Spring 2016 Volume 106 Number 2

Corporate Social Responsibility

Blaster the Burro

Mines Innovation on the ISS

Mines

COLORADO SCHOOL OF MINES MAGAZINE

Mining's New Legacy

Mines, Industry, and Colorado Work to Shape a Greener Future

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ALUMNI ASSOCIATION
COLORADOSCHOOLOFMINES

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SPRING 2016

Cover image: This issue's cover is a composite image of the Minnesota Mine in Empire, Colorado (background), and Mines student Logan Yamamoto testing the soil near the mine during an environmental engineering field session (foreground). (Images by Deirdre O. Keating)

FEATURES

DEPARTMENTS

WEB EXTRAS | MULTIMEDIA To view Web Extras, please visit minesmagazine.com.

Follow Us, @MinesMagazine

Repairs to the "M" In November 2015, the "M" on the east-facing side of Mount Zion is believed to have been struck by lightning. Read the story in the Denver Post about the repairs made by Mines' Blue Key Society to make the "M" shine brighter.

#idigmines Photo Contest #idigmines week was all about celebrating donors who support what they dig the most about Mines. See the winning photos chosen by the Mines Philanthropy Council.

Q&A with Travis Ramos after his return from SEA semester Read about environmental engineering student Travis Ramos' experience spending a fall semester as part of the study abroad program, Sea Education Association (SEA).

It's Almost Golf Season The 2016 Mines alumni golf tournaments are just around the corner. Help raise funds for Mines student scholarships while enjoying a round of golf with other Mines alumni. For dates, locations, and sponsorship opportunities, visit minesalumni.com/events.

Corporate Social Responsibility Interest Group The alumni association would like to pilot a group that connects Mines alumni, students, and faculty working in the area of corporate social responsibility. If you would like to attend events or be kept in the loop about relevant activities dealing with questions about community conflict, sustainability, or public perception in your professional life, join the new interest group at minesalumni.com/CSR.

Icons indicate additional online content — Video, Photos, Text, Audio

3,000 DONORS WILL

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THE SUMMIT IS IN SIGHT

You can be part of the Million Dollar M Climb

We've already reached the first milestone of 1,874 donors and unlocked $500K. With your help we can make it to 3,000 donors by June 30 to unlock the full $1 million provided by generous challengers: Howard '76, '77 and Cherine Janzen and Jerry '72, '75 and Karen Zink.

Give to the area that means the most to you to #unlock1million for Mines students and programs.

Stay updated with the progress of the climb at **giving.mines.edu/unlock1million.**

COLORADO SCHOOL OF MINES FOUNDATION

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Comments and suggestions are welcome. Contact us via our contact form at minesmagazine.com/contact-us/ or via mail at Mines magazine, PO Box 1410, Golden, CO 80402. To update your address, go to minesalumni.com/update or email jmreeves@mines.edu.

Closing the Gender Gap at Mines

I grew up a Trekkie, so it's not surprising that one of my favorite quotes comes from Nichelle Nichols, the actress who played Lieutenant Uhura in *Star Trek*. She said, "Science is not a boy's game, it's not a girl's game. It's everyone's game. It's about where we are and where we're going." I thank my Mines degree for helping me reach new frontiers and be all that I can be.

As a proud Mines alumna, I was captivated by a recent news report highlighting a Mines milestone. Of its latest incoming freshman class, 31 percent are female. With the focus on Women in STEM careers, it was satisfying to see Mines garner this well-deserved attention as a school that seeks opportunities to attract and retain the best and brightest students, including women.

New Mines president, Dr. Paul Johnson, met with our Mines Alumni Association Board of Directors to talk about his vision and goals. Foremost among those goals is student engagement and making continued progress in the recruitment and retention of qualified female students. This inspired me as a board member to seek out ways to engage our alumni and continue to "move the needle" to increase the number of women students attending and thriving at Mines. In collaboration with the President's Office and the new admissions director, the alumni association is on track to offer opportunities to engage alumni as allies to achieve the Mines goal of attracting and retaining top female students.

Several well established organizations at Mines, including Women in Science, Engineering and Mathematics (WISEM) and the Society of Women Engineers (SWE), have proven successful. These programs offer a platform to showcase our alumnae and enable them to share their experiences, successes, and journeys through Mines with incoming freshman candidates. I also checked in on the "Making the Connections" program sponsored by Halliburton, which recently hosted 70 female freshman candidates and their families on campus in a half-day session designed to foster a welcoming spirit for these prospective students.

Our alumni are an important "go to" resource for Mines, and we want to provide a hub and rallying point for engagement. To that end, the alumni association is adding a new "Women at Mines" interest group, designed to communicate upcoming opportunities for our alumni to participate in a variety of programs, events, and initiatives with a lens on the female student experience.

Visit the "Women at Mines" interest group at minesalumni.com/womenatmines for our upcoming "recruitment calling campaign" and additional "Making the Connections" events. We'll make it easy for you to participate and make a profound positive impact.

Live long and prosper.

Sincerely,
Norma Mozeé '83
Member, Board of Directors
Mines Alumni Association

ATTRACTING GIRLS TO STEM

Grad Student Writes Children's Book to Encourage Problem-Solving

Kristen Reichert

Rania Eldam's characters, MD and Finn the fox, go on many adventures learning how to solve daily problems.

Alex Mabrey Photography

Rania Eldam is the author of a children's book series geared toward making STEM education accessible to all young minds.

Geology graduate student Rania Eldam started brainstorming the idea for a children's book two years ago at an Association for Women Geoscientists meeting. "We don't see many children's book series where little girls are the main characters and aren't pretty princesses or fairies," Eldam said. "It's always been so important to me to merge those two ideas. I was the girl who wore princess dresses, but my mom would get furious with me, because I'd also be in the dirt scrounging around for plants or rocks."

Eldam created two main characters: MD (a little girl) and her best friend Finn the fox. Together, they go on adventures and learn how to solve daily problems. Through their experiences, they discover how machines work, how to read maps, and what creates solar energy. Each book in the series will have a different STEM focus, and the characters will represent diverse races, ages, and disabilities.

"Rania is aiming to do something different than other children's books in that she focuses on real-world scenarios and gives children ideas about how to approach something, like baking a cake or building a treehouse, while sneaking in technical skills like measuring and matching shapes," said Kamini Singha, associate professor of geology and geological engineering. "She's really pushing something innovative by providing a wide-range of role models looking at applicable problems; I hope it will encourage a more diverse group of kids to think about STEM careers in their futures."

Eldam finished writing the first book in her series, *MD and Finn Go Camping*, in December 2015. She plans to publish a hardcover and paperback version of the book in the spring of 2016. Find out more about the book series at www.raniaeldam.com/md-and-finn.

—Kathleen Morton

PRESIDENT'S CORNER

Celebrating Mines Pride

Thomas Cooper

One day last spring, sometime between my being selected a finalist for the Mines presidency and visiting the campus, a surprise FedEx box arrived at our home in Arizona. It was filled with the first Mines gear Elyse and I had ever seen: hats, pins, t-shirts, a tie (the only tie I ever wear, when I wear a tie), a pennant, the Mines history book, and a stuffed Blaster. Dividing up the gear was pretty straightforward and peaceful—until we came to Blaster. I won't tell you who won that "discussion," but I will say that I had to get online and order a second one quickly to maintain peace in the house.

Maybe you first saw Blaster's likeness on Mines gear like we did, or perhaps you first saw him in person at a Mines event. In either case, many of you probably experienced that instant connection to Blaster that Elyse and I did. He's the embodiment of our mining history and a symbol of the strong work ethic and perseverance that we value so deeply. Being a burro, Blaster is intelligent and a hard worker, and with his full pack, pick ax, and stick of dynamite, he is ready for action. In person, Blaster attracts young and old, and he can surprise you with his speed (as I personally discovered running with Blaster and Blue Key down the sideline at last year's Homecoming game). To quote the President's Distinguished Lecturer and celebrity astrophysicist Neil deGrasse Tyson, who spoke at Mines last fall, Blaster "is one badass burro!"

We all share great pride in our rich Mines heritage and identity. That comes out strongly when I meet students, parents, and alumni—often in unexpected settings (e.g., on planes, in restaurants, at conferences, in stores, etc.). Blaster is one symbol of that pride and heritage, as are the "M" and our cherished traditions such as E-Days. The triangle and *Earth, Energy, Environment* tagline are newer symbols that tie our history to our future and proclaim our leadership in areas critical to society.

I hope to share that Mines pride with you and hear about your experiences and thoughts for Mines' future when we meet in Houston, the San Francisco Bay Area, the East Coast, and the Middle East this spring. From the Class of 1935 through the Class of 2019, we are all part of the Mines family and invested in the continued success of this great institution. The Mines spirit is alive and well, on campus and around the world.

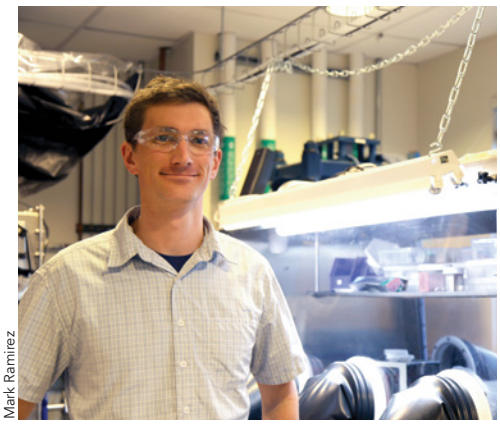
Go Orediggers!

Paul C. Johnson

P.S. The first stuffed Blaster rode on the dash of our car as Elyse and I drove from Arizona to Golden, and we think of him as our good luck charm. On most days, that Blaster sits in the middle of the conference table in my office, along with a cherished second one presented to me by Blue Key. He makes occasional cameo appearances outside of my office—most recently sitting on the podium at December's commencement ceremonies.

FACULTY NEWS

ERIC TOBERER RECEIVES NSF CAREER AWARD



Mark Ramirez

Eric Toberer, assistant professor of physics, received a National Science Foundation (NSF) CAREER Award for research that could ultimately yield the next generation of thermoelectric materials.

The project, titled *Control of Charge Carrier Dynamics in Complex Thermoelectric Semiconductors*, has been awarded $625,000 and seeks to understand the factors that determine the efficiency of certain materials in converting heat into electricity.

The development of advanced thermoelectric materials could have a significant impact on the nation's energy portfolio through solar thermoelectric generators, cogeneration, and waste heat recovery. A deeper understanding of charge transport in complex semiconductors will also advance other applications, such as transparent conductors, photovoltaic materials, and power electronics. As part of the project, research efforts will be integrated into the classroom through active-learning modules.

The NSF CAREER Award is the most prestigious award in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education, and the integration of education and research within the context of the mission of their organizations.

Toberer joined Mines in 2011. He earned a bachelor's degree in chemistry from Harvey Mudd College and a PhD in materials from the University of California, Santa Barbara.

—Mark Ramirez

FACULTY PROFILE

Tracy Camp: Computer Science Professor

Consider the top 30 innovations in the last 30 years, and Tracy Camp will tell you that none of them would have happened without computer science. "Think of what computer science has done for our world," says Camp, a computer science professor at Mines. "Online shopping, medical applications, robotic surgeries, DNA mapping—all that stuff has been created or vastly improved because of computer science."

Camp came to Mines in 1998; since then she has moved up in her role from assistant to full professor. She currently teaches the introduction to programming course, Programming Concepts in C++. In her class, students develop a final project related to a topic they're passionate about, such as a game or data storage utility.

Deirdre O. Keating

Looking at Camp's resume (25 pages of grants, awards, and publications), you might assume she knew at an early age that she wanted to be a teacher, but that wasn't the case. Although she loved logic and math as a child, she didn't have any interest in teaching. It wasn't until she was ready to graduate from Michigan State University with her master's degree in computer science that her parents encouraged her to pursue a PhD.

After receiving a PhD in computer science from the College of William and Mary, Camp began working at the University of Alabama. A few years later, she and her husband decided to move west, and Camp wanted to work at a smaller school. So, they pulled out a map of the United States, and Camp applied to four schools. Although she received three interview offers, she only accepted one of them: Mines.

When she's not teaching, Camp is focused on three areas: technical research, educational research, and women in computing. In total, her research projects have received more than $20 million in external funding. She has been awarded more than 20 grants from the National Science Foundation (NSF), including a prestigious NSF CAREER award.

Camp is an Association for Computing Machinery (ACM) Fellow, and recently, she also became an Institute of Electrical and Electronics Engineers (IEEE) Fellow for her contributions to wireless networking. "Within my research area, there are only eight women that are both ACM and IEEE fellows," Camp said. "I am the first ACM fellow at Mines and the first IEEE female fellow at Mines. We need more!"

The lack of women in Camp's field is something she works on here at Mines. "Research shows that a diverse team creates a better product, so we need diverse teams. And to accomplish that, we need more women at the table," she said.

To that end, Camp works with the CRA-W (Computing Research Association—Women). She also serves as the faculty advisor for the ACM women's student chapter at Mines, through which she founded "Discovering Technology," an after-school STEM program for elementary school girls that includes computer science education. Approximately 300 girls in grades 3-6 visit Mines each semester to learn about a different science and engineering topic. The program has been so successful that Camp is expanding it to include a separate day for girls in grades 7-8.

"We're currently at about 13 percent female computer science undergraduate students at Mines, which is a bit less than the roughly 15 percent national average," Camp said. "My goal is to move Mines to 25 percent women in both the computer science major and the computer science minor by 2020."

—Kathleen Morton

Deirdre O. Keating

Jennifer Jacob, a computer science senior, high-fives a participant in the Mines Discovering Technology program for elementary-age girls.

SHOW YOUR MINES PRIDE

New Mines License Plates for the Lone Star State

You asked for them, and now they're here! The Mines Alumni Association would like to offer Mines license plates for Texas...but we need your help. To make this happen, we need 300-500 people to register their interest and 200 pre-orders before the plates can be manufactured. You will be notified when the license plates are available for purchase. If you're interested, please complete the online form at myplates.com/register/mines.

The price of the license plate varies based on the option you choose and the length of time you wish to keep it. Options include a state-generated message and a full seven-character personalization. Please make sure your contact information is current so we know you live in Texas. You can update your contact info at minesalumni.com/update.

Mike Gullett

The Mines men's cross country team raises the school's first-ever team national championship trophy.

SPORTS

Erasing the Zero

Zero. Nada. Zip. It was a number that the Colorado School of Mines wanted to change. In 126 years, how many national championships had Mines athletic teams won? None.

Enter cross country coach Chris Siemers, a former all-American runner at Western State. Armed with a trio of top flight runners and a team that believed in his methods, Siemers turned out to be the guiding force in establishing a milestone in Mines history.

On November 21, 2015, in Joplin, Missouri, Mines erased the zero. Outstanding efforts by senior Marty Andrie, junior Nathanael Williams, and junior Dan Mahoney, plus gutty performances by freshman Grant Colligan and junior Seth Topper, allowed Mines to beat three-time defending NCAA Division II champ Adams State and collect their first big trophy.

Mike Gullett

Freshman Grant Colligan ran to a 33rd-place finish to earn All-American honors.

The road to the title was not a simple one. Earlier in the season, the team put pressure on itself to win the Rocky Mountain Athletic Conference (RMAC) and NCAA Regional meets—coming up short both times. "Adams State crushed us at the regionals," Andrie said. "It was not our best race."

But that defeat may have fueled the team's preparations for nationals, Siemers said. Plus, not everything went badly for Mines in those meets. Mahoney won the individual RMAC title, a first for Mines, and Williams took third.

Andrie, Williams, and Mahoney finished 18th, 21st, and 22nd, respectively, at nationals to earn all-America status. The key to winning turned out to be the finishes of Colligan and Topper, the fourth and fifth runners in the Mines lineup. With the top five finishers contributing to the team score, Colligan took an impressive 33rd to become an all-American, and Topper grabbed 47th to clinch the victory.

Such improvement led to a dream fulfilled. "At the start of the season, our goal was to do something that's never been done before," said Siemers, a Chicago area native in his fourth season as Mines' head coach. And his runners followed a regimen to success.

Siemers comes from a cross country family, and his brother Art coaches the team at Colorado State. An accomplished collegiate runner, Siemers has won the Denver Marathon, and his assistant coach Andrew Epperson—a two-time all-American for the Orediggers—qualified for the 2016 Olympic marathon trials in Los Angeles. "If you do exactly what Chris [Siemers] says, you'll be good," said Mahoney. "He's invested in making you the best you can be. Sometimes it's surprising how much you improve."

Mines had the advantage of coming close to a national title previously. In 2012, it took second behind RMAC rival Adams State, and then placed fifth and fourth the next two years.

In Joplin, Missouri, a crowd of Mines supporters showed up waving their school flags, and more than 100 fans gathered at the Clear Creek Athletics Complex to greet the national champs on their return to campus. Given that they run all of their meets while they're on the road, the cross country team doesn't always get the fan backing that the higher-profile sports teams receive, but that day was one to cherish.

Andrie, the only senior, sees more success in the program's future. "How cool would it be to have started a dynasty?"

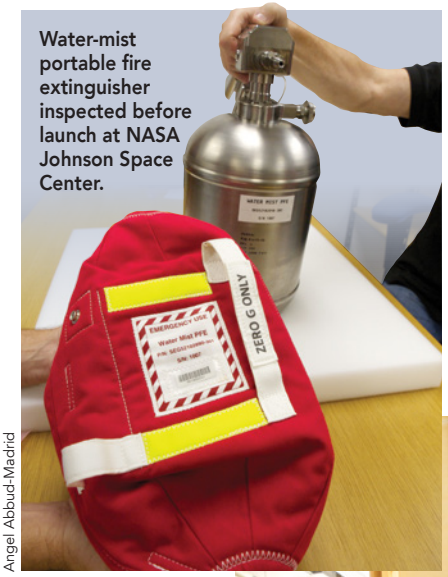
—Greg Haney

For more on Mines athletics, visit csmorediggers.com.

FIGHTING FIRE WITH WATER

Mines Team Creates Fire Extinguisher for International Space Station

For decades, portable fire extinguishers (PFE) have dispensed halon or carbon dioxide (CO_2), agents that were effective, yet presented certain risks. A team of Mines faculty and students have perfected a new alternative—an innovative water-mist PFE—and it's revolutionizing NASA's ability to protect astronauts and equipment in the sensitive, closed environment of the International Space Station (ISS).



Water-mist portable fire extinguisher inspected before launch at NASA Johnson Space Center.

Angel Abbud-Madrid

Admittedly, water isn't a new fire suppression agent. In fact, it's one of the world's oldest. But for many years, water has been eschewed in favor of the chemical compound halon and, more recently, CO_2. Despite their efficacy, these suppressants come with significant drawbacks: halon damages the ozone layer, and carbon dioxide depletes the oxygen supply—a particular concern in enclosed spaces such as the ISS. When Mines' Center for Space Resources director Angel Abbud-Madrid and his team began looking for alternative suppression agents in 1997, water emerged as a strong contender.

"Water mist offers many advantages in fighting fires, particularly in enclosed spaces," says Abbud-Madrid. "It's easily obtainable, causes less water damage than conventional sprinklers, and it is safe for people and the environment." When water gets to the fire, he explains, it evaporates, thereby robbing the area of heat. And as it evaporates, it also expands, depriving the fire of the oxygen it needs to grow while at the same time cooling neighboring surfaces. Water also acts as a cleaning agent, washing away soot particles created by the fire that can be particularly harmful to computers and other electronic equipment.

Selecting water as their agent of choice was the team's first step, and, as it turned out, also the easiest. Abbud-Madrid and fellow faculty Thomas McKinnon, Edward Riedel, and Robert Kee—together with a cadre of two post-docs, four PhD students, 10 students, and scientists from ADA Technologies—have spent the last two decades determining the most efficient and effective way to make water work.

Over the years, they have executed countless tests on land and in space, learning things like the optimal water droplet size required to get to the core of a fire in a zero-gravity environment, as well as the delivery mechanism most capable of withstanding launch loads, operating in multiple orientations, and holding pressure in space for up to 15 years. One of their experiments was aboard the ill-fated Columbia shuttle that disintegrated on re-entry in February 2003.

The end product of these studies was a water-mist fire extinguisher that expels water droplets measuring just 20-30 microns each—less than 30 percent the width of a human hair. The new PFE generates a potent mist that extinguishes fires as effectively as traditional agents such as halon and CO_2.

On December 6, 2015, the team sent their first two water-mist PFEs to the ISS. Seven more will follow in the months ahead, and in September 2016, Abbud-Madrid will travel to Vienna to share his team's findings at the 16th International Water Mist Association conference.

Angel Abbud-Madrid

Michael Tomlinson (left) and Angel Abbud-Madrid complete the final test of the water-mist fire extinguisher at Mines.

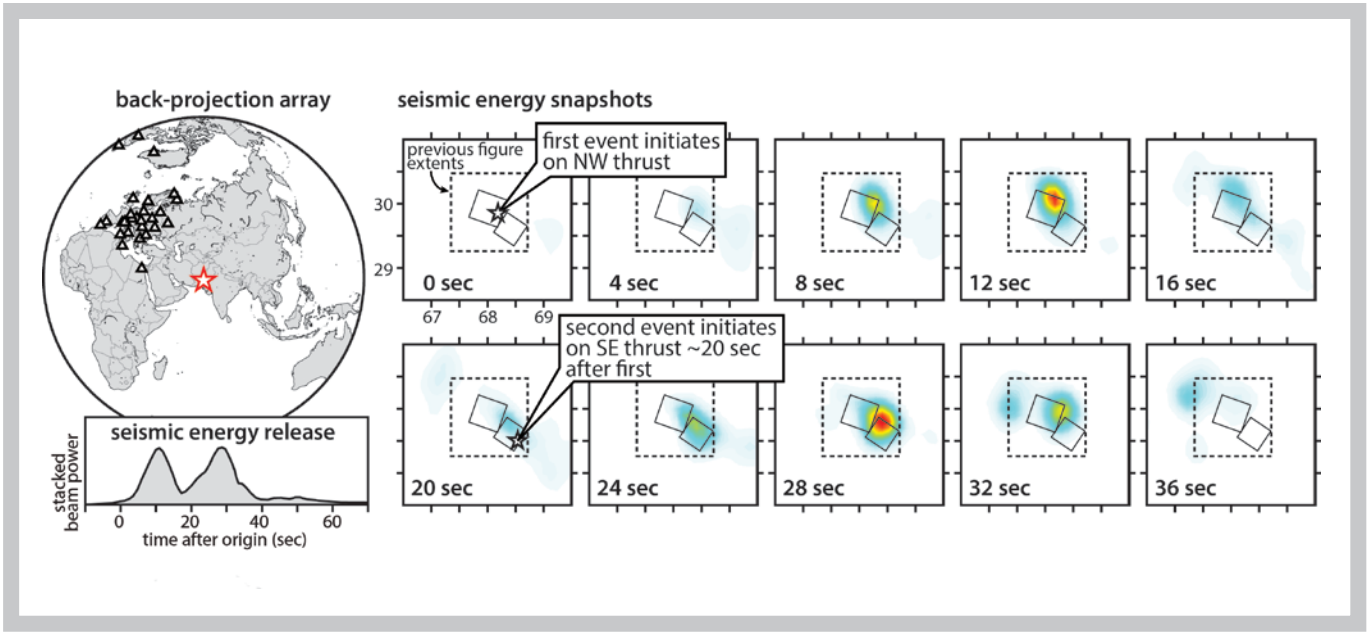
"Water mist technology is more advanced in Europe than it is here in the United States," he says. "It's already being used in libraries, museums, computer rooms, and hospitals across Europe, as well as at our own National Gallery of Art in Washington, D.C." Abbud-Madrid believes that over time, water-mist systems will become increasingly common, and he hopes that the work he and his colleagues have done will promote the technology's spread.

The journey has been long, Abbud-Madrid concedes, but well worth it. "After the Columbia disaster in 2003, we dedicated our efforts to honoring the legacy of those who lost their lives conducting research for us and others. It's gratifying to see their work, and ours, come to fruition."

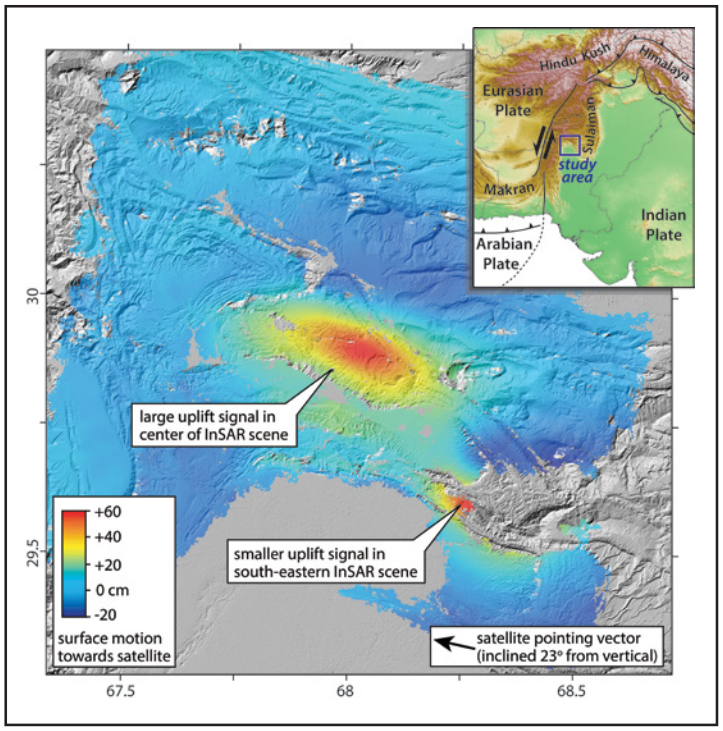
—Lori Ferguson

GEOPHYSICS RESEARCH

Mines Study Reveals Earthquakes Can Jump



Edwin Nissen



This image shows ground deformation in the earthquake doublet mapped by differencing radar images captured before and after the event (a technique called InSAR). Red areas moved towards the satellite in the earthquake, whereas dark blue areas moved away from the satellite.

While studying a 7.1-magnitude intracontinental earthquake that occurred in Pakistan in 1997, assistant professor of geophysics Edwin Nissen, along with other researchers, discovered that earthquakes can "jump" between faults, a concept that was not previously thought possible.

"Remote sensing and seismological observations of a recent earthquake in Pakistan highlighted an unexpected incidence of an earthquake rupture 'jumping' across a large gap between two faults," said Nissen. "This has important implications for how we anticipate the size of future earthquakes, a significant question for the half the U.S. population (and for several hundred million people worldwide) who are at risk from damaging seismic shaking."

The earthquake was listed in published seismic catalogs as a single event, but surface deformation mapped using "before" and "after" satellite radar images revealed two large zones of uplift, generated by slip on two distinct faults. Meanwhile, seismograms show two large pulses of seismic energy, spaced just 20 seconds apart, in the same location as the radar uplift zones.

"The size of an earthquake depends on the length of the faulting involved, and modern earthquake hazard assessments are based on the premise that ruptures are restricted to closely spaced segments and cannot jump between widely spaced ones. Our observations indicate that earthquakes can do just this. In this example, the earthquake doublet greatly increased the duration and area of maximum shaking and probably contributed to the relatively large death toll due to the earthquake," Nissen said.

—Karen Gilbert

NEW MEMBERSHIP MODEL

Your New Mines Alumni Association: 26,000 strong!

There's strength in numbers. And come July 1, 2016, our network of alumni members will grow from 6,000 to over 26,000, enriching connection possibilities for Mines alumni around the world.

The Mines Alumni Association is excited to provide more resources and services to our alumni by adopting a dues-free, all-inclusive membership model. Thanks to significant support from, and in collaboration with, our partners at the university and the foundation, membership dues will no longer be required. Beginning July 1, all Mines graduates will be welcomed into the alumni association with access to all alumni services, including those previously reserved for dues-paying members.

To learn more about the new membership model, or to share what alumni programs and services you'd like to see in the future, visit minesalumni.com/membership.

Get ready...
We encourage you to get involved and stay connected to Mines. As a first step, please make sure we have your correct contact information so we can keep you posted on the latest news, events in your area, and volunteer opportunities. Update your information today at minesalumni.com or email CSMAA@mines.edu.

Stay tuned...
For all the exciting details about enhanced programs and services and new opportunities, watch for more updates in June and in the summer issue of *Mines* magazine.

ALUMNI ASSOCIATION
COLORADOSCHOOLOFMINES

Deirdre O. Keating

Mines student Dalton Ellis participates in a field session that assessed the impact of the abandoned Gold Dirt Mine on North Empire Creek, Colorado.

At 11 a.m. on August 5, 2015, the icy waters of Cement Creek, just outside the scenic Colorado mountain town of Silverton, began to turn to mustard-colored sludge. By day's end, three million gallons of acid mine drainage had poured out of the inactive, 120-year-old Gold King Mine. The tainted water coursed downstream into the Animas River where it horrified kayakers in nearby Durango, prompted water treatment plants to shut off their taps, and ignited alarming front-page photos in newspapers nationwide. Within four days, the surface water had cleared and, according to EPA measurements, returned to pre-spill levels of toxic metals. But the conversation started by the Gold King blowout had only just begun.

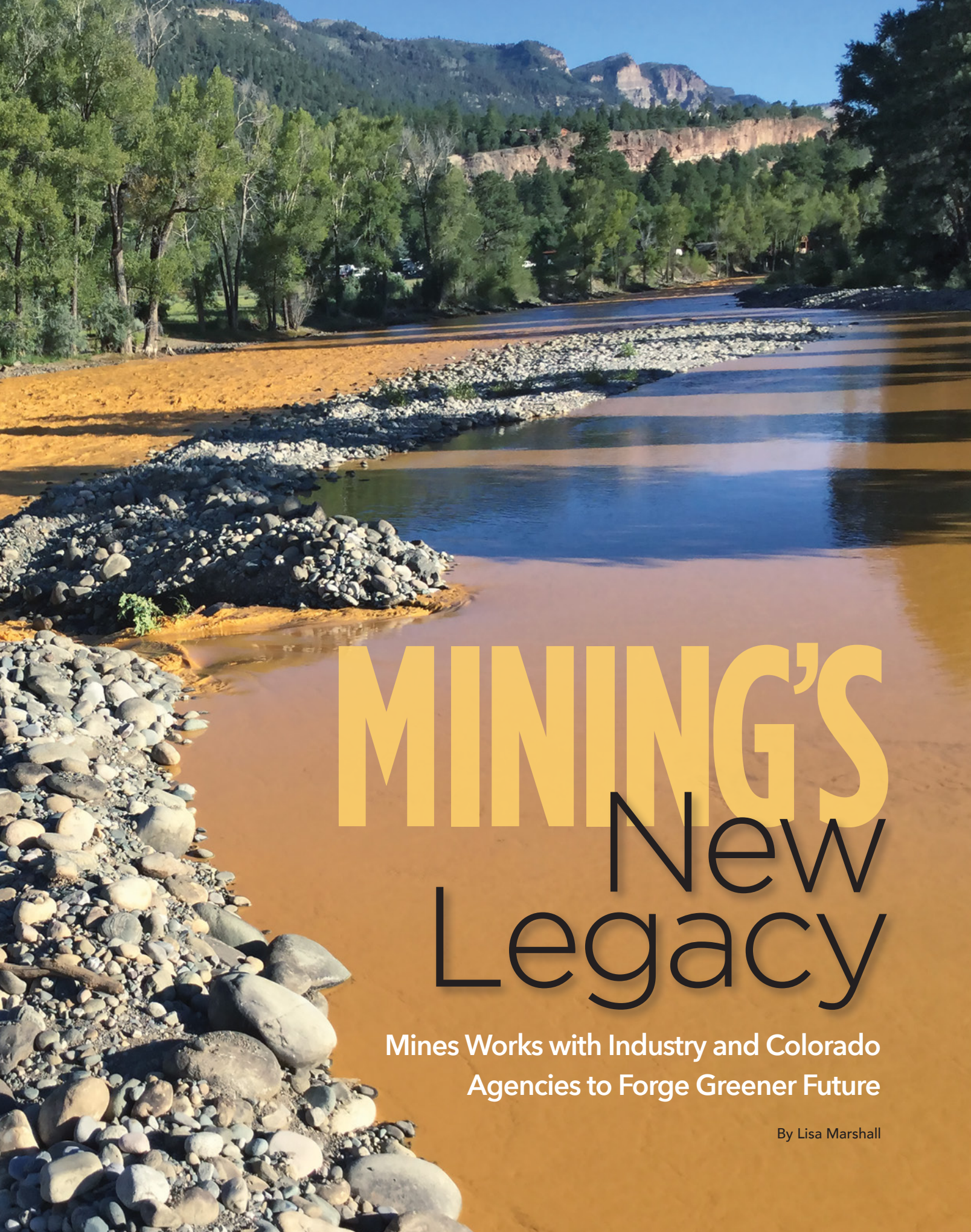
"This was a wake-up call," says Linda Figueroa, a Mines professor of civil and environmental engineering who studies mine remediation techniques. "It lit a fire under the abandoned mine lands community, reminded the public that this is an issue, and prompted people to put it back on the front burner."

As industry and government agencies grapple with what to do about the estimated half-million abandoned mines nationwide, and as the state looks more closely at how to address hundreds of legacy mines fouling thousands of miles of Colorado streams, Mines—with its multi-disciplinary expertise and collaborative relationship with industry and government—is poised to play a key role.

"Our primary objective is to build knowledge, not make money, so we can give problems longer-term attention at lower cost while educating the workforce of the future," says Priscilla Nelson, head of the Department of Mining Engineering. Already, the school has a long history of supporting research that has advanced the way mines are operated and reclaimed. And with a growing focus on the environmental and humanitarian aspects of mining, the school hopes to cultivate a new generation of miners who see themselves as "stewards of the earth's resources," Nelson says.

Butch Knowlton/La Plata County Office of Emergency Management

The Animas River near Durango, Colorado, runs orange with contaminants after the Gold King Mine spill on August 6, 2015.



MINING'S New Legacy

Mines Works with Industry and Colorado Agencies to Forge Greener Future

By Lisa Marshall

As a neutral party, Mines also hopes to facilitate a stakeholder-wide conversation about what happens next. "What do we know and what do we not know? What new technologies need to be developed?" asks Nelson, who hopes to host a symposium on the subject this year. "Let's sit down and talk about it."

Mining, Then and Now

While much media attention has been paid to the number of abandoned, historic mines that riddle hillsides across the West, one positive development is often overlooked: Industry practices have changed dramatically since those mines were built. "There really is no comparison," says Ronald Cohen, a Mines professor of civil and environmental engineering who has studied the history of Western mining. "The demands on industry are so much greater than they were back then."

As early as 1870, a few vague guidelines existed for mine operators, but there was no agency to enforce them and no political will to strengthen them. Even in the mid-20th century, many Western companies still "viewed gravity as their friend," says Cohen. They dumped their waste downstream while operating, and when it was time to close up shop, they left their tailings and rock piles behind and walked away.

"It's not as if they were devils out to destroy the environment," Cohen says, recalling a conversation with an old-time miner. "They felt they were supporting the economic development of their country and, during World War I and II, supporting the war effort. They thought they were doing something very positive."

With the 1970 passage of the National Environmental Protection Act and the 1972 passage of the Clean Water Act (which regulates pollutant discharges into U.S. waters), things began to change. But even before those laws fully went into effect, a few forward-thinking companies were making environmental sustainability a priority.

As it prepared to open the Henderson Mine near Empire, Colorado, in 1975, AMAX Inc. worked with Mines ecology professor Beatrice Willard to select a site that would be the least visible to tourists on their way to Winter Park to ski and have minimal impact on the Clear Creek Watershed. Instead of placing the tailings next to the mine, as was common practice, AMAX went so far as to build a nine-mile underground tunnel from the mine to the nearby Williams Fork Valley, where waste products could be disposed of with the least impact on the environment.

"They were 30 years ahead of their time," says Bill Cobb '81, MS '89 who, as one of Willard's students, visited the Henderson Mine frequently and had test plots for one of his classes at the

Jeff Graves

PENNSYLVANIA MINE

The now-defunct Pennsylvania Mine near Keystone, Colorado, began undergoing a cleanup effort in 2013, led by Mines alumnus Jeff Graves '13. For more information on this project, see page 32.

site. Cobb is now vice president of environmental affairs and sustainable development for Freeport-McMoRan, which owns the Henderson Mine.

Today, a company wanting to develop a brand new, or greenfield, mine in the United States can expect to spend a decade and tens of millions of dollars navigating the regulatory process. In order to get their needed government permits, mine operators must thoroughly assess the potential impact they'll have on air and water, design systems for mitigating these impacts, develop a detailed closure plan (including land revegetation), and put up millions of dollars of financial assurance that they will be able to pay for that plan when the time comes.

Even resurrecting a shuttered mine is a colossal undertaking. When Freeport-McMoRan reopened the Climax Mine near Leadville, Colorado, in 2011, it spent $250 million on a state-of-the-art water treatment plant. The multinational company also invests in equipment made with durable, cutting edge materials throughout its supply-chain and recycles machinery when it breaks, says Michael Kendrick '84, president of the Climax Molybdenum Company, a subsidiary of Freeport. "At Freeport, we have not purchased a new piece of haulage mining equipment in the world since 2008. As trucks wear out, we rebuild them; we don't buy new ones," he says. "Not only does that have tremendous financial benefit, but big picture, it's also good for the environment."

Heightened attention to sustainability, combined with tougher regulations, means the mining industry footprint of the future can be far lighter than it was in the past. "Going forward, we should not end up with a legacy of even more problems" (from newer mines), says Bruce Stover, director of inactive and abandoned mine programs for the Colorado Division of Reclamation, Mining and Safety (DRMS).

That said, there is still a big mess to clean up.

A Challenging Clean-up

In the early 1980s, state surveys pegged the number of legacy "hazardous mine features"—such as mine shafts and openings—at 23,000 across Colorado. (Stover suspects that number could be up to 30 percent higher.) Thus far, the state has safeguarded 9,700 of these features. Meanwhile, about 500 inactive Colorado mines are currently causing "measurable degradation" to stream water quality. In some areas, that degradation results from storm water flowing through waste piles and tailings. To address that, DRMS sometimes removes or buries waste piles.

But in 230 cases, contaminated water flows directly from underground mine tunnels. Of these, 47 are already being addressed with active treatment efforts (such as water treatment facilities and storage ponds), and 35 are being remediated in some way, Stover says. The other 148 are "still out there draining" into state waterways. But installing a water treatment plant at all of them is impossible. "It costs millions of dollars to build one, and then you have to pay to operate and maintain it until the sun burns out," says Stover. Alternative technologies are critically needed, and that's where Mines comes in.

Courtesy of Silverton Standard via USGS

GOLD KING MINE

Miners work inside the Gold King Mine near Silverton, Colorado, in 1899.

BY THE NUMBERS

500,000
Abandoned mines in the United States

23,000
Hazardous mine features in Colorado

500
Colorado mine sites causing "measurable" degradation of water

230
Colorado mine sites draining contaminated water from mine tunnels

1,645
Miles of Colorado waterways significantly affected by mine drainage

As far back as the 1980s, Mines researchers have been exploring the idea of putting resident microbes to work to help chew up and detoxify waste at legacy mine sites. Today, pilot microbial bioreactor projects are in place in several locations in Colorado and Arizona.

Figueroa, who designs and researches bioreactors, cautions that at this point, they wouldn't be a good fit for sites with higher water flow rates (Gold King can discharge hundreds of gallons per minute). For those, an active treatment facility works best. But at sites with lots of land to build a microbial system on and a slow,

steady flow of acid-rock drainage, bioreactors could provide a cheaper alternative that requires less maintenance. "We could make the money go farther and attack more sites," she says.

Bioreactors aside, Figueroa envisions other ways Mines could partner with the state and industry to move the dial forward on legacy mine cleanups: Rather than relying on boots-on-the-ground surveys to locate troublesome mines, agencies could work with Mines students and researchers to devise ways to use drones, satellite imaging, or remote sensing technologies like LIDAR (Light Detecting and Ranging). Instead of focusing on surface water, stakeholders could collaborate with Mines to research how water flows across the land and through the tunnels and what changes occur en route. With that knowledge, they could devise better clean-up strategies.

"So far, most of the emphasis is on surface water. At that point, you can't do anything but treat what's coming out," Figueroa says. "My first remediation strategy is not to do a treatment process at all, but to divert the water so it doesn't come into contact with the minerals that can make water quality worse."

Deirdre O. Keating

Junior environmental engineering students measure water quality parameters for their field session client, Clear Creek Watershed Foundation.

Mark Ramirez

Chemistry professor James Ranville (second from left) leads students in analyzing water samples from streams near mining operations during the Department of Chemistry's summer field session.

A Solvable Problem

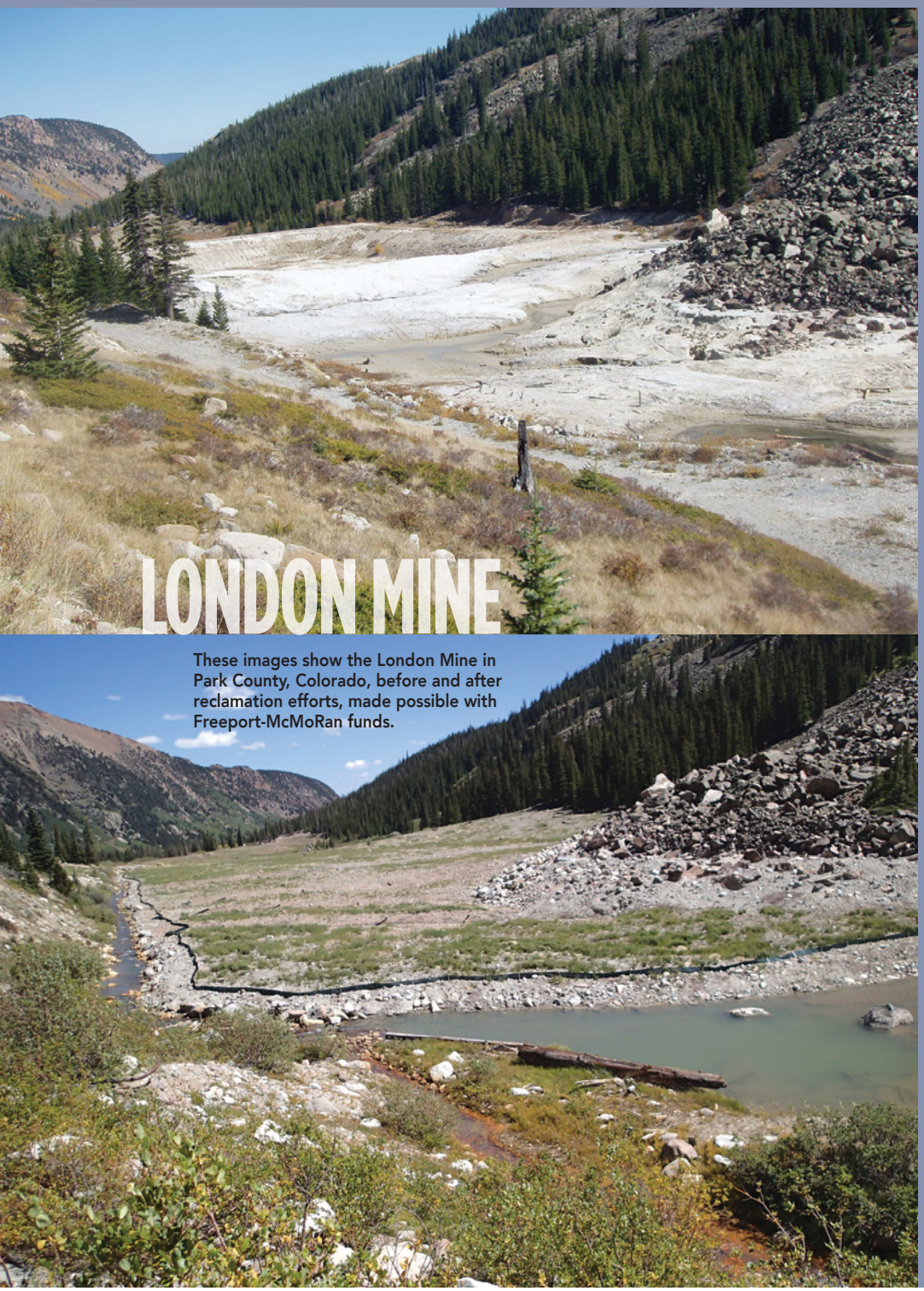
Several sources interviewed for this story say another key piece of solving Colorado's legacy mine problem is for lawmakers to tinker with provisions in the Clean Water Act that currently keep "good Samaritans"—including mining companies, state agencies, universities, and environmental nonprofits—from trying to partially tackle the problem. In essence, if they cannot clean the water completely, they are at risk of being sued for leaving it polluted, says Stover. "Any good Samaritan, after they finish their 70 percent cleanup, could be sued by a third party under the Clean Water Act and be required to address the other 30 percent of the problem. So, if we can't do a 100 percent cleanup, we don't touch the water," he says. In Pennsylvania, which has a state Good Samaritan law to protect nonprofits, more than 50 mine clean-up projects have been completed. Lawmakers are currently mulling a similar federal bill.

Money is also an issue. In recent years, several government agencies have cut their funding for legacy mine reclamation. In November, Colorado Senator Michael Bennet and others introduced a bill that would require mining companies to pay into a federal hard-rock reclamation fund reserved for cleaning up legacy mines—a fund that could amount to as much as $100 million per year. But that idea could be a hard sell at a time when, due to falling commodity prices, mining companies are taking a huge economic hit.

Mines professor Rod Eggert, who teaches natural resource economics, notes that some companies are already cutting back on capital investments as they work to "survive the current economic storm." But he rejects the notion that lean times will dampen enthusiasm, and funding, for sustainable mining efforts overall. "Challenging times reward those who are most efficient," he says. "Those with a long-term commitment to the industry are keeping their eye on the ball and working day in and day out to improve the way they mine and the way they interact with the community."

As far as legacy mines go, Stover sees them as a "solvable problem" with—thanks to the Gold King Mine spill—unprecedented attention on it. "If we can't come up with funding and resolve some of the legal issues now, we never will."

In the meantime, some companies are already stepping up to the plate, very carefully, to help. For instance, Freeport-McMoRan contributes $500,000 per year to Colorado's inactive mine reclamation program, helping the state to fund



Colorado Division of Reclamation Mining and Safety

These images show the London Mine in Park County, Colorado, before and after reclamation efforts, made possible with Freeport-McMoRan funds.

"Those with a long-term commitment to the industry are keeping their eye on the ball and working day in and day out to improve the way they mine and the way they interact with the community."

—Professor Rod Eggert

the removal of solid waste materials from legacy mines left behind by someone else. "We did not create these situations, and we are under no legal obligation to clean them up," says Cobb. "But given our place in the hard-rock sector of Colorado, we feel like we need to contribute to environmental improvement of the state, and this is one thing we can do."

The company also funds restoration projects through the nonprofit Trout Unlimited, and it supports Denver-based Environmental Learning for Kids, an education group that recently participated in a tree planting at the London Mine site above the town of Alma, where Freeport funds were used by the state to clean up the site.

Going forward, Cobb would like to see Mines students get even more involved in solving the problem of legacy mines, perhaps helping to survey abandoned sites and come up with designs to clean them up. "Who knows," he says, "a few years down the road these students could be running an environmental group for a mining company." M

A natural gas drill rig sits near a Colorado housing community.

iStock

OUTSIDE CORPORATE BORDERS

Training Students in the Growing Field of Corporate Social Responsibility

By Daniel Strain

The summer after her first year in college, Jessica Smith traveled back to her parents' home in Wyoming and got a job at a coal mine. She sprayed down mining equipment with a fire hose and drove a haul truck. A Wyoming native, Smith grew up immersed in the mining industry. Her father was a mining mechanic, and her grandfather had served as chief of operations for a uranium mine. But Smith had also just taken her first anthropology class at Macalester College in Minnesota, so when she returned to coal country that summer, she began to observe the mining community the way a scholar would.

"The whole time I was like a mini-anthropologist," says Smith, now the Hennebach Assistant Professor of Energy Policy in Liberal Arts and International Studies (LAIS) at Mines. She was taken not only by the miners' distinctive ways of joking around—they affectionately nicknamed Smith "Lefty" because of her more liberal political views—but also by the deep bonds they formed on the work site. "It was just family out there," she says.

Today Smith, who joined the Mines faculty in 2012, has built her career around exploring the anthropology of those mining "families" that she came to love in Wyoming. She's still intrigued by the lighthearted camaraderie shared by miners. But she's also using her academic experience and time spent in the industry to help mining companies survive in a difficult market by adopting practices that are environmentally and socially responsible.

That goal is part of a growing focus at Mines in a field called Corporate Social Responsibility (CSR), which encourages companies to build relationships with the communities adjacent to well pads and coal mines. In classes taught by Smith and her colleagues, Mines students are learning how to form and maintain these relationships, which is an unprecedented feat for an engineering school. The new focus on social responsibility is a popular one with industry leaders who are eager to hire young engineers with real-world experience in designing projects that not only meet company needs, but also keep communities happy.

Companies have come to realize that "this is the way to do business," says Juan Lucena, a professor in LAIS and director of the Humanitarian Engineering program at Mines. "If they don't pay attention to communities and they don't pay attention to the environment, it's going to cost them dearly."

THE BOTTOM LINE

It's that growing realization—that a corporation's bottom line benefits when it takes the environment and people into account—that underlies the growth of CSR. The field is "about relationships between companies, individuals, communities, and the government, and how you make those as positive as possible for as many people as possible," Smith says.

The CSR approach to doing business has become more common in the United States, partly because the unconventional energy boom has put oil and gas corporations in closer contact with people than they've ever been, Smith explains. That contact hasn't always gone smoothly.

Terry Snyder

Linda Battalora, petroleum engineering professor at Mines, and Brent Koren '08 discuss project development and corporate social responsibility.

Beth Doten/Black Hills National Forest

Foresters present a project related to mountain pine beetles in the Black Hills National Forest at a public meeting in 2011. Soliciting and considering public input is a role increasingly played by engineers.

> "Businesses need to have a much better game on how to keep communities informed and keep them engaged."
>
> *—Matt Most, Encana Corporation*

Benjamin Teschner

Deirdre O. Keating

A "Corporate Social Responsibility in Extractive Industries" workshop was held at Mines on May 14-15, 2015, and focused on integrating corporate social responsibility with engineering education.

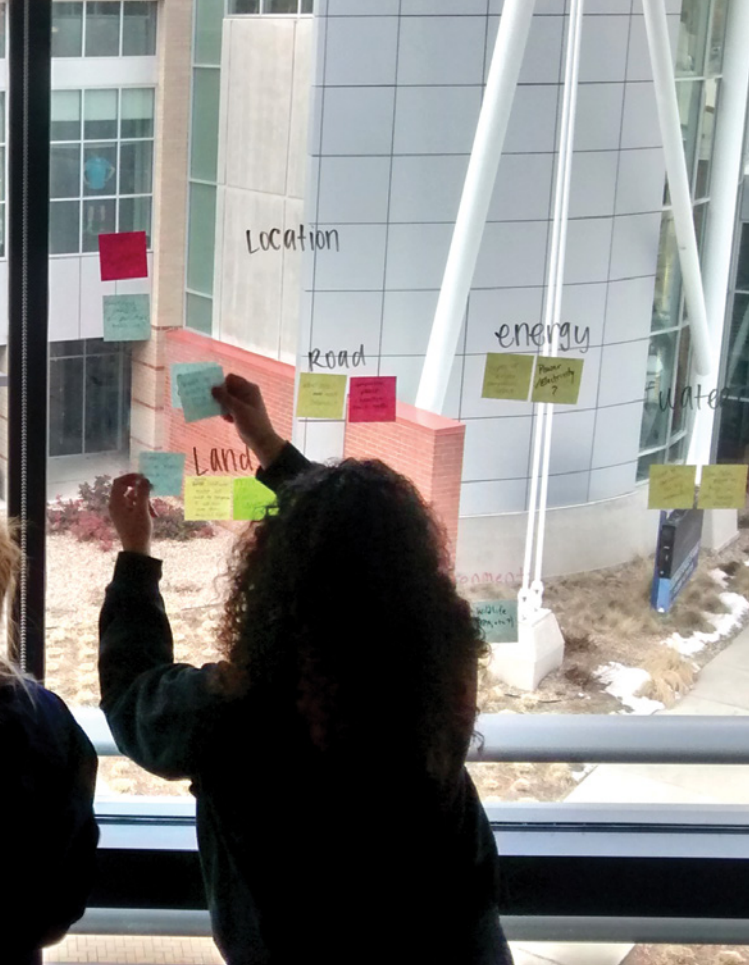
In 2012, residents of Longmont, Colorado, voted to ban hydraulic fracturing ("fracking") for natural gas inside town limits, citing concerns over pollution and public health. The state's Supreme Court heard arguments about the legality of this ban, as well as a similar fracking moratorium in Fort Collins, in December 2015.

In most cases, concerns over oil and gas drilling operations don't reach that level. Businesses, however, "need to have a much better game on how to keep communities informed and keep them engaged," says Matt Most, vice president of government relations for the United States at Encana Corporation, an oil and gas company headquartered in Canada. "It's something that is not going to get any easier, and where we run into trouble as an industry is where we don't manage these relationships well."

Companies have done a lot to up that game or to maintain what social scientists call the "social license to operate." For example, Encana recently launched a community center in Erie, Colorado, a hub of natural gas drilling in the state. The center includes meeting space and a scale model of a well casing. In other cases, companies have entered into legal agreements with communities or green groups. Such "environmental agreements" allow mining and oil and gas operations to move forward but may also provide community members with expanded access to facilities to monitor for environmental violations. Such arrangements are "definitely the new normal," Smith says.

Managing that new normal, however, may mean that engineers will have to take on new jobs: leading residents on mine tours, attending town council meetings, and learning about the history and culture of a region. These tasks go beyond the technical skills traditionally taught at a school like Mines, and that's where Smith and her LAIS colleagues come in. In classes like Corporate Social Responsibility, students learn how to think like mini-anthropologists: how do you listen to individuals to better understand where they're coming from?

When it comes to conflicts over natural resource extraction, "I think the knee-jerk reaction from most students and a lot of people in industry is: if only people understood all of the technical information, then we wouldn't have all these



Students in the "Projects for People" course practice employing the human-centered design problem-solving method to help improve relationships between communities and oil and gas companies in Colorado.

debates," Smith says. "By the time they finish my classes, students realize that's not true. These debates are also about values and how people define what a good life is."

In September 2015, the National Science Foundation awarded Smith a $450,000 grant to study how professional engineers apply CSR in their jobs. It's the largest grant ever awarded to a single researcher in LAIS. CSR education is spreading throughout Mines for a reason: these are practical skills that will help engineers succeed in their jobs, says Linda Battalora, an associate teaching professor in petroleum engineering at Mines who is also an attorney and engineer. "That's what makes this industry so exciting—being able to work with people from all sorts of backgrounds to reach this common goal," says Battalora, who has worked with Smith and her colleagues to incorporate CSR into her courses.

REAL-WORLD EXPERIENCE

Mines student Boshra Alfowzan and her classmates got a crash course in that kind of cooperation in fall 2015 when they tried to solve a seemingly simple problem: how would you go about drilling for natural gas near the top of South Table Mountain in Golden, Colorado?

The assignment was part of Projects for People, a class offered through the Humanitarian Engineering program at Mines. The goal is to introduce students like Alfowzan, a junior in environmental engineering, to the principles of CSR by giving them a taste of the problems that professional engineers face every day. In this case, the class was tasked with designing a well pad that would sit on the local landmark, and they would need to do it while balancing the needs of business with the wishes of the surrounding community.

To make the project more real, the course's instructor, Ben Teschner '08, MS '11, recruited Raymond Priestley '79, a business development advisor for Encana, to play the role of the client. Priestley acted as the president of a faux oil and gas firm called Priestley Energy.

The class wasn't easy, according to Alfowzan. "It puts a lot of pressure on you," she says. "It's like you're an intern trying to prove yourself." As part of that internship, she and her fellow students hit the streets to talk to people. They interviewed patrons lounging in the Higher Grounds Cafe in downtown Golden, they spoke to staff at the Colorado Department of Transportation, and they consulted representatives from the Jefferson County Open Space System.

"It turns out people are really concerned about how that mountain looks, and they want it to remain a certain way. They don't want to see industry on top of that," Teschner says. "And this is the way the world works. All of these things can derail a project."

A native of Saudi Arabia, Alfowzan says she was nervous at first about having to talk to so many people. On the first day of class, she thought, "No way am I going to do this." Now, she feels a lot more comfortable striking up a conversation with strangers. "I don't regret it at all," she says.

Alfowzan also picked up the sort of real-world experience that corporations are looking for in new employees, says Priestley, who is also the president of the Mines Alumni Association. "From day one in their careers, young engineers will be assigned to projects where they're going to have to deal with these sorts of issues," he says. "If they're pre-trained or they recognize where to go to get additional support, it's going to set them apart from the students at other universities." CSR classes at Mines also present opportunities for alumni to return to the university to mentor young engineers, Priestley notes. The alumni association also plans to form an interest group for professionals who work on CSR-related issues.

Jessica Smith, for her part, is working to ensure that students receive educational experiences that reflect the real-life challenges that engineers face in their work. As part of her new grant, she'll spend the next five years interviewing professionals in the mining industry about how their training prepared them—or failed to prepare them—for working with communities. She'll use this feedback to improve the way CSR classes are taught at Mines. It's her way of ensuring the success of the coal mining communities she grew up around in Wyoming.

"The demand for resources continues to grow," Smith says. "Even green technologies like solar and wind energy require rare earth minerals, so we're doing our part to help make it the most responsible and responsive industry possible."

Animal Magnetism

How Blaster the Burro Found Love, and a Home, at Mines

Blaster the burro has become an iconic symbol of Mines spirit.

Katie Schumacher

In the United States, the 1960s was a decade of interesting visuals: long-haired hippies driving around in pastel-colored vans, folks streaking through parks, and environmentalists sitting and singing in forested communes.

The small city of Golden, Colorado, was no exception. There, you would have seen a kindly gentleman, Frederick "Heinie" Foss (1917-2015), walking his burro down North Ford Street on his way to Mines football games. Foss was a popular guy in Golden. In fact, he eventually became known as "Mr. Golden" for all of his community service. He worked as a pharmacist and eventually took over his parents' store, Foss Drug, in 1945.

As a youth, Foss spent a lot of time at Mines; his stepfather, Joe O'Bryne, was a professor and the founder of the "M" on Mt. Zion. Foss came to love the school, and officials even let him audit math and chemistry classes. He ultimately became a member of the Mines Athletic Hall of Fame and the President's Council, and he was made an honorary colonel in the R.O.T.C. and an honorary member of the Mines Alumni Association.

Foss also loved animals. He raised chickens, cattle, and Arabian horses, and he always had plenty of pet dogs and cats at the Foss ranch on North Ford Street. No one knows for sure why he decided to start taking his burro to football games. "It could have been to compete with CU's [the University of Colorado at Boulder] mascot, the buffalo called Ralphie," says Foss's granddaughter, Sarah Labosky '08. "I've asked family members, and they don't know the answer."

Regardless of the reason, Mines students fell fast and hard for the burro, so Foss continued to escort his four-legged companion to football games. Legend has it the burro even traveled by train with the team to away games. In short, he was a shoo-in to become the school's mascot and to be aptly dubbed "Blaster."

Many agree that Blaster is the perfect mascot—burros have long been known for their hard work in the mining industry. Eventually, drawings of Blaster included a stick of dynamite in his mouth to solidify the connection to mining and the university's beginnings.

Marv Kay '63, Emeritus Professor of Physical Education and Athletics and Mines' head football coach from 1969 to 1994, calls Blaster a great mascot. "He represents hard work, determination and dedication of the students, and the early ties of the school to the mining industry," Kay says. "As an alumnus, to see Blaster marching in parades with the band or students, or making the long

Courtesy of Sarah Labosky

In this historic photo from 1955, the Foss children and Blaster are dressed up for Christmas. Pictured L to R: Pamela Foss (McInerney), Patrick Foss, and D. Foss (Kahn).

Courtesy of Leah Jaron

Mines students Nabeel Sheikh, Jacob Wilson, Logan Schuelke, Grant Jacobsen, Daniel Dupuis, Katie Schumacher, Leah Jaron, Stephanie Martella, and Carolyn Reilly with Blaster on the football field in 2015.

walk to the Colorado State Capitol during Engineering Days, or at football games makes me very proud."

Blaster is oblivious to all the history and the adulation, of course, but he's become an iconic mascot and as popular as any burro could ever hope to be. He has more than 1,000 likes on Facebook, as well as accounts on Twitter (@blasterburro), Pinterest, Flickr, and YouTube.

The Blue Key Honor Society, a group that promotes Mines spirit, took over handling Blaster early on and is now officially in charge of caring for the burro. "When Blaster is on campus, Blue Key members must be in control of him—we call it Blaster Patrol," says Steph Martella, a junior biochemical engineering major and spirit chair of Blue Key. "We have buckets to give him water and clean up around him, and we like to keep him on grassy areas so he can eat."

Martella says Blaster attends all home football games (he scampers down the sidelines after touchdowns), Celebration

Kathleen Morton

A statue on the Mines campus immortalizes Blaster the burro.

of Mines, the homecoming parade, the Ore Cart Pull during Engineering E-Days, and other smaller events for various school groups. "Everyone who meets him falls in love right away," says Martella. "He's also a racing burro, and that makes him perfect for running at football games. He's more timid and quiet than other burros, so he is very good around children."

Blue Key has created specific protocols for interacting with Blaster. For example, no one is allowed to ride him (children under 30 pounds may be placed on his back for photos), a space of at least three feet must be maintained behind him, petting is only allowed on his shoulders and forehead, and only Blue Key members are permitted to feed him.

Blue Key leaders say the first Blaster died in the early 1990s at age 33, so Mines is currently on Blaster number two. "We think he's around 25 years old," Martella says. "We're not sure what the average age of a burro is, but they can live to be around 40."

When Blaster isn't attending Mines events, he lives at the Laughing Valley Ranch, a spread for domestic animals in Idaho Springs, Colorado. Bill Lee, the ranch's owner, says Blaster leads a "productive life" and is a "10" on the happiness scale. "I believe when burros have a productive life, they're a lot happier," Lee says. "Blaster is domesticated, so he's not always in a survival mode, and he's pretty active for his age." Active is a good description. Blaster runs five or six burro races a year, most of them in the three-mile range, and Lee says he won two of these races in Golden a few years ago.

Compared to most burros, Lee says, Blaster is a bit small, standing about 39 inches tall from his shoulder to the ground—which is about nine inches shorter than the average burro. "I kind of think that's why he's such a perfect mascot for Mines," Lee says. "He's small and mighty. Mines isn't a huge school either, but it sure is mighty."

—Doug McPherson

THE PAST MEETS THE PRESENT

Connecting Mines Alumni with Students

The process of passing down advice and encouragement from Mines alumni to current students is slowly but surely cementing its importance in campus culture. Events that encourage these learning opportunities allow "students to have a window into the future and an understanding of how they could potentially use their Mines degree," says Scott Hodgson '03. "I have seen the proverbial light bulb go on when students realize that just because they graduate with an engineering degree doesn't mean they have to be an engineer." And this relationship between current students and alumni is mutually beneficial. "Sharing knowledge and experience and helping students develop" proves a strong motivator for giving back to Mines, says Roxanne Skeene '83. "Interacting with young people in any forum feels good."

The Student Alumni Association (SAA), one of the many free clubs on campus, strives to foster opportunities to connect students and alumni. "SAA has helped tremendously in terms of networking, career searching, and leadership development," says current SAA president Hyung Kim (Class of '17). "There aren't a lot of organizations that offer this type of opportunity to students, but SAA is taking the initiative to give this unique experience to the student body."

Spacious board rooms in the new Starzer Welcome Center now host SAA events that bring alumni and students together. A recent "Dinner and Dialogue," consisting of a shared meal and conversation in a comfortable non-academic setting, featured advice provided by Skeene and Andy Baker '89, who skyped in from Tobago and Kuala Lumpur, respectively, and Ben Reisinger '11, who shared his ideas in person. Though this particular panel discussed international work, each dinner brings a new alumni speaker with a unique perspective.

CSMAA

The annual Connections is a networking event that connects students with Mines alumni.

February 16, 2016, marked the fourth annual "Connections" event on campus, sponsored by the Center for Academic Services and Advising. The event features networking on a grand scale for Mines students of all class levels. The 150 participating students rotated among tables staffed by alumni from all industries and backgrounds, who provided students with a constant flow of inspiration, stories, and advice on how to succeed at Mines. "These events are tremendously valuable," says Sarah Hodgson '09. "So many of the students I speak with are struggling with not feeling like they belong at Mines, because they don't want to go into an engineering field. I get to share my story about being in the same place and coming out on the other side with a graduate degree in biomedical sciences and a career in healthcare quality."

As the SAA progresses through its fourth year, club members eagerly await the culminating networking event of the year—"Meeting of the Mines." Planned for early April, this half-day workshop focuses on how and why connections are important and provides time for students to practice making these connections.

Danelle Herra

SAA advisor Sandra Kohl (far left) with the SAA Executive Team (L to R) Megha Gandhi, Hunter Chase, Hyung Kim, Sami Al-Saadawi, and Allison Keator.

"Mines is a great university that provides a technical education to students," says former SAA president Diane Roher (Class of '16) "However, there is always more to learn and tools to be gained that do not exist in a classroom, like the value of networking."

"When I was a student, there were no programs like these—at least that I was aware of," says Scott Hodgson. "I also don't remember understanding the value of talking with alumni. Looking back, I would have really enjoyed having that chance."

—Sandra Kohl

ALUMNI ASSOCIATION

Meet the Colorado School of Mines Alumni Association Board of Directors

Scott Hodgson '03

Golden, Colo.

Director, Colorado Alumni Programming

While pursuing a bachelor's degree in mechanical engineering, Scott participated in varsity track and field at Mines. After graduation, he moved to Utah to work for ATK Thiokol as an engineer on the space shuttle reusable solid rocket motors. While working for ATK, Scott earned an MBA at Weber State University. In 2008, Scott moved back to Golden, Colorado, to work for his current employer, Shaffer Baucom Engineering and Consulting (SBEC). His most recent design project is the future Mines physics building, CoorsTek Center for Applied Sciences, scheduled to begin construction in 2016.

Norma Mozeé '83

Denver, Colo.

Director, Campus Relations

Norma is principal and founder of Afinidad Amercias, LLC, an international business strategy and advisory consultancy focused on energy services companies. Afinidad is expanding into the Americas markets with a special focus on Mexico and other Latin American countries. Norma serves as a managing director for 1stWEST Merges & Acquisitions and is a member of The Chamber of the Americas and the World Trade Center (Denver). She also serves on the *Mines* magazine editorial board. Norma received her bachelor's degree in mineral engineering mathematics at Mines. She also received a master's degree in global energy management from the University of Colorado Denver, as well as a certificate in international trade from the World Trade Center (Denver).

Tim Saenger '95

Frisco, Texas

Director, Admissions

Tim has been the alumni association's Dallas/Fort Worth Section Coordinator since 2003 and has served on the Board of Directors since 2013. He received his bachelor's degree in engineering physics from Mines in 1995 and his MBA from Southern Methodist University in 2006. He started his career as a photolithography process engineer and has most recently served as the sourcing manager for the largest division of Texas Instruments. Tim is also president of USPASSS, a newly formed non-profit organization seeking to help international students get a high school education in the United States.

Mahesh Vidyasagar MS '00

The Woodlands, Texas

Director, Alumni Programming (Beyond Colorado)

Mahesh is a first-generation American with roots in India. He came to Colorado's Front Range after completing his bachelor's degree in geotechnical engineering at New Mexico State University in 1997. He completed a master's degree in mining engineering at Mines in 2000 and subsequently finished an MBA at UCLA with an emphasis in finance and international management in 2010. Currently, he is a Global Procurement Manager at ExxonMobil and lives in Houston, Texas, with his wife.

Find full bios for board members online at minesalumni.com/board. Interested in getting involved with the alumni association? Learn about the opportunities at minesalumni.com/volunteer.

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HOLLY JOLLY MINER'S MINGLE

On December 3, 2015, Mines alumni gathered to celebrate the holiday season and connect with fellow Orediggers. To accommodate the nearly 400 attendees (which broke previous attendance records), the party was held at the Green Center on the Mines campus. As guests entered the ballroom, they were serenaded with holiday carols sung by the Melodic and Harmonic Miners, and later, they two-stepped to the sounds of Thunder and Rain—a Golden-based country and bluegrass band.

In keeping with the party theme, everyone was encouraged to wear their best "mountain casual" attire. While party-goers enjoyed festive holiday drinks and treats, President Paul C. Johnson and Mines Alumni Association president Ray Priestley '79 donned Santa hats and gave out presents to attendees whose names were drawn from a bowl. "This annual holiday event has become so popular that we outgrew the Geology Museum, our previous venue, and had to move to a larger location," says Ruth Jones, the alumni association's senior associate director of programs. "Our local alums have made this an annual tradition—it's almost like a mini reunion. Our staff looks forward to this party as much as our alumni do."

Laurie Schmidt

L to R: Alyse White '15, Chelsea Grimm '15, Helen Ringle '09, MS '14, and Lauren Revis '15 raise a toast at the 2015 Holiday Party.

Laurie Schmidt

Mines president Paul C. Johnson calls out names of gift giveaway winners.

Laurie Schmidt

Cooper Swenson '04 (CSMAA Board of Directors member) and Ray Priestley '79 (CSMAA Board of Directors current president) enjoy some laughs.

Laurie Schmidt

Thunder and Rain, a local bluegrass band from Golden, Colorado, entertained guests at the 2015 Holiday Party.

ON OUR WALL

What is your favorite memory of a Mines tradition?

My run up to the "M" as a freshman with a 10-pound rock in September 1969. I was in good shape (ready for cross country) and made it in just under 30 minutes (first place finisher, of course). I repeated the event four years later on Senior Day with another 10-pound rock and made it to the fence enclosure in 18:13. Of course, that was after four years of Mines track and cross country. Painting the "M" is a great tradition—I hope it endures.
-Jim Gusek '73

...maybe it was the dynamite?
-John W. Anthony '85, MS '88

The M-Climb with a 10-pound rock in hand and certified hard hat firmly seated on my noggin against the hail of water balloons. E-Days fireworks shows on the old field—you know the ones—basically just stacks of dynamite and flamethrowers. Also the trebuchet competitions, soapbox derbies, and cardboard canoe races. Good natured fun from a bunch of engineers who feel a constant desire to build things and then tear or blow them apart.
-Benjamin Collins '12

I can't say I ever had a bad time during E-Days—more specifically, the keg race. For the record, we were short two men in 2008, and we lost by less than a minute. We were basically robbed of the 2008 title.
-Matthew R. Harris '09

The 4x4 mud drive challenge.
-Alex Van Hoeken '91

I would have to say that going to "Coors Lab" after a long day of classes and realizing that all your friends have "Coors Lab" at the same time is pretty special.
-D. Jeffery Smith '99

We always remember and remain grateful to the International Student Office's initiative for hosting a Welcome Gathering where we met our excellent friends Mr. and Mrs. Bretches from Arvada, Colo. Also, the Second Hand Gift Away Initiative that ISO held along with an awesome group of volunteers from the Golden Baptist Church Community to help all new students from overseas settle in with essentials. Finally, we enjoyed I-Day, the International Music and Dance Performance and Food Festival. With such a positive environment, it was easier to perform our best in our academic programs.
-Eduardo Morillo '02

The International Day. Excellent performance from the Malaysian students!
-Ahmed Battashi '92

International Day—great entertainment and food!
-Ken McCarley PhD '99

Winter Carnival was always my favorite, especially the year with the scavenger hunt, and I believe that was also the year with beer from Golden City Brewery.
-Sean Driscoll '11, MS '12

Talking physics over pool and beers at the Ace-Hi Tavern. Or just the pool and beers.
-Leland Rupp '12

If I need to choose from these many traditions, I would choose International Day!
-Feng Lin MS '11, PhD '12

E-Days: wonderful and fun experience.
-Khoi Nguyen '96, MS '98

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ALUMNUS PROFILE

How an Insect Inspired a New Cidery

When you stack his hard cider company's name up against firms like Angry Orchard, Scrumpy Jack, and even Reverend Nat's, Jason Spears '99 admits that Locust is a bit of an odd moniker for a product you might consider drinking. After all, it doesn't sound all that appetizing, and it doesn't boast exotic ingredients. Instead, it's filled with memories of a brutal attack that almost took the mechanical engineering graduate's life when he was a teenager.

Jason Spears

When he was 13 years old, Spears and his younger brother were hitting golf balls when a group of teens grabbed their golf clubs and began to beat Jason. "I thought I was going to die. He only stopped because he snapped the club in half," Spears recalls.

David Volk

Hearing the pulsating, buzzing of locusts while waiting for the ambulance to show up on that hot summer night in his small Texas town not only comforted him, it also inspired him. "I had an extreme moment of clarity and made a decision that I was not going to accept less than the best quality in life," he says.

About a year after graduating from Mines, Spears promptly followed up on his entrepreneurial vision by opening a Colorado Springs coffee house and a successful night club/restaurant, which attracted the likes of Branford Marsalis and Ziggy Marley. When he tired of running his own eatery, he became a restaurant design consultant, eventually signing on with Starbucks.

Then he found a new passion: hard apple cider.

Spears first discovered cider when he developed an allergy to beer, and he quickly took a shine to the fruit-inspired drink. Although he didn't know much about the cider business, Spears says his economics classes at Mines taught him to focus on a problem-solving approach, and he quickly found an issue that he could solve.

"I started drinking cider and I didn't find anything on the market that I liked at the price point I wanted. I am not a deep-pockets kind of guy, and I wanted something that I could buy on a regular basis," he says. Instead, he had a choice between the high-end ciders he loved, like Dupont Cidre Reserve from Normandy, which sells for up to $20 per 750 ml bottle, or mass market favorites like Ace and Spire, which were the only other widely available options.

In keeping with his focus on quality, Spears knew he wanted to make something that was a step up from the mass produced option. It had to be a craft cider that was good enough to drink with friends, yet still sell for less than $10 a bottle. As a result, he became among the first to buck tradition by using cans instead of bottles, because they seal in the taste, they're environmentally friendly, and they cut weight-related shipping costs.

By the time Locust was ready to hit the market, the cider craze was already in full swing. Although Spears had planned to start small and operate out of his garage, he quickly realized that he wouldn't be able to make enough cider to cover licensing, insurance, and other overhead costs. So, he opted for a store-front cidery and tasting room in a strip-mall location where his mix of six ciders on tap—including Original Dry, Dark Cherry, and Thai Ginger—have been attracting customers every weekend. It helps that he set up shop in Woodinville, Washington, a far-flung Seattle suburb known for its wine tasting rooms and distilleries.

If response outside of tourist circles is any indication, Locust is off to a good start. Although it's only been on the market since March 2015, the cider is already in Whole Foods and the Total Wine chain, as well as another major Northwest grocery chain and 30 restaurants in Washington, Oregon, and Idaho. Spears says he's also trying to get his cider into California, Arizona, and, of course, Colorado.

"We're not trying to be the next Angry Orchard," he says, referring to the highly popular mass-market cider made by Samuel Adams brewery. "We're not trying to become millionaires, we're just trying to make enough to keep this going."

And he owes much of his successful business venture to the sound of a lowly insect.

—David Volk

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COLORADO SCHOOL OF MINES THANKS ALL OF ITS OUTSTANDING DONORS

GIFTS AND COMMITMENTS OF $100,000 AND MORE*:

William G. ’82 and **Rhonda Duey** made gifts totaling $149,373 in support of several programs, including The Minds Fund and the Duey Family Endowed Scholarship.

Joe Eazor ’85 made a gift of $200,000 to fund four years of the Joseph F. Eazor Executive in Residence Series.

Hershal C., Jr. ’58 and **Trudy Ferguson** named the press box at the Clear Creek Athletic Complex with a gift of $250,000.

Chevron committed $865,000 to the Chevron University Partnership Program Center of Research Excellence Fund, as well as various departments and student support.

The Ralph Wilson Family Foundation made a gift of $250,000 on behalf of Interstate Highway Construction, Inc. to support the Civil Engineering department.

Newmont Mining Corporation made several gifts totaling $282,000 to support numerous initiatives, including the Newmont Mining Scholarship and the development of the three colleges.

The estate of **John G. Underwood** ’53** made a gift of $350,000 toward advancing the university.

The Adolph Coors Foundation gave $155,000 to fund the Herman F. Coors Professional Chair in Ceramics.

GIFTS AND COMMITMENTS OF $25,000 AND MORE*:

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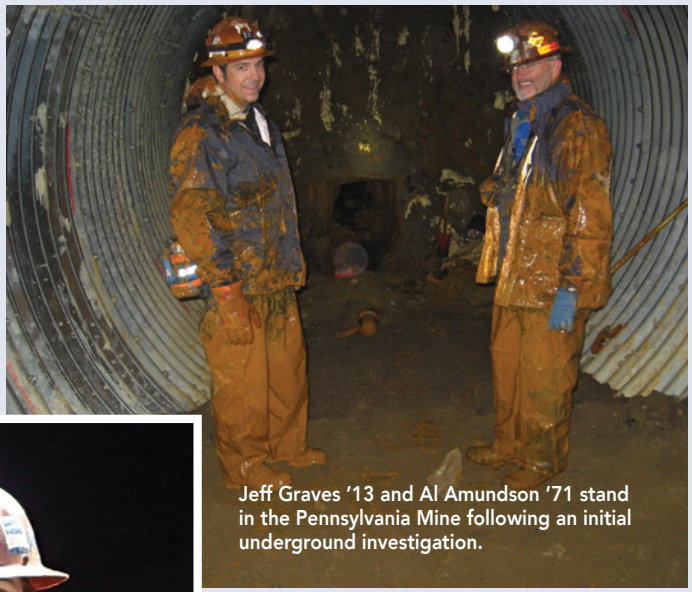
***Deceased*

COLORADOSCHOOLOFMINES FOUNDATION

ALUMNUS PROFILE

Cleaning Up the Past



Bruce Stover

Jeff Graves '13 and Al Amundson '71 stand in the Pennsylvania Mine following an initial underground investigation.

Jeff Graves '13 is a self-styled history buff who is fascinated by Colorado's early mining industry—and by the colorful frontiersmen who, he says, achieved incredible feats of engineering in their hunt for gold and silver. But as a geological engineer, Graves is also grappling with another legacy of mining in Colorado: its environmental toll. Across the state, many old mines leach heavy metals like zinc and copper into nearby streams and rivers through a process called acid mine drainage.

Graves, a senior project manager in the Colorado Department of Natural Resource's Division of Reclamation, Mining and Safety, is leading an effort to halt the flow of pollution from one such site: the Pennsylvania Mine. This now-defunct silver and gold operation, which dates back to the late 1870s, sits several miles east of Keystone, Colorado, on a waterway called Peru Creek. Graves hopes that the drive to clean up the site will demonstrate the state's commitment to dealing with its mining past in a cost-effective manner.

Courtesy of Jeff Graves

Colorado's earliest miners "never intended this to be a problem," Graves says. "So once you get beyond asking who's to blame, the question becomes, what are the solutions? What can we do inexpensively to address this problem?"

In the case of the Pennsylvania Mine, and many historical sites like it, the problem originates deep in the mine workings. Acid mine drainage, Graves explains, occurs when three ingredients—water, oxygen, and sulfur-bearing minerals—mix underground. That mixture causes a buildup of groundwater that is loaded with heavy metals, which can then leak out to the surrounding countryside. Such drainage can pose health risks to both the people living nearby and to stream life.

Near the Pennsylvania Mine, the fallout is visible in Peru Creek. Here, there are "no fish, no bugs," Graves says. "Peru Creek is pretty much dead from the Pennsylvania Mine to the Snake River." And that's a big problem for Summit County, Colorado, where the Snake River is an important outdoor recreation site and a source of drinking water supplies.

Graves, however, has built a career on figuring out how to shut down, or treat, that flow of polluted water from abandoned mines. "The first thing you have to figure out is, how is water moving through here? What's the plumbing system like? It's kind of a big puzzle that you're trying to put together," says Graves.

For a site like the Pennsylvania Mine, there are a handful of possible solutions to that puzzle. In some cases, such as near the massive Argo Tunnel in Idaho Springs, Colorado, reclamation experts have opted to install water treatment plants around mines. These plants clean the escaping water, making it safe for nearby creeks. But they're also expensive and noisy to run.

In its current cleanup effort, which began in earnest in 2013, the Division of Reclamation, Mining and Safety opted for a more low-tech approach. Over a five-year period, Graves' team—in partnership with the U.S. Environmental Protection Agency—will install a series of concrete bulkheads in the mine. These bulkheads should force water to back up within the site, curtailing the processes that lead to acid mine drainage. It's a bit like putting a stopper in your bathtub. "You're trying to return the water table to pre-mining conditions," Graves says. His group has already placed two such plugs in the mine (each up to 20 feet thick), and they plan to install a third in 2016. So far, the project is below budget and ahead of schedule.

Graves, who earned his master's degree in geological engineering, says that his time at Mines was marked by a strong focus on real-life problem solving. In one of the first classes he took, he and his fellow students were tasked with simulating what might happen if a mining drainage tunnel located in Leadville experienced a blowout. "The project was right up my alley," he says. "It was fun to actually be able to use some of what I did in class here at work."

But the history buff-turned-engineer says that there is more to mining reclamation than solving 100-year-old problems—it's also about looking to the future. By studying historical operations like the Pennsylvania Mine and where they went wrong, Graves says that the mining industry has been able to develop new strategies for making today's mines more environmentally sustainable.

"I think there's a place for mining in Colorado still," he says. "Seeing how things were in the past has definitely influenced how mining takes place in Colorado now. And I think that's for the better."

—Daniel Strain

EDITOR'S NOTE

Are you looking for Class Notes? To fulfill readers' requests to increase magazine space for feature articles and other Mines stories, Class Notes are now listed exclusively online. Visit minesalumni.com/minesmagazine to see your classmates' latest accomplishments, employment changes, photos, and other updates.

To submit a marriage, birth, or other alumni news announcement for potential publication in the magazine, visit minesalumni.com/announcement.

AWARD-WINNING CONSTRUCTION PHOTO Rob Percival '10 submitted an award-winning photo to the annual *Engineering News-Record*'s "2015 Year in Construction" contest. The contest solicits photos that show construction in action. The photograph of the U.S. 36 Bridge in Decatur County, Kan., was taken early one morning before the concrete trucks arrived to do a deck pour. Noticing the workers in the haunting, pre-dawn light, Rob snapped the photograph with his iPhone.

WEDDING VOWS IN THE RAIN Whitney Welch '13 and Peter Carow '13 were married October 24, 2015, in Houston, Texas. Whitney now works as the sustainability project coordinator at DBR Engineering, and Peter is a human space flight engineer at Oceaneering Space Systems. Mines alumni in the wedding party included Barbara Anderson '13 (maid of honor), Colette Van Straaten '12 (bridesmaid), Lauren Lundquist '14 (bridesmaid), David Gilmour '13 (groomsman), and Eric Rosing '14 (groomsman). Other Mines alumni in attendance were Brian Smith '13, Alexander Broom '14, Scott Harper '13, MS '15, Adam Hoefler '13, Rebecca (Morales) Hoefler '13, Kristin Thompson '13, and Preston Wierzba '14.

RAILWAY AGE MAGAZINE'S TOP 10 UNDER 40 Joseph Brosseau '03 was named a finalist in *Railway Age* magazine's inaugural "Fast Trackers—10 under 40" contest in the publication's February 2016 issue. Joseph is a principal investigator at Transportation Technology Center, Inc. (TTCI), focusing on communications and train control. The magazine selected 10 industry professionals from freight/passenger railroads, suppliers, and consultants/contractors and judged them on criteria that included industry experience and education, leadership skills, industry contributions, and community service involvement.

A GOLDEN COUPLE Blakelee Midyett '10 and Zachary (Cash) Mills '13 were married on September 19, 2015, at the Historic Morrison Chapel in Morrison, Colo. Blakelee and Zach met at the Ace-Hi Tavern and now live and work in Golden, Colo. Mines alumni in attendance were Michael Midyett '13 (man of honor), Gage Soehner '08, Alisson Soehner '07, Clayton Bruntz '10, and Jason Harms '09. The ceremony was officiated by former Mines faculty member and Golden Software founder, Pat Madison.

MULTICULTURAL CONNECTION Jessica Ho '14 married Robert Godinez MS '15 on November 7, 2015, in Littleton, Colo. The couple met at Mines' winter carnival and participated in the Multicultural Engineering Program and other community events together. Nine Mines alumni attended the wedding, including Emily Malihi '14 and Edward Huss '14, who were both members of the wedding party. The newlyweds live in Parker, Colo.

A SHARP-DRESSED MAN On June 30, 2015, Shane Bigelow '04, MS '08 and Shante Bigelow welcomed a baby boy, Asa, into their family.

WELCOMING TWO MORE Evelyn Grace and Olivia Ann Stingerie were born to Darcy (Souta) Stingerie '08 and Jason Stingerie '07 in Norway on July 20, 2015. The twins join their big sister, Madi.

BLUE-EYED BABY Braxton Lee Vinnola was born on June 6, 2015, to Robbin Vinnola '10 and Danielle (Saulsbery) Vinnola '09 in Las Vegas, Nev. The family lives in Golden, Colo.

YOUNG BRONCOS FAN Emilyanne (Dalton) Hardy '10 and Cole Hardy welcomed a new daughter, Evelyn Rose, to their family on June 23, 2015.

MONGOLIAN AMBASSADOR TO SINGAPORE On July 30, 2015, George Lkhagvadorj Tumur '99, MS '02 (left) presented his credentials to Singapore President Tony Tan to become Mongolia's ambassador to Singapore. George is one of the leading executives in the Mongolian mining industry but relinquished his corporate titles in order to take up his current role. George aims to help promote Mongolian culture and business prospects.

MATCH MADE UNDER THE "M" Grace Boeck '14 married Benjamin Casey '14, MS '15 on September 26, 2015, at the Three Trees Chapel in Littleton, Colo. The couple met during their sophomore year at Mines, and Benjamin proposed on the Washington Street bridge overlooking the "M."

AN OREDIGGER FAMILY Vince "Mike" Gonzales '05 and Emily (Milian) Gonzales '08 welcomed their new son, Oscar Blaise Gonzales, into the world on December 30, 2015. Oscar made his debut after Vince and Emily finished a Colorado trail hike. The couple hopes their future Oredigger will have many more outdoor adventures as he grows.

OUTSTANDING FACULTY AWARD

Roxann Hayes '95, a civil engineering faculty member at CU-Denver, was named the 2015 College of Engineering and Applied Science Outstanding Faculty in Teaching. The award was presented to Roxann at the 2015 Year-End Celebration.

IN MEMORIAM

"When you are sorrowful look again in your heart, and you shall see that in truth you are weeping for that which has been your delight."

—Kahlil Gibran

Francisco "Frank" Amaro-Gomez MS '75 died January 27, 2014, in Denver, Colo. Francisco was born in 1942 in Lima, Peru, and received his master's degree in mining engineering from Mines in 1975. He spent 25 years working for the federal government in the Washington, D.C., area and returned to Denver, Colo., in 2013.

Milton John Bernstein '47, MS '50 died May 24, 2015, in Boulder, Colo. Born in 1920, John served in World War II in the U.S. Army Corps of Engineers until 1946 and received an engineer of mines degree from Mines in 1947. He went on to receive a master's degree in mining engineering from Mines in 1950 and earned an additional master's degree in business from Harvard Business School. From 1952 to 1958, John was the corporation planning manager for Consolidated Electrodynamics Corporation before becoming the director of new business development for the Librascope/General Precision Corporation. In 1963, he was senior financial specialist for the LTV Corporation. He then relocated to Boulder, Colo., where he worked for Ball Brothers Research until 1971. John then worked for Western Tele-Communications as a national sales manager until 1982 and served as the director for business development for Johnson Engineering until 1988. He then worked as a consultant to management for Johnson Engineering until 2015. John was a member of the Mines Heritage Society and the President's Council.

David Bradfield '57 died October 20, 2015. Born in Cortez, Colo., in 1935, David graduated from Mines in 1957 with a degree in metallurgical engineering. As a student, he was a member of the Beta Theta Pi fraternity and participated in varsity track and field. In 1957, David began his career working in uranium facilities in Utah and was also a member of the U.S. Army National Guard, serving from 1957-1967. From 1959 to 1966, he worked for the Dow Chemical Company at Rocky Flats as the lead plutonium, uranium, and beryllium process engineer. He then worked as a process engineer in the Mining and Metallurgical Division for Sterns-Roger Inc., and went on to do consulting work and project management for companies such as Raytheon, Bateman Engineering, Kerr-McGee, Newmont Mining, and Tetra Tech, among others. David was a registered professional engineer; a former committee chairman for the Society of Mining, Metallurgy, and Exploration (SME); a member of the American Institute of Mining, Metallurgical, and Professional Engineers (AIME); and a member of the American Society of Engineers and the American Society of Metallurgy. He retired in 2013.

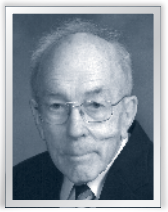
Harold R. Cheuvront died November 21, 2015. Harold was born in 1946 and received a bachelor's degree in 1968 and a master's degree in 1970 from West Virginia University. He then earned a PhD from the University of Northern Colorado. Harold served as the dean of students at Mines from 1986 to 1989 and was known affectionately as "Dean C" on campus. He subsequently served as both the dean of students and vice president of student life from 1989 to 2009 and played an integral role in the development of Student Life and the Residential Campus Program. Harold was a visionary who fostered the development of programs such as the minority engineering program, counseling, student health center, athletics, the student recreation center, and student activities, serving the Mines community for 35 years. He became an honorary member of the Mines alumni association in 1999 and received the Mines Medal in 2010 for his exemplary service to the school. Harold was also a member of the Mines President's Council.

Richard "Dick" Church '56 died December 25, 2015. Born in 1934, Dick received his geological engineering degree from Mines in 1956 and completed a master's degree at the University of Alaska in 1961. He spent many years working in the oil industry in Louisiana, Alaska, Connecticut, Texas, Colorado, Turkey, Libya, England, and Indonesia for companies such as Gulf Oil, Mobil, ARCO, Weeks, and Apache, among others.

James "Gus" W. Gustafson '63 died September 2, 2015, in New Iberia, La. Born in 1940 in Chicago, Ill., Gus received his mining engineering degree from Mines in

To submit an obituary for publication in the magazine, visit minesalumni.com/obituaries.

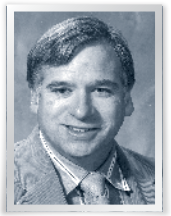
1963. As a student at Mines, he was a member of the Kappa Sigma fraternity and was on the track team. Gus was inducted into the Mines Athletics Hall of Fame in 1998. After graduating from Mines, he served in the U.S. Army Corps of Engineers until 1965 and went on to work as a mining engineer in Missouri and Louisiana. He retired from Cargill Salt.



Robert "Bob" R. Olson '49 died May 24, 2015. He was born in 1925 in Denver, Colo., and began his college education at Mines in 1943. Bob was drafted into the U.S. Navy in 1944 and served on the *USS Kenneth Whiting* as an electronic technician. After he was discharged, he resumed his studies at Mines, receiving his petroleum engineering degree in 1949. As a student at Mines, Bob was a member of the Sigma Alpha Epsilon fraternity and was a junior member of the Mines alumni association. He worked for the Colorado Interstate Gas Company for 25 years before relocating to California to work for Fluor. After he retired in 1988, Bob moved back to Denver and taught electronics at the Community College of Denver. He was a volunteer at the Augustana Lutheran Church preschool, where he read books to children, and he repaired audio book equipment at the Colorado Talking Book Library. He was also a member of the Mines Heritage Society and President's Council.

David E. Perkins '75 died October 26, 2015. Born in 1952, David received his geophysical engineering degree from Mines in 1975. He began his career as a geologist for Kansas-Nebraska Natural Gas Company. David later became the vice-president of geology for Midlands Gas Corporation and was the president of Pinnacle Petroleum, Inc. He then worked as an engineer and test manager for Lockheed Martin Space Systems until his retirement.

Robert T. Reeder '49, MS '76 died November 1, 2015. Robert was born in 1925 in Bellaire, Ohio, and served as a sergeant in the National Guard in Colorado and New Mexico from 1948 to 1958. In 1949, he received his mining engineering degree from Mines. As a student, Robert was a member of the Sigma Phi Epsilon fraternity and a junior member of the Mines alumni association. He spent his career working as a mining engineer and project engineer for various companies. Robert received his master's degree from Mines in 1976 and taught at the school as an associate professor of mining until 1983. He received an Outstanding Teacher Award, served on the Mines alumni association and foundation's board of directors, was the executive director and president of the National Mining Hall of Fame and Museum, and received the Order of the Golden Heart from the Sigma Phi Epsilon fraternity in 1997. Robert also served as a member of the advisory board for Union Bank and Trust and Key Bank and was a member of the Mines Century Society, Heritage Society, and President's Council.



John "Randy" R. Roper '70, MS '77, PhD '85 died October 3, 2015, in Northglenn, Colo. Born in 1947 in Columbia, Mo., Randy earned his metallurgical engineering degree in 1970, his master's degree in 1977, and his PhD in 1985 from Mines. During his career, he worked for Pratt & Whitney Aircraft, the U.S. Department of Energy's Rocky Flats Plant, and GKN Aerospace. Randy was also an instructor at the Rocky Flats and American Welding Society's Precision Joining Center and served as a reviewer for the *AWS Welding Journal* and *Metallurgical and Materials Transactions*. In collaboration with Dr. Clint Heiple, Randy developed a hypothesis on weld pool behavior involving Marangoni fluid flow phenomena, which was proven at the National Physical Laboratory in the U.K. Randy also taught graduate-level courses on welding as an adjunct professor at Mines.

Charles R. Saltzer '67 died November 11, 2015. Charles was born in 1945 in National City, Calif., and received his metallurgical engineering degree from Mines in 1967. As a student at Mines, he was a dormitory president, floor counselor, and a member of the food committee. Charles volunteered for a year in Vietnam during the war, evaluating and delegating helicopter repairs. He became a mechanical engineer at the Marine Corps Air Station in Yuma, Ariz., and retired in 2006 as director of engineering. After his retirement, he established the Somerton Airport for recreational aviation. Charles was a member of the Independent Order of Foresters; the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME); and the American Society for Metals (ASM).

Richard "Dick" L. Stallings '55 died October 20, 2015. He was born in 1933 in East St. Louis, Ill., and received his geological engineering degree from Mines in 1955. As a student, Dick was a member of the Alpha Tau Omega fraternity, Sigma Gamma Epsilon, and Mines' football team. After graduation, he worked for Chevron in New Orleans, La., for 14 years and spent one year working for the company in California. Dick then accepted an overseas assignment that took him to seven different countries including Australia, Madagascar, Norway, Denmark, The Netherlands, England, and China. In 1992, he retired after working at Chevron for 37 years. Dick was a member of the American Association of Petroleum Geologists (AAPG) and the Mines President's Council.

Charles "Hall" H. Swaim '61 died July 4, 2015. Born in 1939 in Delta, Colo., Hall grew up in Colorado Springs and earned a geophysical engineering degree from Mines in 1961. Hall was a member of the Tau Beta Pi Engineering Honor Society and the Alpha Tau Omega fraternity as a student at Mines. He earned a J.D. from New York University School of Law as a Root-Tilden Scholar. After graduation, he practiced

as an attorney at Texas Instruments, developing early semiconductor patents. In addition, Hall served for two years in the U.S. Army Ordnance Corps, where he was promoted to captain. He then practiced in the Commercial Department at Hale and Dorr in 1971 and was one of the first bankruptcy lawyers in the U.S. to recognize the interplay between technology licensing and bankruptcy. Hall was selected as a Fellow of the American College of Bankruptcy in 1999, was the former president of the New England Chapter of Turnaround Management Association, and was a member of the American, Massachusetts, and Boston Bar Associations.

Philip Templeton '37 died August 5, 2015, in Anacortes, Wash. Philip was born in 1915 in Fowler, Colo., and graduated from Mines with a professional engineering degree in 1937. As a student at Mines, he was a member of the Sigma Phi Epsilon fraternity. Philip was a junior engineer for Standard Oil Company of California until 1939 before receiving his master's degree from Purdue University in 1940. He then became a chemical engineer at Texaco's petroleum refinery in Lawrenceville, Ill., until 1942, when he was called to active duty as an officer in the Army Corps of Engineers. He served for four years and was awarded a Bronze Star for his duty on Omaha Beach during the invasion of France. Philip returned to his career at Texaco after the war until his retirement in 1980. He was a registered professional engineer, president of the Pacific Energy Association, chairman of the Northwest Refining Committee of the Western Oil and Gas Association, and the president of Clean Sound Co-Op. In addition, Philip was a member of the Mines Heritage Society and Century Society.

Hilbert A. Ternstrom '49, MS '52 died September 24, 2015. Born in 1924 in Golden, Colo., Hilbert served in the U.S. Army Air Force in the 82nd and the 101st Airborne from 1943 to 1945. He received his professional degree in petroleum refining from Mines in 1949 and his master's degree in 1952. After graduation, Hilbert worked as a chemical engineer with the Bureau of Mines Oil Shale Demonstration Plant in Rifle, Colo. He also worked for Standard Oil in Aruba for four years before relocating to California, where he worked for Mobil Oil until his retirement in 1989. Hilbert and his wife, Patricia, were both members of the Mines Heritage Society.

George M. Thomas, Sr. '44 died June 16, 2015, in Whitefield N.H. George was born in 1921 and received his metallurgical engineering degree from Mines in 1944. After graduation, he served in the U.S. Navy in China at the close of World War II. In 1950, he received a master's degree in metallurgical engineering from Stevens Institute of Technology in Hoboken, N.J. George worked as an associate metallurgist for IBM in Endicott, N.Y., where he spent most of his career advancing solder technology for use in computer mainframes before retiring in 1984. He was also a member of the American Society of Metals, which is now known as ASM International.

David L. Watson '60 died September 9, 2015. David was born in 1937 in San Antonio, Texas, and graduated from Mines in 1960 with an engineer of mines degree. As a student, he was a member of the Sigma Alpha Epsilon fraternity and the student chapter of the American Institute of Mining, Metallurgical, and Petroleum Engineers (AIME). After graduation, David served with the U.S. Army Reserve before beginning his career as a mining engineer with Cerro de Pasco Corporation. In 1974, he joined Kaiser Engineers, where he worked on a number of domestic and foreign mining projects. David retired in 2001 as technical director for Kennecott Minerals Company. He was a Legion of Honor Member of the Society of Mining, Metallurgy and Exploration (SME), as well as a member of AIME, the Mining and Metallurgical Society of America (MMSA), and the Australian Institute of Mining and Metallurgy. David was also a member of the Mines President's Council.

—Compiled and written by Ashley Spurgeon

ALSO REMEMBERED

James H. Alkire '49 ..... September 12, 2013
Robert W. Arrendiell '51 ..... August 18, 2014
Robert P. Barnes '58 ..... March 23, 2015
Ronald E. Becker '52 ..... March 29, 2015
Edward O. Carter '38 ..... January 19, 2014
Alva M. Caster '60 ..... March 30, 2015
Richard Hugh Clayton '62 ..... February 10, 2015
Cleveland Dear, Jr. '50 ..... March 18, 2015
Charles B. Ebinger '56 ..... August 25, 2014
John W. Erwin MS '54 ..... October 3, 2013
George J. Featherstone '43 ..... March 11, 2014
Jennifer Gale ..... June 12, 2014
Michael Gondouin '52 ..... September 9, 2014
Jerry L. Harris '53 ..... March 2, 2009
T. Graham Hereford Jr. ..... September 3, 2014
Samuel M. Hochberger '48 ..... July 2, 2013
Andrew G. Keleher '50 ..... January 15, 2015
Victor Kerlins '59 ..... December 24, 2012
William L. Kirker '56 ..... September 15, 2013
Pritam L. Mehta '55 ..... February 1, 2015
James A. Montgomery '52 ..... September 3, 2014
John J. Nicholl Jr. '79 ..... September 2, 2014
Richard L. Phillippone '49 ..... March 25, 2014
Roderick K. Rawlins '51 ..... January 4, 2015
Rodney L. Samuelson '48 ..... January 23, 2013
Roland H. Shubert '58 ..... October 26, 2013
Cecil H. Smith Jr. '52 ..... July 22, 2014
Robert M. Steele MS '74 ..... December 22, 2012
Lee M. Talbert '36 ..... November 16, 2013
Howard C. Worzel '51 ..... March 25, 2015

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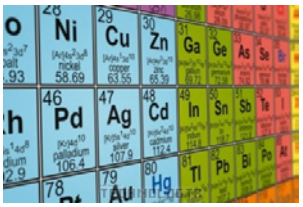

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MINER'S PIC

WALKING THE LINE

When she isn't practicing or teaching yoga, Michelle Griffith '14 spends her time dangling over some of the most scenic canyons in the West. In an adventure sport known as "highlining," athletes perform slacklining high above the ground at a height far above which they could safely fall (most highliners wear a safety harness tethered to the rope).

"Mines instilled a tenacity in me that is still with me today," says Griffith. "When I first discovered slacklining, I was able to approach it with the same attitude of perseverance and passion for improvement and success with which I achieved that little silver diploma."

In this photo, Griffith balances over an area known as "The Fruitbowl," a popular highlining spot near Canyonlands National Park west of Moab, Utah. "There's a whole lot of engineering that goes into ensuring that the highline is safe, redundant, and that the force we exert on the system is significantly less than the Working Load Limit," she says.

Andrew Muse Photography

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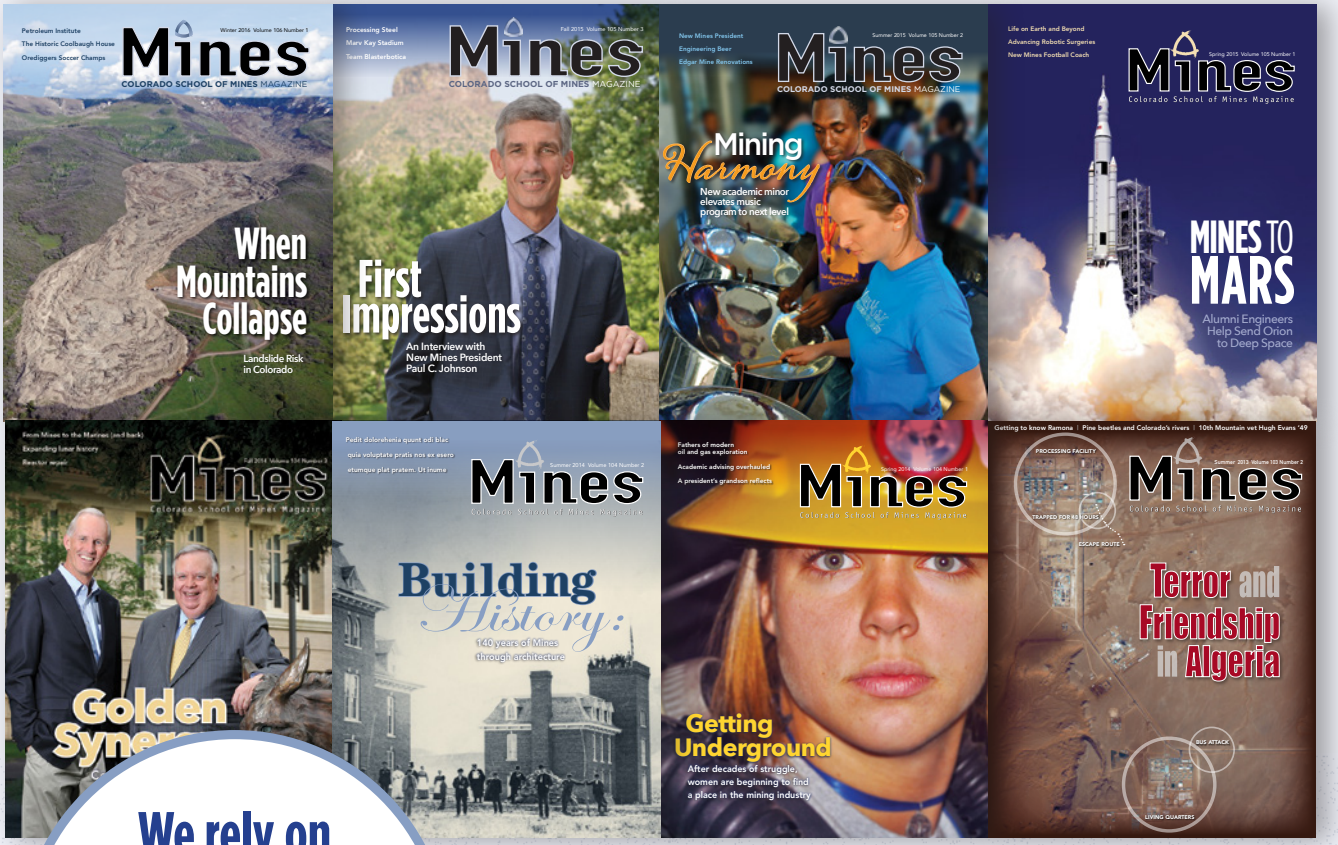

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