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GEOSCIENCE CURRENTS
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Critical Skills Necesssary for the Development of Undergraduate Geoscience Students

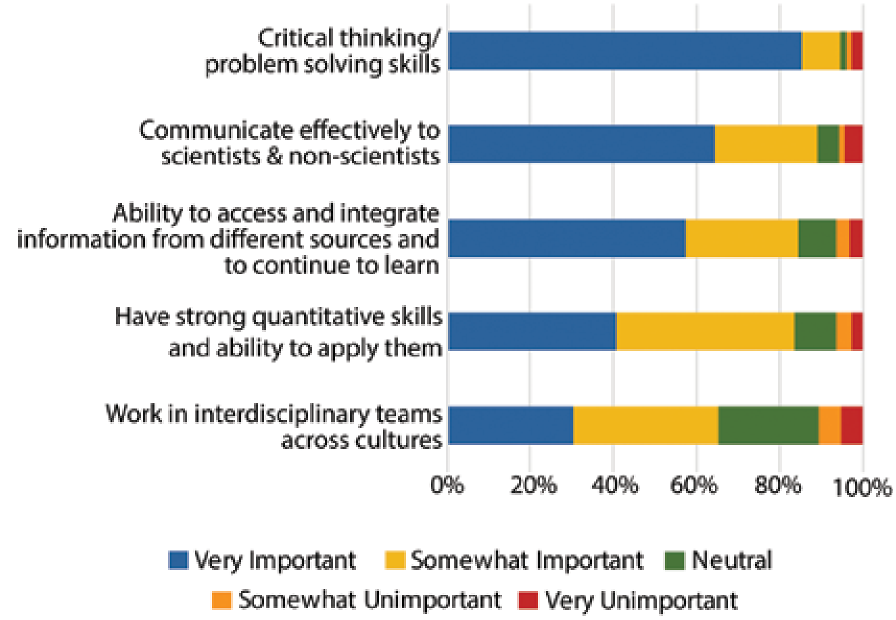
Over the past two years, the working group behind the NSF-funded *Summit on the Future of Geoscience Undergraduate Education* has engaged a diverse spectrum of the geoscience academic and employer community in a comprehensive review of the skills, competencies, and conceptual understandings needed in geoscience undergraduate programs, the best methods of producing these learning outcomes, and how to best broaden, recruit and retain undergraduate geoscience students, especially underrepresented groups. One effort included a survey aimed at anyone in the geoscience community to offer their opinions on the priorities for improving undergraduate geoscience education

The survey yielded 455 responses -- 78% from the academic community, 17% from industry representatives, 13% from government representatives, and 12% from representatives of professional societies and other organizations. The skills have been split into two groups: skills needed by any science professional and skills specifically needed by geoscience professionals in the workforce. The employer community provided more detail on the technical and non-technical skills needed and ways to develop these skills in students.

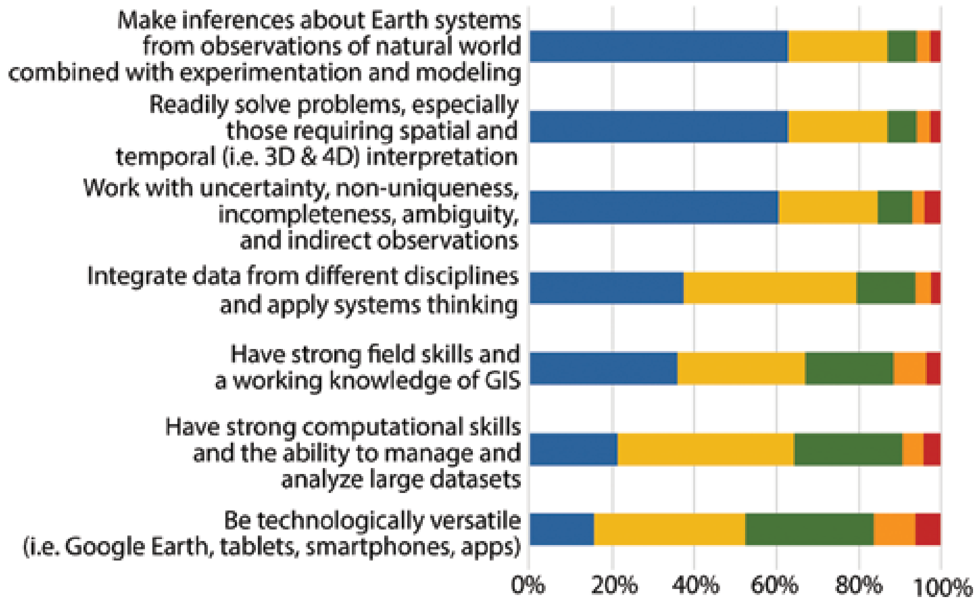
To learn more about the survey results and the further development beyond the survey, please tune in to the *AGU/AGI Heads and Chair Webinar: Impacts from the Summit on Undergraduate Geoscience Education* on Friday, October 9, 2015 at 1 pm eastern time. To register for this webinar, please visit http://www.americangeosciences.org/workforce/aguagi-heads-and-chairs-webinars.

The survey is still open for responses. Please visit
http://www.jsg.utexas.edu/events/future-of-geoscience-undergraduate-education/
to provide your input on geoscience undergraduate education.

Critical Professional Scientist Skills



Critical Geoscience Skills



-Sharon Mosher
Dean, Jackson School of Geosciences
University of Texas at Austin

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FEATURES

View of the outcrop at Usibelli Mine, Healy, AK, containing the minable coal seams interbedded with loosely-cemented sandstone and associated sedimentary lithologies. Photo by Chris Arend, Courtesy of UCM.

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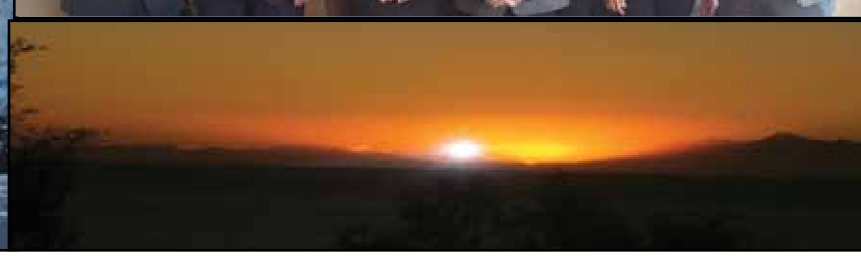
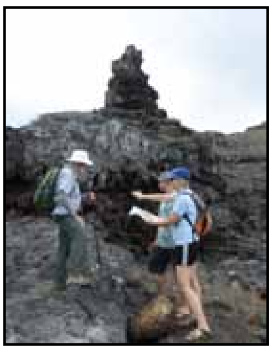
A Good Time was had by all.



The AIPG Hawaii Section is being rejuventated. Here are some photos of a field trip to Ka Iwi Coast, O'ahu, Hawai'i, on August 22, 2015. Members taking part in the field trip are Claire Lueke, CPG-11763, Robert Chenet, CPG-10225, Glenn Bauer, CPG-10855, Jeff Murl, SA-6928, and Kevin Gooding, CPG-10856.

Glenn Bauer, Jeff Murl and Clair Lueke (l to r) chatting with Makapu'u Point in the background.



Glenn Bauer, Jeff Murl and Clair Lueke (l to r) examine an outcrop of pāhoehoe in the Ko'olau Basalt with a sea stack from a higher sea level stand in the background.

Glenn Bauer, Jeff Murl, Bob Chenet and Clair Lueke prepare to hit the trail after looking at a small rockfall in an a'a flow.

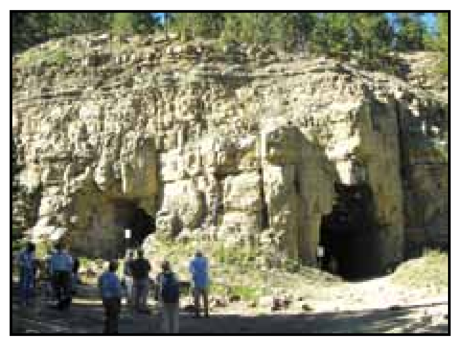
Glenn Bauer, Jeff Murl and Bob Chenet examining calcite deposits in a Honolulu Series tuff deposit.

All photos compliments of Kevin Gooding.

The South Dakota Section held a field trip on September 12 to the Deadwood Formation in the Black Hills of South Dakota and "Frac Sand" Potential. The day-long field trip examined four outcrops of the Deadwood Formation in the Black Hills

Lower Deadwood Formation.

Lower Deadwood Formation



Abandoned mine in the Lower Deadwood Formation.

Trilobite tracks in the ceiling.

Troy Bernier is the current Florida Atlantic University AIPG Student Chapter president and FAPG Regional Coordinator.

Do you need an idea for a section talk, field trip, meeting?

Have you read the AIPG section newsletters on the AIPG website?

- Drilling Demonstration Georgia
- Quarry Quest and Connections in Nature-Wisconsin

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AGI/AIPG Summer Interns become 'Policy Wonks'

Abigail Seadler
AGI Geoscience Policy Associate

This summer, the three AGI/AIPG Geoscience Policy Interns became fully fledged "Policy Wonks." Between meeting congressional and federal agency staff, attending hearings and briefings on Capitol Hill, and keeping the geoscience community informed about relevant policy issues in the Geoscience Policy Monthly Review, Archie Creech, Jr., Kalev Hantsoo, and Sam Jacobson were able to become experts on three distinct policy issues: science communication, carbon capture and sequestration, and critical minerals. In addition, they contributed considerably to the forthcoming update of the 2012 Critical Needs document, which will help inform presidential and congressional campaigns about the value of the geosciences to society for the 2016 election cycle.

The American Geosciences Institute and the three interns are extremely grateful for the support of the Foundation of the American Institute of Professional Geologists, without which these internships would not be possible. These internships provide a once-in-a-lifetime opportunity for young and early-career geoscientists to directly engage with and learn more about science policy.

Below are brief biographies of the three AGI/AIPG summer interns and their articles that showcase the development of their geoscience policy interests over the summer.

Archie Creech is an Environmental Science major at the University of Alabama. Outside of school, Archie works at the Geological Survey of Alabama, where he works in the Hydrologic division as part of the Statewide Groundwater Assessment program. He also worked as an intern for the North River Watershed, a nonprofit that promotes water sustainability and environmental awareness in the North River Watershed north of Tuscaloosa, Alabama. Archie is interested in water resources, especially quantity, and how humans generally interact with the environment around them. In the future, he hopes to work in environmental policy and law and work to facilitate science communication among the scientific community, policymakers, and the public.

Kalev Hantsoo earned his bachelor's degree in Geology from the University of Maryland. His undergraduate thesis focused on the feedback effects between ocean chemistry and animal evolution in the early Cambrian Period. The project included field work with a team of paleontologists and geochemists at the official Ediacaran-Cambrian boundary, located on the coast of Newfoundland. During his AGI/AIPG internship, Kalev researched the economic prospects of carbon capture technology and examined how western states are responding to the ongoing drought. Kalev begins graduate work at Penn State this fall, where he will study carbon cycling and climate change in the geologic past.

Sam Jacobson is a rising junior at Bucknell University majoring in Geology and East Asian Studies. His primary interest lies in economic geology and the consequences of exploiting mineral resources, particularly in regard to Chinese policy. During his AGI/AIPG internship, Sam assisted in the development of the 2016 Critical Needs Document and reported on the state of rare earth elements in the U.S. He is active in his school's outdoor education department and will be studying abroad in China this fall.

Science Communication: A Case Study of Drought and Public Relations

By Archie Creech Jr.

One of the most pressing issues facing the scientific community is the gap between scientific knowledge and public perception. Contentious issues can quickly become characterized by politics and lose their connection to scientific consensus. For example, a January 2015 poll by the Pew Research Center found that 73 percent of U.S. adults believed that Earth's climate is warming, but only 50 percent believed that the warming is human-induced.[1] The same poll found that just 57 percent of U.S. adults believed that scientists agree that "the earth is getting warmer due to human activity," when in reality the number of scientists who agree is closer to 97 percent.[2] Statistics such as these highlight the disparity between scientific knowledge and public perception—how can the public trust scientific consensus if they are not aware of its existence in the first place?

Communication, therefore, is critical. When polled, 99 percent of scientists at the American Association for the Advancement of Science said that scientific inaccuracy in public knowledge and media reports is a problem.[1] In a world undergoing rapid changes, communicating public safety concerns is critical, and for those scientists who have the knowledge to address these issues, it is a moral imperative to communicate them to the public.[3] As a discipline inherently tied to public safety, natural hazards research holds some of the greatest potential for scientists to address this disparity and connect with the public, for although the causes for natural hazards may be politicized, their effects rarely are. Drought

1. Funk, Cary, and Lee Rainie. "Public and Scientists' Views on Science and Society." *Pew Research Center Internet Science Tech RSS*. Pew Research Center.
2. "Global Climate Change: Consensus." *Climate Change: Vital Signs of the Planet*. National Aeronautics and Space Administration.
3. "Guidelines for Ethical Professional Conduct." *AGI Guidelines for Ethical Professional Conduct*. American Geosciences Institute.

in particular offers an excellent opportunity for American scientists to improve their communication, as many citizens are not fully aware of the need to conserve water.[4] Furthermore, eleven of the U.S. western-most states are currently experiencing drought, leaving an imbalance between water use and availability. This challenge gives scientists a prime opportunity to inform policy and public action.

Using water availability as a tool for science communication is not unprecedented. A new *study* published in the journal *WIRE's Water* examined Melbourne, Australia's response to the Millennium Drought of 1997—2009.[5] During the drought, water levels lowered to one quarter of normal levels, and the city of 4.3 million was able to cut its water consumption in half. The reductions were accomplished in large part due to the efforts of the government and scientists to communicate the dire nature of the drought.[6] Without the level of public participation achieved through awareness programs, the reductions would not have been possible. One of the city's more successful campaigns displayed reservoir levels on electronic billboards, which made the reality of the situation clear to the public. Candor combined with scientific insight helped pull Melbourne through its drought. At the end of the drought, one in three residents of Melbourne still had rainwater catchment tanks, and the government established a rebate program for residential communities that recycled their greywater, which is household water that has not come into contact with human waste.

It is easy and arguably preferable to rely on scientific innovation to solve crises instead of relying on changing public attitudes and behaviors, but innovation is unpredictable and, more often than not, slow. Melbourne commissioned a $6 million desalination plant in 2007, but it was not completed until three years after the drought's end and has yet to be put into use. This example is not to say that basic research and support from technology do not provide valuable assistance, but rather that scientific communication needs be a part of technological initiatives. Future water resource management will rely on a combination of new technologies and lifestyle changes, and few things catalyze change like public participation. Further, habits and reforms made during these public-driven upheavals tend to be long lasting. It is unlikely that the rainwater tanks, greywater recycling programs, and vast regional infrastructure established during the Millennium Drought will be shuttered now that the drought is over, and the progress made toward sustainability in the last drought better prepares Melbourne for the next one.

In the future, the practices established here and now for sharing scientific understanding with the public can be applied to more complex environmental challenges, like pollutants in our water or carbon dioxide in our atmosphere. Dan Kahan, a law professor at Yale University who studies science communication, argues that a large part of the disparity between scientific knowledge and public understanding can be explained by the statement, "What ordinary members of the public 'believe' about climate change doesn't reflect *what they know*; it expresses *who they are*."[7] (Emphasis attributed to Dan Kahan.) The solution in Kahan's eyes is for scientists to teach scientific reality without a necessary demand for public consensus, which can be understandably difficult for scientists. Every individual interprets information through her or his own lens, regardless of how that information is presented. By allowing individuals to incorporate the facts presented into their identity, that process is simply made more productive. That principle was at work with Melbourne's reservoirs ad campaign. Ads that state basic facts, like the water level of reservoirs or perhaps the areas served by agricultural land in a drought-affected region, take the opinion out of complex issues that are often intangible and tie them to the individual's everyday life.

Grounding scientific consensus in common terms is a necessary step to successful wide-scale science literacy. Focusing on natural hazards makes the science immediately relevant; addressing water concerns makes the science immediately relatable; and establishing connections between the science community and the public creates the relationships needed to address more complex scientific concerns in the future. Among the scientific principles and mechanisms that guide our everyday lives, water quantity is a relatively straightforward concept to communicate to non-scientists. Water usage is intuitive, and the cycle of water is taught at an early age. Meanwhile, the value of water is lost on no one, and its ubiquitous presence in daily life makes it immediately relatable to all. Scientists can help bridge the gap between scientific knowledge on the sustainable use of water resources and public understanding of what "the sustainable use of our water resources" looks like.

Science communication easily falls into the category of things "easier said than done," but understanding how the public responds to information will help scientists to better share crucial information. The burden of communicating science lies with scientists. The public can not be faulted for not addressing a problem they do not understand, and for better or worse, the public necessarily has to be a part of societal change. Thomas Jefferson said, "An enlightened citizenry is indispensable to the proper functioning of a republic."[8] Helping the public understand the challenges ahead will encourage scientific investment, bring society to a greater understanding of the world, and pave the way to cooperation and mobilization in the future.

Carbon Capture, Carbon Taxation: What is the Future of Emissions Management?

By Kalev Hantsoo

A quick scan through recent articles about Carbon Capture and Storage (CCS) reveals a whirlpool of contradictory messages. Is it the silver bullet for mitigating climate change, or a cynical red herring

4. Attari, S. Z. "Perceptions of Water Use." *Proceedings of the National Academy of Sciences* 111.14 (2014): 5129-134. Web.
5. Low Kathleen G., et. al. "Fighting drought with innovation: Melbourne's response to the Millennium Drought in Southeast Australia." *WIREs Water* 2015, 2: 315-328. doi: 10.1002/wat2.1087
6. "Policy Priorities for Managing Drought." Public Policy Institute of California, Mar. 2015.
7. Kahan, Dan. "*When Science and Politics Collide: Panelists Respond*." Social Science Space, 27 May 2015.
8. Jefferson, Thomas. *Thomas Jefferson on Politics and Government.* Politheo.com.

that will never work? Is it poised to revolutionize the energy industry, or is it a sinking ship that is losing investors? Should we move forward with CCS technology, or is it a waste of money and effort?

CCS refers to trapping carbon dioxide, typically at a fossil fuel-fired power plant, and diverting it away from the atmosphere—typically into a geologic repository, although deep ocean storage and biomass storage are also being explored. A chorus of unlikely allies from the Intergovernmental Panel on Climate Change (IPCC)[1] to the World Coal Association[2] has voiced support for CCS implementation, and the International Energy Agency says that CCS should play a part in any realistic emissions reduction plan.

Despite clean energy's gains in recent years, the U.S. Energy Information Administration predicts that fossil fuels will continue to supply more than three-quarters of global energy demand through 2040.[3] Many developing countries are turning to minimally treated coal combustion as a primary energy source,[4] and even the G7 nations still rely heavily on coal and natural gas.[5] Fossil fuels, in short, will not go away any time soon.

There has been substantial effort in recent years to scale up carbon capture technology to make it more efficient and more financially competitive. Both parts of the process—the capture and the storage—are being researched around the world. Climbing this learning curve is a worthwhile effort, and it could indeed make carbon capture economically viable in coming decades. However, the energy required to capture CO_2, especially from natural gas, makes carbon capture inefficient in its current forms.

On the storage side, the Obama Administration has encouraged research into using deep saline aquifers. Critics of geological storage have questioned whether subsurface reservoirs can be expected to hold carbon without any leakage. However, this misses an important point: the factor that can throw a wrench into the ocean-atmosphere system is not the emission of greenhouse gases but the rate at which they enter the atmosphere. Atmospheric CO_2 is naturally drawn into the ocean and into biomass, but these natural carbon sinks cannot sequester carbon at the rates we are releasing it. In other words, churning out a gigaton of CO_2 in one year will disturb the system's equilibrium more than releasing the same amount over a hundred or a thousand years. Hence, even if geological storage isn't impervious to leakage, it can still help. The tricky part, yet again, is making it economically viable.

How can we use our captured carbon to defray the cost of capturing it? Two prominent coal-fired CCS projects, SaskPower's Boundary Dam power plant in Saskatchewan and Mississippi Power's Kemper County facility, will offset their costs by selling their captured CO_2 to nearby oil fields. The CO_2 then will be injected into the reservoirs of these fields to extract more oil—a technique referred to as Enhanced Oil Recovery (EOR). However, as attractive as EOR is for getting more oil out of mature oil plays, it is largely limited to oilfields with power plants situated close them. Also, the amount of CO_2 produced by commercial-scale power plants dwarfs the demand from EOR operations.

The upshot is that carbon capture is unlikely to become mainstream until it can be engineered cheaply or unless a cap-and-trade system or a carbon tax incentivizes emission reductions. The outlook for such measures in the U.S. is uncertain, but not as improbable as one might think. Carbon taxation actually might have a fighting chance for bipartisan political support if it leads to a drawdown of environmental regulations. In the current environment, energy companies must deal with a complex and ambiguous regulatory system. For instance, oil companies that use CO_2 for EOR are concerned that once their oil plays are depleted, the injection wells will undergo a retroactive EPA reclassification from Class II, intended for "fluids associated with oil and gas production," to the more stringent Class VI, which is intended for "geological sequestration of CO_2." In contrast to the uncertainties and inefficiencies of environmental regulations, an up-front and unambiguous carbon tax can be predicted and planned for; therefore, conservatives might support enacting such a tax in exchange for loosening environmental regulations.

To that end, a consortium of six oil companies including BP and Royal Dutch Shell sent a letter on June 1, 2015, to the UN Framework Convention on Climate Change. The signatories exhorted international governments to create an integrated carbon pricing system: "Whatever we do to implement carbon pricing ourselves will not be sufficient or commercially sustainable unless national governments introduce carbon pricing even-handedly and eventually enable global linkage between national systems." The signatories requested that governments "introduce carbon pricing systems where they do not yet exist at the national or regional levels [and] create an international framework that could eventually connect national systems."[7]

Environmental groups would be hard pressed to find a more improbable ally than the oil industry, but carbon taxation might offer the best chance for a compromise. The details of a carbon tax, such as exactly how many dollars per ton to charge, where to funnel the revenue, how to mitigate the tax's harsher effects on low-income Americans, and how to remain competitive with foreign markets, will obviously present serious challenges. Given the complexity of the systems involved—not only the global climate system but also the global economy and its framework of existing energy and taxation policies—it's impossible to say exactly what will happen, but broad-based climate change legislation may still be in the cards. Either way, geoscientists will need to stay at the forefront of innovation in responsible energy development.

1. Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., & van Vuuren, D. (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.
2. Dodson, S. (2015, February 13). World Coal Association calls for investment in CCS. *World Coal*. Retrieved from *http://www.worldcoal.com*.
3. U.S. Energy Information Administration, (2013, July). *International Energy Outlook 2013*. Retrieved from http://www.eia.gov/forecasts/ieo/pdf/0484(2013).pdf.
4. Steckel, J. C., Edenhofer, O., & Jakob, M. (2015). Drivers for the renaissance of coal. *Proceedings of the National Academy of Sciences,* 112(29), E3775-E3781.
5. Vidal, J. (2015, June 8). Five G7 nations increased their coal use over a five-year period, research shows. The Guardian. Retrieved from http://www.theguardian.com.
6. U.S. Environmental Protection Agency. (2012, August 2). *Underground Injection Control: Classes of Wells*. Retrieved from *http://water.epa.gov*.
7. United Nations Framework Convention on Climate Change. (2015, June 1). *Six Oil Majors Say: We Will Act Faster with Stronger Carbon Pricing*. Retrieved from *http://newsroom.unfccc.int*.

Rare Earth Elements: A Manufactured Crisis?

By Sam Jacobson

Rare earth elements (REEs), a group of 17 elements with special chemical and physical properties, have recently received lots of attention from the national media and Congress. By name, rare earth elements would seem to be an uncommon and precious commodity—a notion that is supported by the role they play in emerging technologies critical to the economy and national security. However, REEs are not rare.

REEs include a chemical group called the lanthanides plus scandium and ytterbium. Their unique electron configuration endows them with specific, hard-to-replicate physical, electrical, and magnetic properties. These properties are leveraged in various modern technologies ranging from jet engine turbine coatings (rhenium) to high capacity batteries (vanadium) to powerful magnets (neodymium).

In 2010, China, the world leader in REE production, set new export quotas reducing the amount of REEs exported by 72 percent, causing the worldwide price of REEs to skyrocket and sending shockwaves throughout the U.S. and around the world. Calls came throughout Congress for domestic REE assessments and stockpiling to prevent serious disruption to sectors of the U.S. economy and national security system. Senators Lisa Murkowski (R-AK) and Tom Udall (D-NM) introduced and supported legislation to increase domestic supplies of REE to fix what was portrayed as an imminent threat to the economy.

Despite their name, REEs are relatively common in the Earth's crust. According to Tao Liang, a geologist at the Institute of Geographical Sciences and Natural Resources in Beijing, "The total contents of REEs exceed 200 ppm in the average crust. Some REEs are even more common than copper or lead in the crust."[1] Rather, the "rare" in rare earth element refers to its scarcity in pure or concentrated deposits. By their nature, REEs are hard to separate from each other; they do not fractionate evenly into distinct minerals. This physical property provides a challenge in economical REE extraction.

So, was the REE shortage in 2010 a false crisis? If it was a crisis, how is the United States protecting itself? If it was not a crisis, what was the motivation for portraying it as one?

As we have uncovered, rare earth elements are not, in fact, rare. But, in 2010 production was primarily concentrated in one country—a phenomenon created by Chinese willingness to shoulder low labor costs and poor environmental standards while undercutting competitors' production costs, not due to a concentration of the elements only in China.

At the time of the shortage, no mines in the United States produced REEs; however, that was not always the case. From the 1950s to the 1990s, Molycorp Inc. operated the Mountain Pass mine in Nevada, extracting minerals with high concentrations of cerium and lanthanum. During that time, Mountain Pass led the world in REE production. But, in the 1990s the market was flooded with an abundance of cheap Chinese rare earths, making economic production difficult. Over the past decade, market volatility such as this has allowed Molycorp to only sporadically produce domestic supplies of REEs; when REE prices rebounded in 2010 Molycorp reopened their Mountain Pass Mine, but they had to close again in 2013 and remain closed to this day. The shuttering of Molycorp and its mine, however, does not mean that the United States is as vulnerable to embargos and REE shortages as lawmakers expect. Under the right market conditions, the mine can start production again, and countries around the world are beginning to produce their own stockpiles of REEs, breaking the monopoly China once enjoyed.

Over the past few years, Senator Lisa Murkowski (R-AK) has introduced legislation to help secure America's supply of critical minerals, including rare earth elements. Most recently, her Energy Policy Modernization Act of 2015 would task the U.S. Geological Survey (USGS) with devising a system to define criticality and track supply and availability of different critical minerals. The bill would also task the Department of Energy (DOE) with researching alternatives to and recycling methods for REEs.

The USGS has a history of exploring the potential for REE mining in the United States and around the world. In their 2002 report, "Rare Earth Element Mines, Deposits, and Occurrences"[2] USGS identified 800 localities around the world with significant REE deposits; some were active mines, others represented undeveloped deposits. Of the 800 localities, 100 were located in the United States in states including Alaska, Arizona, Idaho, and North Carolina. In contrast, only 85 localities were located in China. Similarly, the Department of Energy has conducted research aimed at reducing American dependence on foreign REEs. Their Advanced Research Projects –Energy (ARPA–E)'s Rare Earth Alternatives in Critical Technologies (REACT) program engineers the use of different materials in applications from batteries to motors to magnets. Furthermore, the Ames National Laboratory in Ames, Iowa, also researches alternatives to rare earth elements.

As the supply of REEs continues to diversify and research into alternatives and recycling continues to grow, the risk for high stakes supply disruptions will continue to diminish. With their unique physical properties, REEs will be essential to continued technological advancement. This crisis should show decision makers that although concern over the REE supply chain is warranted, events like this do not spell disaster for the American economy.

1. Liang, Tao, Kexin Li, and Lingqing Wang. "State of Rare Earth Elements in Different Environmental Components in Mining Areas of China." *Environmental Monitoring and Assessment: an International Journal Devoted to Progress in the Use of Monitoring Data in Assessing Environmental Risks to Man and the Environment.* 186.3 (2014): 1499-1513. Print.
2. Orris, Greta J., and Grauch, Richard I., 2002, Rare earth element mines, deposits, and occurrences: U.S. Geological Survey, Open-File Report 02-189 *[http://pubs.usgs.gov/of/2002/of02-189/]*.

AIPG 2015 Honors and Awards Program

The American Institute of Professional Geologists (AIPG) has a history of effective and outstanding service to the profession of geology. From its beginning in 1963, the Institute has emphasized the role that professional geologists play in this fascinating, changing, and highly complex world in which we live.

In an Institute such as this, there are so many highly motivated geologists contributing to the profession, the Institute, the public, and the nations in which we live and work that the identification of a select few for particular awards is a monumental task. The continued success of the Honors and Awards Program is dependent on an accessible nominating process and a diligent screening of those nominated. This is done by the Honors and Awards Committee.

Currently, there are six honors bestowed by the Institute: Ben H. Parker Memorial Medal, Martin Van Couvering Memorial Award, John T. Galey, Sr. Memorial Public Service Award, Award of Honorary Membership, Outstanding Achievement Award, and Presidential Certificate of Merit.

AIPG MISSION STATEMENT

The Mission of the American Institute of Professional Geologists (AIPG) is to be an effective advocate for the profession of geology and to serve its members through activities and programs that support continuing professional development and promote high standard of ethical conduct.

AIPG Honors and Awards Committee

J. Todd McFarland, Chairman
Brent E. Huntsman
John L. Bognar
Richard M. Powers
Daniel J. St. Germain

David M. Abbott, Jr., CPG-4570
2015 Recipient of the AIPG
Ben H. Parker Memorial Award

My professional career has had three major themes, (1) mineral resource and reserve classification systems and their application to individual deposits, (2) professional ethics, and (3) disclosure about mining and oil & gas companies. These themes reflect my career that started with 21 years as a geologist with the U.S. Securities and Exchange Commission and has continued with a consulting practice that began in 1996. AIPG has been a major part of my career and facilitated the professional ethics and disclosure themes through articles in the *TPG* and talks at Section and National meetings over the years. This year I will complete 20 years of *Professional Ethics & Practices* columns, currently on #156 and counting. I am the Chairman of Ethics Committee, a position I held from 1994 to 2001 and since 2004. I also have been a member of the Australasian Institute of Mining and Metallurgy's Ethics Committee since 2007. I've been AIPG's representative to the AGI committees that prepared AGI's *Guidelines for Professional Ethical Conduct* for both the 1999 and 2015 editions. I've given short courses on professional ethics to a number of organizations over the years.

My work at the SEC introduced me to the application of mineral resource and reserve classification systems and their applications to individual deposits. I've been a member of SME's Resources and Reserves Committee since 1995 and actively participated in the preparation of the various editions of the *SME Guideline for Reporting Exploration Information, Mineral Resources, and Mineral Reserves,* most recently in 2014. My professional practice has focused on the use of the SEC, JORC Code, and Canadian NI 43-101 classification systems both assisting companies with compliance and assisting in the investigation and prosecution, when warranted, of mining and oil and gas frauds; work I still do. I assisted the Hong Kong Stock Exchange in the development of their mining disclosure rules.

Geologically, I'm a generalist working on gold, silver, PGM, base metal, and a wide variety of industrial minerals deposits. The industrial minerals work helped highlight the precious metals bias in the resource and reserve classification systems, something that has been addressed in the most recent versions of the classification systems and related disclosure guidelines. I've twice co-taught the Geology of Industrial Minerals Deposits at the Colorado School of Mines.

I've served AIPG at both the Section and National levels in a variety of positions over the years. This has provided me with the opportunity to work with many outstanding geologists in a variety of ways over the years. This work has contributed to my professional development and provided a wide variety of experiences that only come through working with the great group of geologists that are AIPG and for which I'm truly greatful.

Response

Receiving the Ben H. Parker Memorial Award, AIPG's most distinguished and oldest award is great and humbling honor. I am the 45th recipient of this award, which is awarded to individuals who have long records of distinguished and outstanding service to the profession. I've met 24 of the previous recipients of this award and have known and worked with many of them over the years. Several have been important mentors for me.

AIPG has been an important part of my professional life. Even before I had enough years of experience to qualify for Certification—at that time, CPG was the only membership class—I'd been encouraged to attend Colorado Section meetings and then-Executive Director Art Brunton put me on the mailing list.

I'm best known for exploring professional ethics. During his presidency in 1983, Larry Woodfork graciously accepted my call expressing interest in the Ethics Committee and appointed me a member. In 1989 President Richard Proctor asked me to chair a committee to prepare an explanation of the Code of Ethics as a result of a presentation, "Personal Liability, Professionalism, and Ethics in Geological Practice," that I made at the 1988 Annual Meeting in Tulsa. In taking on the task, I realized that a thorough job involved far more than the envisioned pamphlet. I did publish a 3-part article on some aspects of the revised AIPG Code of Ethics in the *TPG* in late 1990 and early 1991. But the real exploration of the subject began at Bill Knight's urging in 1995 when I commenced compiling the "Professional Ethics & Practices" column to begin the exploration of professional geologic ethics. After 20 years and with the important contributions made by a great many, the exploration continues. Compiling the column has been and continues to be a pleasure because of the contributions from others. My wife, Sue, has edited most of the columns for which she deserves many thanks from all of us. Every contribution shines a different and needed light on the issue addressed. Please continue your contributions. I've also made professional ethics contributions to other organizations including the American Geoscience Institute, AAPG's Division of Professional Affairs, the Australasian Institute of Mining and Metallurgy, the International Professional Geologists Conference, the European Federation of Geologists, the Society of Economic Geologists, and the Society for Mining, Metallurgy, and Exploration.

I've also been involved in a variety of activities with other professional organizations. Mineral resource and mineral reserve classification systems and their application to real deposits have been at the heart of much of my professional career. Most of my work at the U.S. Securities and Exchange Commission revolved around determing whether claims that reserves existed or not. This has also been the focus of my consulting practice. I served on SME's Reserves and Resources Committee since its inception in the late 1980s that worked the initial and revised versions of the SME's *Guide for Reporting Exploration Information, Mineral Resources, and Mineral Reserves*, that is the US version of the internationally accepted mining industry classification system. When the effort began, no one was sure that international agreement could be achieved but it was.

You get out of something what you put into it; an old but true observation. I've had a great career so far and AIPG has been an important part of my career. I've met and worked with many wonderful people in many places. And I look forward to a good number of years of similar efforts in the future. Thank you, AIPG for supporting my efforts and, by awarding me the Ben H. Parker Memorial Award, letting me know that I've made a difference.

James J. Jacobs, CPG-7760
2015 Recipient of the AIPG Martin Van Couvering Memorial Award

James Jacobs has been an AIPG member for 25 years. He has 34 years of experience as a geologist focused on answering geologic, environmental impairment and forensic questions. He has a bachelor's degree in English and geology from Franklin and Marshall College. While in college, he worked at the U.S. Bureau of Mines Coal Research Station where he met John Popp and Charlie McCulloch and many others who graciously provided mentoring and encouragement. He has a master's degree in geology from the University of Texas at Austin where he studied under Victor Baker. After several years in the oil industry with SOHIO Petroleum working on the North Slope of Alaska and Petrofina working California leases and farm-ins, he joined an environmental consulting company in northern California. Twenty-five years ago he started Clearwater Group with his wife Olivia Jacobs to perform assessment and remediation of soil and groundwater. He co-authored four technical books, on subjects varying from MTBE, hexavalent chromium, acid mine drainage and oil spills and gas leaks. He has taught workshops and seminars, co-authored over 100 technical articles, and have given over 75 technical presentations. His current research focus has been on the potential for vapor migration of methane and other volatile compounds into sewer systems and possible exposure pathways in homes and offices. He is licensed as a geologist in a dozen states and certified as a hydrogeologist in California and Washington.

He is a Fulbright Scholar, winning four awards to teach geology and environmental science in post-graduate workshops in Jamaica, Israel and India. He served on the Fulbright Peer Review Committee for the Environmental Science/Geology candidates from 2007-2011. For 13 years, he has served Tamalpais Valley as a publicly elected director and past president of a local sewer agency as well as the community services district.

For AIPG, since 1994, he has been the treasurer, vice president and president of the California Section. He was on the national screening committee from 2005 to 2010 and has been on the AIPG National Advisory Board in 2000, and vice president in 2012. He strongly believes in student mentoring, and since 2010, has been the AIPG Sponsor for the University of California at Davis AIPG Student Section. Through AIPG, he has been the president of the California Council of Geoscience Organizations. He enjoys writing articles and book reviews for *TPG*. His wife of 32 years, Olivia, and their two boys, Ross and Elliott are the focus of his family life in Mill Valley, California. For fun, he plays guitar with his son, and he has been a cruise speaker on geologic topics in Hawaii, Alaska, the Mediterranean, eastern Pacific and the Caribbean.

Response

Thank you for the honor and special recognition of the Martin Van Couvering Memorial Award. I look over the list of the previous recipients of this award with great admiration for their accomplishments, and am proud to be joined to this group.

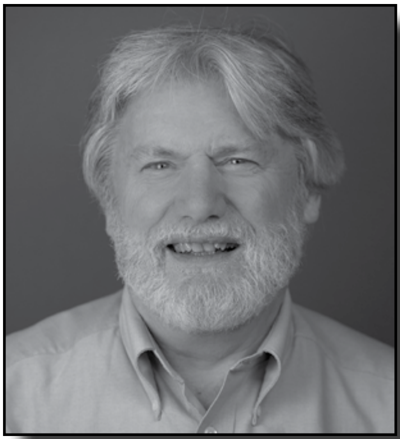
I see AIPG as unique - an organization for geologists of many disciplines which nurtures professionalism, ethics and honesty in interactions and contracting, mentoring of others, and dedication to informing the general public and legislators about important geologic issues. I have dedicated much of my time to the California Section and to the AIPG national organization and it is through AIPG that I have met many life-long friends, professional collaborators and colleagues and have made work contacts.

I was accepted into AIPG in 1990 as Certified Professional Geologist No. 7760. I have always enjoyed writing, and in the early 1990s, while reading a book which was edited by Stephen M. Testa, I contacted him to discuss some of the book's articles. Stephen, a long-time AIPG member, leads by example; shortly thereafter, in 1994, he asked me to be the AIPG California Section treasurer. I served in that position for two years. Over the past 22 years, Stephen and I have written numerous articles and several books together. In October 1996, I attended my first AIPG National Meeting in Columbus, Ohio. At this meeting I was exposed to a high-level of professionalism as well as the broad diversity of the members.

From 1996 to the present, I have been either the vice president or president for the California Section, trading leadership positions with my friend, David Sadoff. In 2000, I served on the National Advisory Board, and from 2005 to 2010, on the National Screening Committee, during which time I met with more outstanding and generous AIPG members. In 2010, I founded the University of California Davis Student Section of AIPG with Professor Robert Zierenberg, Student Advisor. Over the past 5 years, we have kept up a monthly meeting schedule from October to May of each year including one or two field trips in each academic year. All of these activities have given me the opportunity to benefit from working with terrific AIPG colleagues.

In 2012, I served as AIPG Vice President, working with then-AIPG President Ron Wallace and many other capable AIPG leaders and staff. During this time, as we sought to attract members and were evaluating the AIPG program, I had an opportunity to evaluate dozens of other professional societies. We discovered that those organizations which were the most successful adhered to the "attract-retain-engage" philosophy of encouraging students, providing mentoring and opportunities to young professionals, awarding active members generously and recognizing talent and effort, and providing incentive for all members to be professionally active. We seek to mentor, provide opportunities, awards, and recognition. AIPG demonstrates leadership in the promotion of the profession of geology.

Thank you to all at AIPG and a special thank you to my wife, Olivia and two sons, Ross and Elliott for moral support. It has been a pleasure to be a part of the AIPG success story. I am fully aware of the new and higher level of expectations of those so honored. Thank you so much for the honor of the Martin Van Couvering Memorial Award.



Dennis Pennington, CPG-4401
2015 Recipient of the AIPG
Honorary Membership

Dennis Pennington has been fascinated with geology since his public school days. Always investigating, he sought and continues to search for new information and learning experiences. Dennis believes in service to the geological sciences as well as mentoring newcomers to the geological profession. A strong proponent of volunteerism, he has always tried to advance the profession.

He received his B.A. degree from the State University of New York at Potsdam where he met his future bride. He also holds an M.S. degree in geochemistry from Penn State University.

Throughout his career he has been fortunate to be involved with state-of –the –Art technologies and several major environmental issues. From major Superfund sites to soil washing, bioremediation and cold water environments as well as developing artificial recharge processes, he sought challenging projects.

Dennis has been involved with AIPG since his early days as a member. He began volunteering with visiting Washington D.C. got involved with his Section, including time as president, editor, and the conducting of professional seminars, which he continues through today. For example he developed a regional conference for nearby AIPG Sections on geothermal technology in April, 2014. He served on several national executive committees including officer positions leading to being President in 2000.

Dennis has always been known for his mentoring of students (i.e. geology club sponsor at Temple University), including his establishment of AIPG national undergraduate scholarships in 2000 when he was president of AIPG. He is known for his sense of humor, respectful treatment of associates and sensitivity and support he has shown others. Dennis is particularly thankful for the support of his spouse, Mary Lou over the past 40 years.

Response

Thank you very much to the American Institute of Professional Geologists for selecting me for the Award of Honorary Membership. It has been a pleasure to work with the staff of AIPG and the many members of Executive Committees especially as AIPG President in 2000. I have always felt supported and been met with an enthusiastic, can-do attitude by AIPG Staff. The Institute is like a family to me and I continually look forward to seeing everyone at meetings where I can renew friendships.

I first joined AIPG because I felt senior professionals need to communicate the value of geological sciences to society and also to mentor rising professionals. Students are very important to me and I always enjoy working with them and helping them adjust to market changes. I feel it is my duty to support students and help them network to succeed in this changing world. For this reason, I sponsor an AIPG student chapter at Temple University in Philadelphia, PA.

In an era when geology is under pressure we need to let the public be aware about the importance of geology to many environmental problems including the protection of water supplies, understanding of geological hazards, and the need for raw materials. Membership in AIPG is a necessary path for geologists to understand the value of their own profession and to influence public policy. Thank you again for this honor.

Karl E. Karlstrom and Laura J. Crossey 2015 Recipients of the AIPG Outstanding Achievement Award

Dr. Karl E. Karlstrom is a Professor of Geology in the Department of Earth and Planetary Sciences at the University of New Mexico. His research specialties are structural geology and tectonics, especially: formation and stabilization of continents, the supercontinent cycle, mantle-to-surface tectonic interconnections, dynamic topography, and neotectonics. He has been at UNM since 1991.

Dr. Karlstrom grew up in Flagstaff, Arizona and received his B.S. in Geology from Northern Arizona University in 1973. He received his PhD in Geology in 1981 from the University of Wyoming. He conducted post-doctoral work at the University of New Brunswick, Canada (1981 -1982). He held professor positions at North Carolina State University (1983-1984) and Northern Arizona University (1984-1991) before moving to UNM in 1992.

Dr. Karlstrom has generated 5.15 million in external funding, including three active National Science Foundation awards. His CV lists 170 published journal articles and numerous geologic maps, technical reports, guidebook articles, and abstracts (many coauthored with students). He is an expert on the Proterozoic assembly of North America within the supercontinents of Nuna and Rodinia. He is a foremost expert on geologic evolution of Grand Canyon, and has made major contributions to evaluating mantle influences on the tectonics and geomorphic systems in the Colorado Plateau-Rocky Mountain region. He has worked on tectonic influences on water quality in groundwater systems in Australia, Egypt, and the American Southwest. Google Scholar lists 6748 citations of over 425 of his publications since 1979 and an H-index of 43 (43 publications have been cited at least 43 times).

Dr. Karlstrom has mentored 56 graduate students to completion: 5 post-docs, 9 PhD, and 42 MS students, plus numerous undergraduate theses. He currently has 3 PhD, 2 MS, and 2 BS active students. Most of his students have authored peer reviewed publications and many of the students have gone into the professoriate and other influential geosciences positions. His teaching includes all academic levels and includes experiential field-based approaches in Freshman Learning Communities Introductory Geology, New Mexico Field Geology, the core EPS Structural Geology course, and the E&PS Advanced Summer Field Course.

Dr. Karlstrom was originator and PI (with Laura Crossey) for the 15-year-long development of the Trail of Time Geoscience Education Exhibition at Grand Canyon. This exhibition opened in 2010 and provides successful informal geoscience education for ~5 million annual Park visitors. It received the 2011 First Place award from National Association for Interpretation in the Media Awards Competition. He has appeared in dozens of TV documentaries and media appearances to promote the geosciences.

Dr. Karlstrom's professional service includes local, national, and international service. His has served as member of the Canadian Pan-Lithoprobe subcommittee, Australian Research Council (ARC) "expert of international standing", founding member of the NSF Earthscope Science and Education Committee, Science Editor for GSA Today (2000- 2003), and the Geological Society of America Bulletin (2005-2008). He received the 2009 Distinguished Service Award from Geological Society of America and was elected Geological Society of America Fellow in 2010.

Dr. Laura J. Crossey is a professor and Chair of Earth & Planetary Sciences at the University of New Mexico. Her research interests include low-temperature geochemistry; including sedimentary diagenesis, hydrochemistry and geomicrobiology. She has been at UNM since 1985. Dr. Crossey grew up in Deerfield, Illinois and received her Bachelor's degree in Geology from The Colorado College in 1977. She received her Master's degree from Washington University in 1979, and her PhD from University of Wyoming in 1985.

Dr. Crossey has authored numerous journal articles, technical reports, guidebook articles, and abstracts (many coauthored with students). Google Scholar lists 3432 citations since 1979 and an H-index of 31 (31 publications have been cited at least 31 times).

Dr. Crossey has mentored 56 graduate students to completion: 4 post-docs, 13 PhD, and 18 MS students, plus over 30 undergraduate theses. Her teaching includes all academic levels and includes experiential field-based approaches in Freshman Learning Communities Introductory Geology, Aqueous Geochemistry, Geomicrobiology, the capstone course for Environmental Science majors, and the E&PS Advanced Summer Field Course.

Dr. Crossey was originator and PI (with Karl Karlstrom) for the 15-year-long development of the Trail of Time Geoscience Education Exhibition at Grand Canyon. This exhibition opened in 2010 and provides successful informal geoscience education for ~5 million annual Park visitors. It received the 2011 First Place award from National Association for Interpretation. She is the Director of the Alliance for Minority Participation at UNM and has served on the NM Governor's Committee to set State Science Standards for K-12.

Dr. Crossey's professional service includes local, national, and international service. She served as Chair of the Sedimentary Geology Division 2004-2005. She was President of the New Mexico Academy of Sciences (2012). She has served as Special Publications Editor for SEPM (2001- 2007), and Associate Editor for GSA Bulletin (2008-2012), Geology Magazine (1993-95; 1996-98) and Geochimica et Cosmochimica Acta (2006-2008). She was appointed Regent's Lecturer at UNM (1997-1999), was Distinguished Lecturer for the American Association of Petroleum Geologists (1995-1996), and was elected Geological Society of America Fellow in 2008.

Combined Response

We are deeply honored to accept the 2015 Outstanding Achievement Award from the American Institute of Professional Geologists. We were also (admittedly) very pleasantly surprised to receive this honor. We attended last year's meeting in Prescott Arizona and helped lead a fieldtrip to the Trail of Time at Grand Canyon with a group of great geologists (who here was on that trip?). It is a long ways from the depths of Grand Canyon to the heights of Denali, but the mantra of "geologists without borders" resonates with us, and love of geology unites disparate places and different people as evidenced by the group here today.

As long-term academic researchers and teachers, we feel very connected to the training of students toward lifetime careers in the Geosciences. Looking back at the ~ 100 students we have worked with on BS, MS, and PhD theses, and the thousands of students in our classes over the years, we are both convinced that Geology is a field that enriches individuals in terms of personal development and also leads to diverse and satisfying professions. Laurie has been especially active in training and mentoring under-represented groups in the Earth Sciences, especially Women, Hispanic, and Native American students. In all our teaching, our message is that the understandings of Geologic Time and Earth processes are assuming increasing importance as human populations exceed 7 billion on our small planet. Cognition of geologic time provides the vital and difficult-to-comprehend connection between human time scales, societal needs, and the million-year heartbeat of the Earth.

Geologists are known as some of the first scientists to apply new technologies. It was soon after the discovery of radioactivity by the Curies' that geologists used this new technology to learn that the Earth was 3-4 billion years old. Geologists KNEW which rocks to date and were waiting for the way to do it. Karl's father, Thor Karlstrom worked for the USGS in Alaska from 1949-1960; he was first author on the colorful "Surficial Deposits of Alaska" that was published in 1964. He KNEW there was a rich story to be unraveled in the glacial units of the Cook Inlet area of the Kenai Peninsula, as well as throughout Alaska, and he started applying the new and then controversial radiocarbon dating method to Quaternary geology of Alaska. His results starting showing cyclic climate alternations that led him to Milankovitch theory and to a long career in paleoclimate research.

Our department at the University of New Mexico is lucky to have world class analytical laboratories that we can apply to research and educate students with. But we feel equally lucky that our field laboratories include the Grand Canyon, the Colorado Plateau, and the Rocky Mountains. The field laboratory is still ultimately where geology begins because it is here that one discovers the key rocks to date, the key problems to solve, and it is in the field where students often begin see the importance and challenge of understanding Earth's history.

Improved geoscience public education is essential as human societies flourish on our planet of limited resources. The Trail of Time Geoscience Exhibition at Grand Canyon was designed and installed by us because we wanted to reach the world's public with the results of our going research and the exciting stories encoded in Grand Canyon rocks. We worked on this from 1995 to 2010, with support from the National Science Foundation and Grand Canyon National Park. The exhibit won the 2011 Award from the National Association of Interpretation, The Trail of Time encourages many of the Park's 5 million annual visitors to ponder, explore, and understand the magnitude of geologic time and the stories encoded by Grand Canyon rocks, landscapes, and waters.

As a final note, we take this award as an endorsement of accomplishments that we feel have resulted from careers that have been a blend of research, of teaching and mentoring, of outreach, of our love for science, and of fun. Each of these facets of being a professional geologist enriches the others.

Thank you for this recognition.

AIPG Section Leadership Award

The purpose of the AIPG Section Leadership Award is to recognize one or more of our members who have demonstrated a long-term commitment and have been long-term contributors to AIPG at the section level. AIPG has many sections where one or more individuals have demonstrated exceptional leadership for their section and in many instances kept the section together and moving forward. These individuals are commonly not known at the National level or by AIPG members outside of their sections, however, their contributions have been vital to their sections and they perform this work because of their commitment to our profession and AIPG.

Recipients of the 2015 AIPG Section Leadership Award

Paul A. Lindberg, CPG-6344
Arizona Section

Paul Lindberg moved to Sedona, Arizona in 1978, received his CPG from AIPG in 1983, and from our records, has been a volunteer with the Arizona Section for several decades. As a consulting geologist primarily in the mineral resources and structural geology fields, Paul often traveled to some remote areas, mainly in the US, Canada, Peru, and Chile working for the Anaconda Company and then as an independent consulting geologist. Paul's work was focused on structural geology of tectonically deformed Precambrian ore deposits. Paul always had such interesting stories of his geologic mapping in these remote areas. He also spent a lot of time mapping the geology of central and northern Arizona, gaining a better understanding of the complex geology in those areas. He had several reports/papers and maps of the area published through the Arizona Geological Survey.

Over many years, Paul volunteered to lead numerous field trips for the Arizona Section and at the two national annual AIPG meetings hosted by the Arizona

Section. Paul helped develop a series of field trips for the annual meetings in Flagstaff in 2008, and in Prescott in 2014. He prepared the detailed field trip guides and helped with organizational plans for the field trips. Paul has also given geology presentations at several dinner meetings and other functions, often using his "block model" of the Colorado Plateau and Transition Zone to illustrate the geologic history of the Grand Canyon and other sites. His field trips have included the Jerome mining district – Mingus Mountain, the Verde Valley and Sedona area hydrogeology including the Devils Kitchen and Devils Dining Room sinkholes, the "sinks" in the Snowflake-Holbrook-Winslow area and potash deposits, the Grand Canyon and Orphan Mine, the San Francisco volcanic field, Munds Park-Flagstaff-Oak Creek Canyon hydrogeology and geology, Verde Valley-Montezuma Well geology and archeology, Red Rocks-Oak Creek Canyon landscape and geology, and several others. He shows his passion for investigation and understanding the geologic processes of an area. His field trips and talks are of interest to geologists and non-geologists. Paul's wife, Phyllis, often accompanied him on the field trips and Phyllis shared her knowledge of the area especially the plants and archeological history. Paul also serves as an ambassador for the geologic profession, as he gives frequent presentations and leads field trips for other professional groups and interested organizations, promoting the importance of geology, an understanding of geologic processes, and what geologists do.

The Arizona Section is appreciative of Paul's dedication to the profession and in his sharing of his knowledge and enthusiasm for so many years.

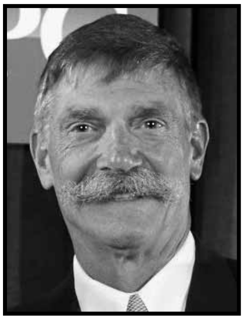
Nominated by: Doug Bartlett, CPG-8433; Barbara H. Murphy, CPG-6203; and Julie Hamilton CPG-9428

Stephen J. Baker, MEM-2353
California Section

Stephen J. Baker, MEM-2353, exemplifies the make-it-happen attitude of the professional geologist trying to give back to California geology students and the professional community. Steve has participated in more than half a dozen Annual Sacramento Drive-In legislative days with AIPG and other groups. He started attending the AIPG California Section meetings on a random basis several years ago. By 2013 he agreed to be an official AIPG Student Mentor, and has consistently been in attendance at the California AIPG - UC Davis Student Section meetings. In the past few years, there have been 8 monthly meetings and one or two field trips every year, and as an official AIPG Student Mentor, Steve has participated in almost all the meetings and a recent field trip. He gave two presentations at the AIPG California Section meetings, including a well-received workshop about job hunting skills and career development in March 2015 featuring resume writing, interviewing and networking skills. In helping the profession in California, Steve Baker participated as an AIPG Student Mentor at the 2015 International Goldschmidt Conference in Sacramento where he spoke about career development to about 95 enthusiastic geology students. In 2014, Steve developed the "Meet Your Mentor" internet radio program to connect real mentors in the water industry with listeners who have interest in training and education in vocational and academic schools, finding a job, continuing education, ethics education and dealing with setbacks experienced in the industry. He has interviewed seasoned professionals and has piloted the project in California. Based on the initial success of the program, with appropriate funding, Steve plans to take the Meet Your Mentor Program nationally.

Professionally, Steve not only started his own groundwater consulting company and ran it for over 29 years, but more recently, he has produced a short segment radio series that guides the listener in feeling and intellectually understanding the importance of water in their lives. "Water is a Many Splendid Thing" series is a short-segment (3 to 8 minute) radio broadcasts that explore water's relationship in the world. Two hundred forty seven segments have been produced to date. They are designed as public outreach pieces and to be easily understood. The radio show is popular and locally, Steve is known as "the Water Guy." As a founding member of Operation Unite®, he has given workshops for communities, neighborhoods and private individuals interested in developing groundwater sustainability strategies and management programs. He also facilitates round table discussions of real situations in communities and public meetings. Some of these meetings are live or recorded radio broadcasts. Stephen J. Baker has given a lot of his time and energy to the California Section and mentoring activities. For his actions in mentoring students, professional geologists and the public in California through his AIPG California Section activities, I nominate him for a Section Leadership Award.

Nominated by: James A. Jacobs, CPG-7760



Logan T. MacMillan, CPG-4560
Colorado Section

Logan MacMillan has held the following positions over the years on the Colorado Section Executive Committee:

- Past-President: 2005, 1995
- President: 2004, 1994
- President-Elect: 2003, 1993
- Vice-President: 2015
- Advisory Board: 2014
- Leg.-Reg. Committee Chair: 2015, 2007, 1991-1993

Note that our historical section records on the Advisory Board and Leg.-Reg. Chair are not complete, so it is likely that he served in one of those positions beyond what I list above.

Serving as the Leg.-Reg. Committee Chair is a critical part of the Colorado Section management structure because this is the person who works very closely with the Section Lobbyist and often interacts directly with some of the state legislators, including testimony before committee hearings. Logan has always been willing to pitch in when need whether that is in an elected position or simply providing support for section activities.

Logan also is working to restart the Section monthly luncheons. A somewhat thankless task given the heavy competition for technical luncheons in the Denver Metro area. However, it illustrates how he is willing to try and do beneficial things for the section that take time and energy many members are unwilling to dedicate.

I feel his long service and can-do attitude make him worthy of the Section Leadership Award.

Nominated by: Douglas C. Peters, CPG-8274

Eric F. Lowe, MEM-385
Georgia Section

Eric has been very active in the Georgia Section. He has been an officer since 2005 and was section president in 2010. During this time he was the sponsor for our student chapter at University of West Georgia. He has helped organize our section field trips and has attended a few of our career nights at different universities. Eric is extremely good with our student members and enjoys working with them. When we have conducted drilling demonstrations for the students Eric loves to explain the different activities going on and to demonstrate soil and groundwater sampling techniques. A few years ago we did a field day demonstration with eleven stations that the students would rotate throughout the day on different environmental activities. Eric was the main coordinator for this major activity with over 100 students attending. Eric helped organize a group of students from three universities to visit his office and talk to them about a career in environmental consulting. The section's major fund raising activity is our remediation conference that has been held since 2008 with our sixth conference this coming September. Eric has been one of the organizers in each of these conferences and helped make them a success. Eric's activities for the Georgia Section is deserving of the AIPG Section Leadership Award.

Nominated by: Ronald J. Wallace, CPG-8153

David G. Pyles, CPG-7364
Illinois/Indiana Section

It is my pleasure to nominate Dave Pyles (CPG-07364) for the AIPG Section Leadership Award. The spirit of this Award is to recognize one our members who have demonstrated a long-term commitment and have been long-term contributors to AIPG at the section level. AIPG has many sections where one or more individuals have demonstrated exceptional leadership for their section and in many instances kept the section together and moving forward. Dave embodies the spirit of this Award.

Dave has been a Certified Professional Geologist with AIPG since 1987. During the past 3 decades he has participated in section activities, served as Section President for six years, and conducted grass-roots campaigns to revitalize the Illinois/Indiana Section of AIPG. His consistent approach of developing and hosting professional section meetings, networking events, and field trips have become "expected" offerings by our membership. In 2011, Dave took on the challenge of bringing the National Meeting to the Midwest. Hosted in suburban Chicago, Dave was the General Chairperson for the 2011 National Meeting. Dave is currently serving the Illinois/Indiana Section of AIPG as "Past-President" and maintains an active role with Illinois/Indiana Section Advisory Board.

I believe that Dave will fit in very well with the highly regarded past recipients of the Section Leadership Award based on his professional reputation, integrity, and history with AIPG. I encourage you to accept this nomination and grant Dave the honor of receiving this Award.

Nominated by: Jeffrey M. Groncki, CPG-11118

Sara V. Pearson, CPG-10650
Michigan Section

On behalf of the Michigan Section, we would like to nominate Sara Pearson, CPG-10650, for the AIPG Section Leadership Award. Sara has been a member of the Michigan Section since 2002, regularly participates in Michigan Section activities, and has led by example.

Sara has served the Michigan Section as Secretary, Treasurer, Vice President, President, and Past President from 2006 through 2010. Besides the Executive Committee positions, Sara has volunteered for numerous committees, helped organize field trips in 2010 and 2011, arranges technical presentations for Section meetings, keeps members aware of new and changing regulatory issues, and has served for several years as assistant newsletter editor. She has also served as an organizer and co-chair of each of the five well attended, multi-day summer workshops. The Workshops have been highly successful, in part because they have been found to be helpful to environmental professionals working on geological and environmental issues in our society.

Sara is the Michigan Department of Environmental Quality's (MDEQ's) Technical and Program Support Team Coordinator, and has been working with the MDEQ since 2004. She is respected by regulators and the regulated community alike, and is a leader amongst her peers and the regulated community. Sara brings the valuable perspective of a MDEQ insider to the Section's membership. This perspective helps bridge the gap between the MDEQ and environmental professionals.

Sara gives selflessly of her time and energy to help make the Michigan Section the active and successful organization it is today. We therefore believe that Sara embodies the spirit intended to be acknowledged by this award, and is well deserving of this recognition.

Nominated by: Adam W. Heft, CPG-10265 and Timothy B. Woodburne, CPG-10532

Jane M. Willard, CPG-6979
Minnesota Section

I am nominating Jane Willard for the AIPG Section Leadership Award because of her outstanding service to the MN Section of AIPG, service to AIPG as a whole, and her commitment to the profession of geology.

Jane started attending AIPG meetings in the Twin Cities in 1981. At the time, there was no non-CPG membership and the section was actually formally known as the MN-WI Section of AIPG. Jane became a CPG in 1984 with the sponsorship of some key section members. Jane has held a number of positions in the Section including but not limited to: President (twice), Director, Sponsorship Chair, and most currently, editor of our first Section newsletters. For our golf tournament fund raisers, she has organized some of the silent auctions. She helped organize the licensing committee in the early 1990s and was instrumental in helping make an established path for professional licensure of geologists in the state of MN. Jane also co-organized at least two half-day seminars on environmental issues including petroleum and assessment back in the 1990s.

At the national level of AIPG, Jane was on the education committee in the mid 1980s and valuated geology programs in Minnesota. She was a director on the National Advisory Board in 2005, and she co-chaired and then chaired the 2006 convention committee from about 2003 to 2006. Jane was also on the Foundation board for a year around 2005.

I have personally enjoyed working with Jane to help organize many monthly luncheons, golf tournaments, socials, and trainings. Her love of geology and pride for the profession is contagious. She has been very good mentor to me as I've taken on leadership roles in the Section. Jane is a joy to be around and she brings a wonderful world view on many matters (e.g. she also served in the Peace Corp in the 1970s and has helped found schools for girls in Afghanistan). She has very useful and in-depth knowledge of Robert's Rules of Order too.

Jane has been so important to the MN Section of AIPG and has remained steadily involved through many changes of leadership, always maintaining at least one smaller role, and often larger ones. If it weren't for Jane, the Section might not be as strong as it is today and geology might not be a licensed profession in the state of MN. Thank you for the opportunity to nominate Jane Willard for the AIPG Section Leadership Award and recognize her for her many and ongoing contributions to our Section.

Nominated by: Jake T. Dalbec, MEM-1599

Curtis J. Coe, CPG-6240
Ohio Section

I have prepared this letter of support to nominate Curtis (Curt) Coe, CPG-06240, for the AIPG Section Leadership Award. Curt is currently serving the Ohio Section of AIPG in a dual capacity, both as past-President and President-Elect for 2016. I have served on the Executive Committee of the Ohio Section for the past 6.5 years, first as a Member-at-Large, and currently as the Section Treasurer. Over the past several years I have had the pleasure to work directly with Curt on the Executive Committee of the Ohio Section. Through our interactions, I have witnessed Curt's unwavering and selfless dedication to AIPG and the geologic profession first hand.

To give a bit of history of Curt, he began his career in geology after graduating from Ohio State University with a Bachelor of Applied Science degree in Geology/Earth Science in 1975, and furthered his academic aspirations with a Master of Science degree in Economic Geology and Mineralogy from Florida State University in 1978. Since graduating, Curt has had a long and diverse career that has included positions as a geologist in private industry, government, and numerous consulting firms throughout the United States and Canada. His career has represented the broad spectrum of the geosciences with his focus ranging from research on ground water supply, coal geology, and underground storage tank management, to detailed site assessment, remediation, and contaminant transport modelling. In addition to being a CPG, Curt is also a registered Professional Geologist in North Carolina, Kentucky and Alberta Canada.

Since 2011, Curt has been a bastion for geology in Ohio through his work as a hydrogeologist at the Ohio Department of Natural Resources (ODNR), Division of Soil and Water Resources. In this position, he has the unique opportunity to provide technical support to the public, government, consultants, and private industry. His involvement in the state government has allowed him to work on a variety of geologic and hydrogeologic issues that are of great importance to the protection of public interests and the economy of Ohio. Examples of issues include groundwater supply conflict investigations, groundwater supply for Utica Shale oil and gas well drilling and coal mining, and involvement with groundwater potentiometric surface mapping and GIS Investigations for ground water supply exploration.

In terms of AIPG, Curt has been involved with the Ohio Section of AIPG for over 30 years. He joined the Ohio Section AIPG as a Certified Professional Geologist in 1983. Highlights of his early involvement with AIPG include his first term as Ohio Section President in 1986 and National Chairman for the AIPG Annual Meeting held in Columbus and hosted by the Ohio Section in 1996. Since starting at ODNR in 2011, Curt has reimmersed himself in AIPG, first as a member of ad-hoc committees, then as President again in 2014 and soon-to-be 2016.

Through his work within the Ohio Section Curt has provided the Membership with a wide variety of opportunities to further their knowledge of geology in Ohio. Curt has strived to obtain both entertaining and informative guest speakers for Ohio Section meetings and has provided members with unique field trip opportunities including tours of active shale gas drilling sites and operating coal mines. Through the meetings and field trips, he has furthered our knowledge not only of Ohio geology, but of issues of economic and political importance. Curt has also been the primary contributor to the Ohio Section website blog, and successfully led the process of revising the Ohio Section bylaws as part of his presidency in 2014. Curt also serves as the Chair of the Ohio Section Awards Committee, dedicating his personal time each year to identify and recognize Ohio CPGs who have shown strong dedication to geology and AIPG.

At the AIPG National level, Curt has spear-headed the organization of the past three AIPG National shale gas conferences held in Ohio, using his extensive contacts to assist AIPG National with arranging vendors, guest speakers, and other conference details.

Throughout his career, Curt has demonstrated a selfless dedication and commitment to the furthering of the profession and the Ohio Section of AIPG. Therefore, it is my honor as his colleague and friend to nominate him for the Section Leadership Award.

Nominated by: Brent R. Smith, CPG-11130

Michael D. Campbell, CPG-3330
Texas Section

Michael Campbell truly deserves recognition from the American Institute for Professional Geologists for his efforts on behalf of all Texas and professional geologists nationwide. Michael has been a member of American Institute of Professional Geologists since the 1970's. He has brought the strength of his commitment to the professional over the last several decades through his actions of volunteering and mentoring. In his work life, Michael personifies what it means to be a professional geologist because he has served as a mentor to generations of geologists, including me. Michael is an innovator: when many geologists were caught by a downturn in the oil and gas industry several decades ago, he developed a low-cost training program in Houston to introduce them to the fundamentals of the environmental arena. I attended part of that training when I was unemployed in the Houston area. Michael served as a catalyst by helping to train and provide encouragement for many geologists faced with making a career change within the wide variety of aspects in the geologic profession. Michael is an unusual leader because he not only identifies goals and people capable of achieving common goals, he participates in making them happen.

Michael is an early adopter when it comes to technology as he volunteered to develop and host the American Institute of Professional Geologists Texas section web pages in the mid 1990s. When the Texas section of the American Institute for Professional Geologists devolved over the past ten years, he drew on his vast network of geologists he had mentored over the decades and committed to kick starting the section back into existence and it is thriving once more. Michael called upon me to serve as a leader in Texas as well as devoting his own time over the past several years. Even now, Michael steps up to identify opportunities for the section and volunteers himself for tasks and gets them done, such as outreach to start or revitalize our commitment to student sections at the major Texas universities with geoscience programs. Inevitably, during our monthly teleconference meetings he guides the discussion with parry and thrust of an expert fencer; he knows when to talk about past efforts, to prod action, and when to move us on in our discussions to make our time spent productively and efficiently. He generates genuinely helpful ideas, suggestions, and plans to make the section move closer towards the level it should be performing.

I hope that you can see now that Michael is an exceptional personal in every task and job he takes on. These examples listed are only a few of the extraordinary efforts Michael has gone to in support of the geologic profession in Texas, the United States, and ostensibly, worldwide. I believe you will find Michael Campbell worthy of national-level American Institute for Professional Geologists recognition.

Nominated by: Rima Petrossian, CPG-10038

Christine F. Lilek, CPG-10195
Wisconsin Section

Like some of the other sections, the Wisconsin Section had the same leadership for many years, resulting in a rehashing of the same ideas and a decrease in enthusiasm for advancing them. Since Christine has become involved, she has re-invigorated our section, bringing new energy and new ideas. A few of the items she is responsible for include:

- the development of a student section at the University of Wisconsin-Whitewater;
- a partnership for the AIPG Wisconsin Section with the Annual Student Research Symposium at the Riveredge Nature Center in Newburg Wisconsin (each year, she also serves as a judge of the student presentations);
- a partnership with the Ice Age Trail Alliance including volunteer hours building and maintaining trails; and
- the sponsorship of a very well attended Frac Sand Webinar in 2014, co-sponsored with the Minnesota AIPG Section, the Wisconsin Ground Water Association, the Society for Mining, Metallurgy and Exploration, and the American Geosciences Institute.

Nominated by: Jayne A. Englebert, CPG-8907

Presidential Certificate of Merit

Each year, the AIPG President may award one or more certificates of merit to individuals who, through dedicated and meritorious service, have made an outstanding contribution to the Institute. **J. Foster Sawyer, 2015 National President.**

Recipients of the 2015 AIPG Presidential Certicate of Merit

Helen V. Hickman, CPG-7535
For meritorious service and leadership for AIPG at both national and section levels.

Michael D. Lawless, CPG-9244
For exemplary leadership of AIPG and outstanding representation of AIPG to sister societies.

Anne M. Murray, CPG-11645
For outstanding leadership and accomplishments for the AIPG Florida Section.

Keri A. Nutter, CPG-11579
For exceptional service and leadership for AIPG at both national and section levels.

Kristina Pourtabib, SA-3410
For service as a superb role model for students and for outstanding contributions to *The Professional Geologist*.

Student Chapter of the Year Award

The purpose of the AIPG Student Chapter of the Year Award is to recognize the most outstanding student chapter for their participation in, and contribution to, the American Institute of Professional Geologists.

Recipient of the 2015 Student Chapter Award

Florida State University
Tallahassee, Florida
AIPG Student Chapter Founded 2013

Chapter Sponsor-**Anne Murray**, CPG-11645; Faculty Sponsor-**David Farris**

Student Chapter Officers: President-**Hannah K. Klein**, SA-5156; Vice President-**Chelsie N. Bowman**, SA-5390; Secretary-**Janine M. Giambalvo**, SA-5422; Treasurer-**Meg M. Wilson**, SA-5391; Historian-**Stephanie G. McColaugh**, SA-5393; Graduate Student Liaison-**Claire M. Routledge**, SA-6296.

Congratulations Student Poster Winners

The following students were selected as posters winners at the AIPG Annual Meeting in Anchorage, Monetary prizes were given to each student winner.

Undergraduate

1st place-

Tim Olson, SA-5651, Colorado

2nd place-

Jessica Davey, SA-4424, Colorado

3rd place-

Collin Roland, SA-5921, Texas

Graduate

1st Place-

Kannikha Kolandaivelu, SA-5436. Virginia

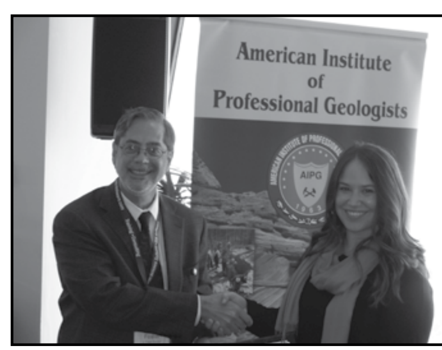
Poster winners from left to right, Kannikha kolandaivelu, Collin Roland, Jessica Davey and Tim Olson.

Letter to the AIPG

Dear AIPG Members and Executives,

Thank you so much for this incredible opportunity! We have worked very hard to encourage students in our department to be involved with AIPG and promote the geological sciences with the Florida State University campus and surrounding community. It feels incredible to be recognized by such an esteemed organization as AIPG, and we are just thrilled to be named Student Chapter of the Year. Thank you!

Sincerely,
Hannah Klein
FSU Geological Society
President (2014-2015)
Hkk09@my.fsu.edu



Hannah receiving the student chapter of the year award from President Foster Sawyer.

Trends in River Pesticide Levels Echo Pesticide Use

Trends in pesticide concentrations in 38 major rivers in the U.S. during 1992-2010 reflect large-scale trends in pesticide use and regulatory changes, according to a new study by the U.S. Geological Survey.

The study, the first to rigorously compare riverine pesticide concentrations with trends in pesticide use at the national scale, examined 11 pesticides that have sufficient historical data for trend analyses and that are among the top 20 most frequently detected in rivers and streams in the United States. Most of the 11 long-used chemicals had primarily downward trends in concentrations in most regions over the study period. Focusing on this group of 11 pesticides with the most extensive concentration data affords a unique opportunity to study the relations between river concentrations and use or other factors that may influence trends.

Trends in pesticide concentrations followed agricultural usage patterns and regulatory restrictions on use for pesticides used primarily on agricultural crops — cyanazine, alachlor, atrazine (and its degradate, deethylatrazine), metolachlor, and carbofuran.

"In major river basins, the overall influence of agricultural pesticide use is so strong," said Karen Ryberg, USGS statistician and lead of the study, "that any changes in other causes of trends in pesticide concentrations in the water — changes that might be traced to enhanced agricultural management practices — are difficult to discern, especially without improved data on both the use of specific pesticides and the timing, location, and extent of management practices."

Alachlor concentration trends in major rivers, for example, declined nationwide from 1992-2010 as the use of alachlor, a herbicide most commonly applied to corn, dropped from about 20,000 to 2,500 metric tons. The introduction of a new herbicide (acetochlor) and the increase in use of glyphosate-resistant corn and soybeans contributed to the nationwide decline in alachlor use.

For pesticides with substantial use in both agricultural and urban areas — simazine, chlorpyrifos, malathion, diazinon, and carbaryl — pesticide concentration trends in major rivers reflect both agricultural and nonagricultural usage patterns.

Urban contributions of pesticides have marked effects on concentration trends of some pesticides in major rivers, despite there being a much smaller area of urban land compared to agriculture in most river basins.

More than 400 pesticides are used in agriculture each year. Regulatory changes, market forces, and introduction of new pesticides continually alter the use of these pesticides over time. The USGS National Water-Quality Assessment Program currently monitors less than half of the pesticides currently being used for agriculture because of resource constraints. However, USGS is working to fill these gaps by monitoring new pesticides that come into use, such as the neonicotinoid and pyrethroid insecticides.

The article, "Trends in Pesticide Concentrations and Use for Major Rivers of the United States" by Karen Ryberg and Robert Gilliom, has recently been published in the journal Science of the Total Environment.

National maps and trend graphs that show the distribution of the agricultural use of 459 pesticides for each year during 1992-2012 in the conterminous U.S. are available online.

Here is the link to the USGS article *http://water.usgs.gov/nawqa/pnsp/MajorRiverTrends.STOTEN.2015.pdf*

AIPG Student Chapters

Bowling Green University
Founded in 2004
Chapter Sponsor:
Robert K. Vincent, MEM-0216

Central Michigan University
Founded in 2003
Chapter Sponsor:
Eric Wallis, CPG-09518

Colorado School of Mines
Founded in 1999
Chapter Sponsor:
Graham Closs, CPG-07288

Columbus State University
Founded in 2011
Chapter Sponsor:
Ron Wallace, CPG-08153

Eastern Illinois University
Founded in 2013
Chapter Sponsor:
Craig McCammack, MEM-1295

Eastern Michigan University
Founded in 2006
Chapter Sponsor:
Walter J. Bolt, CPG-10289

Florida Atlantic University
Founded in 2014
Chapter Sponsor:
Anne Murray, CPG-11645

Florida State University
Founded in 2014
Chapter Sponsor:
Anne Murray, CPG-11645

Georgia Southwestern State University
Founded in 2013
Chapter Sponsor:
Ronald Wallace, CPG-08153

Georgia State University
Founded in 2005
Chapter Sponsor:
Ronald Wallace, CPG-08153

James Madison University
Founded in 1998
Chapter Sponsor:
Cullen Sherwood, CPG-02811

Metropolitan State University of Denver
Founded in 2013
Chapter Sponsor:
Thomas Van Arsdale, CPG-11073

Middle Tennessee State University
Founded in 2014
Chapter Sponsor:
Todd McFarland, CPG-11348

Northern Kentucky University
Founded in 2015
Chapter Sponsor:
Bill Brab, CPG-11693

Ohio State University
Founded in 2004
Chapter Sponsor:
Robin Roth, CPG-09264

SUNY Geneseo
Founded in 2015
Chapter Sponsor:
Dennis McGrath, CPG-08578

Temple University
Founded in 2006
Chapter Sponsor:
Dennis Pennington, CPG-04401

University of California-Davis
Founded in 2010
Chapter Sponsor:
James Jacobs, CPG-07760

University of Georgia
Founded in 2011
Chapter Sponsor
Ron Wallace, CPG-08153

University of Kentucky
Founded in 2015
Chapter Sponsor
Bill Brab, CPG-11693

University of Nevada-Reno
Founded in 2008
Chapter Sponsor:
Jonathan G. Price, CPG-07814

University of Northern Colorado
Founded in 2014
Chapter Sponsor:
Willam Hoyt, CPG-07015

University of South Dakota
Founded in 2013
Chapter Sponsor
Derric Iles, CPG-10986

University of St. Thomas
Founded in 2015
Chapter Sponsor
Sara Nelson, MEM-2505

University of Tennessee-Chattanooga
Founded in 2014
Chapter Sponsor
John R. Sewell, MEM-2487

University of West Georgia
Founded in 2010
Chapter Sponsor:
Eric Lowe, MEM-0385

University of Wisconsin-Whitewater
Founded in 2015
Chapter Sponsor:
Christine Lilek, CPG-10195

Wayne State University
Founded in 2012
Chapter Sponsor:
John Barkach, CPG-09121

Western Michigan University
Founded in 2015
Chapter Sponsor:
John Barkach, CPG-09121

Wright State University
Founded in 1996
Chapter Sponsor:
Thomas Berg, CPG-08208

Low-Energy Alternatives for Removing Contaminant Plumes in Groundwater

Paul F. Hudak

Abstract

A "no-action" and three low-energy groundwater remediation alternatives were evaluated with a numerical mass transport model. The low-energy alternatives included a permeable reactive barrier, non-pumped wells with filter media, and an extraction-injection well pair. Components of each alternative occupied a linear transect located 5 meters (m) downgradient of a contaminant plume and perpendicular to the regional hydraulic gradient. The model identified the shortest barrier, least number of non-pumped wells, and lowest pumping rates necessary to contain the plume onsite. The plume moved offsite in the no-action alternative, but was successfully contained with each low-energy alternative. Within 910-950 days (d), each alternative removed the contaminant plume; however, the well pair was most effective, requiring less infrastructure and pumping only 2.6 m3/d. Results of this study suggest that low-capacity extraction-injection well pairs may be viable alternatives to more costly permeable reactive barriers and non-pumped wells in some settings.

Introduction

Low-energy alternatives for cleaning contaminated groundwater have become increasingly popular over the past 20 years. A common example is permeable reactive barriers located in the pathways of migrating contaminant plumes, that remove or decompose contaminants without pumping groundwater.[1] At field sites in several countries, permeable reactive barriers have treated metals,[2] metalloids,[3] hydrocarbons,[4] nutrients,[5] chlorinated solvents,[6] and radioactive solutes.[7] Several modeling studies also have shown the capability of permeable reactive barriers.[8-12] However, permeable reactive barriers require specialized trenching equipment and are costly to install and maintain, especially for installations more than 20 m deep that operate for many years.

In some environments, multiple wells with removable filter cartridges instead of submersible pumps are alternatives to permeable reactive barriers.[13] Media inside the cartridges immobilize or transform contaminants. Cartridges are easily removed and replaced following chemical breakthrough.[13] Drilled wells can reach much greater depths than trenches; however, non-pumped wells also apply to shallow aquifers. Sufficiently dense arrays of non-pumped wells may function like a permeable reactive barrier, potentially at much lower installation and maintenance cost.[14] A possible limitation of non-pumped arrays is that contaminant plumes may migrate between adjacent wells and possibly offsite.[15]

A third low-energy alternative is an extraction-injection well pair operating at a low pumping rate, creating a hydraulic barrier downgradient of a contaminant plume.[16] The well pair occupies a transect downgradient of the plume and approximately perpendicular to the regional hydraulic gradient. The extraction well removes contaminated water, which is treated above ground and then injected back into the aquifer. This alternative tends to be less expensive to install and has more predictable long-term performance than a permeable reactive barrier.[16] In addition to creating a hydraulic barrier with the extraction well, the injection well dilutes contaminant concentrations in groundwater. In some cases, well pairs requiring low pumping rates can be operated with solar power in favorable climates.

Natural attenuation processes augment any remediation alternative; for example, if a contaminant plume is allowed to migrate and attenuate within an onsite buffer zone, hydrodynamic dispersion can further lower contaminant concentrations.

While others[16] evaluated the viability of injection-extraction well pairs based upon advection and flow-line distributions, this study examines their relative performance considering advection and hydrodynamic dispersion. A no-action alternative was compared with three active alternatives: a permeable reactive barrier, non-pumped wells with filter media, and an extraction-injection well pair.

Materials And Methods

The computer program MT3DMS[17] was applied to a hypothetical unconfined aquifer (Figure 1). MT3DMS is a modular three-dimensional multi-species transport model. This numerical groundwater flow and mass transport simulator utilizes a block-centered finite-difference grid, in this case comprising 195 rows (east-west), 400 columns (north-south), and one layer. Adjacent nodes were 0.25 m apart along rows and columns. The water table had an elevation of 10.000 m and 9.003 m at the western and eastern boundaries of the model domain (respectively), yielding an average regional hydraulic gradient of approximately 0.01 eastward. The aquifer's base had an elevation (datum) of 0 m. The lateral northern and southern boundaries, and the lower boundary of the model domain were set as no-flow boundaries. Hydraulic conductivity and the effective porosity of the simulated aquifer were 2 m/d and 0.25, respectively.

The model initially produced a flow field and contaminant plume from a 1.6 m^2 source area with a constant concentration of 100 mg/L located near the western boundary of the model domain (Figure 1). After 410 d, the plume was 45 m from the eastern boundary, establishing initial contaminant concentrations for subsequent remediation trials. In mass transport simulations, longitudinal dispersivity was 1.0 m, transverse dispersivity was 0.1 m, and the effective molecular diffusion coefficient was 0.00001 m^2/d. The concentration boundary of contaminant plumes was 1.0 mg/L.

A no-action and three active remediation alternatives were modeled, including: (a) a 0.5-m thick permeable reactive barrier of minimum length to prevent the contaminant plume from traveling offsite; (b) linear transects of non-pumped wells with filter media spaced 0.5 m apart, of minimum number to prevent offsite contamination; and (c) an extraction-injection well pair, each well pumping a minimum (identical) rate to prevent offsite contamination. The permeable reactive barrier, non-pumped wells, and well pair all occupied linear transect(s) located 5 m downgradient of the initial contaminant plume and oriented perpendicular to the regional hydraulic gradient. In the extraction-injection well scenario (c), one well injected clean water, considered treated above ground after extraction from the other well. Locations and pumping rates of wells were adjusted through an iterative process to identify a minimum number of wells in the non-pumping filter media wells scenario (b) and pumping rate in scenario (c) necessary to contain the plume onsite.

Vertically, wells and trenches traversed the entire aquifer. The hydraulic conductivity and effective porosity of reactive filter media was set at 100 m/d and 0.35, respectively. In the model, the permeable reactive barrier and non-pumped wells were contaminant sinks with a concentration of 0 mg/L. All groundwater flow and mass transport simulations used the preconditioned conjugate gradient and generalized conjugate gradient solvers, respectively. Mass balance errors were less than 0.01%.

Results And Discussion

Without intervening, the initial contaminant plume was simulated to migrate to the eastern boundary after 470 d (Figure 1). Therefore, natural attenuation alone could not contain the plume onsite. When it reached the boundary, the plume had grown in size but decreased in concentration, due to the effects of hydrodynamic dispersion and dilution by clean groundwater (Figure 1).

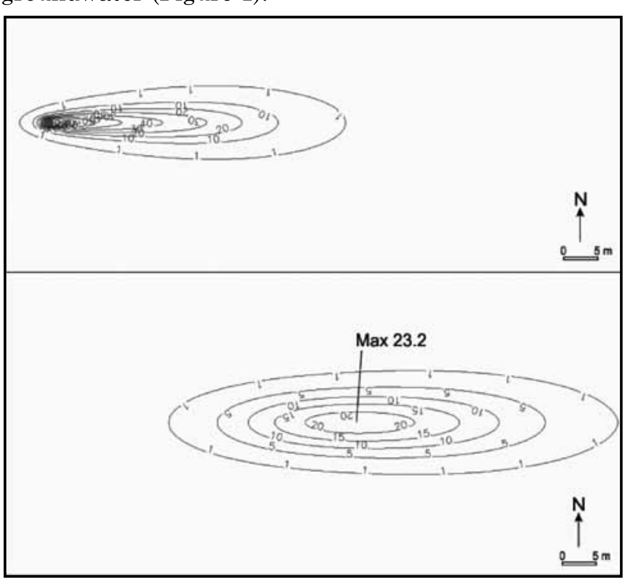


Figure 1. Map of initial contaminant plume (top) and residual plume after 470 d with no remedial structure (bottom); contours in mg/L.

For scenario (a), a 10.5 m-long permeable reactive barrier was simulated to contain the plume onsite (Figure 2). The barrier was centered on the long axis of the initial contaminant plume, reflecting the plume's symmetry in a uniform initial groundwater flow field. While the simulated contaminant plume moved past the barrier, it did not reach the eastern boundary of the model domain (Figure 2). After 770 d, the plume reached its farthest point of advance, 17.75 m from the eastern boundary. After 910 d, the plume was gone; that is, concentrations at all model cells dropped below 1 mg/L.

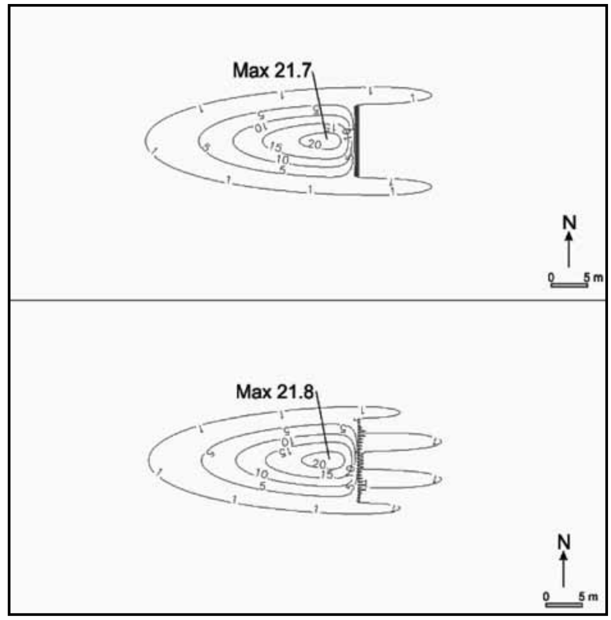


Figure 2. Map of remaining contaminant plume after 500 d with permeable reactive barrier (top) and non-pumped wells (bottom); contours in mg/L.

Alternative (b) required a minimum of 31 non-pumped wells along parallel cross-gradient transects, one containing 26 wells and the other containing 5 wells, to contain the contaminant plume (Figure 2). Wells along the second, shorter transect captured enough contamination moving past the first transect to contain the plume onsite (Figure 2). After 720 d, the plume reached its farthest point of advance, 17.5 m from the eastern boundary. Similar to scenario (a), scenario (b) removed the plume after 910 d; however, scenario (b) required more than 30 wells to contain the plume onsite.

An extraction-injection well pair separated by 7.5 m and discharging only 2.6 m^3/d also contained the contaminant plume, removing it after 950 d (Figure 3). The pair's midpoint was positioned slightly (approximately 1.1 m) south of the initial plume's long axis. This slight asymmetry reflects the geometry of the groundwater flow field induced by the well pair, creating a small tendency for southerly movement in this example (Figure 3). As with other alternatives, scenario (c) allowed the contaminant plume to travel past the remedial structure, but not offsite. After 920 d, the plume reached its maximum distance of 9.5 m from the eastern boundary of the model domain.

Thus, each active scenario contained and removed the contaminant plume within a similar time-frame; however, the extraction-injection well pair required the least infrastructure. While the well pair requires above-ground treatment of contaminated water, it does not involve costly excavation and disposal of filter media in permeable reactive barriers. Aboveground treatment is also easier to monitor and maintain than filter media in reactive barriers. The other alternative of non-pumped wells offers the convenience of easily replaced filter cartridges; however, a very substantial infrastructure (large number of wells) was necessary to contain the contaminant plume onsite.

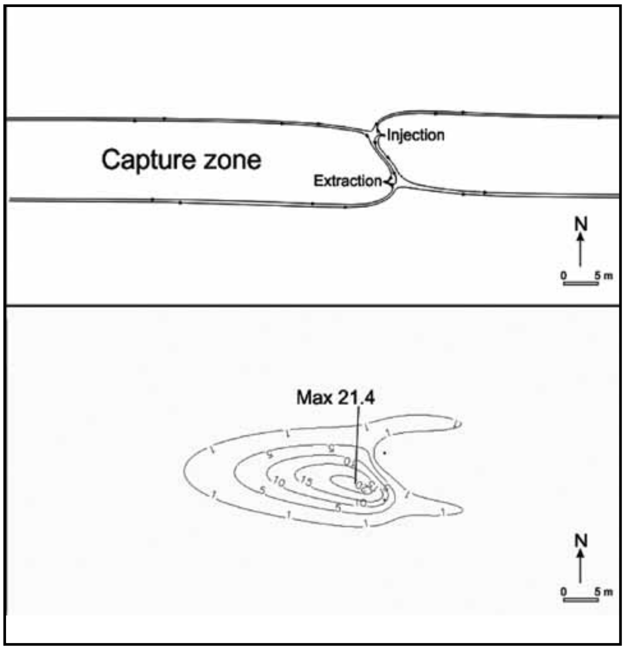


Figure 3. Map of selected flow lines (top) and remaining contaminant plume after 500 d (bottom) with injection-extraction well pair; contours in mg/L.

Alternatives outlined above share certain features. Each requires groundwater to carry dissolved contaminants, while involving hydrodynamic dispersion and dilution to lower contaminant concentrations. Active alternatives removed similar contaminant mass: 15.55 kg for the permeable reactive barrier; 15.12 kg for the non-pumped wells; and 15.53 kg for the extraction well. Furthermore, each alternative enabled portions of the contaminant plume to migrate past the structure, but ultimately contained the plume onsite. The results outlined above indicate that enabling a contaminant plume to travel and attenuate within an onsite buffer zone can help remediate contaminated groundwater.

Some field conditions would render the above alternatives less effective. In particular, low seepage velocities and low solubility would delay or prevent contaminants from moving into reactive barriers, filter cartridges, or extraction wells. In practice, groundwater remediation systems are highly dependent upon site-specific conditions and require careful monitoring to verify operational efficiency.

Conclusions

The objective of this study was to evaluate alternatives of no-action and three active remediation scenarios to contain and remove a plume of contaminated groundwater. A modest seepage velocity and relatively narrow contaminant plume were simulated. The active alternatives included a permeable reactive barrier, non-pumped wells with filter media, and a low-capacity extraction-injection well pair downgradient of the contaminant plume. The no-action alternative did not contain the plume onsite. Based upon required infrastructure and timeframe for contaminant removal, the low-capacity extraction-injection well pair was most effective and is worthwhile to consider as a remediation alternative in practice.

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Dr. Paul F. Hudak is a professor and chair in the Department of Geography at the University of North Texas. He received a B.S. in Geology from Allegheny College, M.S. in Geology from Wright State University, and Ph.D. in Geography from the University of California, Santa Barbara. Previously, Dr. Hudak worked as a consultant for geotechnical firms in Pennsylvania, Ohio, and California. Dr. Hudak's current research interests in include groundwater monitoring and remediation, geological hazards, and wetland mitigation.

Please consider nominating someone you know for one of the distinguished National Awards. The award nomination form for 2016 can be found on page 39 of this issue. The deadline for the 2016 nominations is January 15, 2016.

We want your feedback! Have you perused the electronic version of *TPG*? Was it easy to navigate and view articles? Please send us your comments on the electronic *TPG* and suggestions how we can improve your viewing experience.

Should I Become a CPG?

Have a you been thinking about upgrading your membership to CPG? If the answer is yes, What are your waiting for? To find out if you have the qualifications go to Article 2.3.1 of the AIPG Bylaws. The AIPG Bylaws can be found on the AIPG website or the directory.

The CPG application can be found on the website under 'Membership'. Just follow the instructions. The basic paperwork includes the application, application fee, transcripts, geological experience verification and sponsors.

If you have any questions, you may contact Vickie Hill, Manager of Membership Services at aipg@aipg.org or call headquarters at 303-412-6205. ***www.aipg.org***

One Less Thing on My Field-Bucket List

Jean M. Neubeck, CPG-11438

I'm sporting a camouflage cap this issue because that's what I wore in the field while visiting Alaska. Not so I might blend with the residents (heavens no, *they know* who's a tourist) but because you just can't fret about your looks when you're scouting for wildlife and scenery in the "Interior." My poor index finger was cramped from taking more than 1000 photos. It's understandable that for many, Anchorage was too great a haul to attend the recent annual meeting but it was a lifetime opportunity for me and tremendous fun for those lucky enough to make the trip. It was my first time in AK, so I was yet another geologist in a giant rock-candy store.

Like most AIPG events, one of the conference highlights is going on field trips to just about anywhere, guided by intrepid geologists who generously volunteer their time and knowledge to make sure us rockheads enjoy ourselves while we learn something geologic. It's fair to say that I only "managed" to learn some things because despite the clear and informed presentations, it was hard to concentrate between gawking and snapping photos.

I sincerely appreciate all, but acknowledge here only a few, of the people that contributed to successful (nobody got hurt!) and engaging experiences on the field trips I attended. Special thanks to Dr. Kris Crossen, who lead the "1964 Great Alaska Earthquake" trip; Dr. Nicholas VanWyck, CPG-10553, who graciously herded us through a 2-day trek to Denali Park and Usibelli Coal Mine (UCM); Bill Brophy and Justin Seavey from UCM; and Denali Park Geologist (really, how do you get *that* gig?) Dr. Denny Capps. Many thanks also to all the conference volunteers.

To share a little of the coal mine tour… Okay yes, I skipped over Denali but of course it was spectacular. It was wall-to-wall geology: mountains, formations, landslides, faults, glaciers, more mountains plus bears and moose. Denali is a vast and pristine wonderland but you really need much more time than we could spend to explore even a fraction. So I'm focusing on the coal mine. As beautiful as Denali was (is!) I'm fascinated by construction so I was bowled over by the heavy equipment and scale of the surface mine at Healy.

Gracing *TPG*'s cover (and article pg. 47) are photos of reportedly, the most photographed outcrop in Alaska, and for good reason. The dark coal seams interbedded and in sharp contact with the buff-colored sedimentary rocks strike a geologic contrast that is awesome (yes, that's the *right* use of that word). Sadly, UCM reports they have disappointed more than one geologist bucking for a mining job - they simply don't need help to find the coal. Strike one.

We started out meeting in the Usibelli office building where historical photos and artifacts of their mining history are proudly displayed. Bill Brophy gave a short presentation to orient us to coal mining (remember the hierarchy of anthracite, bituminous, lignite, and peat?) and also summarized the physical setting, reclamation, water treatment, and coal's use for cogeneration to produce both electricity and heat.

Donning hart hats and ever-stylish safety glasses, we toured the infrastructure and maintenance that keeps the huge dozers and trucks running. Then we headed out to see the real action. I should sound more professional, but what can only be described as a *humongous* drag line (30-40 CY capacity) that requires two operators is used among other methods to remove overburden to access the coal. It looked like a fun job, but it's serious work that requires a high skill level of skill. Strike 2.

And as large as that drag line dubbed "Ace in The Hole" is, the equipment is absolutely dwarfed by the scale of the mine's geology with its steep headwalls, benched topography, and in-your-face stratigraphy in full display. At our request, Bill collected some fresh "hand specimens" so the collectors among us could keep souvenir. The sub-bituminous coal is pretty friable, but my carefully wrapped samples survived the baggage handlers.

Family member and geologist Mitch Usibelli wasn't with us but he provided summary descriptions of the stratigraphy from a USGS report that liberally references the work of Clyde Wahrhaftig (USGS, now deceased). Wahrhaftig spent a significant part of his career focused on the Healy coal field, publishing numerous papers, and producing detailed geologic maps that still are actively used today. Field mapping is done. Strike 3.

Late in his career, Clyde also designated the local coal formations of the Usibelli Group. You can download Clyde's USGS maps to gain a good overview of the local geology.

So while I struck out on job prospects, my Alaska tally is: 30+ glaciers, 9+ Dall Sheep, 7 Moose, 5 Grizzlies, 3 Bald Eagles, several Sea Lions and Sea Otters, one surface coal resource, and an undisclosed number of Alaskan micro-brewery beverages. Check that field-bucket list good!

Answers on Page 30

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1. In general, a sinuous, long, narrow ridge of stratified glacial drift deposited in tunnels within the glacial ice or by flowing meltwater streams under the glaciers depict what we term:
   a) A kame
   b) A drumlin
   c) An esker

2. This "sulfate" mineral is used in the manufacturing of rubber, paint, glass and in oil-well drilling fluids:
   a) Hematite
   b) Sphalerite
   c) Barite

3. In our field studies we find fossil "placoderms." What is the likely geologic age of the strata where these are found?
   a) Ordovician
   b) Devonian
   c) Jurassic

4. The term "graded bedding" is generally used in reference to:
   a) A gradation in grain size from coarse below to fine above.
   b) A gradation in grain size from fine below to coarse above.
   c) A vertical or lateral variation in the lithologic makeup of contemporaneous sediments

5. A subsurface petroleum prospect has been mapped. The structural closure (expected to be hydrocarbon-bearing) covers three sections. The net effective pay is believed to be 15 feet on average. Core data reveals that the reservoir has a porosity of about 18% and a water saturation of 22%. To a first approximation and using the "volumetric method," calculate the "oil in place" in the reservoir:
   a) 19,735,560 barrels
   b) 31,369,628 barrels
   c) 45,373,901 barrels
   d) Man, this is what engineers are for, to do this kind of stuff!

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Answers:

1. The answer is choice “c” or “an esker.”

   “Kames” constitute mounds or hills of glacial sediment that accumulate in depressions on a retreating glacier. These mounds are left behind resting over the land surface as further glacial melting occurs.

   “Drumlins” are mounds or hills of glacial sediment that are generally streamlined and asymmetrical in a lengthwise profile. The steep side faces the direction in which the ice came from.

2. The answer is choice “c” or “barite” ($BaSO_4$). Sulfates contain the SO_4^{-2} ion or SO_4 radical.

   “Hematite” is a reddish-brown iron oxide (Fe_2O_3) with an earthy (or sometimes metallic) luster and constitutes an important iron ore.

   “Sphalerite” is zinc sulfide (ZnS) and defines an important ore of zinc.

3. The answer is choice “b” or “Devonian.”

   “Placoderms” constitute a type of primitive, jawed and armored-plated fish that lived mainly from about the mid Silurian to the end of the Devonian. They became greatly dominant and abundant in Devonian time. Most “placoderms” disappeared at the close of the Devonian Period with a minimal number of related species enduring into the Carboniferous. It is thought that the demise of the “placoderms” helped sharks proliferate.

4. The answer is choice “a” or “A gradation in grain size from coarse below to fine above.” “Graded bedding” may be found in fluvial depositional environments and “turbidite” sequences.

   Choice “b” is more characteristic of barrier bars associated with littoral environments. Choice “c” implies what we may define as a “facies change.”

5. The answer is choice “b” or about 31,369,628 barrels.

   To a first approximation, we may use the formula:

   $$Oip = 7758 * (h) * (A) * (\varphi) * (1\text{-}Sw) \qquad (1)$$

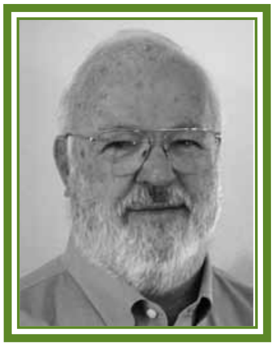
   The “oil in place” (Oip) in the reservoir is a function of the net effective pay (h), the drainage area (A), porosity (φ) and oil saturation (So = 1-Sw), where Sw is the water saturation. Note that there are 7758 barrels per acre-foot and a “section” is equivalent to 640 acres. Thus:

   $$Oip = (7758 \text{ barrels/acre-foot}) * (15 \text{ feet}) * (3 * 640 \text{ acres}) * (0.18) * (1.0 - 0.22) \qquad (2)$$

   $$Oip = 31{,}369{,}628 \text{ barrels} \qquad (3)$$

   Equation (3) gives us the number that we seek. Note that this is not the “recoverable oil!” The latter (see equation 4) is also a function of the “recovery factor” (RF) and the “oil volume factor” (BOI), or reservoir barrels per stock tank barrels. Thus, recoverable oil is approximately:

   $$Orec = \{[7758 * (h) * (A) * (\varphi) * (1\text{-}Sw)] * (RF)\} / BOI \quad = [(Oip) * (RF)] / (Boi) \qquad (4)$$



Topical Index-Table of Contents to the Professional Ethics and Practices Columns

A topically based Index-Table of Contents, "pe&p index.xls" covering columns, articles, and letters to the editor that have been referred to in the PE&P columns in Excel format is on the AIPG web site in the Ethics section. This Index-Table of Contents is updated as each issue of the TPG is published. You can use it to find those items addressing a particular area of concern. Suggestions for improvements should be sent to David Abbott, dmageol@msn.com

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Twenty Years of PE&P Columns and Counting

Twenty years ago, the first PE&P column appeared in the November 1995 issue of *TPG*. The years have flown by.[1] I'm periodically asked how I keep coming up with new material for this column. The answer is that comments, questions, etc. from 100s of geoscientists over the years, and news stories prompt the initiation of, or further comments on, a topic. The observations I made in that first column (slightly edited) are worth repeating. Producing this column requires input from many people, not just me. No one knows everything there is to know about geoscience ethics and practices and geoscientists tend to be rather opinionated besides. Contributions and discussions need to come from all AIPG members, including students and young professionals. Please feel free to contribute. A good question is much appreciated. I would prefer to be far more a compiler than author.

This column is titled "Professional Ethics & Practices" because, although different, professional ethics and practices tend to be closely related subjects. Good professional practices can be employed to avoid ethical problems. Consideration of ethical issues often prompts suggestions for good professional practices.

A great many geoscientists have contributed to the columns over the years. Their contributions help make this column what it is. I've cited 159 articles and columns by 96 authors in the *TPG* over the years, which are included in the Geologic Ethics & Professional Practices CD that is updated with each issue. Several of these authors have made multiple contributions over the years including **Martin Andrejk**o, CPG-8512, **Bill Stone**, MEM-2164, and our three Student's Voice columnists, **Nancy Price, Stephanie Jarvis,** YP-0125, (who continues as a Young Professional columnist), and **Kristina Pourtabib**, SA-3410. Their columns have addressed a variety of ethics and practice issues and demonstrate that AIPG's younger members can make excellent contributions to this column. My wife, **Sue Abbott**, AS-001, has edited most of these columns. Her support and excellent comments assist in improving the quality of these columns.

Updating the AIPG Code of Ethics

The time has come to look at AIPG's Code of Ethics and propose changes that address several issues:

- AIPG's current Code is organized by duty to various groups while the 2015 *AGI Guidelines for Ethical Professional Conduct* (discussed in columns 153 and 155) are divided two categories: the day-to-day activities of individual geoscientists and a geoscientist's activities as a member of a professional and scientific community.

Should the organization of AIPG's Code be changed?

- As noted in column 153 (Jan '15), the *AGI Guidelines* include statements on the following subjects not currently in the AIPG Code:
    - Separate facts/observations from interpretations.
    - Encourage and assist in the development of a diverse and inclusive workforce.
    - Promote greater understanding of the geosciences by other technical groups, students, the general public, news media, and policy makers through effective communication and education.
    - Acknowledge the complexities and uncertainties of Earth systems.
    - Inform the public about natural resources, hazards, and other geologic phenomena clearly, accurately, and responsibly.
    - Advocate responsible stewardship of the planet through an improved understanding and interpretation of Earth systems, and by communicating real and potential implications of human actions.

Should some or all of these subjects be added to the AIPG Code? See the *Geoethics* topic below for papers on some of these issues.

The use of "should" or "shall":

Robert Tepel, who writes on licensure issues for the *AEG News*, reviewed the ethics codes of the US states and the Canadian provinces and territories that license geologists and several professional organizations, including AIPG.[2] Tepel states, "If a professional membership organization views its members' duties to each other, or their duties to their clients or employer, as more important than their duties to the public, it will show in the strictness hierarchy of its code of ethics by way of 'shall' vs. 'should,'

1. My 95-year-old Mother asserts that time seems to continually speed up as you get older.
2. Robert E. Tepel, 2012, LXIII: the "primacy clause" in codes of ethics: a window into licensure board and professional organization values: AEG News, 55, March 2012, p. 32-37.

or 'should' vs. vague, suggestive, aspirational, or equivocal wording—or concepts left out." Tepel argues that protection of the public's health, safety, and welfare should be clearly stated as a primacy clause at the beginning of a strong code of ethics. He notes that the various codes he examined ranged between those with strong primacy clauses, those with weak clauses, those with equivocal clauses, and those lacking such a clause. In Tepel's view, "should" is indicative of a weak statement that is "suggestive and nonbinding."

Tepel's examination of AIPG's Code of Ethics missed the second and third sentences of the Preamble that states, "The Institute's Code of Ethics comprises three parts: the **Canons**, which are broad **principles of conduct**; the **Ethical Standards**, which are **goals** to which Members **aspire**; and the **Rules of Conduct**. Compliance with the Rules of Conduct is mandatory and violation of any Rule will be grounds for disciplinary action by the Institute." I've added italics and bold face to highlight the structure of the Institute's Code. The Rules of Conduct use "shall." While the quoted sentences are not the explicit primacy clause Tepel was looking for, I like the Institute's Code's structure of principles, aspirational goals, and mandatory rules.

I encourage all AIPG members to consider the foregoing questions and suggest changes to the AIPG Code of Ethics. The AIPG Code of Ethics can be found at *www.aipg.org/about/ethics.htm*. Download a copy, make your suggested changes (preferably in MS Word with "track changes" on) and send me your suggestions.

Disabled Geoscientists at Field Camp and Otherwise

In column 155 (Jul/Aug/Sep '15) I reviewed comments on field camp and field training by **Stephanie Jarvis**, YP-0125, **Kristina Portabib**, SA-3410, and 2015 SEG President **François Robert**. The July 2015 issue of *The Geoscientist* contained some additional reflections on this subject.

George Jameson, in heralding a Geological Society of London (GSL) conference on "opening the gate to accessible fieldwork," noted that while "Field experience is a crucial component in the professional practice of geology," talented people with disabilities can be deterred by the physical and psychological challenges presented by fieldwork. In her "In the field" column in the Apr/May/Jun '15 *TPG*, Stephanie Jarvis noted that an increasing number of geoscientists, including students, spend little or no time in the field. Instead they work with data collected by others that has not yet been analyzed, at least not with the type of expertise these geoscientists have. I don't know what the results of the GSL conference were. I do remember that when I was required to take graduate field camp at the Colorado School of Mines, one of my fellow students, who had been disabled by a fall, was allowed to work on outcrops near the roads in the field area. His graduate work focused on micropaleontology and he went on to a career in the petroleum business. This is one example of accommodation for a physical disability.

The American Geosciences Institute adopted a *Consensus Statement Regarding Access and Inclusion of Individuals Living with Disabilities in the Geosciences* this past June. The AGI statement includes four specific points:

- Encourage the development of flexible learning environments and inclusive curricula, including in the classroom, laboratory, and field that are conducive to developing the skills of geoscientists of all physical, sensory, or cognitive abilities.
- Foster the participation and support the retention of geoscientists who live with disabilities in academic communities, our professional organizations, and the workforce.
- Promote accessible pathways for students with disabilities to transition into geoscience careers that maximize their unique perspectives, competencies, and abilities.
- As a representative society, ensure that career and professional development opportunities are made available to geoscientists with all abilities to support life-long growth, and by extension, promote inclusion and act as an example for other organizations.

The full AGI statement can be found at *www.americangeosciences.org/community/disability-consensus-statement*. AIPG is among the signatories of this AGI statement.

Mike Harris, in an article, "Fieldwork and mining," in the July 2015 *Geoscientist*, *https://www.geolsoc.org.uk/Geoscientist/Archive/July-2015/Fieldwork-and-mining,* notes that those wishing to engage in mining exploration should possess "a passion for being in the field, working on or looking for ore. They must be tough in field, and enjoy it—and not be worried about less than balmy conditions—just appreciating the opportunity of being there. They must be able to get along with a range of people, often very different from themselves, and to cope with relatively high levels of responsibility early on." Harris goes on to note that mining exploration often occurs in third world countries and other out-of-the way places. Being away from home for extended periods during field season is common. Harris suggests that having summer jobs at a mine or on an exploration team is an excellent way of determining if mining exploration is the field for you.

Clearly those with physical and other disabilities should consider the fieldwork expectations of the area(s) of geoscience they wish to pursue. Mining exploration may not be a good choice while petroleum exploration may well be. There are a variety of career paths open to the disabled. However, an understanding of field relationships is critical to most areas. Computer models are useful but they are just models subject to revision and are only as good as the data density (number) and coverage (distribution within the modeled volume) supporting them. It occurs to me that mini drones and other recent technologic developments may provide an increasing array of accommodations for those unable to go to the field themselves.

Geoethics: The Role And Responsibility Of Geoscientists

Geoethics: the role and responsibility of geoscientists, Geological Society of London Special Publication 419, edited by S. Peppoloni and G. Di Capua, was published August 21, 2015. The articles in this volume cover a variety of topics, several of which address topics included in the 2015 *AGI Guidelines* discussed above. In particular, geohazard risk assessments and communication of these risk assessments to the public in various ways are addressed. The book's contents include:

Cocco, M., et al., The L'Aquila trial[3]

Parkash, S., Cooperation, coordination and team issues in disaster management: the need for a holistic and integrated approach

Acharjee, S., Urban land use and geohazards in Itanagar, Arunachal Pradesh, India: the need for geotechnical intervention and geoethical policies in urban disaster resilience programmes in a changing climate

Crescimbene, M., et al., The seismic risk perception questionnaire

Kostyuchenko, Y. V. & Movchan, D., Quantitative parameter of risk perception: can we measure a geoethic and socio-economic component in disaster vulnerability?

De Pascale, F., et al., Geoethics and seismic risk perception: the case of the Pollino area, Calabria, southern Italy and comparison with communities of the past

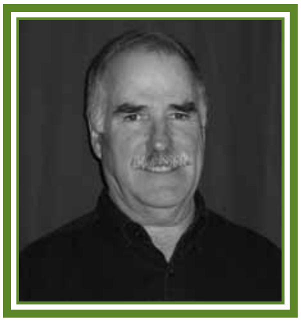
Albarello, D., Communicating uncertainty: managing the inherent probabilistic character of hazard estimates

Solarino, S., How to strengthen public trust in geosciences

Marone, E., et al., Communicating natural hazards: marine extreme events and the importance of variability and forecast errors

Abstracts of these papers can be viewed at *http://sp.lyellcollection.org/content/419/1 along with ordering information.*

1. The initial trial in L'Aquila (Italy) ended with a conviction of six seismologists and a seismic engineer for multiple manslaughter and serious injuries. They were sentenced to six years in jail, perpetual interdiction from public office and a fine of several million euros to be paid to the victims of the earthquake of 6 April 2009 (moment magnitude 6.3) for having caused, by their negligent conduct, the death of 29 persons and the injury of several others. In November 2014, the convictions of the six seismologists were cleared and the 6-year jail sentence of the seismic engineer was reduced to 2 years.



Conceptual Models Count

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Playas or salt pans, the flat, periodically flooded areas in the center of arid basins or bolsons, are common features of basin-and-range country. Soluble salts (for example, borax, trona, etc.) left by evaporating water may reach thicknesses of economic significance (think Death Valley). Sound exploration for such deposits requires a sound conceptual hydrogeologic model.

The water that ponds in playas has one of two contrasting origins: surface water or ground water. Surface water is the most common source and originates as runoff from adjacent mountain slopes and streams. The amount of salt left by evaporation is minor because runoff is ephemeral and total-dissolved- solids content of runoff is not great. Alternatively, since the basin center is often the discharge area for the hydrologic system within the adjacent mountain range, the water in a playa may also come from ground-water surfacing there. The amount of salt left by evaporation in this case is more substantial because discharge is more constant and total-dissolved-solids content of the ground water is greater than that of runoff (greater contact time). Therefore, economic salt deposits are more likely to be associated with the ground-water-discharge origin.

A west-coast company exploring for economic salt deposits hit upon a playa in the Southwest where I was employed by the state geological survey. The company apparently assumed (hoped?) the ground-water-discharge model applied. After considerable drilling yielded nothing, they abandoned the project. But their disappointment was avoidable. We had already done considerable hydrogeologic work in the basin, including some drilling. However, they were so secretive that they never spoke to anyone in the state survey, which has historically been confidentially supportive of exploration activities.

I later included the playa as a stop on a field trip for my hydrogeology class. We walked to the middle of the playa where there was about one inch of standing water. I had the students hand auger down about one foot and then asked them if this was a runoff or ground-water playa. The answer was obvious: beyond an inch or so the clayey sediment was dry. No ground-water discharge here! Maybe the salt company didn't have a hand auger. Tip: Conceptual models are important. Be sure the one you're going by is reasonable, based on readily available data.

Dr. Stone has more than 30 years of experience in hydroscience and is the author of numerous professional papers as well as the book, Hydrogeology in Practice – a Guide to Characterizing Ground-Water Systems (Prentice Hall). Feel free to argue or agree with him by email *(wstone04@gmail.com)*.

AIPG Membership Totals

	As of 10/30/14	As of 10/9/2015
CPG / Active	3,331	3,238
CPG / Non-Practicing	370	410
Prof. Member	981	968
Associate Member	46	54
Young Professional	71	95
Student Adjunct	2,983	3,292
TOTALS	7,782	8,057

New Applicants and Members can now be found on the AIPG website at *http://aipg.org/membership/newappsmems.html*

Section News can now be found on the AIPG website at *http://aipg.org/sections/sectionnews.html*

GPS - Just a Matter of Time

Michael J.Urban, MEM-1910

An interesting connection between the geosciences and modern physics can be made through an examination of the Global Positioning System (GPS). The precision with which measurements of location on the Earth are made via GPS is extremely valuable for geological mapping efforts. A number of factors contribute error to the determination of location, but for most, significant error corrections can be applied. Our ability to minimize errors in GPS measurements continues to be enhanced through technological advancement.

What is GPS?

The Global Positioning System, developed by the United States Department of Defense in 1978, is a means for determining and providing specific data about locations on Earth in terms of point position (latitude, longitude, and elevation) and relative position (vector location). Initially designed for military purposes, it is now widely utilized for a variety of applications in both government and civil initiatives, including navigation, surveying and mapping, mining, road construction and maintenance, agriculture, and for instances when exact time with atomic clock accuracy is needed. The Global Positioning System consists of three components: satellites, ground stations, and receivers. Satellites transmit signals which are picked up and used by ground-based receivers to determine details about latitude, longitude, and elevation of its location. Ground stations verify the position of satellites in their orbits, a necessary "ground-truthing" action for the confirmation of data accuracy. Receivers use satellite transmissions to calculate satellite distance and determine locations on the Earth. The information about location can then be given numerically, or translated into maps through comparison to archived position and map data in the receiver device.

The accuracy of GPS technology has steadily increased since its inception and the degree of measurement error has evolved from meters to centimeters (or less). Prior to the year 2000, the Department of Defense intentionally prohibited maximum accuracy for civil use, termed *Selective Availability,* as a precautionary measure related to national security. Since then, the best signal has been made accessible, enabling anyone capable of purchasing the most sophisticated receivers to enjoy unsurpassed location resolution. Today, even relatively inexpensive GPS receiver units provide reasonably valid position information (error on the order of meters).

The U.S. Air Force controls the Global Positioning System of the United States, which is funded through taxpayer dollars mostly out of the Department of Defense budget. A network of 31 satellites currently comprises the GPS constellation (United States Naval Observatory, 2015). A baseline configuration of at least 24 satellites is needed for total coverage, and extra satellites may be rotated into the baseline when a satellite is damaged or requires servicing (National Coordination Office, 2015). The solar-powered satellites, weighing several thousand pounds each and encompassing various generations of technology since the 1990s, circle the globe twice each day at a distance of 20,000 km above the Earth. [See the references for details about the types and launch dates of the GPS constellation satellites.] The satellites are arranged into six planes spaced 60 degrees apart and inclined approximately 55 degrees with the equatorial plane (NAVSTAR GPS User, 1996). Each orbital plane contains at least four satellites in specific locations. The arrangement permits at least four satellites to be detectable by a receiver at almost any point on the Earth in any moment. The constellation baseline configuration was expanded in the year 2011 by repositioning six satellites to accommodate the addition of three more; the resulting operational baseline constellation of 27 satellites has improved coverage globally (National Coordination Office).

How does GPS work (basic)?

In order to determine an exact position via GPS, an Earth-based receiver uses data from four orbiting satellites simultaneously. All of the satellites regularly broadcast information about their position and the exact time (to an accuracy of nanoseconds). Time is a critical component of GPS, because despite the rapidity of the speed of light (i.e., radio signal), there is a delay between signal transmission from the satellite above and reception of the signal on the Earth below. It is this time lag that is actually used to determine the satellite distances from the receiver at the time of signal transmission. A clock in the receiver records the time the signal is received and computes the distance by comparing the reception time to the transmission time – embedded in the code of the satellite signal – to determine the time lapse in relation to the known speed of light. The time measured by the satellites and receiver must be in sync. However, this is not the case, so a correction must be applied.

Ideally, only three satellites would be required to trilaterate[1] the position of the receiver on the Earth, because three overlapping spheres provide two possible

1. Using lengths of the sides of triangles instead of angles, which would be triangulation.

locations for the receiver – one of which would be located in space above the planet and could be eliminated as a possible location. In reality, though, range data from a fourth satellite is used to correct the time of the clock in the receiver and adjust the distance calculations. Satellite time is measured using atomic clocks, and this same level of accuracy is needed by ground-based receivers to precisely define position. Since atomic clocks are expensive, and would be cost prohibitive if included in hand-held commercial grade receivers, the time from an independent, fourth satellite, is used to verify or adjust the time recorded by the receiver. If the measurement of distance to a fourth satellite intersects the identified location from the other three satellites, then the position of the receiver is *precisely* known; however, if it does not intersect, the receiver time is invalidated compelling the receiver to seek a single time correction that will unite all of the distance measurements in a common intersection point (Trimble Navigation Limited, 2015). The overall effect is to sync the receiver clock back up with satellite time.

There is the potential for several sources of error in the determination of position using GPS, including: ionospheric disruption; atmospheric refraction, or the slowing down of transmitted signals as they pass through the atmosphere; signal blockage and reflection from tall, ground-based objects; quality of the receiver; whether an augmentation system is used or not[2]; distribution of satellites in the sky (Dana, 1994; Trimble Navigation Limited, 2015). Additionally, the positions of the satellites in their orbits fluctuate slightly and decay over time, so ground-based monitoring stations use radar to track the satellites and send corrected position data to the satellites routinely. In this way, valid distance and time data is continuously available via satellite transmission to update the almanacs of satellite position in receiver units.

How does GPS work (more advanced)?

GPS satellites transmit on specific frequencies (e.g., 575.42 MHz, 1227.60 MHz), which are coded using complex pseudorandom noise (PRN) codes.[3] The PRNs allow for distinguishing between individual satellites (each having a unique code), minimizing the potential for receivers to lock onto other similar signals (natural or artificial), complicating possible jamming attempts, and enabling receivers to identify cycles for phase comparison (Dana, 1994; Trimble Navigation Limited, 2015). The data transmitted along with the code includes: transmission time, orbital data, almanac data, clock corrections, coefficients for ionospheric delay, and other information (NAVSTAR GPS User, 1996). The receiver determines which satellites it is receiving signals from, and then uses the best signals available for ranging. A receiver compares the transmitted satellite codes to the identical codes it uses, by shifting its code to align with the satellite code, and thereby, determining travel time from the phase shift (NAVSTAR GPS User, 1996). There are openly available codes for civilian use, and also restricted codes for the military.

Another, critical consideration of GPS, routinely omitted in many articles on the subject, relates to the relativistic effects (i.e., general and special) of satellites in orbit versus receivers on the surface of the Earth. Believe it or not, without also accounting for the relativistic effects, GPS would not work accurately enough to be useful!

The principles of general relativity pertain to observed effects and differences within gravitational fields, such as that of the Earth's. Time is observed to vary depending on proximity to a gravitational source (or, more correctly, varies based on the geometry of spacetime, which is affected by the mass of objects like planets, stars, black holes, etc.). Clocks at different distances from gravitational sources record time at different rates, with those farther away running faster (Taylor & Wheeler, 2000). The clocks on satellites keep different time than clocks in the receivers, and the differences must be taken into account. Similarly, special relativity explains that clocks in orbit, which are traveling much faster, will keep time at a different rate than the slower-moving clocks on the surface of the planet (Taylor & Wheeler, 2000). It turns out that these two relativistic effects oppose each other: the satellites orbiting high above the Earth experience an increase in the rate of time, due to the gravitational relativistic effects, and a decrease in the rate of time as a consequence of their velocity (special relativistic effect) compared to the Earth-based receivers. The gravitational effect, the more pronounced of the two relativistic effects, causes an overall increase in the time measured by the satellites, in comparison to the receivers, when both effects are combined (on the order of a few tens of thousands of nanoseconds) (Taylor & Wheeler, 2000).

There is more to GPS than a brief article on the topic can cover, so interested readers are encouraged to examine the references. For many of us, just having a basic understanding of the principles is enough. GPS is a multicomponent system comprised of at least three parts: space-based satellites, and ground-based receivers and monitoring stations. Simply put, satellites transmit signals to receivers, which decode the transmissions and translate them into coordinates of latitude, longitude, and elevation. Control and monitoring stations ensure the proper positioning of satellites in their orbits, and verify the transmitted signal data. The accuracy of position data depends on a variety of potential error sources and making appropriate corrections. Receivers with different capabilities and purposes may be purchased, with the major difference being cost. Even inexpensive GPS devices typically provide relatively accurate position data to within a few meters of true position.

GPS as a STEM Teaching Topic

At first glance, GPS may seem like a simple way to determine very accurate position information for a variety of uses. However, a closer inspection reveals that it is quite intricate, relying on a number of scientific principles, and consequently, presenting an excellent topic for an integrated STEM (science, technology, engineering, and mathematics) lesson. For example, the exploration of: orbital mechanics, atmospheric effects on light transmissions, embedding data in carrier waves, and time dilation [*science*]; the operation of atomic clocks, electronics and functioning of GPS receivers, and satellite advancements [*technology*];

2. Augmentation is any way to enhance GPS capability. An example is the network of Continuously Operating GPS Reference Stations (CORS) that receive GPS signals and transmit position data allowing users to gain greater accuracy in the coordinates of their position.
3. For details about the nuances of PRN and phase shifts, see the references.

design and manufacture of solar powered satellites and components of GPS [*engineering*]; line-of-sight signal reception, trilateration, and calculations of phase shift and time delay [*mathematics*].[4] In an instructional setting, GPS provides a range of possible complexity and topic coverage, depending on the goals and the intended audience. One possible lesson could be structured around a problem such as: how do we use satellites to determine locations on Earth via the global positioning system?

Featured Resource

Not surprising, this issue's featured resource is the *United States Government's Global Positioning Website* accessible at *http://www.gps.gov/*

The website provides details about the operation of the GPS, in addition to featured stories and articles about changes in GPS, uses for GPS, satellite types and innovations, FAQs, technical documents, legislative updates, budgets, videos, and more. The site also includes informational and educational handouts, and activities (found under the *Multimedia > Handouts and Multimedia > Tutorials* menu options respectively).

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4. The various concepts and topics of GPS transcend the specified and arbitrarily imposed boundaries, which makes it a great integrated lesson topic.

Royal Gold Donates $500,000 to Minerals and Energy Industries Center

RAPID CITY, S.D. (Aug. 31, 2015) – The South Dakota School of Mines & Technology has received a $500,000 donation from Royal Gold, Inc. ("Royal Gold"), to advance the university's minerals and energy industries programs, bringing a total of $1.5 million raised this year for the project.

Royal Gold is a precious metals royalty and stream company engaged in the acquisition and management of precious metal royalties, streams and similar production based interests. Based in Denver, Colorado, Royal Gold owns interests on 198 properties on six continents, including interests on 38 producing mines and 25 development stage projects.

The gift will be dispersed over a five-year period and will support renovation of the current Mineral Industries Building that houses the Departments of Geology & Geological Engineering, Mining Engineering & Management and Materials & Metallurgical Engineering. The project is estimated at $17 million and is expected to be completed in 2022.

"This is a very generous donation from an industry leader. Mines prepares exceptional graduates in a facility that needs to be refurbished. We appreciate very much the commitment of industry to help with that effort," said South Dakota Mines President Heather Wilson.

"The South Dakota School of Mines provides an excellent technical foundation to students entering the mineral and energy industries, as evidenced by its strong placement record and numerous alumni serving critical roles in our business," said Royal Gold President and CEO Tony Jensen. "Royal Gold is pleased to assist in enhancing the school's core infrastructure to ensure that its technical leadership continues well into the future."

Wilson and Foundation staff have been working with department heads and a task force representing their advisory boards to secure funds to expand and enhance South Dakota Mines' expertise in the minerals and energy industries. In addition to the gift from Royal Gold, another $1 million has been secured from a donor who wishes to remain anonymous.

"This generous gift from Royal Gold reflects a confidence from industry in our already strong minerals and energy programs. We hope it will inspire others to support the School of Mines as we move forward with our expansion plans," said Foundation President Joel Kincart.

SD Mines is one of only five universities in the United States that teach the three core minerals industry disciplines – economic geology, mining engineering and metallurgical engineering.

The South Dakota Board of Regents approved the development of a preliminary design of a renovated Mineral and Energy Industries Center of Excellence in June 2014. The Clark Enersen Partners Science & Research Design Group, an architectural firm in Kansas City, Missouri, was selected for the project. The firm has already completed its preliminary feasibility assessment and is working on a programming and conceptual design study before creating a detailed design and construction plans.

The updates to the center will enhance education, engineering design, and research collaborations among the departments and industry partners while strengthening experiential learning and attracting diverse, high-quality students and faculty.

Dr. M. Dean Kleinkopf, CPG-593. The national geologic community and the Tobacco Root Geological Society in particular have lost one of our long term and most distinguished members. Dr. Kleinkopf passed away in Henderson, Nevada, Saturday, August 1. A three-year cancer survivor, he fought a courageous battle with a positive attitude until the end. Dean loved his family, rocks, wine and spirits, pie, traveling with his wife, Nancy, and stayed in good enough shape to hike the Grand Canyon at age 77.

Appointed to West Point, Dean then served in the Navy during World War II. Returning home, he earned a mining engineering degree from what is now the Missouri University of Science and Technology at Rolla. He received his PhD in Geology from Columbia University in 1955, and promptly accepted a position at Chevron Oil as an exploration geologist for petroleum in the Western United States and Alaska for ten years. In 1965, he moved his young family to Denver to work for USGS at the Federal Center in Lakewood.

In September 1988, Dean married Nancy. Over the last twenty-seven years, they spent many weeks abroad on adventurous foreign travels: Europe, Asia, Africa, even the Middle East. Dean remained a civil servant until 2000. After retiring, the couple built a home in Mesa, Arizona. His status changed to Emeritus Geologist when he joined the USGS Tucson office, adding his expertise for several years before uprooting, and relocating to Nevada as a sincere retiree.

During his 33-year tenure as a Research Geophysicist/Geologist, Dean worked overseas extensively, including Thailand, Bangladesh, Indonesia, and Saudi Arabia. He worked in many U.S. states as well, focusing primarily on geophysics in Montana, Idaho, and Colorado. He produced innumerable USGS publications, including professional papers, open-file reports, and aeromagnetic and Bouguer anomaly maps. He also worked extensively in the Belt, including older projects such as RARE II and the Upper Mantle Project. He studied the regional gravity and magnetic anomalies of the Stillwater Complex, and contributed to Special Publication 92 produced by the Montana Bureau of Mines and Geology. His journal articles and abstracts were published in the Geological Society of America's Geology and GSA Bulletin, the American Geophysical Union's Eos, and the Tobacco Root Geological Society's Northwest Geology.

Service work for professional societies was important to Dean, giving generously of his time and council. His many memberships included the American Association of Petroleum Geologists and the American Geophysical Union; he was certified by the American Institute of Professional Geologists and was elected President of the Arizona Section in 2004; he became a Fellow in the Geological Society of America, serving as President of the International Division in 2002-2003, and serving a three-year term on GSA's Annual Program Committee representing the International Division.

Dean was one of the first regular attendees of the Tobacco Root Geological Society, and rarely missed a meeting in its 40-year history. He made newcomers feel welcome, served on several committees, was elected President in 1987-1988, and then appointed to the Board of Directors in 1989. He received the Society's highest honor, the "Hammer" award, in 2004, and was granted Honorary Member status in 2010.

Dean Kleinkopf had been a kind-hearted, knowledgeable, and compassionate man. He will be sorely missed by Nancy, his four children, twelve grandchildren, and a host of friends and colleagues.

Peter W. Hummel, CPG-2325, passed away July 25, 2015. Born on the 4th of July 1929, Peter dedicated his life to his family, his extended family, the Boy Scouts of American, the State of Nevada and the U.S. Navy during the Korean War.

A graduate of Stanford University and Harvard Business School, Peter was active in minerals exploration in Nevada and the Rockies. He served on the Nevada Minerals Commission for 25 years and was instrumental in establishing current rules and regulations for mineral exploration in Nevada.

Peter was a member of the Reno Prospectors Club for 57 years. His social involvement included being a member of the Rancheros Visitadores, the Los Angeles Country club and was a Bohemian

Peter believed strongly in duty to his country, the valuable life lessons taught through the Scouting program and the important love connection between people and their animals. Peter led a full and adventurous life - may he rest in peace.

Henry Baker
MEM-1008
Member Since 2012
2015
Sarasota, Florida

Peter W. Hummel
CPG-2325
Member Since 1971
July 25, 2015
Reno, Nevada

M. Dean Kleinkopf
CPG-0593
Charter/Emeritus Member
Member Since 1965
August 1, 2015
Henderson, Nevada

Is Your Profile Correct?

It is important to keep your address, phone numbers, and e-mail information up to date in our records. Please take the time to go to the AIPG National Website, ***www.aipg.org,*** login to the member portion of the site and make sure your information is correct. You can edit your record online. If you do not know your login and password you can e-mail National Headquarters at *aipg@aipg.org* or call (303) 412-6205.

REQUEST FOR NOMINATIONS

The AIPG Awards Committee is seeking nominations for future recipients of the Ben H. Parker Memorial Medal, the Martin Van Couvering Memorial Award, the John T. Galey, Sr. Memorial Public Service Award, Honorary Membership, and Outstanding Achievement Award. The qualifications for these awards can be found below. Nominations for these awards, accompanied by supporting statement, should be sent to AIPG Headquarters, c/o Honors and Awards Chr., 12000 Washington St., Suite 285, Thornton, CO 80241.

BEN H. PARKER MEMORIAL MEDAL

The Ben H. Parker Memorial Medal is the Institute's most distinguished award. It was established by the Executive Committee in 1969 in posthumous honor of a truly great leader, who devoted much of his life to improve the quality of geology and geologists and the services they provide. The medal is awarded to individuals who have long records of distinguished and outstanding service to the profession.

The most important criterion for this medal is a continual record of contribution to the profession of geology. A wide variety of contributions can be considered, such as (a) the education and training of geologists, (b) professional development of geologists, (c) service to the Institute, (d) leadership in the surveillance of laws, rules, and regulations affecting geology, geologists, and the public, and (e) activity in local and regional affairs of geologists.

MARTIN VAN COUVERING MEMORIAL AWARD

The Martin Van Couvering Memorial Award was established by the Executive Committee in 1979 in posthumous honor of the first president of the Institute. Martin Van Couvering made the presidency a full-time occupation for the first two years of the Institute's history. His dynamic leadership, diplomacy, and organizational abilities established the solid foundation from which the Institute has grown. Few, if any, have given so much to the Institute.

The most important criterion for the Martin Van Couvering Memorial Award is service to the Institute. As in other awards, a wide variety of contributions to the Institute may be considered. By far the most important contribution a geologist can make to the Institute is that of time. It is the contributions by individuals to the Sections, the committees, and special projects that enable the Institute to enhance the practice of geology.

JOHN T. GALEY, SR., MEMORIAL PUBLIC SERVICE AWARD

The American Institute of Professional Geologists' Public Service Award was established by the Executive Committee in 1982 in recognition of one of its primary purposes: service to the public. In 1992, it was renamed the John T. Galey, Sr., Memorial Public Service Award, in posthumous honor of our fourth President, whose long professional career was a continuum of service to both the geological and the general public.

Recognition of public service is important because so many Members have distinguished themselves and the Institute by giving expert testimony to governmental commissions and committees, and by providing geological expertise where it was needed by the public at large.

The application of geology to the needs of the general public may be in many different forms. Recipients of this award have outstanding records of public service on the national, state, or local level well beyond their normal professional responsibilities.

AWARD OF HONORARY MEMBERSHIP

Since 1984, AIPG has conferred Honorary Membership to those who have an exemplary record of distinguished service to the profession and to the Institute.

OUTSTANDING ACHIEVEMENT AWARD

The Outstanding Achievement Award was established by the 1989 Executive Committee to honor a non-member of AIPG who is widely recognized as a major contributor to the profession of geology. The award is not necessarily given annually, but only when the Awards Committee recommends an outstanding candidate to the Executive Committee for their consideration.

American Institute of Professional Geologists
Nomination form for 2016 AIPG Awards

(Please check one)

☐ Ben H. Parker Memorial Medal ☐ John T. Galey, Memorial Public Service Award

☐ Martin Van Couvering Memorial Award ☐ Award of Honorary Membership ☐ Outstanding Achievement Award

NAME OF CANDIDATE:________________ Telephone:________________

Address:________________________ Fax:________________

Address:________________________ E-Mail:________________

NAME OF PERSON MAKING THE NOMINATION:________________ Telephone:________________

Address:________________________ Fax:________________

Address:________________________ E-Mail:________________

Signature:________________________ Date:______________

Supporting Statement (In brief here, **please submit detailed letter of support**):____________________

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RETURN TO: AIPG, Attn: Awards, 12000 Washington St., Suite #285, Thornton, CO 80241. Ph. 303-412-6205, Fax: 303-253-9220
DEADLINE: Completed nominations must be received by **January 15, 2016.**

Looking Back

Stephanie Jarvis, YP-0125,
stephaniekjarvis@gmail.com

My favorite annual issue of *TPG* is the one with the scholarship essays in it. I always find it refreshing to read the stories of rock collections and great teachers, of early explorations and mind-blowing revelations, of the enthusiasm that comes from finding a passion and having the freedom to thoroughly explore it. It's a good reminder of my own enthusiasm for the science and the possibilities—enthusiasm that can occasionally get buried in the day-to-day. This year's batch prompted me to go dig up my own scholarship essay from 2009 ("Gertrude and the Gorge: The beginnings of a Geologist"). I expected to be embarrassed by my idealistic younger self and to feel disconnected from the aspirations of long ago. At the very least, I figured I'd get a good laugh. I was surprised by how true it still rang, in some ways feeling truer than much of what I've written recently. Sometimes, we have a lot to learn from our younger selves.

David Abbott, CPG-4570, who is much better at keeping up with such things than I, recently noted that this column marked six full years as a regular *TPG* columnist for me. Six years of scrambling for topics at the last minute, of fully exploiting my naive-student/YP status to address controversial issues, and of hashing out issues I hadn't been able to articulate until I was writing whatever came to mind and suddenly found myself with a column. A lot has happened in six years, though to attempt to summarize it in hindsight makes it seem pretty boring. A few things have stayed consistent, including my enthusiasm for the science and my mom's willingness to be my personal editor (thanks Mom!!). To say I have appreciated the opportunity to share my thoughts and experiences during that time with AIPG would be an understatement. I am, however, feeling the need for a break from being a regular columnist and six years is a good milestone to pause and reassess. Therefore, this is the last of the Young Professional Column you will be seeing from me, though I am sure I will be writing guest columns from time to time. Any other YPs out there, I strongly encourage you to step up and share your prospective with us! It is truly a great experience.

Once again, I am incredibly grateful for the opportunity to be part of *TPG*. I have learned so much from the feedback I've received and the people I've met (both in person and virtually) over the years, and I look forward to continuing my involvement with AIPG in other ways. Thanks for reading, and congratulations to the 2015 Scholarship winners!

UC Davis-AIPG Califonia Section had an initial meeting on October 7, 2011. The highlight of the meeting was introducing a new co-advisor for the UC Davis Student Section Prof. Nicholas Pinter.

Dr. Pinter (left in the photo) is the Shlemon Chair in Applied Geology Dept. of Earth and Planetary Sciences and Center for Watershed Sciences at the University of California Davis. Dr. Zierenberg will continue as a co-advisor, but is on a sabbatical this year. The new co-advisor is an expert in applied geologic problem solving and he presented an overview of his interesting fluvial forensic cases that he has worked on during the past few years. Steve Baker and Bob Sydnor, California Section Student Mentors answered professional geology questions. Chris Holt, the new UC Davis Student Section president and James Jacobs, sponsor were also present.

Calling all members… *TPG* is your magazine! We're starting a new feature on field work adventures, or possibly more aptly named "misadventures." The idea was suggested by CPG Jim Burnell.

Most geologists have conducted field work at some time for a project, research, or non-work pleasure - please consider your field experiences and write us a story to share, especially with newer geologists. The field piece could be about one of your adventures that was the most rewarding, challenging, funny, hapless, dangerous, in an unlikely location, etc.

We know you have a good story out there! Were you swinging from a helicopter, chased by a bull, stranded on an ice floe, drilling in -50 wind chill, or filleting lizards to survive the desert? Or maybe you were pulled over by police and taught how drive a manual shift in a foreign country like student member columnist Franklin Wolfe (see page 42)!

Perhaps your "field" was in a court room or speaking at a public presentation, and involves a good story about interacting with non-geologists. Have you been pummeled by tomatoes, misquoted to the point of humor or embarrassment, questioned by bungling counsel and shot back a good geologic retort? We await your response...

Research Doldrums

Kristina Pourtabib, SA-3410
pour1824@vandals.uidaho.edu

For anyone that has been or is currently involved in working on research, the "research doldrums" are something that should be very familiar to you. In fact, I happen to be experiencing it right at this very moment. These slow points in your work are either self-induced or are the result of having to wait on other aspects of your research to wrap up before you can move on. Come to think of it, in my case, my research doldrums are probably attributed to my end of summer procrastination. Everyone can relate to the pre-summer procrastination that comes when school starts to wind down and everyone waits in giddy anticipation of their summer travels, but end of summer procrastination is just as apparent. The truth is, research can get dull at times, and it can be difficult to stay motivated, thus part of my struggle with research right now.

Excitement related to doing research comes in waves. One minute you are completely wrapped up in enthusiasm about the work you are producing, and the next you are frustrated about something not turning out as planned. For these moments it is important to take a step back from the work you are doing and focus your attention on something completely unrelated. By diverting your attention to another task, you are able to let go of your frustrations and get back to your research with a clear mind and refreshed point of view for problem solving. I have shared in previous *TPG* articles about my own research frustrations in both my career as an undergraduate and graduate researcher. I think that dealing with countless research hurdles in my undergrad really helped me to see any hurdles I faced in my graduate career as not being so bad. Once you get hung up on one thing not panning out, then the rest of your work seems to falter. I remember when I experienced my first setback as an undergrad, I thought my research project was ruined, and then after the next setback I was already feeling better about my ability to adapt and redirect my research course. After that, handling new setbacks became much easier to digest. There comes a point when you just have to realize that you've done the best you can and everything will work out, if not the way you had originally planned then in hopefully a better way. A few of the main points I've gathered about research are that 1) it gets frustrating, 2) timelines are not definite, and 3) it's important to take enjoyment in little accomplishments along the way. My research philosophy is not perfect, but it has been working for me (for the most part), and it's up to the individual to come up with the best work plan for himself or herself in order to reach their own goals.

Don't let these research doldrums deter you from ultimately making advances in your work. Sometimes it's good to take a mental break from what you're doing in order to reevaluate the overall goal of what you're trying to accomplish. Research is a process that takes time and persistence to complete. It's important to realize that you can only control yourself and your personal outlook towards research. You are bound to run into hiccups with your work, but the real test is learning how to overcome difficulties and continue in your work.

****Attention Students****

Are you going to grad school?

Have you graduated?

Please notify AIPG Headquarters so we can keep your contact information updated.

aipg@aipg.org

Your section needs to start a *Student Chapter Today*. Contact Vickie Hill at AIPG Headquarters for more details.
vlh@aipg.org

AIPG Executive Director Position Announcement

The American Institute of Professional Geologists is accepting applications for the position of Executive Director. The position is to be filled as soon as a qualified candidate is vetted. Applications will be accepted until the position is filled. Details can be found at *www.aipg.org/ExecDirPosition.pdf*

Development of 3D Geologic Models in Europe

Franklin Wolfe, SA-4334
wolfef16@mail.wlu.edu

The Glarus Thrust.

Santa Maria de Montserrat Abbey.

I set out with Stephen Ball (WLU '16) on an amazing journey this summer to gather data for creating 3D geologic models of famous rock outcrops at the Montserrat Mountain in Spain and the Glarus Thrust in Switzerland and to understand the cultural diversity of visitors to these locations. Our journey began at Montserrat Mountain, a serrated, multi-peak mountain near Barcelona that is famous for the majestic Benedictine monastery of Santa Maria de Montserrat, perched a thousand meters above the valley. Montserrat Mountain is part of the Catalan Pre-Coastal range and was formed during the Eocene from an accumulation of gravels, sands, and clays deposited as a delta in an inland sea. During the Oligocene, the Catalano-Balearic massif collapsed, creating a structure that lifted the conglomerate to its present elevation. Since this time, rainwater has infiltrated the joints of the conglomerate and weathered them into their 'rounded-pillar-like' appearance.

Each morning started with a breathtakingly beautiful, and equally terrifying, cable car ride from the valley floor to the monastery. A typical day included hiking the monastery's grounds on pathways that snaked around the side of the mountain, lined with countless religious statues, engravings, and iconographic images. Through our treks, we took over 500 photos of the monastery and the mountain to use back at W&L (Washington and Lee University) in developing our 3D geologic models.

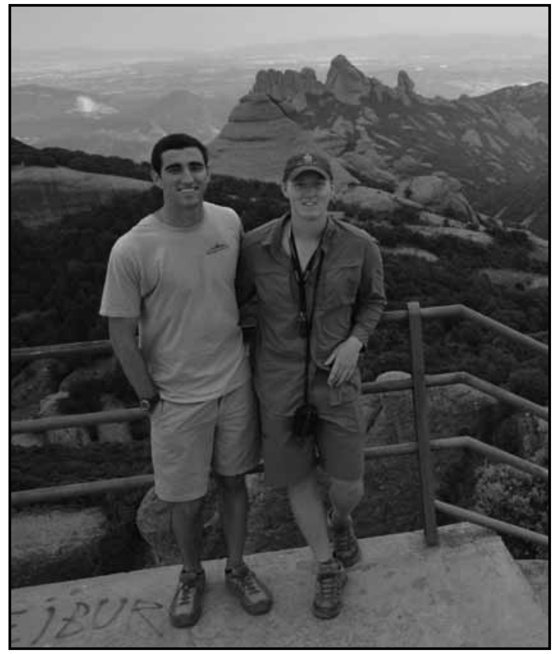
We learned from interviews with visitors that people worldwide converge on Montserrat. At the basilica's entrance, we met a man from South Korea who had come to pray at Our Lady of Montserrat, a landmark statue of the Virgin Mary and infant Christ. My most moving experience happened on the last day. As I entered the basilica, a family rushed up behind me, breathing heavily and franticly, and immediately began weeping and praying when they saw the statue. This demonstration of such raw emotion made the importance of Montserrat extremely real for me.

Next, we journeyed to Zurich, Switzerland where we faced an unexpected challenge on our first day. If you have learned to drive a manual transmission vehicle, I am sure you can relate to this experience: turn the key in the ignition…Press down the clutch…Shift into first gear…Slowly apply pressure to the gas pedal, while releasing pressure from the clutch… Stall out…Start over… Stall out again. However, I bet your experience did not land you in the back of a Swiss police car. After stalling out many times and creating a 10-car traffic jam (including an 18-wheeler) at an inclined intersection, blue lights flashed in our rearview mirror. Stephen from the left-side passenger seat said exactly what I was thinking, "I knew we shouldn't have rented the manual." Thankfully, the two Swiss police officers were not there to arrest us. Instead, they commandeered our vehicle, put us in the back of their police car, drove us to a nearby parking lot, and gave us a 15-minute driving lesson. After this rocky start, and having "mastered" driving our manual car, we traveled the winding Alpine roads to the Glarus Thrust in the eastern Swiss Alps.

The Glarus Thrust is defined by a razor-sharp fault plane that cannot be missed by the naked eye. The thrust developed as the European and African continents collided in the Eocene, causing a kilometer-thick layer of rock to be translated 40 kilometers and pushing much older rocks (250-300 Ma) on top of younger rocks (35-50 Ma). At the Glarus Thrust, we collected photos to use in developing another 3D geologic model. The biggest challenge we faced at this location was that we were literally "in the clouds" for most of our time near the rock outcrops of interest. We often had to sit in the snow for long periods of time waiting for a clearing so that we could take the "money shot."

We are currently finalizing our 3D geologic models. Creating a model utilizes a new geospatial technique known as photogrammetry, in which identical features of the rock outcrops are aligned from multiple photos taken at different orientations to develop a 3D image. The model can then be visualized digitally and rotated in any direction or printed using a 3D printer. We hope W&L geology professors might use these scaled-down models of real world rock outcrops as a teaching tool. We are also preparing our cultural booklet with information about each site we visited and our interviews.

My summer research project was an awesome opportunity, and I am extremely grateful for the W&L Johnson Opportunity Grant. This grant provided me the opportunity to integrate my passion for geology with my interests in exploring new cultures and places. Navigating foreign landscapes, learning new geologic concepts, gaining practical field experience, and working with Stephen to overcome daily challenges were unparalleled learning experiences and a highlight of my time at W&L.



Stephen and I at Sant Jeroni's peak.

Hiking to the top of an adjacent ridge to take photos of the Glarus Thrust.

Hiking to Saint Jeroni's peak in Montserrat.

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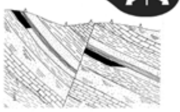

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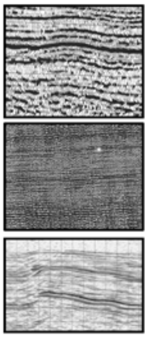

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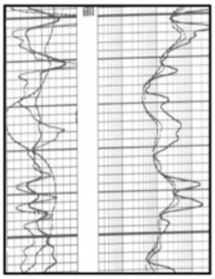

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General Stratigraphy of the Usibelli Coal Mine, Healy, Alaska
The Central Alaska-Nenana Coal Province

Compiled By Jean M. Neubeck, CPG-11438

Editor's note: The 2015 AIPG annual meeting in Anchorage featured several field trips including an excursion to the Usibelli Coal Mine on September 20, 2015. The following information was provided through Usibelli Coal Mine, Inc. (UCM) where not otherwise cited. The abbreviated descriptions of the geologic formations are based on a 2004 USGS report that was excerpted and modified for the AIPG field and further edited for TPG. We thank Bill Brophy, V.P. Customer Relation, and Justin Seavey, Sr. Mining Engineer for their guidance on the field trip, and UCM geologist Mitch Usibelli, who is a member of the Usibelli family that owns and operates the mine. Additional sources are cited within the corresponding text, as applicable.

Coal is the most abundant fossil fuel in the U.S., which produces about 1 billion tons of coal annually, based on 2009 data. Twenty-seven percent (27%) of the world's coal is located in the U.S. and half of all U.S. coal resources are found in Alaska. Nearly 30 percent of U.S. mines are owned by public companies that produce approximately 75 percent of U.S. coal. Approximately two-thirds of coal production in 2009 within the U.S was from surface, rather than underground, mining.

UCM has identified a surface mineable reserve base of approximately 700 million tons, of which, 450 million can be classified as proven and 250 million as probable utilizing surface mining techniques. Approximately 35,100 acres (14,200 hectares) are under coal lease primarily from the State of Alaska. Mining is primarily from seams 3, 4, and 6 of the Suntrana Formation. These seams average approximately 18' (5.5m), 30' (9.1m), and 24' (7.3m) respectively. The 2015 annual UCM production level is approximately 1.5 million tons (1.35 million metric tons).

Subbituminous coal is generally considered a soft coal and relatively young, between 10 and 50 million years old. It can have a medium to high moisture content, but has lower moisture and higher heat content than lignite. This rank of coal is typically used for generating electricity. Subbituminous coals are mined primarily in the Powder River Basin of Wyoming and Montana.

Coal from the Usibelli mine is approximately 8 to 20 million years old and is ranked Subbituminous C. The age of the coal is one factor which determines its contained energy value. At 7,800 BTU, Usibelli coal is well suited for use in power plants for steam production which is utilized to spin the electrical turbines. The steam then can be utilized for heating commercial buildings and structures, resulting in its dual use of energy for both electricity and heat, or "cogeneration."

The US Energy Information Administration website *http://www.eia.gov/coal/* contains an Annual Coal Distribution Report (ACDR). The ACDR (excerpted bullets below from 2013) provides detailed information on domestic coal distribution by origin state, destination state, consumer category, and method of transportation. Also provided is a summary of foreign coal distribution by coal-producing state. Some highlights in 2013 included:

- Total coal distributions for 2013 were 976.0 million short tons (mmst), a decrease of 2.7% compared with 2012.
- Distributions to domestic destinations were 858.3 mmst, a decrease of 19.0 mmst (i.e. 2.2% decreases) compared with 2012. Distributions to foreign destinations were 117.7 mmst, a decrease of 8.1 mmst (i.e. 6.4% decreases) over 2012.
- Wyoming was the leading origin state of coal, accounting for about 385.5 mmst of domestic shipments, while Texas was the leading destination for coal, accounting for about 99.0 mmst of receipts.
- Railroads moved about 67.9% of the domestic coal, while river accounted for 12.6%, truck about 11.5% and tramway, conveyor, and slurry pipeline accounted for 8.0%. Great lakes and tidewater pier transport modes accounted for less than 0.1% of the total shipments.
- The electric power sector received approximately 92.5% of the domestic distribution, while industrial plants excluding coke received 5.0%, coke plants about 2.3%, and commercial and institutional plants about 0.2%.

Coal seams #3 and #4 are exposed in this spectacular natural outcrop of the coal-bearing rocks north of Hoseanna Creek, near Healy, Alaska. The two coal seams are typical of the ultra-low sulfur subbituminous coal found in the Nenana coal field and mined at UCM.

"Mining Coal is Easy. Getting to it is the Hard Part."

The Nenana Coal Field is currently the only active coal producing field in Alaska and has produced a record 50 million tons of coal. At the Usibelli Coal Mine in Healy, up to 100 feet of unconsolidated sandstone or overburden must be moved to uncover the top seam (seam 6) of coal. Another 120 feet of interburden must be moved to uncover the second seam

(seam 4), and roughly 80 feet of interburden must be removed to uncover the third seam of coal (seam 3) reaching nearly 400 feet at its deepest point. The overburden is removed by four different methods: 1) The dragline removes the bulk of the overburden; 2) Blasting utilizing explosives loosens and casts the overburden; 3) Bulldozers move overburden short distances prior to drag line operations; and, 4) Shovels strip and load overburden and coal into the haul trucks.

The following information is excerpted from the USGS publication: "Alaska Coal Geology, Resources, and Coalbed Methane Potential," Romeo M. Flores, Gary D. Stricker, and Scott A. Kinney (2004), DDS–77 USGS, and was edited for TPG by Jean M. Neubeck. The complete report with cited references can be found at: https://catalog.data.gov/dataset/alaska-coal-geology-resources-and-coalbed-methane-potential.

Clyde Wahrhaftig(USGS) deserves special recognition for his geologic work and mapping that the USGS references throughout their report. Interested readers can use the following link to download the local Healy D-4 Quad Geologic Map that covers the area that AIPG members toured during the field trip. The map contains the type section of the coal-bearing formations at Suntrana Creek: http://ngmdb.usgs.gov/Prodesc/proddesc_2108.htm

Estimated Alaska coal resources are largely in Cretaceous and Tertiary rocks that are distributed within three major provinces; NorthernAlaska-Slope, Central Alaska-Nenana, and Southern Alaska-Cook Inlet. Most of the Tertiary resources, mainly lignite to subbituminous coal with minor amounts of bituminous and semianthracite coals, are in the provinces of Southern Alaska-Cook Inlet, and also the Central Alaska-Nenana province, which is sumamrized herein.

The combined measured, indicated, inferred, and hypothetical coal resources in the three areas are estimated to be 5,526 billion short tons (5,012 billion metric tons), which constitutes about 87 percent of Alaska's coal and surpasses the total coal resources of the conterminous United States by 40 percent.

Coal mining has been intermittent in the Central Alaskan-Nenana and Southern Alaska-Cook Inlet coal provinces, with only a small fraction of the identified coal resource having been produced from some dozen underground and strip mines. Alaskan coals have a lower sulfur content (averaging 0.3 percent) than most coals in the conterminous United States and are within or below minimum sulfur value mandated by the 1990 Clean Air Act amendments.

The identified resources are near existing and planned infrastructure to promote development, transportation, and marketing of this low-sulfur coal. The relatively short distances to countries in the west Pacific Rim make them more exportable to these countries than to the lower 48 States of the United States.

Central Alaska-Nenana Coal Province and Mining History

The Central Alaska Nenana coal province is in the northern foothills of the Alaska Range, extending from about 50 mi (80 km) west to 50 mi (80 km) east of the Parks Highway and Alaska Railroad corridor. It consists of several east-west trending synclinal basins partly or wholly detached from each other by erosion of coal-bearing rocks from intervening structural highs. These coal-bearing synclinal basins are recognized as coalfields that include the Jarvis Creek, East Delta, West Delta, Wood River, Mystic Creek, Tatlanika Creek, Lignite Creek, Healy Creek, Rex Creek, and Western Nenana coalfields. The Healy Creek (aka Suntrana) and Lignite Creek (aka Hoseanna) deposits are currently mined and account for the majority of coal historically mined in Alaska.

The construction of the Alaska Railroad provided the initial transportation to market. In 1918, underground coal mining by the Healy River Coal Corporation began at Suntrana, 4 mi (6.4 km) east of the confluence of Healy Creek and the Nenana River. Horse-drawn sleds to the railroad camp in Healy originally transported coal until a railroad spur was built to the mine in 1922. The Healy River coal mine accounted for one-half of Alaska's production from 1920 to 1940. The rest of the production was from the Evan Jones mine in the Matanuska coalfield in the Southern Alaska-Cook Inlet coal province.

The military buildup in Alaska in the 1940s and after World War II provided a new market for coal that resulted in opening more mines to meet the demand. UCM opened the first surface mine in the coal province east of Suntrana in 1943. In 1961, UCM purchased the Healy River Coal Corporation and continued mining underground. The Arctic Coal Company opened a small mine on Lignite Creek and operated it until 1963. The Vitro Mineral Mine was opened in 1963 east of Suntrana and was purchased by UCM in 1970. UCM remains the only active coal mine in Alaska today.

(UCM reports that it delivers coal directly to Golden Valley Electric Association's Healy #1 and #2 mine-mouth power plants by truck and also supplies coal northward by rail to five additional Interior Alaska power plants. UCM has also supplied coal to the south by rail and onto ocean-going vessels out of the Seward Coal Terminal for international export since 1985.)

Tertiary Usibelli Group

The Usibelli Group (Wahrhaftig, 1987), a nonmarine sedimentary sequence of Tertiary age, consists, from bottom to top, of the coal-bearing Healy Creek Formation, Sanctuary Shale Formation, coal-bearing Suntrana Formation, Lignite Creek Formation and Grubstake Formation. The group is overlain unconformably by the Nenana Gravel Formation.

As many as 30 coal beds are recognized in the Usibelli Group, which are mainly 2.5 ft (0.7 m) thick but can be as much as 30 ft (9.1 m) thick. UCM has encountered and mined seams as thick as 40-60 feet. The depositional environments of the Usibelli Group have been interpreted as fluvial and lacustrine deposits.

Healy Creek Formation

The Healy Creek Formation is the oldest rock unit in the Usibelli Group. The formation is as thick as 445 ft (136 m) and consists of interbedded sandstones, conglomerates, siltstones, and mudstones, including carbonaceous shale and coal beds. Sandstone is the most common rock type and coal is the least common. The formation unconformably overlies the pelitic and quartzose schist sequence with erosional relief of as much as a few hundred feet. In most of the synclinal coalfields, the Healy Creek Formation is early to middle Miocene.

The Healy Creek Formation consists mainly of fining-upward sequences of conglomerates, sandstones, and silty sandstones. The Healy Creek Formation was interpreted to originate as braided to high-sinuosity stream.

Sanctuary Formation

The Sanctuary Formation is composed mainly of 130 ft (40 m) of gray, thinly laminated, varved mudstone and shale that weathers to chocolate brown in color. The formation also contains minor sandstone, siltstone, and limestone. This formation conformably overlies the Healy Creek Formation and is assigned to the middle Miocene. The Sanctuary Formation is interpreted to have accumulated in a large, shallow lake.

Suntrana Formation

The Suntrana Formation unconformably overlies the Sanctuary Formation and is as thick as 1,310 ft (400 m). The formation as a whole, thickens gradually southeastward and pinches out in the northwestern part of the coal province. It consists of interbedded sandstones, siltstones, mudstones, carbonaceous shales, and coal. Coal beds are interbedded with carbonaceous shales and have a combined thickness ranging from 1.6 to 65 ft (0.5 to 20 m). Most of the coal beds can be traced laterally over distances of as much as 15 mi (25 km). Three of the thicker beds (Nos. 3, 4 and 6) are currently mined at UCM's Two Bull Ridge and Jumbo Dome mine sites. The Suntrana Formation was assigned to middle Miocene.

The fining-upward, erosional-based sandstones of the Suntrana Formation probably were deposited in braided streams by migrating longitudinal bars and transverse side channel bars. A thick coal bed commonly overlies the fining-upward sandstones, which reflect accumulation of peat on raised mires.

Lignite Creek Formation

The Lignite Creek Formation, ranging from 490 to 790 ft (150 to 240 m) thick, overlies and is conformably gradational with the Suntrana Formation. The Lignite Creek consists of interbedded sandstones, siltstones, mudstones, carbonaceous shales, and coals. The sandstones are fining-upward pebble to coarse grained in the lower part and fine grained in the upper part. The dominant mudstones and sandstones in the Lignite Creek Formation reflect its deposition in a high-sinuosity or meandering stream setting.

Grubstake Formation

The stratigraphically highest formation assigned to the Usibelli Group is the Grubstake Formation. This formation consists of dark gray laminated shale and mudstone that is 590–980 ft (180–300 m) thick in the northeastern part of the Nenana coal province but only 2–6 ft (0.6–1.9 m) thick in the southwestern part. The Grubstake Formation probably accumulated in a lake closely similar to that of the Sanctuary lake.

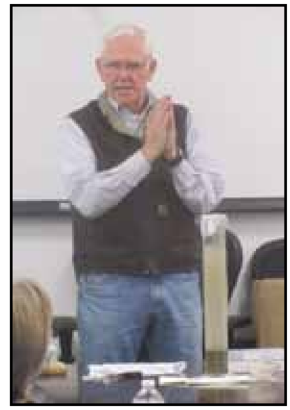
Nenana Gravel

The Nenana Gravel consists of poorly consolidated, buff to red, pebble- to boulder-size conglomerates overlying the Usibelli Group. It ranges in thickness from 3,940 ft (1,200 m) at the south edge of the Nenana coal province to 980–1,310 ft (300–400 m) along the north edge of the Alaska Range foothills. It is comprised of gravel detritus that was shed northward from the rising Alaska Range. Its age is bracketed between 8.3 and 2.75 Ma. The Nenana Gravel is much more widely distributed than the Usibelli Group, which is primarily confined to synclinal basins deformed early in the orogeny that later deposited the Nenana Gravel.

Photo of the "drag line" in action at the Usibelli mine. The massive machine removes overburden with a capacity rate of 30 to 40 cubic yards. For scale, a pick-up truck is visible at the base of the drag line that was named by local students as "Ace in The Hole." Photo by Chris Arend.

A typical train loaded with Usibelli coal to be delivered along Alaska's scenic railways. Photo by Chris Arend.

Bill Brophy (UCM) demonstrates to AIPG field trip participants how process water from mining operations is treated to cause sediment to flocculate and settle to the bottom for initial removal of suspended particles.



The AIPG field trip group poses in front of a UCM dump truck, and is dwarfed by the tires. And you think you pay a lot for new tires… these run into four-figures each.

Very large equipment is required to move material efficiently for mining in general and at the Usibelli mine. A bulldozer with its load of coal is shown here. Photo by Chris Arend.

The shovel capacity of a loader is demonstrated by the people for scale. Photo by Chris Arend.

The mining machinery are impressive at moving large volumes of material, as shown here by a typical loader and dump truck in action. Photo by Chris Arend.

Connections and Networking in Unusual Places: Awareness of Sewer Air and Vapor Intrusion

James A. Jacobs, CPG-7760

In a very unsettling way, we are more connected than we think. Although these connections may not be well documented or until recently, even widely acknowledged, some subsurface conduits such as our sewer pipes may provide a pathway for toxic chemicals to enter into our work and living spaces. Earth scientists have long been involved with developing site conceptual models for releases of hazardous compounds and in assessing and determining the fate and transport in the subsurface and associated exposure pathways. In some cases, geologists and other professionals evaluate human exposure pathways and, specifically, indoor air quality in relation to groundwater plumes containing volatile organic compounds (VOCs).

Up to now, one human exposure pathway from subsurface VOC plumes has not received evaluation. Recent studies document that legacy sewer-plumbing systems, land drains and subsurface utility conduits/lines/trenches are exposure pathways for VOCs in the shallow subsurface to migrate into indoor air. The term legacy sewer refers to a sewer which through time allows leakage into and also out of the pipes and components. Sewer air (the air space above the transiting sewer wastes in the pipes) in leaking sewer systems that intercept VOC contaminated groundwater or vapor are predicted to contain VOCs. By design, sewer-plumbing systems inside buildings completely vent sewer air gases to prevent them from entering the living spaces. Several decades or even centuries after installation, many components of sewer systems in the subsurface and in buildings leak, and some vapor seals designed to protect against sewer air intrusion into structures become compromised (pipes crack, fittings loosen, wax seals degrade and crack and P-traps dry out).

Plumbing venting was not designed to contain VOCs, which are excellent at diffusing through very small apertures. When compromised, sewer and plumbing systems intercept groundwater containing VOCs, the VOCs partition into sewer air, the indoor air becomes connected to sewer air, and then the indoor air can contain VOCs. The nationwide result is that legacy sewer lines are unintended conveyance systems for VOCs. VOCs that might be found in sewer air might include industrial chemicals such as petroleum hydrocarbons and chlorinated solvents, household cleaners and maintenance compounds, and even wastes associated with illegal drug manufacturing and medicine disposal. These compounds could be sourced from the disposal act itself, or by infiltration of the contaminants into the leaking sewer lines.

Are these abstract worries? Migrating VOCs in sewer air have not been carefully evaluated for human exposure potential. Many sewer-plumbing systems were not designed to be liquid and vapor tight, resulting in the diffusion and fugitive release of VOCs. Recent vapor intrusion studies in Denmark and Massachusetts have shown unhealthy indoor levels of tetrachloroethyene (PCE) vapors air in buildings when vapor seals (p-traps, wax toilet rings, etc.) have failed in areas with nearby PCE-containing groundwater plumes.

How many vapor seals leak? If you have ever smelled a moldy or sulfur smell in a bathroom near a low-use sink or tub or in the basement, it is possible a p-trap may have dried out. A wobble on a toilet can indicate wood rot and a damaged wax seal ring (leaking vapor seal). Based on six smoke testing projects in northern California, about 10% of the sewer laterals leak, and about five laterals out of 1,250 houses (0.4%) leak within 2 feet of the building, under the building or in the building vents. Certainly more research is needed to study VOC migration in active and abandoned sewer lines, land drains, and other systems which are some of the largest known connected pore spaces in the subsurface.

References

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Please contact author James A. Jacobs at his *email address below* for a complete list of references and the entire article from which this was based; *"PCE Vapors within Sewer Air in Legacy Sewer Systems Outside of Plume Areas,"* by James A. Jacobs and Olivia P. Jacobs.

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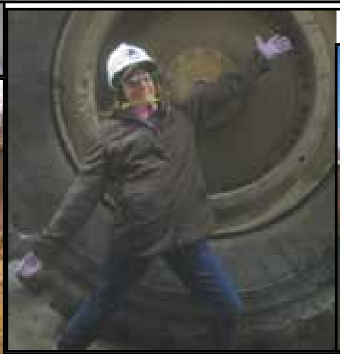


1917

A Unique Metal with a History in Colorado

Jim Burnell, CPG -11609

Beryllium is a metal with properties useful to industry. It is six times stiffer than steel and 30% lighter than aluminum. Beryllium maintains its physical properties over a large range of both high and low temperatures. Beryllium has high thermal diffusivity (that is, it does not hold heat), it doesn't spark, and it is virtually transparent to x-rays.

Those characteristics make beryllium valuable for use in connectors, springs and switches in electrical and electronic equipment; x-ray equipment; nuclear reactor rods and control rods; trigger mechanisms in nuclear weapons; and numerous other defense, aerospace and electronics applications (McKay, 2011; Vulcan, 2008; *www.geology.com*; Sabey, 2006).

The U.S. is currently the world's leading producer of beryllium and only 10% of the country's 220 metric tons of consumption came from imports in 2012 (USGS Commodity Reports, 2013). The Spor Mountain bertrandite deposit in Utah is the main source and the U.S. maintains some beryllium in its strategic stockpile.

Beryllium is sold only in alloy form, of which alloys of copper, nickel and aluminum are the most common (Sabey, 2006). The price per pound of beryllium-copper master alloy with 65% contained beryllium ranged in 2008 through 2012 from $159 per pound to $209 per pound. The current price of beryllium is not available. World reserves, according to the U.S. Geological Survey (USGS Commodity Reports, 2013) are not defined.

Beryllium is found predominantly in the minerals beryl and bertrandite. While most beryllium in the world is currently produced from the aforementioned bertrandite deposits in Utah, Colorado has historically been a major producer of beryllium from beryl. Meeves (1966) attributes significant production of beryllium to nine counties in the state. These are presented in pounds of the mineral beryl through 1963:

Boulder – 2925
Chaffee – 49,805
Clear Creek – 8796
Douglas – "some"
El Paso – "some"
Fremont – 1,086,946
Jefferson – 108,152
Lake - 311
Park – 61,566.

In Colorado, most beryllium occurs as beryl in pegmatites. Vanderwilt (1957) detailed beryl occurrences (and production) as coming mainly from the Eight Mile Pegmatite District in Fremont County, in particular, the Devils Hole Pegmatite. Other production came from the Crystal Mountain Pegmatite District in Larimer County. By 1960, Del Rio (1960) noted production from a number of sources, but extended the occurrences to Grand County (Green Ridge and High Lonesome Pegmatites) and the famous Brown Derby Mine of Gunnison County (Quartz Creek Pegmatite District).

By the late 1950s, Park County became the most significant beryllium producer in the world and that was from a non-pegmatite source. In fact, beryllium has been the primary product of the Lake George (aka Badger Flats District) and Mountaindale Districts in Park County. The most important property was the Boomer Mine. Siems (1963) estimated production between 1956 and 1960 of 778 short tons of 8% BeO, 336 short tons of 5% BeO, and 1078 short tons of 2-4% BeO. Additional production was achieved from the Redskin Gulch, Mary Lee, and China Wall Mines.

The beryllium in Park County occurs with tin and tungsten in greisens associated with granitic intrusions. Veins, pipes, and more complex greisens occur in the Precambrian Redskin Stock (granodiorite) with some in the Silver Plume Granite (Hawley & Griffitts, 1968). Beryllium is mostly contained in beryl, but some bertrandite and even rare euclase occurs. Most of the commercial mineralization has been shown to be shallow, with the Boomer developed to a depth of 150 feet (Meeves, et al, 1966; Hawley, 1969). The Boomer Mine was last listed as active in 1970 (Blake, 1970), although the property was purchased by the International Beryllium Corporation around 2008.

While the probability seems small that beryllium production will resume in Colorado, the state does have a history of production and it may well be worth some exploration activity. Nonetheless, the potential for sample collecting is always there.

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