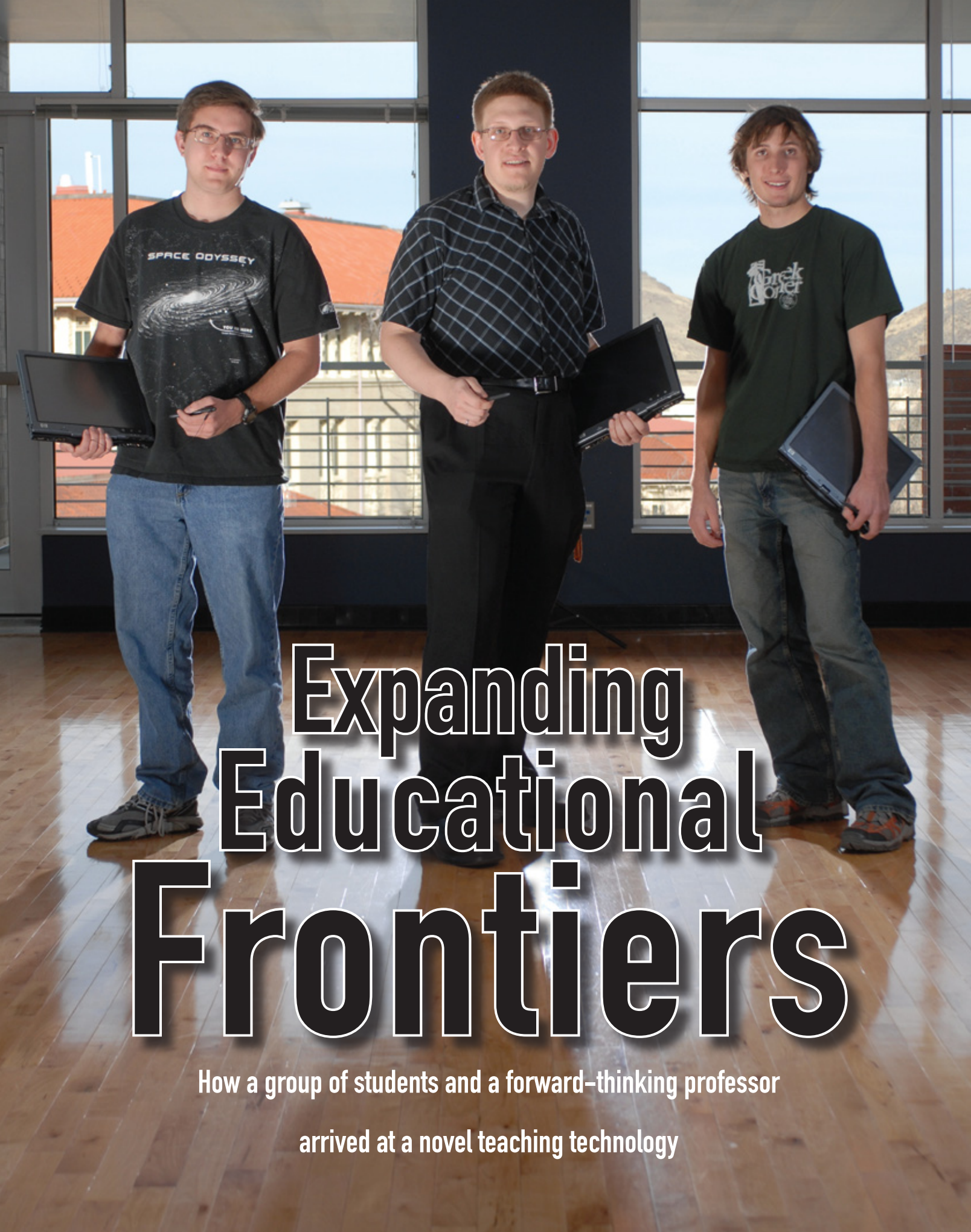
Rio Tinto contributed $48,000 toward the Rio Tinto Student Scholarship Fund.

Schlumberger gave a Faculty for the Future Award of $36,290 to a graduate student in Materials Science.

Shawnee Mission Mining contributed $25,000 to support graduate research in the Department of Mining Engineering.

Shell Oil Company contributed gifts totaling $32,000 in support of the Shell Incentive Scholarships and the Oil Shale Symposium.

Don '56, MS '61 and **Patricia Warner** established a charitable gift annuity with a gift of $50,000, the residuum of which will fund the Don L. and Patricia Warner Scholarship Fund.



Expanding Educational Frontiers

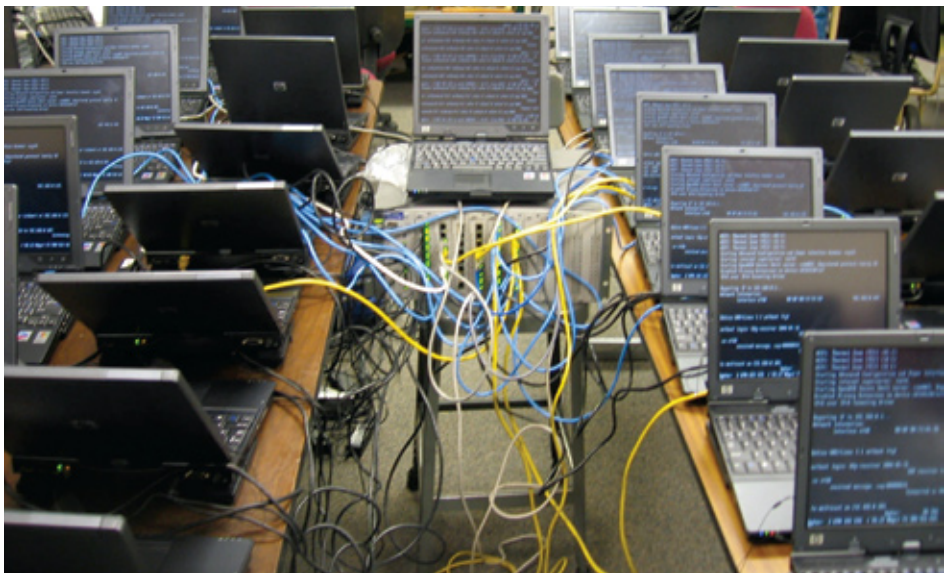
How a group of students and a forward-thinking professor arrived at a novel teaching technology

By Millicent Schmidt

Large foundational classes are an economic necessity for almost all universities, but this reality flies in the face of another: often, the larger the class, the less students learn. Frustrated by this double bind and faced with some challenging material to teach, professors in Mines' Physics Department have been exploring innovative teaching technologies for some time. Led by Professor Frank Kowalski, this quest has taken several interesting turns and culminated in the development of one particularly innovative technology, thanks in large part to a group of ingenious and hardworking students.

The first significant step was taken in 2002, when the department won a Colorado Commission of Higher Education Program of Excellence Award to equip some of their larger lecture halls and classrooms with "clickers"—small wireless devices that electronically transmit student responses to a given question and make the answer distribution instantly available.

Giving professors the ability to instantly assess student understanding, the clicker system was a success and is now widely used on the Mines campus. In fact, five years after being introduced, several classes require that students purchase their own clickers, which are available at the bookstore. Professors find that the technology engages students more actively in lectures and provides helpful feedback on what students do and do not understand. However, the system is limited to multiple-choice questions (or, in some cases, short numeric answers).

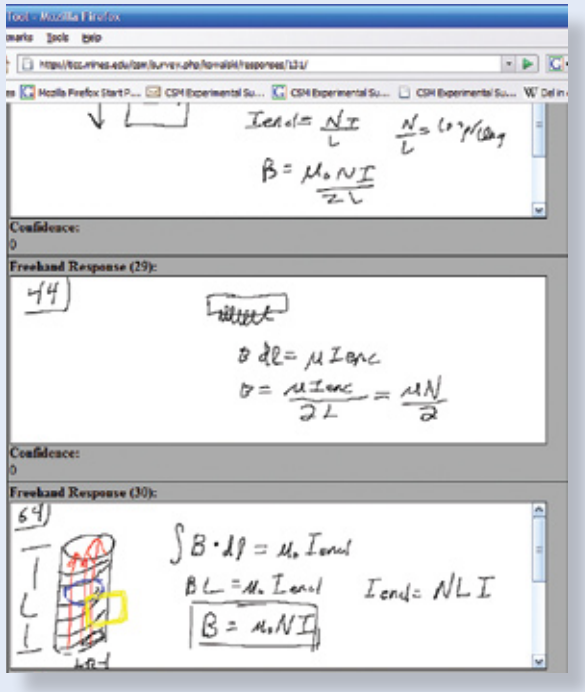


Left: Needing to load identical software onto 60 tablet computers, members of TICC figured out how to configure a single PC and simultaneously "image" that configuration to the others. Facing page (left to right): David Murrell, Erich Hoover and Thomas Wells—three of the six founding members of TICC.

After using clickers for a few years, Kowalski wanted to explore how to assess student understanding more deeply. "A clicker tells you whether students can or can't solve the problem, but if they can't, it doesn't tell you why," said Kowalski. He wanted to be able to pose open-format problems and see how students went about solving them.

To this end, he submitted a request to HP's Technology for Teaching Grant Initiative to equip each of the 60 students in his class with a tablet computer, which allows the user to write on the screen. "The language of math and science is graphical," said Kowalski. "You can't work through a complex problem using a keyboard, so regular laptops weren't an option." His plan for what he'd do if the request was granted was conceptual: "Since students could work problems out on the screens and the PCs had wireless capability,

Thomas Cooper, lightboximages.com



Thomas Cooper, lightboximages.com

This screenshot from the instructor's webpage shows three different students' solutions to the assignment.

I reasoned there must be a way to get their work to my computer at the front of the class for rapid review." But when the department won the grant, the nuts and bolts proved quite challenging as there was no suitable software available on the market.

Instead of trying to tackle the problem himself, Kowalski invited students to take it on. A group of physics majors volunteered and the Technology in the Classroom Committee (TICC) was formed. Kowalski never provided a detailed plan for how the computers would operate, giving TICC free rein to design the best teaching tool they could. They simply had to turn 60 HP tablet computers into an interactive teaching tool that took advantage of the unique features of the computer. Jim Vanides, the worldwide higher education grants program manager for HP, spoke of the novelty of Kowalski's approach: "Recruiting students to develop the teaching technology was brilliant. I don't know of any other projects that took it on from that angle," he said.

TICC ultimately created what is now called *InkSurvey*—a web-based tool for compiling images generated on a tablet PC. The software enables students to post handwritten responses (equations, graphs, diagrams, derivations, etc.) to a website, which can then be viewed instantly by the professor. Vanides, who has seen a wide range of instructional software, spoke in glowing terms of *InkSurvey*: "It's the assessment tool that educators have been looking for forever, because if you know what students are thinking right now, you can help them. If you wait a week, chances are you're not going to help them."

The journey from the HP grant to the launch of *InkSurvey* was not easy, but at each turn, difficulty bred creativity. When members of TICC first approached HP for advice on how to install both Linux and Windows on the computers, the students were told it couldn't be done on this hardware. Responding in true Mines fashion, they took this to mean it wouldn't be easy, and two weeks later they had solved the problem. Funding was another challenge: they had almost none. But by writing their own code and relying on free software available on the internet, they creatively assembled a robust system at minimal cost. Loading the same software on all 60 of the PCs also posed problems. In the end, they prepared one computer and copied that image to the rest. And to help other students optimize their use of the tablet, TICC created a wiki—a document accessed online that can be edited and refined by any user—with documentation and instructions on how to use the software. Instructional support was provided through an online forum, which Kowalski monitored closely.

Frank Kowalski worked closely on this project with his wife, Susan, who is the project coordinator for the Colorado Commission on Higher Education Program of Excellence Award. They are both very proud of what TICC accomplished and are delighted with how *InkSurvey* operates in the classroom. "It's so much easier to clear up misconceptions as students are working on a problem," said Frank Kowalski. "After I pose a problem, I go to my instructor's website and review responses as they come in. After just a handful have been submitted, I'll identify common errors and stop students to address the misunderstanding. Each time I refresh my webpage, I collect more responses, and these guide additional comments. It's a remarkably powerful tool. I can see exactly where students are confused and where to focus my instruction. And if I see that some students are two steps ahead, I make an additional, more challenging problem available for them to work on. It's as close to one-on-one teaching as you can get with a class of 60."

Hilary Brown, a senior majoring in physics, took Kowalski's class in the spring and saw the technology at work first hand: "Dr. Kowalski offered hints to help us along during the allotted time. He was obviously going through and figuring out where we had problems applying concepts. And as we mastered concepts, he'd ask us to apply the concept to a new problem or to set up a new problem. He could match the pace of instruction with the rate at which we were learning."

Knowing that TICC had come up with something quite remarkable, Kowalski asked HP to sponsor travel expenses for some of founding members of TICC to showcase *InkSurvey* at their 2006 Educational Technology Conference in Monterey, CA. A little skeptical at first, Vanides agreed to arrange for six mini-sessions on various aspects of the project. "Sometimes students come along to conferences in a support role for professors. But the Mines students ran their own show entirely, and they created a genuine buzz of excitement. I think they were the highlight of the whole conference," said Vanides, who invited the group back for an encore performance at the 2007 conference.

InkSurvey clearly has great commercial value (evidenced by the number of informal job offers TICC members received at the HP conferences). However, the students are adamant that access to *InkSurvey* and their website (http://ticc.mines.edu) remain free. "We're from a scientific background. We didn't do this to make money. We're just interested in seeing the software get used," explained Erich Hoover, a founding member of TICC who is now a graduate student in Engineering. Fellow TICC member and graduate student David Murrell echoed these sentiments: "The bottom line is that we had almost no funding, and other colleges that get this grant or buy the tablets aren't likely to have much either. We got a lot out of the experience. And we were well fed—Susan Kowalski is a great cook!"

With so much of their energy invested, members of TICC are gratified that the word is spreading. Professor Jane Dong of the Electrical Engineering Department at California State University Los Angeles uses *InkSurvey* in her freshman engineering design course. "It's very empowering," she says. "I believe it's a teaching model that will have a huge impact on science and engineering education in the future."

Frank Kowalski is equally optimistic about the integration of technology in education. "The effective use of technology in the classroom is still a relatively immature field. *InkSurvey* is a significant advance in addressing the needs of each student in a large class setting. With our need for good engineers and scientists greater than ever, those institutions that deliver a better learning experience will be in high demand. For me, it is exciting to have found a new way to enhance learning, and the process itself has been most rewarding. It wouldn't have been accomplished without this remarkable group of students who were willing to volunteer their talents to develop and move the project forward."

Thomas Cooper, lightboximages.com

What makes them TICC?

Founding Members:

Luke Campagnola '03
Sidney Cox '07
Erich Hoover '07 (current grad student)
Mike Hurowitz '07
David Murrell (current grad student—5-yr BS/MS prgm)
Thomas Wells '07 (current grad student)

TICC members continue to maintain and administer the use of tablet PCs in the classroom. Current and former members of the committee are listed below:

Tal Atlas '07, **Nicolas Bailey, Paul Boschert, Elliot Grafil, Andrew Hubl, Ben Jones, Kenton Larson and Michael Young**

Advisors:

Frank Kowalski, Susan Kowalski

What Mines is doing to avert an impending economic crisis

Staying in

By J. L. Sommars

Norm Augustine, former chairman of Martin Marietta, has concerns about our country's economic future, and they are personal: "I have three grandchildren," he said.

Augustine's fears are outlined in a National Academies report he coauthored for Congress called, "Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future." The report contains several ominous indicators that suggest our country is rapidly losing its competitive advantage when compared to other developed nations:

- High school graduation rates in the U.S. rank 17th.
- U.S. 12th-graders rank in the fifth percentile in science testing.
- During the past 20 years, the number of university students achieving bachelor's degrees in science, technology, engineering and math has dropped 40 percent.
- Fewer than 15 percent of high school graduates have sufficient math and science credentials to pursue an engineering degree.
- Only six percent of high school students express an interest in becoming scientists or engineers.
- Fewer than two percent of high school graduates eventually receive engineering degrees from U.S. universities. That number is less than one percent for women and minorities.
- In 2002, Asian countries awarded 636,000 engineering degrees, compared to North America's 122,000.
- China graduates more English-speaking engineers than the U.S.

In his testimony to Congress, Augustine warned, "Americans, with only five percent of the world's population, but with nearly 30 percent of the world's wealth, tend to believe that scientific and technological leadership and the high standard of living it underpins is somehow the natural state of affairs. But such good fortune is *not* a birthright. If we wish our children and grandchildren to enjoy the standard of living most Americans have come to expect, there is only one answer: We must get out and *compete!*"

While some of the claims of the "Gathering Storm" report have been debated, few question what Augustine believes to be the most critical challenge—"repairing our failing K-12 educational system, particularly in mathematics and science, by providing more teachers qualified to teach those subjects." And he believes higher education can play an important role in this effort.

During his recent visit to campus, Augustine was impressed by the School's many K-12 outreach programs.

"We've been doing this for years," says Barb Moskal, associate professor in Mathematical and Computer Sciences, and director of the Center for the Assessment of Science, Technology, Engineering and Math. Moskal is particularly proud of the Learning Partnerships Program she heads up, which was initiated more than a decade ago by Drs. Catherine Skokan '70, MS '75, PhD '75, Barbara Bath and Gary Baughman MS '73, PhD '74, among others. Funded largely by the National Science Foundation and the Colorado Department

the Game

Shutterstock

of Education, Learning Partnerships is aimed at making science and math more engaging and more fun.

"Our basic premise is that if K-12 students learn about exciting applications of science, mathematics and engineering, they are more likely to enter the related fields," says Moskal. "They need to become involved in real experiments and not just read about them in a book." Mines works primarily with sixth through eighth grade teachers because that's when many students, especially girls and minorities, tend to lose interest in science and math.

Teachers come to campus for eight- to ten-day workshops during the summer. Since almost 70 percent of U.S. middle school math teachers don't have a degree in that field, the mornings are spent boosting their knowledge and confidence in disciplines related to science, technology, engineering and math (STEM). In the afternoon, working with Mines graduate students, they learn hands-on projects and experiments.

$$Xn = n/(n+1) \quad Yn = 1/(n+1)$$

"For example, we help them teach conic sections by building a parabolic oven where they can demonstrate the focal point by toasting marshmallows," explains Agata Dean '04, MS '06, who participated in the program when she was a student and now serves as program manager. "We teach experiments that kids will find fun."

When the school year starts, graduate students join the teachers in their classrooms for 10 to 20 hours each week, assisting with experiments and sometimes leading the class. "The teachers love it," says Dean. "They appreciate the extra pair of hands in the classroom and learning new activities. They don't have the time to research and learn new ways of applying their knowledge. They're too busy doing lesson plans and grading papers." Tina Falconer, who teaches science at Ranum High School in Adams Country, also appreciates the student's expertise: "Having a specialist in the classroom who can take activities to the next level is a huge thing. It helps take the fear away," she says.

Falconer says the program changes lives, and not just those of her students. Rosamond Parkhurst '05, MS '07 became a teacher as a result of her involvement with the program. She came to Mines to become an engineer, but subsequently changed her mind. After switching majors and struggling with what to do with her life, Moskal encouraged her to join the outreach program. "The moment I stepped foot in the classroom, I loved it," Parkhurst recalls. "I instantly realized that's what I wanted to do. I felt I could make a difference."

In addition to hosting teachers on campus during the summer and sending grad students into classrooms during the academic year, Mines also offers summer technology camps in Golden to middle school children. "The idea came from Leanne Miller, one of our grad students," says Moskal. "Leanne felt her students weren't having enough positive experiences with technology. She wanted to bring the kids out to campus to see what a college is like and learn about technology. I thought it was a great idea, but didn't have the time to take on a new project. I told her I'd pay for it if she did all the work."

So Miller and her fellow students rolled up their sleeves and arranged for buses, raised money from local businesses to pay for lunches and worked with the Athletic Department to provide recreational activities. "Going to a college campus gives the kids something to aspire to," says Falconer. "I'm in a school district where 60 percent of our students are immigrants or live close to, or below the poverty line. They just don't have these role models."

Students are chosen for their desire to learn, not just their ability level. The technology camps also separate the girls from the boys. "From observational studies, boys almost always take over," says Moskal. "The boys handle the materials—they do the scientific experiments and the girls sit back and watch. Separating them frees the girls to act like scientists."

Gender issues are central to the discussion of how to boost the number of STEM-educated college graduates in the U.S. In fact, several studies suggest that if the percentage of women enroll-

ing in math and science were comparable to other professions, the nation wouldn't have a shortfall in STEM-educated college graduates; but so far, women aren't choosing these fields in large numbers.

"Over the past 25 years, when you look at the traditionally male dominated disciplines like law, medicine and business, there has been a tremendous increase in female enrollment," says Heidi Loshbaugh, research associate for the Center for Engineering Education. "Unfortunately, there has been very little change for engineering." So while veterinary schools are 70 to 80 percent female, engineering schools average 17 percent. (Mines' female enrollment is 22 percent, ranked 57th among 331 institutions.)

Barbara Olds, associate vice president for educational innovation, believes some of the problem may lie with engineering schools. "In many cases we've operated under a deficit notion concerning women and minorities in engineering," she says. "The tendency is to say there must be something wrong with them that they're not going into engineering. I think more and more people are asking what's wrong with engineering or engineering schools that we're not attracting women and minorities."

Mines is looking at ways to revise its curriculum to appeal more to women. The Humanitarian Engineering Program is an example; as of December 2007, 50 percent of the students who signed up were women, according to Dave Muñoz, associate professor of engineering and director of the program. Humanitarian Engineering emphasizes practical engineering with an impact on human welfare that is immediate and sustainable. Over 180 Mines students have been involved in more than 40 projects all over the world. A few examples include a solar power system in Belize; water projects in Honduras, Mauritania, Senegal, Ghana and Uganda; and a church roof in Mexico.

"Our goal is to have the curriculum, climate and culture in place so we have a campus where women want to work, go to school and become involved," says Debra Lasich, executive director of the Women in Science, Engineering and Mathematics program. "That can be challenging because this has been a male-focused environment."

Increasing female enrollment is one key objective of an institution-wide diversity plan initiated by Mines President Bill Scoggins. "Increasing diversity is one of my top priorities," he says. "If gender or ethnicity are an impediment discouraging students from applying to Mines, or turning them away after they get here, then we have a problem. An inclusive environment that welcomes diverse cultures and encourages women to succeed is essential to our core mission and responsibility."

While Mines is ahead of national averages with regard to female enrollment, it lags behind in minority enrollment by 4 percent (14 percent compared to the national average of 18 percent), despite having doubled the number of minority students on campus over the past 20 years. "One of the challenges is that the math and science scores of minority students aren't as high as we'd like," says Khanh Vu, director of the Minority Engineering Program. "It's hard to get properly prepared students into Mines because we have some of the highest standards in the state. Our largest concentration of minority students to draw from is the Denver Public Schools and Aurora. With an average ACT score of 19, these students fall below both Mines' average incoming freshman score of 27 and state averages on standardized tests."

Which brings us back to Augustine's directive for improving K-12 math and science education: "The focus must be on teachers," he says. "That's where the leverage is. Each teacher affects a lot of students, so there's a multiplying effect."

This is the rationale behind Mines' outreach programs. "Our outreach programs impact about 60 teachers, who are responsible for 100 students each. That's 6,000 kids per year, and that's just the beginning," Moskal says. "We recently received a $2.5 million commitment from the Bechtel Foundation that will allow us to move into the high schools. Starting next year we'll also introduce technology clubs as an after-school activity for high school students."

Moskal has so far been unable to obtain standardized test scores from the state to track each outreach classroom, which she finds frustrating. "We do see an impact in terms of the amount of hands-on interaction teachers have with their students," she says. "We also know that teachers improve their level of knowledge through pre- and post-test scores." The program promotes a winning situation: Mines graduate students receive the necessary financial support to complete their degrees; participating teachers acquire a deeper understanding of the content that they teach, while receiving classroom support; and K-12 students learn how science and mathematics can lead to exciting careers.

"Mines is at the very top of just a handful of schools nationally that are known for doing very good work in engineering education," says Maura Borrego, assistant professor in the Department of Engineering Education at Virginia Tech. Borrego, who collaborates on research projects with Mines, says, "When a university has a reputation for doing good work, it says something about the culture—that there's a critical mass of people doing good research and good outreach, because the two are related. Other people are going to find out about the great things going on at Mines and soon they'll replicate them. That's the way you change the system."

"It's exciting that these small ideas are not just impacting Mines," Moskal reflects, "they're impacting the community and, even more broadly, impacting the world." And, hopefully, the futures of all our grandchildren.

Thomas Cooper, lightboximages.com

Oil from Stone

The promise and perils of oil shale development

By Paul Roberts

Oil shale is, at the outset, not much to look at. Most of it is dusty gray streaked with sooty black—a rock that is unlikely to find its way into your child's summer rock collection. Much of oil shale country is, to many, equally unappealing: an arid scrubby landscape tens of thousands of adults drive through annually, hoping the car doesn't break down or run out of gas.

However, oil shale holds a lot of promise. How does enough fuel to keep our SUVs and our energy-intensive lifestyles cruising well into the next century sound? If this image causes a cacophony of conflicting thoughts, then you can understand the excitement, and the reservations surrounding the oil shale industry today.

"It's a huge, huge resource," exclaims Jeremy Boak, oil shale project manager for the Colorado Energy Research Institute (CERI) housed at Colorado School of Mines.

At current estimates there are roughly three trillion barrels of recoverable oil lying dormant within the world's known oil shale deposits. This equals the total amount of liquid oil known to have existed on our planet, *before* we even began extracting it. One half of these resources exist within the United States.

The vast majority of the U.S. deposits lie in what is known geologically as the Green River Formation, which sits under 17,000 square miles of Colorado, Utah and Wyoming. Of the one trillion-plus barrels of potential oil streaked throughout these sediments, a moderate estimate promises that at least three quarters, or 800 billion barrels, is recoverable. That's three times the proven oil reserves of Saudi Arabia.

The oil shale is a very dense resource as well. As Dag Nummedal, CERI's director puts it, "The numbers are just astounding. There is five times the amount of oil per acre in the Piceance Basin [Colorado] as within a rich oil field like Prudhoe Bay." One reason for such potential productivity is the thickness of the Green River Formation oil shale. The very best liquid oil reservoirs are 100 to 300 feet thick, whereas much of the oil shale in this area is 1,000 feet thick.

Oil shale has recently become a hot news topic, but Colorado School of Mines has been studying it for years. A longtime senior executive in the industry, Glenn Vawter '60 recalls, "I was on a Mines field trip in the late fifties and Professor Barb Petroleum Engineering] points across at these cliffs and says, 'Someday this is going to be the salvation of our energy problems in this country.' It caught my attention then, and I've spent the better part of 25 years working on oil shale."

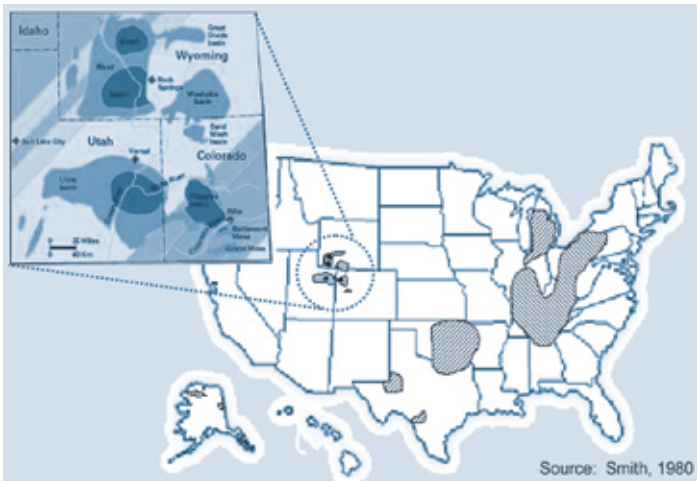
In October of this year Mines hosted its 27th Oil Shale Symposium in partnership with CERI. The event recorded one of its largest turnouts, with more than 330 attendees from 23 states, four Canadian provinces and 20 countries. With such high levels of interest, it doesn't seem to be a question of whether this industry will get off the ground, but when—and most pressing—how.

The first part of the challenge lies here: Oil shale does not actually contain oil. The sooty black streaks that run through these ancient sediments is kerogen, a precursor to liquid oil. To turn it into the real thing, it needs either several million years of geologic heat and pressure from nature, or a few years of artificial heat induction arranged by an enterprising corporation.

The second aspect of the challenge is the enormous scale of development required to realize those 800 billion barrels of oil, and many fear that the risks of development at a commercial scale are too high. Impacts on ecosystems, water and, notably, global warming, are primary concerns, and no one feels the heat more than the corporations looking to develop the industry.

Ralph Coates, senior engineer with Combustion Resources, spoke of a news release last June from six environmental groups detailing how one large oil shale plant would produce more carbon emissions than all the coal-generated electricity in Utah, Colorado and Wyoming: "That's obviously a problem for any development of oil shale. The industry has got to satisfy these complaints and concerns with getting the plants permitted," he said.

Below: A retort in Rifle, CO. Right: Location of Green River Formation. Bottom right: Industry professionals survey a site in Colorado.



Adam Brandt, with the Energy and Resources Group at the University of California, Berkeley, states, "By the time an industry gets up and going, there's a fairly good chance that there will be carbon regulation, so any technology that would be developed would need to be amenable to a carbon mitigation effort."

With years of effort, tens of millions of dollars on the line and environmental concerns looming, corporations are moving cautiously—nevertheless, there is excitement in the air from industry representatives. With crude oil prices this high and no relief expected in the foreseeable future, oil shale is economically viable. Additionally, new technologies, and older technologies with new twists, are being applied that could address concerns about carbon emissions and other environmental issues.

Converting kerogen to liquid oil involves a process called retorting—a distillation process in which the oil shale is heated to high temperature (greater than 350° Celsius) to produce hydrocarbons in both gaseous and liquid form. There are two basic strategies for doing this: *ex situ* and *in situ*.

In *ex situ* processing, or above-ground retorting, the shale is mined (either open pit or room-and-pillar), crushed and then heated for an hour or two in an enormous above-ground kiln called a retort. Surface retorts yield a thick tarry product, which is then further refined into transportation grade fuels and other products.

With *in situ* processing, oil shale deposits are heated where they naturally exist, deep in the ground. The shale is heated for two to four years and the resulting liquid, and gaseous hydrocarbons are pumped up and out. The product is a less viscous, lighter oil that requires far less refining than traditional shale oil to make gasoline, jet fuel and diesel fuel.

As of June 2007, the Department of Energy listed 23 companies developing extraction technologies for oil shale. Here's just a taste of what's being cooked up…

Shell Oil is acknowledged as the leader in the *in situ* processing field, due to the considerable amount of time and money they have invested, and the creative strategies they have developed. Shell's *in situ* approach is tackling head on a problem specific to the deepest and richest oil shale resources: free flowing groundwater that, if contaminated, could impact communities far and wide. Shell's answer is to create a "freeze wall" that surrounds the block to be developed, extending hundreds of feet down into the ground. The barrier is created by pumping a refrigerant through plumbing that surrounds the target block. The wall excludes groundwater that would make heating the shale impractical, and protects the surrounding aquifer from contamination. Electric heating elements are inserted into a series of boreholes which cook the kerogen slowly over three to four years, yielding a high quality liquid product condensed from the hydrocarbon vapors created in the formation.

"It's a totally different product than taking fresh rock and running it through an oven for 90 minutes," says Tracy Boyd, Shell's spokesperson. "Short duration retorting yields a very heavy product that has lots of issues to make it usable."

Shell plans to use electricity to heat the shale at a commercial scale, which will likely involve the construction of new power plants, either coal fired or nuclear. "Maybe in the long run we'll have a mix of sources like wind, IGCC (Integrated Gasification Combined Cycle) and who knows what the mix will be. Market factors will likely play a role," says Boyd.

Commercial *in situ* production is not expected to begin anytime soon, with the most ambitious estimates being 2015. Shell is testing its freeze walls: breaching them, measuring effects and developing protocols for possible contingencies. But Boyd is more than

At least 800 billion barrels is recoverable from the Green River Basin. That's three times the proven oil reserves of Saudi Arabia.

optimistic, "Shell has not been researching this since '81 and doing tests in the field since '96 just because we enjoy R&D. We see an opportunity here that's too big not to take seriously."

EGL Resources is taking a different tack. "Our *in situ* approach is different in how the shale is heated," says Glenn Vawter '60, manager of EGL's Oil Shale Division. "We drill down and go horizontally underneath the shale, and use convection (via superheated steam), not just conduction as others are doing. In simplest terms it's like a radiator system you'd have in your house where you are circulating a hot fluid through [pipes]." The heat then radiates upward through the shale. Product is extracted from vertical wells drilled and "spidered" throughout the target deposits above the horizontal heating conduits. The advent of directional drilling, a relatively recent but commonly used technique in conventional oil operations, makes this possible. "You know, 30 years ago when we were trying to do things like this in oil shale, there wasn't nearly the level of technology that there is today," says Vawter.

Energy efficiency is critical. EGL plans to use the natural gas produced in the retorting process (about a third of the product) to heat the shale and then recover the heat from the circulating system in spent blocks for use in the next fresh block of shale. EGL doesn't expect a field test until late in 2009.

Kevin Shurtleff, founder and president of Mountain West Energy, is developing an *in situ* gas extraction process in which natural gas, heated and pressurized at the surface, is injected into the deposit, heating the shale by convection as the heat rises up through the deposit, "sweeping" hydrocarbon rich vapors to the surface for collection.

"In our process we convert [the hydrocarbons] to a gas, and it stays as a gas, until we bring it back to the surface," says Shurtleff. "If you leave it in the vapor state, you get much better mobility—it flows much more easily out of the reservoir."

For powering the operation, Shurtleff says, "I'm biased against electricity....The problem is you have huge conversion losses so it's always going to cost more energy and produce more pollution than if you use direct heating."

Initially, Mountain West plans to use natural gas (eventually collected on site from the gas fraction of the product) to power their operation. "Ultimately the natural gas we produce we'd prefer to sell, and move to a solar thermal process...that can produce 400° Celsius gas," says Shurtleff, who hopes that eventually such technologies can take him to a zero CO_2-emission extraction process.

Surface retorting, the other way to produce shale oil, is already being used commercially for oil shale in Estonia, China and Brazil. At one point a pilot project was launched in Australia before being shut down, in part due to environmental concerns. A similar process is used to extract heavy oil from oil sands in northern Alberta in Canada. Surface retorting is considered the most invasive of extraction methods, due to the mining required, and because existing commercial processes burn the spent shale for fuel, compounding the carbon emissions. For surface retorting to meet anticipated regulatory requirements in the United States, some refinements are being devised.

Combustion Resources is developing a low carbon emission *ex situ* process. Ralph Coates, senior engineer for the firm, explains, "The main advantage of our [above ground] process, at least theoretically, is we'll heat [the oil shale] with hydrogen as the fuel and avoid producing CO_2 as a flue gas. We propose using a similar approach to the FutureGen project: producing the hydrogen by gasifying coal, separating the CO_2 that's produced, liquefying it at high pressure and transporting it for either use in secondary oil recovery or underground storage."

FutureGen is the Department of Energy's $1.5 billion initiative to create a coal-based, zero-CO_2-emission electricity and hydrogen power plant. "It's a very logical approach for solving the problem of CO_2 emissions from coal fired plants," adds Coates.

If oil shale in the Green River Formation ever becomes a meaningful and economically viable source of energy for the nation, it will have to be on a massive scale, which inevitably brings with it substantial regional population growth, necessitating new urban infrastructure. The environmental challenges are also daunting: large quantities of power and water will be required; restoration projects will need to follow in the wake of recovery operations; measures to protect groundwater may be complex and costly; and extracting the resource without emitting massive quantities of CO_2 and other compounds brings significant challenges and costs. Some argue that such huge capital investments are better spent elsewhere.

"It's not clear to me that it's what we should be doing ahead of increasing efficiency, looking at alternatives and energy conservation, which might limit the need to produce oil shale, at least for the coming decade," says Berkeley's Adam Brandt. "Eventually we might have to use it," he concedes.

Jeremy Boak is pragmatic about environmental concerns and future demand for energy: "Something we are trying to emphasize at CERI is that we've got a huge energy transition going on, and we expect it will take one, two or three generations to complete. In the meantime, any alternatives to fossil fuels will require investment and subsidies which would need to be taken from somewhere. There are plenty of incentives to produce oil and gas, but if you take some of those away, you will lose production. We've got a very careful balancing act ahead of us to make this long-term transition, and we think that making the traditional energy sources more carbon neutral is a really, really important part of that."

High-energy cosmic rays reveal mystery of their origin

By Nick Sutcliffe

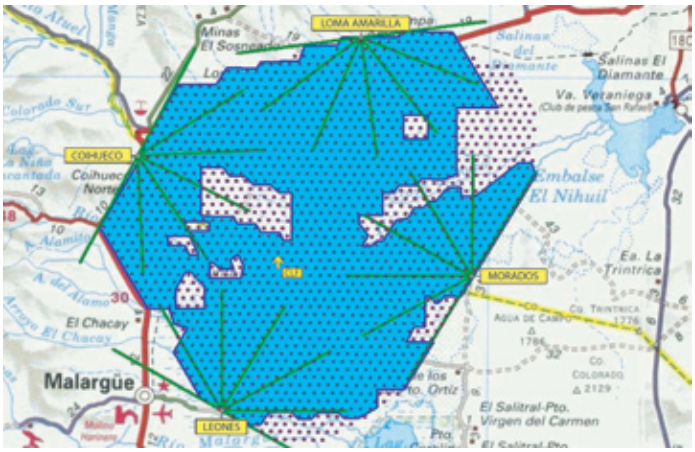
Messengers from Distant Galaxies

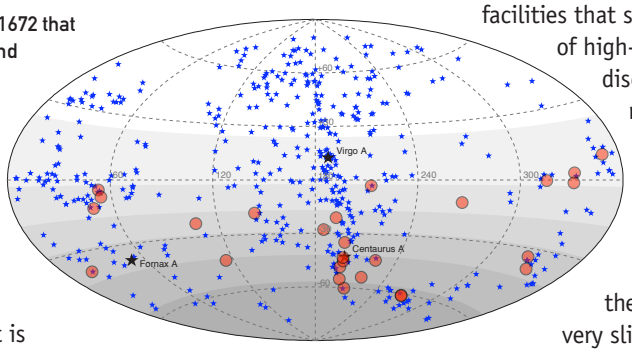
Every now and then subatomic particles slam into the Earth's atmosphere packing energy 100 million times greater than can be achieved in the world's most powerful particle accelerators. Scaled up to the size of a pea, these particles would have energy equivalent to 270,000 billion Boeing 747s traveling at 600 mph. For decades these powerful cosmic rays have remained an alluring and paradoxical mystery to astrophysicists: Although their extraordinarily high energies are evidence that they originate from some of the most extreme events in the universe, their source has eluded astronomers and astrophysicists since their discovery more than 40 years ago.

However, an international team of scientists that includes Lawrence Wiencke and Fred Sarazin of the Colorado School of Mines Physics Department has linked these unusual particles to a particular class of nearby galaxies that have active nuclei in their centers. Active galactic nuclei (AGN) are thought to be powered by massive and tumultuous black holes that consume stars and gas, and may emit jets of plasma far into intergalactic space. The team's findings are reported in a paper published in the November 9, 2007 edition of *Science*.

Making the link between high-energy cosmic rays and AGN was not easy. Made up of single protons or atomic nuclei, almost all cosmic rays carry a small electrical charge. As these charged particles travel through the magnetic fields that permeate space, their paths are altered. While scientists can now calculate the trajectory of certain cosmic rays that collide with the Earth's atmosphere, the information is meaningless if they haven't come in a straight line from their origin. However, a small class of the most powerful cosmic rays (those with energies over 4×10^{19} electron volts, or 40 EeV) are much less subject to deflection. They are also extremely rare—a few per square mile per century.

To collect a reasonable amount of data on such a rare phenomenon, the Pierre Auger Southern Observatory was constructed in Argentina





Facing: Hubble's view of the barred spiral galaxy NGC 1672 that contains an active nucleus (image courtesy of NASA and STScI). Above: Layout of the Pierre Auger Southern Observatory in Argentina. Dots represent each of the 1,600 particle detectors. Right: Depicting Earth's view onto the universe, the diagram includes red circles denoting the directions from which the 27 highest-energy cosmic rays came. Blue stars indicate the direction of known active galactic nuclei within 200 million light years.

to span 1,200 square miles. Not surprisingly, it is the largest observatory ever constructed. But even with an aperture of this size, the observatory records the passage of just a few dozen ultra-high-energy cosmic rays per year—80 events with energies over 40 EeV have been detected at Auger since 2004. However, the data from these events make such a compelling case that scientists on the team are sharing their findings and telling the fascinating story of how they were obtained.

The trajectories and energy of cosmic rays are actually extrapolated by recording the arrival of secondary particles created by the impact of the cosmic ray. When a cosmic ray slams into our atmosphere, it creates a fluorescent shower of subatomic particles, mostly muons, that fan out to cover about a 15-square-mile area on the Earth's surface.

The observatory measures these secondary particles with two types of detectors. A grid of 1,600 individual particle detectors spaced one mile apart records a particle shower's arrival to a tenth of a microsecond (1/10,000,000 of a second). By also recording the level of luminescence created when the particle shower passes through a large tank of water, these same detectors collect information on the intensity of the shower. As an incoming shower will be registered at several stations, the minute differences between arrival times provide adequate data to calculate the trajectory of the original cosmic ray to within one or two degrees—the more powerful the cosmic ray, the more accurate the estimate.

The second type of detector records the amount of fluorescence light emitted by the impact of a cosmic ray, but it will only do so on clear moonless nights. Although most nights aren't clear and moonless, the minority of events that are captured provide relatively precise information about the energy level of the incoming cosmic ray. As such, this data can be used to calibrate the much more plentiful information captured day and night by the array of particle detectors. "Energy measurement is especially important," says Wiencke, who came to Mines as an associate professor in August, 2007. "Our detectors record many more cosmic rays at lower energies, but only higher-energy rays provide meaningful directional information. Making this distinction is critical."

The exciting finding of this study came when the trajectories of the 27 most powerful cosmic-ray events recorded since 2004 were analyzed. Of the group, 20 point to within a degree or two of known AGN. Of the remaining seven, several have trajectories that pass through the relatively opaque plane of our own galaxy, where optical surveys of AGN are incomplete and magnetic bending effects are strongest.

Wiencke, who is responsible for the calibrated laser test-beam facilities that simulate the optical signature of high-energy cosmic rays, says, "The discovery is exciting and fundamental. We don't know whether the sources are AGN or something related in the vicinity, but this is an important step in understanding the origin of cosmic rays. The likelihood that these findings are coincidental is very slim."

Scientists think that most galaxies have black holes at their centers, with masses ranging from a million to a few billion times the mass of our sun. The black hole at the center of our Milky Way galaxy weighs about three million solar masses, but it is not an AGN. Galaxies that have an AGN seem to be those that suffered a collision with another galaxy or some other massive disruption in the last few hundred million years. The AGN swallows the mass coming its way while releasing prodigious amounts of radiation.

All of these AGN are relatively nearby in cosmological terms—within 200 million light years. Wiencke says this is to be expected. Cosmic rays with over 60 EeV lose energy to the radiation left over from the Big Bang that permeates all of space. The only cosmic rays reaching Earth with energies over 60 EeV are those from nearby sources.

To complement data from the Argentine observatory, Auger scientists are developing blueprints for a Northern Hemisphere observatory to be located in Southeast Colorado, close to Lamar. Planned to be seven times larger than the Argentine facility, the project is being promoted by the Colorado Coalition for Cosmic-Ray Research (C3R2), a collaboration representing Mines, Colorado State University's Fort Collins and Pueblo campuses, Lamar Community College and Colorado Southeast Enterprise Development.

"Hosting such a world-class scientific experiment constitutes a fantastic opportunity for Colorado," said Fred Sarazin, assistant professor of physics at Mines and chair of C3R2. "We will need strong support from the state to secure federal and international funding." If completed, the Northern Pierre Auger Observatory would have exposure to skies not seen by its sister facility and a capability of recording considerably more data from these cosmic messengers from some of the most tumultuous corners of the universe. M

The Network

Online Community Coming Soon!

Starting soon, the Colorado School of Mines Alumni Association is going to be ramping up its online presence; our brand new online community is scheduled for launch late spring/ early summer. Built on a widely used and feature-rich platform, the online community will make it easier than ever to reconnect with old friends and stay in touch with Mines. Here is a preview of what it will include;

- Member profile pages customizable and viewable by others (unlimited photos and text);
- Search for friends or fellow alumni by name, city, degree, occupation, and more;
- Customize the information you receive from Mines—you tell the Alumni Association what you want to hear about;
- Reconnect with classmates through user-friendly message boards, chat, friends list, instant notes and who's online features;
- Register for events quickly and easily—see who's already attending;
- Create sub-communities: by region, graduation year, occupation, interests… whatever you wish (full community feature functionality at subgroup level);
- Stay up-to-date with new happenings in your regional Mines community and the School;
- Post and review job openings;
- Update your contact information;
- Pay membership dues securely;
- Buy Mines apparel from the new merchandise store;
- Donate online;

And More!

Life Members

The Alumni Association gratefully acknowledges its new Life Members listed below. This list includes members welcomed between May 21 and Oct 31, 2007.

Daniel G. Anderson '85
Andrew L. Baker '89
James M. Beideman '00
James E. Bland '06
Jeffrey A. Block '88
David J. Blumer '74
Elizabeth A. Bradford '85
Albert C. Brown '05
Robert Bruzgo '95
Ryan P. Cadenhead '05
Keith Cooper MS '90
Anne M. Cornellisson '82 and Joseph L. Cornellisson '79, MS '84
Brian S. Crandall '00
Kevin H. Crist '98
Karl L. Egbert '84
Trevor R. Elenbaas '96
Eric D. Emerson '86, ME '87
William W. Everett ME '65
Susan E. Evers '97
Richard J. Gardner ME '70
Mark E. Gregg '80
David J. Hagerman '91
Elizabeth Hall '02
Anna C. Hanley '95
J. David Hanley, Jr. '06
Philip W. Henderson '93 and Susan F. Henderson '94
Lianne S. Hill '03
Howard E. Janzen '76, MS '77
Amanda M. Kelly '02
Daniel E. Kelly '82 and Lisa M. Kelly '82
Jonathan J. Kepler '01
Marco E. Leon '01
Sarah A. Lincoln '04
Claudio D. Manzolillo MS '77
Theron C. McLaren '85
Brandon L. McLaughlin '04
Tiffany L. Mensing '02
Travis T. Moore '98
Anthony L. Morroni '71, MS '74
Michael J. Morrow '82
Michael S. Nagorka '83, MS '86
O. Akin Oduolowu MS '72, PhD '78
Jake D. O'Gorman '99
Manuel Leonardo Padilla-Palma MS '06
Cara A. Phillips '00
Christopher W. Ramsay PhD '90
David J. Reimer '82
Jeffrey A. Reimer '05
Heidi Linch Reynolds '86
Dennis J. Schilly '90
Adam A. Schmetzko '06
Paul A. Sease '83
Jeremy T. Sell '06
Sarah E. Shearer '02, MS '05
Toni S. Showan '92
Adrian J. Sikorski '01
Cleave A. Simpson, Jr. '84
Carly E. Skinner '06
Michael D. Spruiell '99
Edward W. Stafford '98
Paul E. Taylor '82
Donald L. Thomas '70
Lee A. Turner '70
Glenn M. Vangolen '81 and Tracey Smink Vangolen '83
Joshua D. Venters '05
Daniel R. Walton '71
Laura A. Westler '00
William M. Westler, Jr. '00
Marcus T. Wichmann '82
Gary R. Williams '68
Holly Daugherty Willman '01

Life Membership to the Alumni Association is $1,000, and payable over five years if preferred.

Panel of CEOs and Senior Executives Share Secrets of Success

The Colorado School of Mines Alumni Association recently invited a panel of seasoned executives to share their experiences and perspectives on leadership before a standing-room-only audience of students and alumni in the Green Center. The title of the event was "Lessons in Leadership: Advice You Can Use," and panelists responded to a variety of practical questions. The event was held under the direction of CSMAA board member **Kelly Taga** '00 and **Jafar Tabian** '00. Full audio of the event can be downloaded from the *Mines* magazine website. Here we share a selection of comments from panelists.

Tim Marquez '80

Founder, Chief Executive Officer and Chairman of the Board, Venoco, Inc.

"The two personality factors that most contributed to my success are tenacity and drive to excel. I think my tenacity was both instilled and inherent. I was born into a family of hard-headed people, but I have successfully refined this to a higher (more stubborn?) level. My drive to excel was instilled. There was a time that I accepted mediocrity, but I have come to abhor it and always try to excel at everything I do."

Bruce D. Hansen '80

Chief Executive Officer and Director General, Moly, Inc.

"Natural resource development is globally diverse. I recommend pursuing an overseas assignment to broaden your understanding of the global dynamics. Also, take a course from the CSM MIPER program to learn about political risk assessment and get some foundational education about the global community. Be a world citizen—educate yourself by reading, studying and travelling."

Robert Carlson '96

Director of Finance and Treasury, CoorsTek Inc.

"I am an avid reader and one book that has influenced me is *The Fountainhead* by Ayn Rand. I admire her idea of self betterment and individualism. Our purpose is to make ourselves better and push ourselves harder on a daily basis. I believe that when we prove ourselves everyday, we become better leaders, better thinkers, and better friends."

Sandy Stash '81

Vice President – Regulatory Affairs and Compliance, BP Exploration (Alaska) Inc.

"Sheer tenacity most contributed to any success I have had in my career—and in my life. There are a lot of smart and talented people out there, and I truly believe that many times its tenacity that makes the difference."

CSM Alumni Association

1600 Arapahoe Street
P.O. Box 1410
Golden, CO 80402
Office: (303) 273-3295
(800) 446-9488, ext. 3295
Fax: (303) 273-3583
E-mail: csmaa@mines.edu

www.alumnifriends.mines.edu

Please read this important message from the CSM Alumni Association.

Colorado School of Mines Alumni Association

Dear Alumni:

The Colorado School of Mines Foundation, Inc. was created in 1951 to operate "exclusively for charitable, scientific or educational purposes designed to promote the welfare of the Colorado School of Mines." Much has changed over the past 56 years, including the way university foundations are governed.

In an effort to be more transparent and to increase alumni activity and support for the School, the Foundation is updating its governing documents to allow for a wider base of shared accountability and responsibility. There are four major objectives:

- To create an active up to 35-person Board of Governors;
- To create a more open Foundation governor nomination process;
- To fully vest decision-making to the new Board of Governors and the Executive Committee of the Board of Governors. All matters, as they pertain to decisions outlined in the articles of the Foundation, will be vested with the Board of Governors or the Executive Committee of the Board of Governors, or both.
- To demonstrate working compliance with the Sarbanes-Oxley Act in the Foundation's articles and bylaws.

In the proposed new Foundation bylaws, alumni will play a critical role in the governance of the Foundation like never before. The Foundation seeks to add a Nominating Committee through which the Board of Governors and the Executive Committee will be appointed. The Nominating Committee will be charged with seeking nominations from the CSM Alumni Association, the CSM Board of Trustees and the Mines community at large. The Board of Governors will elect the Executive Committee. This will provide alumni at large an opportunity to nominate Governors—*the old articles did not provide this openness to nominations from alumni at large*.

The Foundation's current bylaws require a minimum of 75 members in attendance at a meeting and a two-thirds majority affirmative vote to amend the bylaws. However, participation at previous annual meetings of the Foundation has been about 35 alumni, the majority of which consist of the 24 directors and officers of the CSMAA Board of Directors. With a diverse population scattered all over the world, this requirement in the old articles has become impractical and does not allow enough fluidity for the Foundation to operate efficiently; nor do the present articles reflect the best practices of an independent foundation.

In the absence of solid and consistent support from the State of Colorado, the Foundation is now playing a vital role in the sustainability of Mines' financial welfare. Therefore, the creation of a Board of Governors will allow 35 of the most financially active supporters of Mines to engage in advancing Foundation initiatives, thereby actively leading Mines into its future.

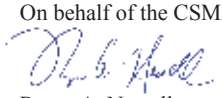
While its mission remains the same, modernization of the Foundation's articles of incorporation and bylaws are necessary to abide by current standards, nonprofit best practices and confidentiality policies, and to meet additional IRS requirements. Additionally, the Foundation's assets have increased to a market value of $200 million. Now, more than ever, the Foundation requires an even greater level of sophistication and diligence in the management of those assets. These changes represent a very different snapshot than the one presented in 1951. Due to declining financial support of higher education by the State of Colorado and an increase in funding needs for research programs, technology transfer, and other strategic initiatives, the endowment needs to grow substantially to sustain the excellence in education that Mines provides. The Foundation is looked upon increasingly to provide unrestricted revenue to assist various Mines programs, including support of the CSM Alumni Association.

With a new president at the helm who has demonstrated both the commitment and capability to carry out Mines' written Strategic Plan, it is important that we stand by our alma mater as it seeks to sustain its excellent reputation around the world. The CSMAA Board of Directors stands by the School and President Scoggins, and fully supports the proposed changes to the Foundation's articles of incorporation and bylaws. *But the rest depends upon you*. There are several steps you can take to become more involved and help effect further positive change:

1. Go to the website and read the proposed new bylaws: www.alumnifriends.mines.edu/CSMFbylaws
2. Participate in the Public Forum on January 23 from 5:00-6:30 MST, held to discuss this very issue. Go to the website referenced above for meeting and dial-in details.
3. Vote at a special meeting, set for Friday, February 8, in multiple locations (minimum 75 in attendance to pass), and then attend the Foundation's annual meeting, set for Saturday, February 9, when results of the vote will be announced. See the website for details on meeting locations.
4. If the new articles of incorporation and bylaws are passed favorably, nominate yourself or someone you know to serve on the Foundation's new CSM Foundation Board of Governors. Empower the School to be in control of its future, rather than having to chart its financial course based on the whims of government.

We hope you'll agree that there has been immense positive change on campus, and we seek your aid to effect even more. *Please read, participate, and vote*. So much depends upon you, and we *thank you* for your loyalty and consideration.

On behalf of the CSMAA Board of Directors,



Roger A. Newell
President, CSMAA

All-Class Basketball and Baseball Reunions 2008

Basketball Reunion
FEBRUARY 8 & 9, 2008

Come cheer on the Orediggers at four great basketball games, reunite with old teammates and play some pick-up games!

Friday, February 8

5:00 pm – Pre-game Reception for alumni and current players
Student Recreation Center, Charlie McNeil Room—$15

6:00 pm – Women's Basketball Game — Mines vs. Nebraska-Kearney

8:00 pm – Men's Basketball Game — Mines vs. Nebraska-Kearney

Saturday, February 9

2:00 pm – Pick-up game (men's and women's)
Student Recreation Center

5:00 pm – Reception for alumni, family, and friends
Student Recreation Center, Charlie McNeil Room—$15

6:00 pm – Women's Basketball Game — Mines vs. Chadron State

8:00 pm – Men's Basketball Game — Mines vs. Chadron State

Baseball Reunion
and Dedication of Jim Darden Baseball Field
APRIL 4–6, 2008

Come watch some ball, reunite with your old team and find out what E-Days is like these days.

Friday, April 4:

4:45 pm – Dedication and BBQ for alumni & current CSM players

7:00 pm – Mines vs. Mesa State

E-Days fireworks display following the game

Saturday, April 5:

1:00 pm – Mines vs. Mesa State, 3:30 pm – Ice-Cream Social

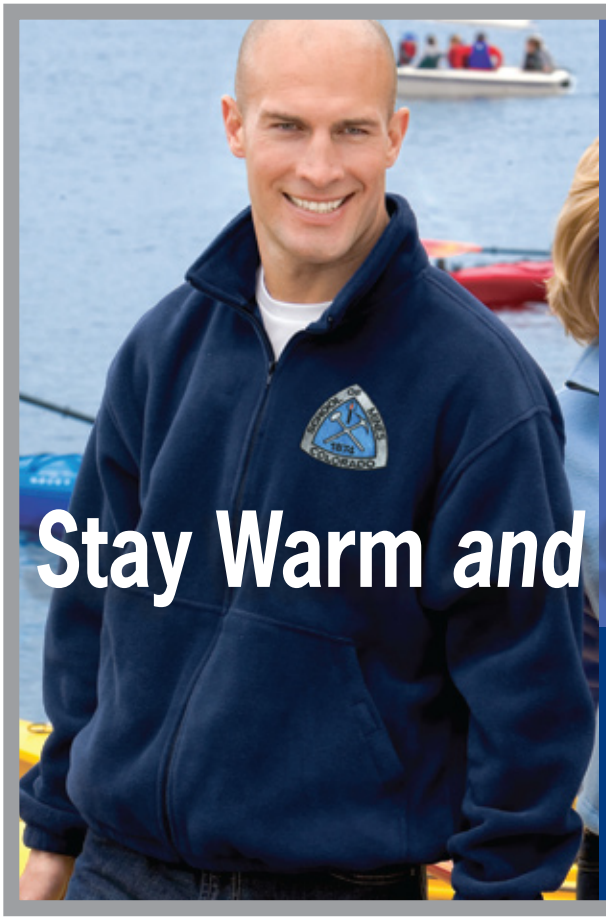
4:00 pm - Mines vs. Mesa State

E-Days Comedian

Sunday, April 6:

Alumni/Cycling Club Race – TBD, 2:00 pm – Mines vs. Mesa State

Mark your calendars for these special reunions! Schedules are tentative.
RSVP to Alison Wheelock at alison.wheelock@is.mines.edu or call 303-273-3424.
For current information go to http://alumnifriends.mines.edu and click on News and Events.
All tickets for the CSM basketball and baseball games can be purchased through the Athletics Office: 303.273.3517 or tickets@mines.edu
Co-Sponsored by the Colorado School of Mines Alumni Association and Athletic Department



The Colorado School of Mines Alumni Association is offering a fleece sport jacket and a fleece sport vest designed with the Mines community in mind! Made by Port Authority®, these items come in a True Navy color, with a full-zip front, deep front pockets and the CSM logo emblazoned on the left breast.

Stay Warm *and* Sport the Mines Spirit!

These items are currently in stock at the CSMAA offices in Golden, CO, for both men and women, but are going fast! The following sizes are available:

Men's Jackets: XS, S, M, L
Ladies Jackets: XS, S, M, XL, XXL
Men's Vests: XS – XXL
Ladies Vests: M, L, XXL

The price for a jacket is $50 (XXL is $55) and the vest is $45 ($50 for XXL), plus shipping and handling. To order, please email Elizabeth Garcia, Associate Director of Campus Programs and Membership Services at elizabeth.garcia@is.mines.edu or call 303-384-2143.

Fast Forward

Class Notes
Weddings
Alumni Profiles
Births
Passings

1950

Robert E. Keith is a senior scientist for ITT Industries, Inc. in Colorado.

1953

Richard D. Erdman is retired and lives in Brentwood, TN.

1961

William S. Price is retired and lives in Woodland Park, CO.

1964

Leroy P. Berti has retired from the Continuous Learning Group. He lives in Golden, CO.

Edward A. Faeth is retired and lives in Paso Robles, CA.

Russell S. Powers is semi-retired, but remains vice president of Lone Tree Exploration, LLC, a mineral exploration group in Lone Tree, CO.

1965

Gary K. Gantner is chief operating officer for Aquiline Resources Inc. in Golden, CO.

William G. Rankin Jr. is president and chief executive officer of UQM Technologies, Inc. in Frederick, CO.

1966

Gordon P. Kallenberg is chief executive officer and founder of Kallenberg Metallurgical Consulting in Katy, TX.

1968

Edgar T. Foy is retired and lives in Grand Junction, CO.

C. M. Holmgren has retired from Core Laboratories. He and his wife, Emily, live in Katy, TX.

1969

Todd A. Brown is president and chief operating officer for Unique Pak in Chicago, IL.

Morris A. Miceli is an independent consultant in Edmond, OK.

Robert I. Watkins is a project manager for Fluor Limited in Moscow, Russian Federation.

David E. Wright is senior engineering advisor for WZI in Bakersfield, CA.

1970

David W. Armstrong is an associate professor in the Mining Department at Montana Tech in Butte, MT.

B. William Distel is a senior project geologist for Integrated Science Solutions, Inc. in Las Vegas, NV.

Robert K. Nichols is director, tubular applications engineering for IPSCO Tubulars, Inc. in Houston, TX.

1971

Craig B. Clemmens is managing partner for Appalachian Geophysical Surveys in Apollo, PA.

Edwin Dale Thompson is an engineering advisor—reservoir for Noble Energy, Inc. in Houston, TX. He lives in Spring, TX.

1972

Marvin R. Frisinger is retired and lives in Divide, CO.

1973

Navin D. Shah is a staff environmental engineer for Chevron in Houston, TX.

1974

Alfonso F. Ballon is retired and lives in San Isidro, Peru.

Dave O. Cox is vice president of engineering for Babcock & Brown Energy in Denver, CO.

1975

Christopher T. Sheeran is regional recruiter for Wycliffe Bible Translators in Cheney, WA.

S. Arthur Stewart is manager of operations for Comet Ridge USA in Denver, CO.

1976

Frank J. Chlumsky, Jr. is a project geophysicist for BP Exploration & Production Inc. in Houston, TX.

William L. Gillette is division manager for Texas Crude Operator, Inc. in Midland, TX.

1977

Bruce K. Clements is general manager for Freeport McMoran Bagdad in Bagdad, AZ.

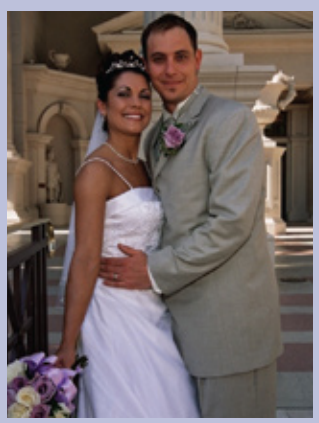
William M. Colleary is a senior geologist for BTA Oil Producers in Denver, CO.

Weddings

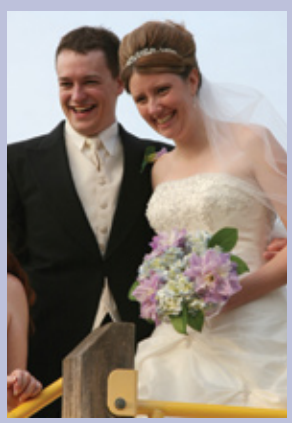
Patrick Wieck '06 and **Michelle Powis** '04, MS '05 were married on September 15, 2007 at Chateaux at Fox Meadows in Broomfield, CO. Family and friends, including several Mines graduates, attended the event.

Levi Campbell '02 and Erynn Gryniewicz were married on August 11, 2007 at the Vineyard Chapel in Littleton, CO. Groomsman included **Jesse Adams** '02, **Eric Drennan** '02 and **James Hochnadel** '02. Other Miners in attendance were **Robert Westerberg** '82, **Michelle Davis** '00, and **Jenni Garrison** MS '05.

Michael D. Spruiell '99 and Jamie L. Martin were married at Wente Vineyards in Livermore, CA, on August 17, 2007. They honeymooned on the French Polynesian Islands of Tahiti and Bora Bora, before settling into their San Francisco home. More than 20 Mines alumni were in attendance.



Michelle D. LeHota '96 and Bryon Tracy were married May 14, 2005 at Caesar's Palace in Las Vegas. **William Aradi** '07 and **Ami Walker** '06 attended the ceremony.



Abbigail L. Cochran '03 and Kevin Cates were married on January 6, 2007 in Roseburg, OR. **Tauna Rignall** '06 was a bridesmaid.

David B. Crawford II is operations manager for Angola LNG for Chevron in Houston, TX.

Charles L. Murphy is principal consultant for ConocoPhillips in Bartlesville, OK.

1978

Mark L. Bricker is manager of Energy/Utilities Programs for CH2M Hill, Inc. in Kirkland, WA.

Richard W. Jolk is an independent consultant in Golden, CO.

Stanley L. Obernyer is owner of Netcher Resources, LLC in Pine, CO.

1979

Kenneth J. Danti is a design engineer for Freescale Semiconductors in Austin, TX.

Mark A. Hamouz is a principal for LONCO, Inc. in Denver, CO.

Dennis A. Pieters is a reservoir engineer advisor for ConocoPhillips in Houston, TX.

1980

Ramona J. Stuehm is owner of PostNet in Helena, MT.

1981

Jere B. Harper is a civil engineer in the San Francisco District for the US Army Corps of Engineers in San Francisco, CA.

Michael D. McGehee is vice president for Williams Construction Company in Pryor, OK.

Sandra M. Stash is vice president of regulatory affairs and compliance for BP Exploration Alaska, Inc. (BPXA) in Anchorage, AK.

1982

Charlie F. Beecham is moving back to Denver to become the branch chief for Solid Minerals for the Bureau of Land Management, Colorado State office, in Lakewood, CO.

Miles M. Hunter is an assistant professor in the Construction Management Technology Division in the College of Engineering, Architecture & Technology at Oklahoma State University in Stillwater, OK.

Michael P. Nemeth is operations manager for Chevron Phillips Chemical Company LP at their Pasadena Plastics Complex in Pasadena, TX.

Kamal A. Sandarusi is a consulting geophysicist for Chevron in San Ramon, CA. He currently is working in Russia.

Tor C. Tschanz is a senior metallurgical engineer for Quest Reliability, LLC in Boulder, CO.

1983

William A. Burgett is principal for Sand Eagle Enterprises in Houston, TX.

Sean P. Kelly is senior staff geologist for Anadarko Petroleum Corporation in Denver, CO.

1984

Arvind K. Garg is shareholder advisor for Shell in Mina Al Fahal, Oman.

Kimberly A. Legg is an operations engineer for Forest Oil Corporation in Denver, CO.

Michael D. Lontine is a group engineering manager for Accellent, Inc.

1985

Glen M. Gallo is senior materials and corrosion engineer at the Puget Sound Refinery for Shell Oil Products US, in Anacortes, WA.

Roy A. Kemp is staff production/facilities engineer for ConocoPhillips in Grand Junction, CO.

1986

Christopher L. Beato is president of Exaro Energy in Houson, TX. He lives in Keystone, CO.

E. MacLain Burriss is a staff assistant for the Department of Labor—Mine Safety and Health Association in Dallas, TX.

David J. Camille is a consent decree program coordinator for ConocoPhillips in Houston, TX.

Mark D. Mueller is senior vice president of the Rocky Mountain Region for St. Mary Land & Exploration Company in Billings, MT.

Mark L. Peak is a senior environmental engineer for Tri-State Generation & Transmission Association, Inc. in Westminster, CO.

Ruth C. Stinson is the owner of Stinson Environmental Group in Lenexa, KS.

1987

Paul J. Taylor is senior business analyst for BHP Billiton Ltd. in Houston, TX.

Mark J. Vanarelli is a water resource engineer for the Office of the State Engineer, Division of Water Resources in Denver, CO.

1988

Carlos A. Baptista is open-pit mine manager for Montana Exploradora de Guatemala in Guatemala City, Guatemala.

Corey D. Kramer is a contracts superintendent for CS Energy in Brisbane, Queensland, Australia.

Scott M. Miller is refinery manager for Safety-Kleen Systems, Inc. in East Chicago, IN.

Matthew M. Weaver is project manager for BHP Billiton Ltd. in Adelaide, Australia.

1989

William R. Arnold is a district engineer for Samson Resources in Denver, CO.

Scot W. Hume is senior engineer for Vintage Reproductions in Colorado Springs, CO.

Anthonius W. Vervloet is senior staff engineer for Chevron in Lagos, Nigeria.

1990

John H. Fronczak is a technical support engineer IV for Baker Hughes Centrilift in Tulsa, OK.

Andrew M. Kellett is a senior radar engineer for Fugro EarthData in Frederick, MD.

Profile

Meghan McKee '06

Mines magazine offers this excerpt from a conversation with a recent graduate about her first year working in the oil industry in Alaska.

Tell us where your career has taken you since you graduated in 2006.

I began my career with ConocoPhillips in Anchorage in July 2006. A mechanical engineer by degree, I knew little about petroleum engineering, and even less about Alaskan oil fields, so I had a lot to learn. ConocoPhillips new hires are sent on rotations that expose them to the industry. My first assignment was to Alpine, a relatively new field on Alaska's Western North Slope. I spent several months there developing a model for future power needs for the Kuparuk field, where I subsequently spent several months. After my year of rotations, I now have a full-time, two-weeks-on/two-weeks-off position at Kuparuk as a drillsite facility engineer, and I've moved back to Colorado to be with my fiancée and family.

How have you liked living in Alaska?

Wonderful! I befriended a Mines alum, **Liz Galiunas** '04, and accepted her offer to share her Anchorage condo. I was excited to have a friend with whom to enjoy my first Alaskan experiences! Many people in Alaska, especially in the oil industry, are from somewhere else. There was an outpouring of hospitality, and I felt very welcome. There are so many Mines alumni in Alaska.

You had several offers from potential employers. What led you to choose ConocoPhillips?

I was a ConocoPhillips SPIRIT Scholar at Mines, so it was partly a matter of loyalty after all the support I'd received, but it was also the exposure I had to their corporate culture. All of the SPIRIT scholars had the opportunity to visit ConocoPhillips operations around the country. One trip to their facilities in Bartlesville and Ponca City, Oklahoma, stands out. The people I met there were excited about their careers and the opportunities available to them—from upstream and downstream operations, to R&D, marketing and transportation. Interacting with employees there and elsewhere gave me confidence that the company culture, especially in Alaska, was in line with my values when it comes to work/life balance.

What aspect of your Mines education has been most valuable in your career so far?

The ability to communicate with a diverse group of people. Not to downplay the technical skills I acquired at Mines and continue to use daily, but it has been intriguing to observe the successes and failures that result from good or poor communication.

Gifts of Appreciated Property Are Appreciated...

...and can provide for you and the School, for example:

- You may receive a tax deduction for the full market value of your property.
- You may avoid any taxable capital gain.
- You may be able to provide lifetime income for yourself and your family.
- You may realize estate-tax savings.
- With gifts of $1,000 or more in value, you are recognized as a member of the CSM President's Council.

Undeveloped, revenue generating or environmentally sensitive land may be accepted by the CSMF Property Management Corp. The unique expertise and talents of the CSMF Property Management Corp. could help relieve you of the liability of property with environmental issues.

Gifts of property, stock or other capital assets can be used in making a charitable gift to your alma mater. As with any gift to the School, you will have the satisfaction of knowing that you are providing for future generations of students.

For more information, contact the Executive Director, CSM Foundation Inc. Linda M. Landrum at (303) 273-3142

1991

Larry F. Adamson is a partner for Broad Reach Exploration Company, L.P. in Houston, TX.

Steven R. Klimowski is a project leader for CGG Veritas in Houston, TX.

Keith W. Melcher is procurement manager for Texas Instruments Inc. in Kuala Lumpur, Malaysia.

1992

Lisa R.L. Fisher is executive vice president and director of geoscience and engineering for Escalante Mines Inc. in Golden, CO. She is also a PhD candidate at the Colorado School of Mines.

1993

Michael P. Sheehan is a consulting geologist for Eurasian Minerals in Littleton, CO.

1994

Marcelino De Santiago G. is general director for Black & Decker HHI.

Amy Foster is a process engineer for Texas Instruments Inc. in Dallas, TX.

Mark Moseley-Williams is vice president of project development for Fortuna Silver Mines in Oaxaca, Mexico.

Linda B. Murray is vice president of Parsons Corporation in Fairfax, VA.

Sapta Nugraha is advisor for environmental affairs for BPMIGAS in Jakarta, Indonesia.

Craig R. Walters is manager of Rockies EOR for Anadarko Petroleum Corporation in Denver, CO.

1995

Nicole D. Cain is a senior engineer for Roche Colorado Corporation in Boulder, CO.

Matthew J. Hearon is a project engineer for Westhollow Technology Center in Houston, TX.

Michele M. Mossman is a metallurgical/materials engineer for Ball Corporation in Broomfield, CO.

Mary E. Palen-Murphy is an independent consultant in Lakewood, CO.

Evangeline C. Simones is president and chief executive officer for Simones Consulting in Littleton, CO.

Thien Ta Q. Ta is a software engineer for Statline in Englewood, CO.

1996

Jennifer R. Glennon is a metallurgist for Carpenter Technology Corporation in Reading, PA.

Mark B. Reiner is principal of Symbiotic Engineering LLC. Symbiotic performs life-cycle assessments of projects and products as well as GH6 Management Plans. Mark is also founder and president of Birambye International (www.birambye.org), a non-profit working for economically sustainable projects in developing nations.

Michelle D. LeHota Tracy is a mechanical engineer for Samuel Engineering in Greenwood Village, CO.

Christie J. Briscoe Zarkovich is associate director of investments for The William and Flora Hewlett Foundation in Menlo Park, CA.

Ryan E. Zorn is director and portfolio manager for Saracen Energy Advisors LP in Houston, TX.

1997

Safian Atan is a reservoir engineer for Marathon Oil Company in Houston, TX.

Marc P. Oettinger is the new commercialization manager for Southeastern Universities Research Association (SURA) in Washington, DC.

Misty L. Pyatt-Gervais is a senior R&D engineer for Abbott Vascular in Temecula, CA.

1998

Robert C. Busse is a contract engineer for Volt Technical Services. He lives in Firestone, CO.

Jason H. Carmichael is staff ITS administrator for Anadarko Petroleum Corporation in Denver, CO.

Joseph E. Furtado, Jr. is an I&C engineer for Utility Engineering in Denver, CO.

Ronald J. Keller is a civil/structural engineer for Utility Engineering in Denver, CO.

Eugene E. Ley is a senior process engineer for Intel Corporation in Santa Clara, CA.

Kyndra S. LupPlace is senior applications technologist for Raytheon in Arkadelphia, AR.

Erick I. Martinez is a senior engineer for Eaton Aerospace in Aurora, CO.

April E. Mestas is a production engineer for Williams Energy Group in Parachute, CO.

Cyndi M. Wheeler is patent counsel for Apple, Inc. in Cupertino, CA.

1999

Alexis K. Bloomfield is a major gifts officer for the Office of Institutional Advancement at the Colorado School of Mines.

Crystal J. Heter is senior project manager for Kinder Morgan, Inc. in Lakewood, CO.

Michelle L. La Due is senior account specialist for Epsilon in Lafayette, CO.

Melissa Lane is an engineer for Amgen, Inc. She lives in Evergreen, CO.

Kiran Patankar earned his MBA from the Yale School of Management in May 2007. He is now living and working in Vancouver, BC, as an associate investment banker in the Global Resources Group at Macquarie Bank, which is headquartered in Sydney.

Robin L. Swank is senior staff geologist for Rimrock Energy LLC, in Denver, CO.

George Tumur is executive director of IBE Co. Ltd. in Ulaanbaata, Mongolia.

2000

Jason A. Brucker is a manager at Protiviti Consulting in Denver, CO.

John Hyatt is a rate analyst for Arkansas PSC in Little Rock, AR.

R. Kris Jensen is a plant engineer for Granite Construction in Lubbock, TX.

Michael J. Liedtke is business analysis advisor for EnCana Oil & Gas (USA) Inc. in Denver, CO.

Ian M. Nickerson is quality coordinator for the Gary Works for United States Steel Corporation in Gary, IN.

Nickolus R. Pigott is vice president of operations for Pinnacle Metals, Inc. in Freeport, IL.

Mahesh Vidyasagar is a project manager for Tetra Tech in Fort Collins, CO.

2001

Ibiso Victor Chieduko is a project engineer for UQM Technologies, Inc. in Frederick, CO.

Sandrine Deglin is a senior scientist for Exponent, Inc. in Washington, DC.

Rebecca A. Furtado is an electrical design engineer for Utility Engineering in Denver, CO.

Profile

Exploring a Sacred Guatemalan Cave

Paul Burger '91, MS '99 recently co-hosted a History Channel documentary entitled "Journey to the Center of the World: Sacred Cave of the Maya," which features a team of professional cavers, filmmakers and microbiologists journeying deeper than ever before into the sacred Mayan cave of Naj' Tunich in the jungles of Guatemala. Describing Mayan religious beliefs that caves are living breathing beings, Burger says, "The further in [the cave], the closer you are to the gods. And the harder it is to get there, the more sacred it is." Deep inside the cave, the team saw evidence of human sacrifice, as well as detailed drawings and other artifacts. During their successful bid to be the first team to ever reach the bottom of the cave, one member of the party was injured and a dramatic 24-hour rescue ensued.

Interested in caves since his childhood, Burger is now the park geologist-hydrologist at Carlsbad Caverns National Park in New Mexico. He wrote the guide, *Cave Exploring* (Globe Pequot Press, 2006); co-authored *Deep Secrets* (Cave Books, 1999) on the exploration of Lechuguilla, North America's deepest and most extensive cave; and recently completed *Geologic Walking Guide to Carlsbad Cavern* (Carlsbad Caverns Guadalupe Mountain Association, 2007). For more information, go to Burger's website www.cave-exploring.com

Shelan M. Golightly is an engineer for Petrogulf Corporation in Denver, CO.

Patrick J. Hill is a financial advisor for UBS Financial Services Inc. in Denver, CO.

David A. Jack received his MS in applied mathematics and his PhD in mechanical and aerospace engineering from the University of Missouri–Columbia in 2006. He is now a visiting assistant professor at Florida State University in Tallahassee, FL.

Scott M. Shepherd is a mechanical engineer for Lockheed Martin.

Holly Daugherty Willman is a process engineer for BP.

2002

Anne M. Barnhart is a chemist II for Corporate Express in Aurora, CO.

Charles B. Burris is project manager for HTM Construction in Golden, CO.

Columbo D. Eddleman is a project manager for White Lodging Services in Indianapolis, IN.

Guglielmo Gottoli is a senior analyst for Deloitte in Melbourne, Victoria, Australia.

James J. Hochnadel is deputy offshore representative for Chevron Corporation in Paris La Defense, France.

Amanda M. Kelly is a captain and a network enterprise resource manager for the United States Air Force.

Edgar I. Mellor III is an engineer for Sequel Energy Ventures LLC in Denver, CO.

Jack M. Pecoraro is a gradaute student at the Colorado School of Mines.

Jennifer E. Phillips is a systems engineer for Lockheed Martin.

Brandon S. Schrenk is zone engineer for Air Liquide in Pasadena, TX.

2003

M. Jarred Cundith is an independent consultant in Golden, CO.

Weston A. Dobson is a process technician for Primestar Solar in Golden, CO.

Kimberly A. Hill is a product manager for Medtronic Inc. in Louisville, CO.

Jason P. Keenan is a technical consultant III for Alliance Wood Group Engineering in Denver, CO.

Christopher L. Landon is a mechanical engineer for Apex Drive Laboratories in Portland, OR.

Melinda S.A. Lee is an airport planner for Carter & Burgess, Inc. in Arlington, VA.

Profile

Life After Cancer

A 24-year-old graduate student in the Metallurgical and Materials Engineering Department, **Matt Hayne** '06 has an extraordinary level of maturity and drive. "Cancer makes you grow up very fast," he said during a conversation in November. He was sixteen and a junior at high school in Yampa, CO, when he was told he had an aggressive form of non-Hodgkins lymphoma. Six months of intense chemotherapy ensued. It was grueling, he admits, but he speaks mostly about how grateful he feels: grateful to his doctors who put it all together so quickly; grateful to his family for being with him every step; and grateful, in particular, to one man who gave him hope. "The first night I went into Children's Hospital," Matt recalls, "there was a resident doctor who looked at me after my initial treatment and said, 'I remember sitting in your exact same seat at your exact same age, pretty much going through the same treatment.' That was very powerful. To be able to look at somebody who was very fit, very athletic…how I imagined I wanted to be when I was his age. he was on the other side of what I was facing. Now that I've made it, I see it as my responsibility to do the same." And Matt has found a lot of ways to do this: he and his family prepare an annual Thanksgiving Day meal for the staff and patients on the Oncology Ward at Children's; He participates in Relay for Life—a fundraising event for cancer research; He attends the Teen and Young Adult Support Group at Children's where he can provide the kind of support to others that meant so much to him; and, the activity closest to his heart, he participates in First Descents. First Descents could loosely be described as a kayaking Outward Bound camp for cancer patients and survivors, but it's

more than that. "The 15 camp participants have all been through what you've been through," he says. "After a week together, you establish some deep, lifelong connections." And the physical challenge is an important component: "The counselors are very experienced, so the safety net is there, but they let you push it as far as you want," he says. But most of all, Matt talks about First Descents in terms of the opportunity it gives him to reach out to other campers, particularly those in the middle of treatment: "My cancer made me see that life is not just about me. It's about whom you help and the people around you. That's my main focus now," he says. "I wouldn't be the same person I am today if I hadn't had cancer; in a lot of ways, I now view it as a gift."

2004

Casey Aakhus-Witt is a patent examiner for the U.S. Patent and Trademark Office in Alexandria, VA.

Thomas L. Bonnie is a geotechnical engineer II for Black and Veatch in Leawood, KS.

Amy L. Hinkle is a geophysicist for ConocoPhillips in Anchorage, AK.

Tara N. Holz is an engineering graduate student at the Colorado School of Mines.

Ronald P. Pearson is a process engineer for NANA/Colt Engineering, LLC in Anchorage, AK.

Katherine E. Peeke is an engineer for Lockheed Martin.

Loic F.A. Wagner is pursuing an MBA degree at INSEAD in Fontainebleau, France.

Catryn E. Wilson received her master's in environmental systems management from Southern Methodist University in 2007. She is an environmental specialist for James Hardie Building Products in Irving, TX.

2005

Michael J. Asheim is a math/computer science engineer at Colorado School of Mines.

Amanda L. Dolezal is an abandoned mine lands hydrologist for USDA Forest Service in Boulder, CO.

David R. Farrar received an MS in health physics from Colorado State University in 2007. He is a health physicist for Environmental Restoration Group, Inc. in Albuquerque, NM.

Carolyn S. Houser is an associate technical professional for Halliburton in Grand Junction, CO.

Heather L. Barkley Kerr is a process engineer I for the Fluor Corporation in Houston, TX.

Katherine A. Morris is Grand County's water projects manager in Hot Sulfur Springs, CO.

Adrienne L. Nemanic is an assistant civil engineer for Burns and McDonnell in Houston, TX.

Kevin T. Oughton is a materials and quality technician for NanoProducts.

Louis M. Pitet is pursuing his PhD in chemisty at the University of Minnesota, Twin Cities in Minneapolis, MN.

Travis A. Yenne is a field engineer for BJ Services in Brighton, CO.

2006

Chia-An Chen is a construction engineer for Martin Martin in Lakewood, CO.

Nicholas P. Creadon is a production engineer for Anadarko Petroleum Corporation. He lives in Littleton, CO.

Huy Q. Dang is a field support engineer for Chevron Phillips Chemical Company LP. He lives in Baytown, TX.

Mark E. Donnelly is a project manager for Rooney Engineering in Centennial, CO.

Heather J. Flier is a software engineer for the Lockheed Martin Space Systems Company in Littleton, CO.

Megan H. Fry is a quality engineer for United Launch Alliance.

Thomas H. Harris is an engineer II for Carroll & Lange, Inc.

A. Scott Harrison is a facility engineer for Chevron, in Bakersfield, CA.

Nica M. Hoshijo is an environmental engineer for Washington Group International in Denver, CO.

Timothy J. MacIntyre is a geologist for EnCana Oil & Gas (USA) Inc. in Denver, CO.

Timothy A. Notz is flow assurance engineer for Technip USA, Inc. in Houston, TX.

Brian C. O'Connor is a level II structural design engineer for CDM Engineers & Constructors, Inc. in Denver, CO.

Chrisman G. Scherf III is an electrical engineering associate for United Launch Alliance.

Andria L. Eickelman Schmid is a structural engineer for KRM Consultants, Inc. in Avon, CO.

Kaitlin E. Schmidt is a project manager for the ExxonMobil Exploration Company in Houston, TX.

Rachel R. Sommers is an engineer/scientist for Knight Piesold in Denver, CO.

Jared R. Wageman is a process engineer for the Sundyne Corporation in Arvada, CO.

Heath R.M. Williams is a production engineer for E&B Natural Resources in Bakersfield, CA.

Caitlin J. Wilson married **Jonathan M. Wilson** on December 21, 2006 in Golden, CO. Caitlin is a process engineer for Commonwealth E & C and Jonathan is a facilities engineer for ExxonMobil in Houston, TX.

2007

William S. Aradi is a field engineer for Schlumberger in Bergen, Norway.

Matthew B. Arnold is a production engineer for Aera Energy.

Tumen Badarch is a miner for Kinross Gold Corporation in Fairbanks, AK.

Andrew F. Bairn is a metallurgical engineer for Kappes, Cassiday & Associates in Reno, NV.

Nicholas A. Belden is a field engineer for Archer Western Contractors in San Diego, CA.

Benjamin C. Betts is a petroleum engineer for Whiting Oil & Gas in Denver, CO.

Robert H. Blanchard II is an associate geophysicist for Marathon Oil Company in Houston, TX.

Matthew J. Brangan is a field engineer for Granite Construction.

Brent Chacon is a formwork engineer for Ceco Concrete Construction in Tempe, AZ.

Gabriel G. Colburn is a systems engineer for Northrop Grumann at Schriever Air Force Base in Colorado Springs, CO.

Justin C. Colby is a reservoir engineer for Chevron in Bakersfield, CA.

James W. Condon is a military officer in the United States Air Force.

Brandon L. Crayne is an engineer for Bechtel.

Brian L. Curkendall is an electrical engineer I for Black and Veatch in Centennial, CO.

Paul Davis is a staff engineer for Intermountain Rural Electric Association in Sedalia, CO.

Todd W. Dalessandro is a petroleum engineer for ConocoPhillips in Farmington, NM.

Elio S. Dean is a reservoir engineer for ExxonMobil Development Company in Houston, TX.

Michelle A. Debacker is a steel business associate for Timken Company in Canton, OH.

James A. Deyerle is an intern software engineer for Aerostream Communications in Golden, CO.

Russell J. Dowling is an improvement engineer for Dow in Seadrift, TX.

Chase L. Downs is an engineer for Anadarko in Casper, WY.

Mark A. Doyle is a technical consultant for Alliance Wood Group Engineering, LP in Denver, CO.

Emily L. Drolshagen is a 2nd Lieutenant in the United States Army.

Matthew D. Duncan is an engineer III for Metro Wastewater Reclamation District in Denver, CO.

Henry B. Fagnant is a consultant for SAIC, Houston, TX.

Colin H. Fitzgerald is a field engineer for CUDD in Grand Junction, CO.

Class of 2028

Eric Tanner '03 and his wife, Jamie, announce the birth of their second son, Rocky John Tanner, on November 30.

Josh and **Sarah (Marchwick) Lau** '00 welcomed their first child, Atticus Jefferson Lau, on November 25, 2006, in Portland, OR.

Glenda (Anderson) Rhodes '03 and her husband Tristan welcomed their daughter, Chloe Marie, on May 12, 2007.

Alex Yancey '01 and **Katrina (Britton) Yancey** '01 announce the birth of their first child, Ella Rider Yancey, on January 14, 2007.

Jordan Dimick '04, MS '07 and **Charlotte Dimick** MS '05 announce the birth of their son, Caedmon David Dimick, on September 7, 2007, in Littleton, CO.

Dawn (Kerr) Culley '00 and her husband Alan announce the birth of their son, Samuel Alan Culley, on May 4, 2007.

Aaron Martinsen '99 and his wife Sara announce the arrival of Daxton Michael Martinsen, born June 11, 2007 in Omaha, NE. Also pictured are sisters Mia Rae (4) and Adelaide Nikole (3).

Brian M. Fitzpatrick is a project engineer for M.A. Mortenson in Phoenix, AZ.

Aaron Forehand is a field engineer for Kiewit Underground.

Kevin V. Galloway is a graduate student at the Colorado School of Mines.

Mark A. Gefreh is a graduate student in the Engineering Division at the Colorado School of Mines.

Steven Goolsby is co-owner of Goolsby Brothers & Associates, Inc. in Centennial, CO.

Ryan E. Grady is a graduate student at the University of Notre Dame.

Gaurav Kumar Gupta is an application engineer for G.E. Energy.

Wilson G. Hahnenberg is a petroleum engineer for Whiting Oil & Gas in Denver, CO.

Thomas W. Hamilton is an operations engineer for Chesapeake Energy Corporation in Oklahoma City, OK.

Nathan T. Hancock is pursuing a PhD at the Colorado School of Mines.

Harold P. Hanneman is a junior exploration geologist for Goldfields in Denver, CO.

Brian E. Hansford is pursuing a PhD at the Colorado School of Mines.

Matthew S. Heller is a graduate student at the Colorado School of Mines.

Matthew P. Hergert is a geophysical technician for Olson Engineering in Wheat Ridge, CO.

Alexander T. Hrin is a graduate student at the Colorado School of Mines.

Kristin J. Illi is an engineer 6 for Anheuser-Busch in St. Louis, MO.

Michael H. Iwata is a system engineer for Lockheed Martin in Boulder, CO.

Dwyatt D. Jackson is an engineer for Devon Energy.

Jeremiah J. Jantzen is an engineer for Washington Group International.

Bart D. Jordan is an engineering geologist for Maptek.

Jacob W. Kirkley is a project engineer for Wagner Power Systems in Aurora, CO.

Adam R. Koester is a junior engineer for Vision Land Consultants, Inc. in Golden, CO.

Kyle A. Kranker is a petroleum engineer for Occidental Oil & Gas.

Gregory J. Kruse is a project engineer for Kahana Ventures, LLC in Westminster, CO.

Steven L. Kuhmichel is an engineer for BP.

Allen J. Kuhn is a production management trainee for Loprino Foods in Roswell, NM.

Ryan N. Lavergne is a production engineer for XTO Energy in Farmington, NM.

Brian A. Law is staff engineer for Kahuna Ventures LLC in Broomfield, CO.

Theodore B. Lawrence is a field engineer for Ground Engineering Consultants.

Brandon K. Lee is a field engineer for Pathfinder Energy Services in Lafayette, LA.

Brett L. Lewis is a field engineer for Pathfinder in Casper, WY.

Qiwei Li is a production engineer for Dow Chemical Company.

Jianliang Lin is a graduate student at the Colorado School of Mines.

Po-Chen Liu is pursuing a PhD at the Colorado School of Mines.

Ronald Jason Livesay is a postdoctoral researcher at Oak Ridge Associated Universities, Inc. in Oakridge, TN.

Ryan P. Loewen is a management associate for USS-Posco in Pittsburgh, CA.

Carl D. Lundin is a graduate student in the Environmental Science and Engineering Division at the Colorado School of Mines.

Matthew A. Madsen is an engineer for TRANE in Pueblo, CO.

Lisa Mary Mauger is a graduate student in applied physics at California Institute of Technology in Pasadena, CA.

Allison M. McCormick is a senior project engineer for TSC Group, Inc. in Arvada, CO.

Jeannette E. McGill is a research group leader for CSIR.

Clayton J. McWhite is an engineer for ConocoPhillips in Farmington, NM.

Ryan J. Miles is a mining engineer for Washington Group International, Inc. in Denver, CO.

Grant E. Millener is an engineer for Kiewit Construction.

Patricia Beth Moran is a chemist for Knight Piesold in Denver, CO.

Charles T. Morley is an LM21 and strategic business initiatives lead for Lockheed Martin in Denver, CO.

Jonathan C. Morrill is a reservoir engineer for Occidental Oil and Gas Corporation in Bakersfield, CA.

Zachary T. Morrison is an engineer in training for Lafarge North America, Inc. in Denver, CO.

John G. Muller is a production engineer for Hunt Petroleum in Shreveport, LA.

Nathan N. Myers is an engineer tech 1 for Denver Water in Denver, CO.

Natalie L. Naeve is a petroleum engineer for Berry Petroleum Company in Denver, CO

Jessica M. Nekuda is pursuing a PhD at the Colorado School of Mines.

Audrey L. Nelson is a process engineer for Chevron in Richmond, CA.

Suu Nguyen is a customer applications engineer for Xilinx.

Allison L. Nold is a process engineer for Washington Group International, Inc. in Denver, CO.

Kelsey J. O'Connor is an analyst for Dolt and Phelps in Denver, CO.

Scott A. O'Connor is a mine engineer for Climax Molybdenum Company in Empire, CO.

Erin C. O'Hearn is a project engineer I for Anadarko in Denver, CO.

Nathan F. Ostrander is a student trainee for Defense Information Systems Agency.

James G. Ostroot is a drilling engineer for Marathon Oil in Houston, TX.

Ryan M. Owen is a graduate student at the University of Colorado, Boulder.

Antonio Peralta Romero is a professor at the University of Guanajuato in Guanajuato, Mexico.

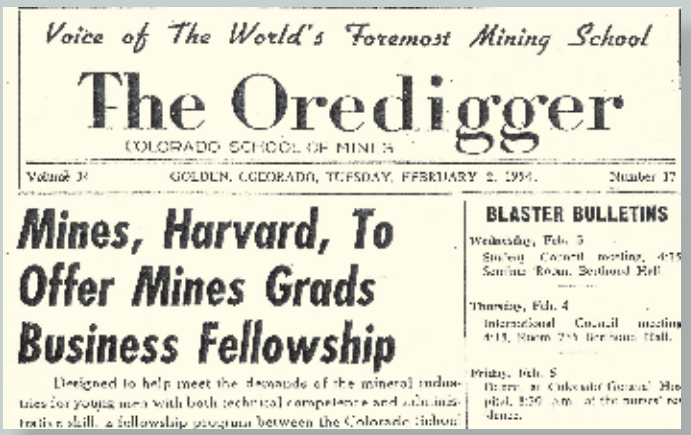
Jonathan A. Poncelow is pursuing a PhD at the Colorado School of Mines.

Heather A. Rehmer is a facilities engineer for ExxonMobil.

Joseph D. Rice is a lab scientist for Gambro BCT in Lakewood, CO.

Profile

Harvard Business School's Mineral Engineering Fellowship—Reserved for Miners Only



Voice of The World's Foremost Mining School

The Orediggger

COLORADO SCHOOL OF MINES

Volume 34 GOLDEN, COLORADO, TUESDAY, FEBRUARY 2, 1954. Number 17

Mines, Harvard, To Offer Mines Grads Business Fellowship

Designed to help meet the demands of the mineral industries for young men with both technical competence and administrative skill, a fellowship program between the Colorado School

BLASTER BULLETINS

Wednesday, Feb. 3

Student Council meeting, 4:15

Senate Room, Second Hall

Thursday, Feb. 4

International Council meeting

Friday, Feb. 5

The Colorado General Hospital

The article that follows this 1954 *Oredigger* headline announced the creation of a fellowship at Harvard Business School for Colorado School of Mines alumni. Created by the American Climax Foundation, the award was established as an enticement for mineral industry professionals to augment their business skills. After being established, the fund lay dormant for some time, allowing it to appreciate considerably. However, in recent years, there has been a steady stream of recipients, the most recent being Nathan Dutzman '02, MSc '06. Like others, Nathan didn't know the fellowship existed when he applied for assistance: "I received quite a bit more financial aid than I was told to expect." He remained puzzled until he later discovered the source of the windfall. Before Nathan, the fund's previous recipient was Matthew Moore '96. Now based in Houston, he values the combination of his Mines education and his experience at Harvard: "Mines challenged me to develop the technical competence and academic discipline necessary to solve problems. Harvard challenged me to apply those skills to business leadership." Along with Dutzmann and Moore, there have been six additional recipients of the fellowship since 1954, including Anthony Lewis '96, Jennifer Knepp '98, Jeffrey Childs '84, Joseph Mahoney '86, Nancy A. Keegan '82 and Kathleen Wiltsey '77. If Mines alumni are admitted to Harvard Business School and meet its criteria for financial assistance, they become eligible to receive the fellowship, which is applied toward tuition.

Brandon W. Richardson is a management associate for Aggregate Industries in Golden, CO.

Christina B. Rollins is a tech service and development engineer for DOW.

Andrea E. Romine is a materials engineer for Cummins in Columbus, IN.

William J. Rowden is a drill site manager for Chevron in New Orleans, LA.

Wesley J. Ryan is a mechanical engineer for United Launch Alliance in Littleton, CO.

Chad D. Schell is an electrical engineer for Chevron Phillips Chemical Company.

Alexander N. Schroeder is a program manager for the Western Governors' Association in Denver, CO.

Henry E. Scott is a granite engineer for Granite Construction Company in Bakersfield, CA.

Nicholas M. Sealy is a systems engineer for Lockheed Martin in Valley Forge, PA.

Janel L. Servis is the director of environmental services for Carroll and Lange, Inc. in Lakewood, CO.

Ross E. Shaeffer is a risk engineer for Kinder Morgan, Inc. in Houston, TX.

Christopher R. Siron is a geological engineer for Ur-Energy, Inc. in Ken Caryl Ranch, CO.

Michael J. Slavens is a production engineer for Shell in Denver, CO.

Jessica A. Smagala is a petroleum engineer for EnCana Oil & Gas (USA) in Denver, CO.

Jesse Snyder is a chemist for Wibby Environmental in Golden, CO.

Zachary T. Spence is an engineer I for Noble Energy, Inc. in Houston, TX.

Daniel M. Sprague is a facilities engineer for Terracon Consultants, Inc. in Wheat Ridge, CO.

Joshua T. Staker is a graduate student at San Diego State Graduate School.

Tony J. Stebleton is an operations engineer for Aspect Energy in Denver, CO.

Bryce A. Swinford is a geologist I for Apache Corporation in Tulsa, OK.

Jordan J. Ter Har is a project engineer for Archer Western Contractors, Inc. in San Diego, CA.

Matthew D. Tharp is an LWD engineer for Weatherford International in Houston, TX.

Andrew D.W. Thiel is a graduate student at Stanford University in Palo Alto, CA.

Richard P. Tinetti is a control systems engineer for Washington Group International.

Sarah Vander Meulen is an electrical reliability engineer for ExxonMobil in Torrance, CA.

Janelle M. Wadas is an environmental engineer for Noble Energy Inc. and is also a graduate student at the Colorado School of Mines.

Chelsea R. Weitzel is a graduate student at the Colorado School of Mines.

Jeremy R. Wells is a junior engineer for W.W. Wheeler & Associates, Inc.

Thomas C. Wells is a graduate student in engineering systems–electrical at the Colorado School of Mines.

Garrett J. Whipp is a mining engineer for Maptek in Lakewood, CO.

Kristine Wille is a field engineer for M.A. Mortenson.

Bradley S. Wolfinger is a project geologist for Science Applications International Corporation in Lakewood, CO.

Adam D. Woods-McCormick is a graduate student at the Colorado School of Mines.

Christopher R. Wooten is a metallurgist engineer I for Phelps Dodge in Morenci, AZ.

Michael J. Worrall is a graduate student at Texas A&M University.

Passings

To live in hearts we leave behind Is not to die.

—Thomas Campbell 1777-1844

William H. Ballew '51, MS '57 of Midland, TX, died on June 1, 2007, at the Hospice of Midland Inpatient Unit. In 1942, as a 17-year-old, he followed his brother into the US Navy. Serving as a radar technologist, he spent time in Chicago, San Diego and Honolulu. At the conclusion of World War II, he returned to Colorado where he continued military service in the Army Corps of Engineers. He earned both his bachelor's and master's degrees in geology and geological engineering. After leaving Mines, he turned down a scholarship from Harvard Law School so he and his new bride, Betty Louise Clark, could focus on their careers and family. In 1953, he moved to Midland, TX as a petroleum geologist with Shell Oil Co. After 10 years with Shell, he began working as an independent consultant. He was a longtime member of the American Association of Petroleum Geologists. With two sons playing baseball, he volunteered as a coach for Little and High Junior leagues. He served as a lay reader at St. Nicholas Episcopal Church. He was predeceased by his wife of 50 years, Betty Lou; his sister, Peggy Hankla; and his brother, Thomas. He is survived by his two sons, William and Scott; and one grandson.

William Bartlett '51 of Reno, NV, died on March 11, 2007. Prior to enrolling at Mines, Bill served in the Pacific as a corporal in the Marine Corps during World War II. Soon after graduating from Mines with a degree in petroleum engineering, he launched a long and prosperous career as a petroleum engineer in Saudi Arabia, remaining there until 1980. In 1961, he earned the award of Best Paper from the Arab Oil Summit in Alexandria, Egypt. Bill taught classes and workshops to engineering students in the Middle East and South America. An inveterate traveler, he was a champion of the Afghan people before, during and after their struggle against the Soviet Union. One of his greatest wishes was to see peace return to the people of that region and to the Middle East. Bill was a longtime volunteer for CSMAA and is survived by his wife of 49 years, Juliette; and his daughters Karen, Liza, and Jennifer.

Thomas P. Bellinger II '47 of Dallas, TX, died on July 7, 2007. After graduating from Newton Falls Union School in Newton, NY in 1935, he went on to the US Naval Academy in Annapolis, MD, before beginning his active military service in Pearl Harbor in 1940. He was engineering officer of the USS Boggs during the Pearl Harbor attack. He graduated from Mines with a bachelor's degree in metallurgical and materials engineering before returning to active duty in Korea (1950-1953) as executive officer aboard the USS *McNair*, and later commanding officer of the USS *Hulbert*. In 1954, he served as associate professor of naval science at Northwestern University in Evanston, IL. He transitioned from active military to employment with Chance-Vought in Grand Prairie, TX, as a registered professional engineer and was involved with projects such as the F-8 Crusader. Since retiring in the 1970s, he has enjoyed rebuilding classic cars and spending time with his family. He was predeceased by his sisters, Ruth and Judy; and his son, Howard Dye. He is survived by his wife of 65 years, Mary Dye; son, Thomas III; three granddaughters; and his brother, Jim.

Lisa L. Bissett '94 of Boston, MA, died on February 13, 2007, at her home. Prior to earning her master's degree in hydrogeology from Mines, she earned a bachelor's degree in geological engineering from Queen's University in Kingston, Ontario. After Mines, she went on to earn an MBA from the Wharton School at the University of Pennsylvania. She served as a strategy professional for McKinsey and Co. and Clean Harbors. She also started the floral design business, Blooming Color. She enjoyed international travel, taking trips to Ireland, Brazil, South Africa, Japan, China and, most recently, the Galapagos Islands, accompanied by her husband and best friend, Matt Mcleod. In recent years, she volunteered at the Tufts-New England Medical Center. She is survived by her husband; her parents, Gerald and Kathleen Bissett; her sister Tara; her brother, Todd; her nephew, Gavin; and her grandmother, Conny Landmann.

Roy F. Carlson '48 of Abilene, TX, died on June 25, 2007. Born near Longmont, CO, he served as a second lieutenant in the U. S. Navy during World War II. At Mines, in addition to earning his degree in petroleum engineering, he was editor of the *Oredigger*. After Mines, he earned another bachelor's degree from Tufts University in mechanical engineering. He began his career as a petroleum engineer with Phillips Petroleum Company. While in Midland serving as the West Texas editor of the *Oil and Gas Journal*, he met his wife, Martha, with whom he shared more than 50 years. He joined the American Petroleum Institute in Dallas in 1953 and served as director of the Dallas office from 1966 until his retirement in 1984. He was a member of Zion Lutheran Church and Kiwanis Club of Greater Abilene. He was predeceased by his brother, John E. Carlson. He is survived by his wife, Martha Scott Carlson; son, J. Scott; daughter, Laura Carlson Dyer; five grandchildren; and brother, Kenneth.

Clifford M. Chappell '49 of Houston, TX, died on March 6, 2007. Born in Denver, he served in the Navy after graduating from high school. After completing his degree in geology and geological engineering at Mines, he joined the ROTC and became a commissioned officer in the Army Reserves. He worked for Shell Oil in Corpus Christi, TX on offshore explorations. While there, he met and married Rosine Joseph, with whom he shared his life for the next 56 years. After deciding to enter the computer field, he went to work for IBM first in Salt Lake City, UT; then Seattle, WA; and finally, Houston, TX. In Houston he developed expertise in array processors, specifically used to facilitate oil exploration. He attained the highest rank awarded any scientist in his division. After retiring from IBM, he worked briefly with Unocal to set up their computer

department, before retiring permanently. He enjoyed cycling and square dancing with Rosine, and he was active in his synagogue, Brith Shalom. He also read for the blind and volunteered for MD Anderson Network in Houston. Cliff is survived by his wife; his sons, Glen and Rick; his daughter, Andrea; and three grandchildren.

Phillip Denbo, Jr. '65 of Durango, CO, died at his home on January 9, 2007. A Colorado native, Phillip graduated from Mines with a degree in geophysical engineering, before serving in the U.S. Navy for two years in Pensacola, FL. In the mid-sixties, he moved to Durango, where he worked for oil companies on a seismographic crew. He was a member of the American Legion. He is survived by his daughter, Ann Malburg; and his sister, Cadette Denbo.

Norman H. Donald, Jr. '39 died on August 19, 2007 at St. Joseph's Hospital in Atlanta, GA. A geologist, he obtained his bachelor's degree in geology from Princeton University before obtaining a second undergraduate degree in geology and geological engineering from Mines. In 1944, he became chief geologist for the St. Joseph Lead Company at Balmat, NY. He was later transferred to the company's New York City office, where he became chief geologist and vice president in charge of world-wide exploration and production until his retirement in 1967. He was also associated with the New Jersey Zinc Company, a provider of lead and zinc to the World War II war effort. He is survived by his wife, Grace; his two sons, Norman H. Donald III and Williamson P. Donald; his brother, Douglas D. Donald; step-children, Peter Feininger and John Feininger and Gail Van Winkle; four grandchildren; and four great-grandchildren. He was predeceased by his first wife, Angelene Pell Donald; his daughter, Annette; his sister, Mary May Miller; and his grandson, Norman H. Donald IV.

Terry C. Huff '73 died on July 7, 2007, in Lakewood, CO. He grew up in McCook, NE, where he graduated from high school in 1962 and shortly thereafter entered the U.S. Navy and served during the Vietnam War. In 1971, he married Elaine Hayes, also from McCook, and the two moved to Denver. After earning his degree in petroleum engineering from Mines, he worked for Getty Oil and Murphy Oil Companies as a petroleum engineer. He was preceded in death by his two step-sons, Jay and Darryl Seger; and his brother, Robert. He is survived by his wife, Elaine; seven step-children, Jamison Seger, Elana Seger, Pamela Laidley, Christina Seger, Sabrina Schlegel, Viola Schlegel and Sidney Seger; his sister, Marilyn Augustyn; 14 step-grandchildren; and seven step-great-grandchildren.

Roger L. Kaesler '59 of Lawrence, KS, died on August 11, 2007. He earned his bachelor's degree in geological engineering from Mines before going on to the University of Kansas, where he earned his master's and doctoral degrees in paleontology, before joining the faculty. He retired from the university in 2006. He taught classes at the non-major, undergraduate and graduate levels. He also led a summer geology field camp in Canon City, CO. He received the Distinguished Alumni Award and the Van Diest Medal from Mines. He also received the Geological Society of America's Distinguished Service Award and KU Geology Department's Haworth Distinguished Alumni Award. He was a fellow of several professional organizations, including the American Association for the Advancement of Science, the Paleontological Society (USA) and of the Geological Society of America. He is survived by his wife, Jerelyn Boudreaux Kaesler; his son, Stephen Kaesler; daughters Jane Kaesler Stotts, Andrea Kaesler, and Susanne Broussard Grossoehme; five grandchildren; and his brother, Walter Jr.

Richard Lowery '52 of Midland, TX, died on March 31, 2007. Born in 1930, Richard grew up in Sedgwick, CO, where he balanced work on the family farm with academic studies and his place on the Sedgwick High School basketball team. At Mines, while earning his engineer of mines degree, he met his future wife, Mary LaVelle. They were married in Eades, CO, in 1953. Shortly thereafter, Richard was deployed to serve in the Korean War as a lieutenant in the Army Corps of Engineers. Richard returned to civilian life in the U.S. two years later, going to work for Shell Oil in Houston. After 25 years with Shell, he retired and began working as operations manager for an oil company in West Texas called Maralo Inc. In 1994, his wife of 42 years, passed away. Richard was married to Sherri Hill Scott in 1996. He retired in 2000, devoting himself to family and church. He is survived by his wife, Sherri; his daughter, Nancy Mihlon; his three sons, Clark, John, and Brent; Sherri's children, Penny, Scotty, and Monty; his three sisters, Louis Bowman, Marilyn Winans, and Esther Smith; his brother, Lawrence; and 23 grandchildren. In addition to his first wife, Mary, he was predeceased by his sister, Louise Murphy; and his two brothers, John and Roland.

Marvin A. Mantooth '48 died on November 7, 2006, in Metairie, LA. Born in Denver, Marvin served in Europe in 1945 with the 3548th Ordinance. After earning his degree in petroleum engineering from Mines, he went to work for Chevron, drilling wells in Colorado, Utah and Wyoming. It was during this interval that he met and married Dorothy Elizabeth Powell, also of Denver, with whom he moved to New Orleans in the fifties. He enjoyed a 40-year career with Chevron as a drilling and production engineer and was among the first to work in offshore recovery. After retiring in the 1980's, he remained active in Chevron's retirement organization and traveled. He was a member of St. Augustine's Episcopal Church. He was predeceased by his wife, Dorothy. He is survived by his sons Chris and Geoff; his daughter, Janet Burgess; eight grandchildren; and his brother, Lester.

William E. McCool '49 of Lakewood, CO, died on May 25, 2007. After growing up in Pennsylvania, he enrolled with Carnegie Institute of Technology in 1939 to study Aeronautical Engineering. During World War II, he was a P-40 fighter pilot in the U.S. Air Force. He flew in 80 combat missions in Africa, Sicily and Italy and served as an instructor after his tours overseas. He graduated from Mines with a degree in petroleum engineering and went to work as a cost estimator for Mine and Smelter Supply Company. Two years later, he began working for Shell Oil as a drilling and production engineer in the Mid-continent Division. After 28 years with Shell, Bill retired and pursued his lifelong passion for golf. He was predeceased by his wife, Beverly Joan. He is survived by his sons Richard and Stephen; his daughter, Mimi; four grandchildren; and several great-grandchildren.

Fred F. Meissner '53, MS '54 of Littleton, CO, died on September 18, 2007. A Colorado native, he earned both his master's and bachelor's degrees in geology and geological engineering. He served for two years during the Korean War in the Army Corps of Engineers. He then spent 17 years with Shell Oil Company, including a stint at the Shell Development Company research lab in Houston. Early in his career, he published several highly significant publications on cyclic and reciprocal sedimentation within the Permian Basin. Fred elected to stay in Denver when Shell consolidated its divisions in Houston in 1973. He subsequently worked in domestic and international exploration for several independent agencies, and later on his own as a consultant. In addition to receiving Mines' Distinguished Achievement Medal, he received AAPG Honorary Membership, Rocky Mountain Association of Geologists (RMAG) Distinguished Service Award and RMAG Scientist of the Year Award. He is survived by his wife Jackie; three children, Mark, Susanna, and Mike; 8 grandchildren; and his brother, Dick.

Adolph V. Mitterer '52 of Lakewood, CO, died on August 22, 2007. Born in Denver, he graduated from West High School in 1945. He spent one year with the Army's 252nd Engineer Construction Battalion as a 2nd Lieutenant in Berlin, Germany, and a second year with the Army Corps of Engineers in Colorado. After graduating from Mines with an engineer of mines degree, he worked for the School's Research Foundation. In 1954, he was employed by International Minerals & Chemicals as chief mining engineer at Carlsbad, NM, and later as a corporate mining engineer at IMC headquarters in Skokie, IL. He joined the Continental Oil Co. in 1978, initially based in Ponca City, OK, and then transferred to Denver, where he became manager of mining and milling for their minerals division. His final employment was at Rocky Mountain Energy Co., in Broomfield, CO, where he served as vice president for technical services. After retiring in 1988, he enjoyed time spent in the mountains, on his computer, taking photographs, vacationing and gardening. He is survived by his wife of 55 years, Shirley; two sons, Steven and Thomas; and a brother, Albert.

Frank J. Murphy '50 of Aurora, CO, died on April 4, 2007, at Parker Adventist Hospital. Born in Denver, he graduated from Regis High School before serving as a radar operator in the U.S. Navy during World War II. While earning his degree in petroleum engineering at Mines, he met and married his wife of 55 years, Joan Gardener. After graduating, he worked as a junior petroleum engineer for the Union Oil Company of California in Newcastle, WY. Two years later, he returned to Denver to work for the California Company as a drilling engineer. His career took him around the country and the world, including Utah, Louisiana, Texas, Singapore, Malaysia, Indonesia and Norway. He was predeceased by his son, Pat, and his wife, Joan. He is survived by his daughter, Sharon; his sons, Mike and Dan; and eight grandchildren.

David W. Nelson died on November 27, 2007, in Littleton, CO. Born in 1983, in Ft. Defiance, AZ, David graduated from Round Valley High School in Springerville, AZ, in 2002, having played varsity soccer and earned his Eagle Scout award. While at Mines, he was active in the American Indian Science and Engineering Society (AISES) and was elected president of the chapter in his senior year. He was an avid video gamer and music lover. He also enjoyed basketball, racquetball and skiing. Having come close to completing his degree at Mines, a debilitating illness interrupted his studies in August 2005. It was his great hope that he would be able to return to Mines to complete his degree. He is survived by his parents, Michael and Sally Nelson; and by his sisters, Rachel and Miriam.

Scott D. Neunuebel '83 of Santa Rosa, CA, died on August 21, 2007. Scott graduated from Mines with a degree in mining engineering and worked in several gold mines in Colorado. He was later an account executive for Dean Witter Reynolds in Albequerque, NM, before he moved to California. In Santa Rosa, he worked as a financial analyst for 16 years at Washington Mutual Bank. He is survived by his fiancé, Susan Main; his daughters, Rebecca and Danielle; his sons, Adam and Colin; his brother and sisters, David, Nancy, and Barbara; his father, Robert; and three grandchildren.

Bernard Radovsky '55 of San Diego, CA, died on February 12, 2007. Born in Fall River, MA, he enlisted in the Army Air Corps in 1942 and drove trucks across North Africa, Italy and Southern France. While earning his degree in geological engineering at Mines, he met his first wife, Temple. After graduation, he worked as a petroleum geologist in Venezuela and Trinidad before returning to the United States, where he worked for Texas Gas Explorations in Houston as a senior geologist. In 1992, eight years after the death of his first wife, he married Margaret. During his retirement, he traveled extensively, often by motorcycle, VW bug and tramp steamer. He was a proud member of MENSA, read voraciously, played Scrabble aggressively and liked to complete the *New York Times* crossword puzzle in pen. In addition to his first wife, Temple, he was predeceased by his siblings, Doris, Everett, Rita, Joseph, Joy, and Claire. He is survived by his wife, Margaret; his children, Laurie and Joseph; his two grandchildren; and his siblings, Lester, Billie, Avis, Saul, and Frank.

Ben H. Slothower, Sr. '50 of Bozeman, MT, died on October 7, 2007, in his home. Born in California, he later moved with his family to Colorado Springs where he attended high school. His Mines education was interrupted by military service with the 15th Air Force, serving as an aerial navigator in Italy. After returning from active service, he married Patty-Rae Esmiol, with whom he spent 62 years. After earning his mining engineering degree from Mines, he went on to obtain an MBA from Stanford University Business School. He spent 23 years with Kennecott Copper Corporation in Salt Lake City, UT, after which he moved to Montana to operate a private mining consulting business, in which he was a partner. A board member of Holly Sugar Corp in Colorado Springs for 20 years, he maintained close ties with Colorado friends. He was a member of numerous professional mining societies and served on several boards of directors. He operated a ranch in Montana for several years with his son. An outdoorsman, he was an avid duck hunter. He enjoyed time on the river, boating, picnicking and spending time at the family's cabin. He is survived by his wife, Patty-Rae; his son, Ben; and his daughter, Lucille.

Gerald C. Smith, Jr. '82 of Moodus, CT, died January 6, 2004, at his home. He was born in Sidney, NY, where he graduated from Sidney High school in 1978. He earned a bachelor's degree in petroleum engineering from Mines, before going on to the University of Houston, where he earned a second undergraduate degree in mechanical engineering. He worked as a service engineer for Babcock and Wilcox in New York City, while residing in Kingston, NY. He moved to Moodus in June 1999, where he worked as an engineer for Northeast Utilities. He is survived by his wife, Nancy A. Lavriha-Smith; his two children, Devin and J.T.; his parents, Gerald C. Sr. and Ann; his grandmother, Shirley; and two sisters, Shelley and Kristen.

P. Kent Tribelhorn '69 of Santa Fe, NM, died on March 15, 2007. Born in Denver, he met and married his wife, Kathryn, in 1967, while still a student at Mines. After earning his degree in petroleum engineering, he launched his career as a project controls engineer. He was a keen outdoorsman who enjoyed fishing, camping and boating. He also enjoyed motorcycling, woodworking and making model planes. He is survived by his wife; his son, Kevin; his daughter, Kelly; one granddaughter; and his sister, Diane Outerbridge.

Paul A. Wichmann '58 of The Woodlands, TX, died on August 13, 2007, in Houston. Born in Tulsa, OK, he spent much of his childhood in Calgary. A successful athlete throughout his youth, he was named the Outstanding Track Athlete and High Scorer at Mines after medaling in both his hurdles specialties in two conference meets. After earning his degree in petroleum engineering from Mines, he joined Shell Oil as an exploration engineer, later moving on to Dresser Atlas, where he remained for 17 years. While with Atlas, he earned an MBA from Southern Methodist University. He served as British Petroleum's chief petrophysicist for seven years and helped develop Prudhoe Bay Oil Field on Alaska's North Slope. He subsequently joined Teleco as vice president and chief petrophysicist. He is the author or co-author of 40 papers, and spoke and taught widely. An active member of the Society of Professional Well Log Analysts, he earned its Medal of Honor, having served the society in several capacities, including as president. During retirement he was ordained as a deacon in the Catholic Church and volunteered to teach children and young adults. He was predeceased by his brother, Lothar. He is survived by his wife of 50 years, Margie; daughter, Gretchen Juergens; sons, Robert and Russell; seven grandchildren; brother, Dewitt; and sisters, Barbara Bateman and Dorothy Maas.

Also In Memoriam

Michael J. Belt '89 ..... August 20, 2007
John H. Church '50 ..... August 10, 2007
Richard C. Johnson '52 ..... August 29, 2007
Matthew S. Mitchell '00, MS '06 ..... August 17, 2007
Thomas E. Northrop '32 ..... May 29, 2007

Sao and Inge were married in Denver in 1953.

Memories from Burma

By Dave Coolbaugh '43, '47, DSc '61

With the recent news regarding Burma (Myanmar), it is a good time to recount the story of Sao Kya Seng '53, who became the hereditary ruler of Hsipaw Shan State in Burma, and is thought to have died at the hands of Burma's military dictatorship, although his body was never found.

When he was a young man, his family and advisors felt that Sao should obtain mining and engineering experience, since Hsipaw had great mineral wealth and several mining operations within its borders, including the famous Bawdwin Mines operated by the British. After some deliberations, it was decided to send Sao to the famous Colorado School of Mines. While Sao was attending Mines, he met an Austrian exchange student, Inge Eberhard, who was a student at Colorado Women's College. They were married prior to returning to Burma.

In late 1957, I was contacted by the Dunwoody Industrial Institute of Minneapolis, MN, to consider a position as advisor in mineral technology to the Burmese Government. My area of expertise was mining and dealt primarily with mineral processing, exploration, assaying and surveying. A curriculum was developed and laboratories were prepared and maintained. Two other instructors in mineral technology were employed, one from Mines, Harry McFarland '32, and one from the Netherlands.

Insein is located some ten miles north of Rangoon and within a month of my arrival in Burma I had located some of the few Mines graduates from Burma. Most of them were employed by government agencies or the national university and worked in Rangoon. We occasionally met for informal alumni meetings, and Sao sometimes met with us when he was in the city for business.

On numerous occasions the Burmese Mining Ministry sent me to mining operations or prospecting areas. In the summer of 1959, I was sent to the Bawdwin Mines located within the Hsipaw Shan State. The mines had been badly damaged during the Japanese occupation of Burma during World War II but were in operation. Since I was to be in Hsipaw, I arranged for a visit with Sao and Inge. This was a special opportunity, as my son and two small daughters were able to visit a state ruler and his princess—the girls still remember meeting a real princess. I was also pleased to have the opportunity to observe some of the great things Sao had accomplished for his subjects in the way of advanced agriculture, employment and infrastructure in his Shan state. Though we observed Burma as somewhat technically backward, it was populated with wonderful, caring people, and it was an interesting and colorful country.

I left Burma in September 1959, but have kept up with news of the country ever since. In the *Mines* magazine of July/August 1996 there was an article* written by Sao's wife, Inge, who had returned to the United States and later married Tad Sargent, and was living in Boulder, CO. This article, plus her book *My Life as a Shan Princess* (published by the University of Hawaii Press) enumerated how she and Sao had met, the great things he had done for the Hsipaw State, and of his death at the hands of the Burmese army. Her book also details her problems being under house arrest for two years and how she finally made her escape to Austria with her two daughters.

*Download a PDF of this article from the *Mines* magazine website.

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