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ON THE COVER - A new snow fall blankets the exploration project site located in Moffat County, Colorado as the drilling crew prepares the rig for a day of coring. The drilling program was conducted in an area containing extensive surface and underground resources of coal. The project was continuous for almost two years and up to eight drill rigs were contracted to complete the work which extended through the winter months. Winter drilling brings an array of issues that need to be addressed with specific protocols to assure a safe and efficient operation. Water management, difficult access, icy ground, frozen core, pumps and equipment all produce challenges when the temperature drops below freezing. Photo by Alex Papp, CPG-09615.
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AIPG Publication Policy, October 4, 2010. AIPG encourages submission of articles and editorials for publication in TPG on topic related to the science and profession of geology. Submissions shall be of interest to the members of AIPG, other professional geologists, and others interested in the earth sciences. Articles and editorials may be noted as follows at the discretion of the Editor: "The opinions, positions or conclusions presented herein are those of the author and do not necessarily reflect the opinions, positions or conclusions of the American Institute of Professional Geologists." All materials submitted for publication, including author opinions contained therein, shall include accurate and appropriate references. The Editor has the authority to solicit, edit, accept, or reject articles and editorials and other written material for publication. The Executive Committee reserves the right to act on any particular case to support or overrule actions of the Editor regarding the solicitation, editing, acceptance, or rejection of any particular article, editorial, or other written material for publication.

American Institute of Professional Geologists (AIPG) is the only national organization that certifies the competence and ethical conduct of geological scientists in all branches of the science. It adheres to the principles of professional responsibility and public service, and is the ombudsman for the geological profession. It was founded in 1963 to promote the profession of geology and to provide certification for geologists to establish a standard of excellence for the profession. Since then, more than 10,000 individuals have demonstrated their commitment to the highest levels of competence and ethical conduct and been certified by AIPG. 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 standards of ethical conduct.

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For AIPG news and activities go to www.aipg.org.
**AMERICAN INSTITUTE OF PROFESSIONAL GEOLOGISTS**

**SCHOLARSHIP PROGRAM**

**Purpose**

To assist students with college education costs and to promote student participation in the American Institute of Professional Geologists (AIPG). Up to four scholarships will be awarded to declared undergraduate geological sciences majors who are at least sophomores.

**Scholarship Awards**

Scholarship awards in the amount of $1,000.00 each will be made to eligible students attending a college or university in the U.S. Scholarships are to be used to support tuition and/or room and board.

**Eligibility Requirements**

Any student who is majoring in geology (or earth science), is at least a sophomore, and is attending a four-year accredited college or university in the U.S. can apply. Also, the student must be either a student member of AIPG or must have applied for student membership at the time the application for the scholarship is submitted.

Each student who is awarded a scholarship agrees, by accepting the scholarship, to prepare a 600 to 800 word article for publication in The Professional Geologist. The subject of the article must be related to a timely professional issue.

**Application Process**

Applicants must submit: a letter of interest with name, mail and e-mail addresses, and telephone number; proof of enrollment in an eligible geological sciences program, transcripts; an original one-page essay on why the applicant wants to become a geologist; and a letter of support from a faculty member familiar with the applicant’s academic work. The application packet should be submitted to:

American Institute of Professional Geologists
Attn: Education Committee Chr.
12000 Washington St., Suite 285
Thornton, CO 80241

For questions regarding the application process call (303) 412-6205 or e-mail: aipg@aipg.org.

**Applications must be received by**

**FEBRUARY 15th**

**Awarded the month of**

**SEPTEMBER**

**Basis of Awards**

Awards will be based on the content and creativity of the essays as judged by the Education Committee. The decisions of the Education Committee are final.
AIPG had a booth at the National GSA Convention, October 31-November 3, 2010, in Denver, Colorado. Volunteers helped in signing up 131 new student members, and discussing the benefits of joining AIPG.

AIPG Headquarters would like to say *Thank You* to all of the booth volunteers. Those volunteers are Cathryn Stewart, Joe Struckel, Alan Benimoff, Rick Obernolte, Steve Krajewski, Tom Cavanaugh, Curt Johnson, Ben Maas, Raju Sitaula, Christina Bicksler, Ed Ullmen, Jim LoCoco, Mark Wood, Sam Gowan, Cameron Morissette, Peter Maciulatis, Cindy Cason, Larry Cerrillo, Chris Kravits, Jim Burnell, and David Abbott.

The following names were drawn as raffle winners at the AIPG booth. Chris Banser (Font CD), Drew Chenoweth (sweatshirt), Kyle Greenberg (sweatshirt), Sierra Derby (AIPG beanie), Mike Phillips (Arizona Geological book), Hunter Morton (Geological Hazards Book), Andrew Parisi, (AIPG briefcase), Jeremy Wenemelchh (Colorado Roadside book), Judah Epstein (AIPG Briefcase), Brandt Kayser (coffee mug), Ellyssa Tennant (travel mug), and the Grand Prize went to Chris Kakolewski (crystal tourmaline). The drawing was held at noon on the last day of the convention. All winners had to be present to win.

Thank you to Joe Struckel, who came back to help with the raffle.

The AIPG booth was a great success due to the help from all of the volunteers.
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Elementary Student Asks About Geology and the Ice Age

In mid-November AIPG Headquarters received the following letter from Benjamin Lui,

“Dear AIPG,

“My name is Benjamin Lui and I am eleven years old. I am in the Elementary Laboratory Center (ELC) in Quincy, Massachusetts. I also go to Beechwood Knoll Elementary School. In ELC, I am doing an independent research project on something I find interesting and I chose ice ages. I picked it because I liked snow and ice. Once, in third grade, I put ice cubes in my sister’s socks and, well, you get the picture.

“When you open the envelope, you will find a sheet of paper with a few questions on it and a self-addressed envelope. If you have time, please answer my questions. Thanks! If you know anyone who might help with my project, please mail a sheet with their address to me.

“Sincerely,
Benjamin Lui”

Ben’s questions are:
1. How did you get interested in geology?
2. What was your favorite animal in the ice age?
3. Would you like living in an ice age?
4. In your opinion, what do you think would be good about living in an ice age?

AIPG Headquarters e-mailed copies of Ben’s letter and questions to a number of AIPG members and here are their responses.

Mike Lawless, CPG-09224 and 2010 AIPG President wrote:
Dear Ben,

Thank you for sending your questions on the ice ages. I am glad to hear you are interested in geology because it is a very exciting field of study. I became interested in geology as a boy when I spent my summers in Maine in Acadia National Park. I loved the bald granite mountains that had been scraped clean by the glaciers during the last ice age. Seeing how black basalt had intruded into the pink granite, leaving straight black lines of rock through the granite made me realize the rocks had a story to tell about their formation.

My favorite ice age animal is the saber-toothed cat. Their long canine teeth must have made them a fierce predator. It would have been exciting to see them hunting and catching the large game animals that lived during the ice age, as long as I wasn’t the prey!

I would not have liked living in an ice age because I don’t like the cold weather, or snow and ice.

I think it would have been very difficult to live during the ice age because of the cold. The good part would be that there would be plenty of food if you could catch it, but unfortunately not many fresh vegetables. I bet you’d probably like that part!

1. How did you get interested in geology?
2. What was your favorite animal in the ice age?
3. Would you like living in an ice age?
4. In your opinion, what do you think would be good about living in an ice age?

Questions from Ben

From the Desk of...
Benjamin Lui
US Postale Rd.
Quincy, MA 02170

Dear AIPG,
My name is Benjamin Lui and I am eleven years old. I am in the Elementary Laboratory Center (ELC) in Quincy, Massachusetts. I also go to Beechwood Knoll Elementary School. In ELC, I am doing an independent research project on something I find interesting and I chose Ice Ages. I picked it because I like snow and ice. Once, in third grade, I put ice cubes in my sister’s socks and, well, you get the picture.

When you open the envelope, you will find a sheet of paper with a few questions on it and a self-addressed, stamped envelope. If you have time, please answer my questions. Thanks! If you know anyone who might help with my project, please mail a sheet with their address to me.

Sincerely,
Benjamin Lui
I hope you continue to pursue your interest in geology. There are many jobs available in geology and it is great to be able to earn a living and have fun at the same time.

**Sam Gowan**, CPG-07284 and 2011 President wrote:

Dear Ben,

I appreciate your interest in Geology. We need many more like you with an interest in the sciences. Geology is a lot of fun, and we have a lot yet to discover.

My interest in geology started when I was eight years old. My parents took my brothers and me to Alberta, Canada where a Canadian friend of ours hooked us up with a guide who led us to the Canadian Badlands along the Red Deer River. We found dinosaur bones eroding out of the clay. I still have the bones, which my children and I have shown many times to students like you.

My favorite ice age animal is the short-faced bear. This is an animal that lived in the area near where you live now toward the end of the last ice age. I am fascinated by its size and the fact that it must have been able to run very fast. Some scientists believe it could have run 35 miles per hour. People that lived then must have been very scared since it only ate meat, unlike bears of today that also eat berries, seeds and other plant material. I feel sorry for those families that had that animal lurking around in the woods near their homes.

I would have liked living in the ice ages because I, like you, enjoy the cold, snow and ice. I think that families and their clans would have needed to be very strong and must have helped each other a lot to survive. I suspect that people that lived during that time would have been fun loving even though they would have needed to work hard to find food and survive the cold. These are good reasons for living during an ice age.

I hope you continue to pursue geology. It is good to work at something you enjoy.

**Robert Font**, CPG-03953 and 2005 AIPG President, wrote:

Dear Benjamin,

I am glad to know that you are interested in geology. It is a profession that can be filled with much excitement and great experiences. It has been the case for me!

I became fascinated with geology once I was in college. I started out in physical education and foreign languages, but later drifted into mathematics and science. When I took my first geology course, I fell in love with the subject matter. At first, I wanted to study volcanoes and earthquakes and later specialized in geological engineering and petroleum geosciences. I worked as a university professor, for a large oil and gas company, and for the past 20 years as the head of my own consulting and service company. I have enjoyed my career tremendously.

Now about the ice age; I’ve got to tell you that I grew up around the Caribbean Sea, swimming and diving in its crystal-clear waters. I am much more of a beach guy than a cold-weather person. If I had lived during an ice age, I would have done my best to stay warm. I bet you I would have looked like a walking fur ball! I would have spent much time hunting and fishing and studying nature around me. As for my favorite animal, I have two to mention. I like the saber-toothed cats and the dire wolves. They had to be strong and smart to eat and survive.

I hope that you pursue geological studies. You will learn about many beautiful things that occur in nature and find out ways in which we can help mankind by using the Earth’s resources.

Good luck Benjamin.

**Barbara Murphy**, CPG-06203 and 2011 AIPG President-elect, wrote:

Dear Ben,

I was glad to learn of your interest in geology and the ice ages from your letter to AIPG. I am sure you are learning about the ice ages in Massachusetts and the glacial features throughout New England. I am a bit familiar with Quincy where you live. I went to college in South Hadley. I also took geology classes at Amherst College while I was at Mt. Holyoke College. Amherst College has a museum with information about the ice ages. You might enjoy visiting there if you have the opportunity.

In response to your questions, I became interested in geology when I had an earth science class in 9th grade. I was interested in the history of the Earth, how mountains formed, what made volcanoes erupt and what caused earthquakes, and the history of early life and dinosaurs. When I was growing up, I really loved being outside, hiking and exploring. I still do. Now I have a better understanding of the Earth.

My favorite animal of the ice ages is the wooly mammoth. I have a stuffed animal wooly mammoth and he is so cute.

I think I would like to live in the ice ages. At one time I thought about being a glaciologist because I liked snowshoeing and skiing and being in the snow and mountains. I also hope to go to Antarctica sometime. I have been to northern Canada.

Living in an ice age would mean that man would need to be more innovative and adjust to the climate changes and use of resources. People might be very dependent on transporting food and other products to those areas affected by the ice age. There would certainly be other changes in lifestyle because of the climate change and the ice age.

I hope you will find geology and the ice ages very interesting. There is so much to explore, to see, and to learn but be sure to enjoy your pursuits.

Good luck. It was nice to receive your letter.

**David Abbott**, CPG-04570 and *TPG* ethics columnist, wrote:

Dear Benjamin,

The American Institute of Professional Geologists (AIPG) sent me and several other geologists your letter and asked that each of us respond to it. I hope you receive several responding letters because they will all be different.

I am a consulting geologist specializing in the evaluation of a wide variety of mineral resources including precious metals (gold, silver, and the platinum group metals), base metals (primarily copper, lead, and zinc), and the industrial minerals (a very broad category covering the minerals we use everyday although we may not recognize them as such). The industrial minerals include salt; the minerals that make paper white and take ink; the clays used in porcelain (sinks, bathtubs, plates, cups, etc.), tiles, bricks, etc.; building stones; aggregate for concrete and asphalt; the limestone from which cement is made; potash and phosphate fertilizers; wallboard and plaster; abrasives like sand paper, emery boards, etc.; the silica used in glass and computer chips; a variety of components in paints; and a wide variety of other things.

You asked four specific questions. My answers follow.

How did you get interested in geology?
I grew up in Colorado and traveled around the west by car with my family. I visited places like the Grand Canyon, Teton, Rocky Mountain, and Yellowstone National Parks. I also did a lot of camping as a Boy Scout and did a lot of mountaineering in high school. As a result, when I took my first geology course as a college freshman, I’d been to half the places pictured in the textbook as examples of geologic features. I realized that I knew a lot more geology than I thought I did. One of the hardest parts of any subject area is learning the technical terminology and really understanding what the terms mean. Because of my travels, camping, and mountaineering experiences, I knew what dikes, moraines, cirques, glaciers, meanders, faults, and many other terms meant. My knowledge reflects the fact that geology is a field science. You have to go out and look at the rocks, at the landscape. You get paid to take hikes and visit all sorts of interesting places. I was hooked on becoming a geologist by that first course.

Too often most people’s exposure to geology is visiting natural history museums and seeing collections of fossils and minerals. While minerals and fossils are important parts of geology, they are only a part. Why is the landscape shaped like it is? Why are there mountains in some places and not others? Why do different mountain ranges look different? Why are volcanoes interesting? These and lots of other questions are what fascinate geologists. A famous 19th century geologist, G.K. Gilbert, once said that every geologist should experience three things: walk on a glacier, watch a volcano erupt, and feel an earthquake. I’ve experienced all three.

What is your favorite ice age animal?

I don’t have one. While I know something about the ices ages—there have been several in addition to the most recent Pleistocene ice age you like—ice ages have not been a subject of particular interest to me. Saber tooth tigers are pretty cool. And the pronghorn antelope of the American west—they are really common in Wyoming—evolved into an incredibly fast runner in order to get away from the big cats that hunted them during the ice age. Although the big cats are extinct, antelope are still with us.

Have you been reading about the recent discovery of a treasure trove of ice age animals in Snowmass, Colorado? The dig is still going on, although winter snow will shut it down shortly. This is one of the most important ice age mammal and plant finds in long time. The remains have not yet been fossilized, that is converted to stone. Look up the stories on the internet. Sources include the Denver Post, the Denver Museum of Nature and Science at www.dmns.org/museumnews/mammoth-and-mastodon-madness-day, www.9news.com, and the Aspen, Colorado papers.

Would you like living in an ice age?

The answer to this question depends on where one would live. At the time of maximum ice extent, your home in Quincy was under a glacier. The southern part of Cape Cod is a terminal moraine. Colorado during the ice age would have been more like Alaska is now with alpine glaciations in the mountains and ice-free areas in the valleys. So Colorado would have been an okay place to live. Because of all the ice, the rivers were a lot wider and deeper then.

In my opinion, what do I think would be good about living in an ice age?

If you look over the average temperatures for past 500 to 600 million years, you’ll realize that the Earth’s current temperature is still below the long-term (500 million year) average.

Global temperature fluctuations have been going on for a very long time. We’re still coming out of the last ice age. As reflected in my previous answer, what would be good about living in an ice age depends on where, particularly on what latitude and elevation, you live. Today people living in Antarctica require constant resupply from the rest of the world. People living in Alaska, northern Canada, and in the world’s high mountain ranges are living in conditions that are not unlike conditions that would have existed during the ice age.

Bill Siok, CPG-04773 and AIPG Executive Director, wrote: Dear Benjamin,

Well, young man, you certainly wrote an interesting letter. Thank you for sending it to AIPG.

I must tell you that I also enjoyed snow and ice when I was growing up in Massachusetts. Now that I’m a bit older, I don’t enjoy the cold and the elements which come with it quite as much. Of course, since you’re asking about the Ice Age, perhaps you’ll find my responses interesting. I hope that by the time you read this, you’ll be enjoying a nice cold, snowy New England winter.

Your first question is an excellent start. My geologist friends and I discuss this question among ourselves frequently. There is a common thread among us, we all enjoyed (and still enjoy) being outside and working outside. Studying geology allowed (and still allows) me to understand how the earth formed and how it looks from the top of the atmosphere down to its core 4000 miles below our feet.

I too learned about glaciers and the ice age when I was in elementary school. I was fascinated by the idea that the town I lived in was covered by more than one mile of ice ten thousand years before I was born! To be honest, I didn’t give much thought to animals which existed during the ice age, I was too busy wondering how people were able to live.

When I did begin to think about the ice age animals, I believe I was most fascinated by the woolly mammoth. I was impressed that an animal which looked like an elephant with hair could live in the northern cold climates and find enough plants to eat and also survive hungry predators like the saber toothed tiger.

I would not have enjoyed living in the glaciated areas of earth during the ice age. Humans did exist during the ice age, but most lived closer to the equator where the weather was milder. The main reason I would not have enjoyed living during the ice age was that life expectancy was so short. Very few people lived beyond their 35th birthday.

The good thing about living during the ice age was that there were no computers, cell phones, TVs and so forth. On a serious note, our ancestors had to work very hard merely to find food and stay warm. I don't know what we (modern man) can say about the good or the bad of living during that time except that life was short and harsh. The good is that our ancestors were able to survive and live to establish a lineage that resulted in our being here on earth today.

I truly hope that my responses were of some value to your project.

Stephanie Jarvis, SA-1495 and Student Voice columnist, wrote: Hi Ben,

I’m glad to hear that you’re interested in geology! I am currently studying geology and biology in college and am always happy to hear from another geology enthusiast, especially
one with such great questions. Your first one is definitely the easiest, so I'll start off with that.

Growing up hiking in the Red River Gorge in Kentucky, with all of its natural arches and bridges, probably had something to do with my fascination with geology. Most basically, however, I have always liked rocks. Now, there is definitely more to geology than rocks, such as climate and water, but rocks are a pretty big deal to us. And they're really cool. Some of my earliest memories are of filling boxes and jars with pebbles from the walkway behind my house—I loved all the colors! And once, during recess in elementary school, I found a rock with a leaf imprint on it—quite the find in the sea of gravel under the monkey bars. I think that was a defining moment for me. I wanted to understand everything about that little piece of rock, and the leaf that left its mark, that I could. There was no turning back.

Now, for your hard questions. Would I like living in an ice age? Of course, people did live in ice ages—they left records of their lives on caves and rocks, so it's definitely possible. It would be hard, though. I would miss my garden! However, I think it would have been really neat to see animals like the woolly mammoth. I also really like cold weather. Think of all the skiing and skating you could do! I believe I would like it, but probably not as much as I like living in a non-ice age.

My favorite ice age animal? That's a hard one. Giant Beavers, which were the size of black bears, were pretty cool, though the saber-toothed squirrel from the movie is awesome!

Good luck with your project!

Bob Stewart, CPG-08332 and TPG Editor, wrote:

Dear Benjamin,

I received your letter through the American Institute of Professional Geologists (AIPG). My response will join those of others who were copied on your letter.

Most of my work is in Connecticut, and deals with the investigation and clean-up of contaminated sites. This is my third career. During and after my graduate studies at university, I worked in mineral exploration for several mining companies, exploring for gold, uranium and diamonds, mostly in Canada. I was then fortunate enough to achieve one of my professional goals to teach and conduct research at the university level, which I did for six years at Iowa State University. Since then, I have been working as an environmental consultant, investigating and cleaning up contaminated property, mainly in Connecticut. Presently I work for a multi-national consulting company called Arcadis in their Manchester, Connecticut office. My university education includes degrees in geology and soil science, and I specialize in glacial geology.

How did you get interested in geology?

I spent my kindergarten through grade 6 years living in Toronto, Ontario. During the summer my parents would take me to the beach on the shore of Lake Ontario. The beaches were stabilized against wave erosion with limestone boulders quarried inland from Ordovician and Devonian rocks. The limestone boulders were full of fossils and I found them to be absolutely fascinating. I always managed to collect a few hand specimens for my room. My parents were very supportive, and my mother periodically moved my collection to the rock garden in front of our house when it was time to clean my room.

At one of my elementary schools, the path around the baseball diamond was covered with crushed stone (basalt, it turns out), which contained crystals of fool's gold (pyrite). None of us could hit very well, so the infielders spent as much time picking up fool's gold as fielding grounders. My teacher noticed me one day, and said her husband was a geologist, working in the Timmins area of northern Ontario. This was about the time (1964) that Texas Gulf Sulphur geologists discovered the Kidd Creek mine, one of the world's largest deposits of copper, lead, zinc, and silver.

We moved from Ontario to Massachusetts when I was 12, and began to vacation on Cape Cod. As you may be aware, Cape Cod is a product of Pleistocene glaciation, and the glaciers left behind many erratic pebbles and boulders eroded from bedrock north of the Cape. I continued my rock collecting, although the fossils were fewer and harder to find. I've always enjoyed swimming and surfing, and I started to pay attention to how the beaches changed in response to tides and storms. My high school did not have a geology class, but my biology class included a discussion of evolution, prehistoric life, and geologic time. As a university freshman I took introductory classes in biology and geology. The geology class included a field trip to examine the geology of northeastern Pennsylvania, and I thought that if the geology department will do this for an introductory class, things can only get better, and that proved to be the case.

What is your favorite ice age animal?

Without a doubt the woolly mammoth—it epitomizes the ice ages to me.

Would you like living in an ice age?

It would be a challenge. Because of my interest in glacial geology, I have often thought about living in an ice age to see how continental glaciers actually worked in terms of creating landscapes with unique characteristics. How would I survive? I can only imagine the difficulties associated with finding food and shelter. I can get a good idea from books I've read about arctic and alpine exploration.

In my opinion, what do I think would be good about living in an ice age?

Much of the northern hemisphere of the planet was covered by glacier ice, which would have caused a drop in sea level of about 300 feet, so many coastal areas would have been much larger. Climates world-wide would have been different, along with the distribution of plants and animals. I think I would be interesting to observe these differences. For instance, fishing trawlers occasionally dredge up mammoth teeth from the sea bottom off Cape Cod, so we know that when the sea level was lower, the continental shelf was exposed, and mammoths were living there.

Ron Wallace, CPG-08153 and 2010AIPG VicePresident, wrote:

Dear Ben:

I received a copy of your letter and I'm happy you are interested in geology and the ice age. When I was about your age I did read many books on cave dwellers and the animals. I thought that was an interesting time in man's history. It wasn't until I was in college that I took my first introductory course in geology that I became hooked.

I've lived in the south most of my life, so I'm not a real fan of cold weather. The woolly mammoth would have been great.
Students: Gazing Darkly Into the Future — Career, Life, and Everything

David M. Abbott, Jr., CPG-04570

Douglas Adams, in The Hitchhiker’s Guide to the Galaxy, asserts that the answer to the ultimate question about life, the universe, and everything is 42. He also notes that if you do not understand the question, you will not understand the answer. This article reverses that Geology 101 maxim, “the present is the key to the past,” by believing that the past—the experiences of those who have been out of school for a couple of decades or more—has something to tell you about your futures.

You have begun your geoscience career by majoring in the subject. Perhaps you have already acquired experience in the field through summer and/or part-time jobs. Regardless of the specialty you are pursuing, you can expect that the cyclic nature of the business will result in your having several employers. If the experiences of those who went before you provide any guidance, it indicates that in order to stay employed, you must be flexible enough to switch specialties, perhaps more than once. For example, moving from the petroleum business to hydrology or environmental geology can build on the realization that fluids moving through rocks behave in similar ways. The analysis of fractured crystalline rock aquifers has similarities to the movement of mineralizing solutions through similar rocks. Coal is not only a fuel itself; it contains another fuel, methane. The point being that basic geologic skills are needed regardless of your current or future specialty. Some of you may even have done some specialty switching in school because of job opportunities or research support.

Reflections on a Geologic Career, which available for free at the AIPG website, www.aipg.org under “AIPG Publications,” contains a variety of papers addressing the issue of finding and retaining professional positions. Download a copy and read it for a wealth of practical advice. The authors provide answers to questions they wished they had known when they were your age. Key points are expecting that change will occur, being flexible, and networking through active participation in professional societies. An advantage AIPG offers as a professional society is that its members are from all specialties and employers, so you become part of a broader network when it comes time to switch specialty.

But your professional career is only a part of your life—at least I hope so. Joining with a spouse is a common big step in life. Some of you have already taken this step or have specific plans for doing so. For others of you, this is still something in your future, but probably enough of your friends have coupled up so that marriage is less of a theoretical concept than it was in high school.

Being part of a couple has a distinct impact on your career. You no longer have the flexibility you had when you were single. Do you want to travel as much? Where can your partner find work in his or her chosen field? Teachers, family practice MDs, and nurses are examples of professions with greater job mobility than many others. Investment bankers generally do not. If your job moves you to a different town, can your partner find suitable satisfying work as well?

Whose career opportunities will be pursued when? Some couples have had successful marriages despite the frequent or prolonged absence from home by one or both partners, but this seems to be the exception rather than the rule. Does one of you work for a firm providing family health coverage? One of the problems of hooking up with another geoscientist is that you both will be in similar job cycles. But marrying someone in another profession does not guarantee against both of you being simultaneously caught in downturns. I know this from personal experience.

Being part of a couple usually leads to two other life characteristics (features or bugs, depending on how you look at them), a house and children. The mortgage must be paid every month. Children have lots of ever changing needs and wants, most of which cost money. Your job provides the income but its location affects your style of life. Relocations are disruptive to a greater or lesser degree. Some locales have greater job opportunities than others. The same is true of educational, cultural, and other characteristics. Some people pick a place to live and do whatever is required to live in that place. Others follow their career, relocating whenever relocation is required.

While only you can provide answers to the issues discussed above, they are very real issues that you should carefully consider in planning your career. A planned career is far more likely to be successful and rewarding than an unplanned one. While no one can see into the future, you can learn to spot trends and make necessary adjustments in what you are doing. You should have goals in mind. Although being open to serendipity is worthwhile as well. All your opinions and choices have consequences. Think about the consequences of your choices as you move through life.

This article was originally published in 2005 and was reprinted in 2008. Because students are not in college that long, periodic republication is warranted.

David Abbott is a consulting geologist specializing in evaluating precious metal, PGM, base metal, and industrial mineral resource and reserve estimates and mineral property appraisals. He spent 21 years as a geologist for the US Securities and Exchange Commission (the first law of exploration is “Use someone else’s money,” which means some sort of securities transaction). He has been a consultant since February 1996. He compiles the Professional Ethics & Practices column for TPG. AIPG has awarded him the Martin Van Couvering Award and Honorary Membership.
Here and There!

James N. Adu, MEM 1311, Graduate Student, New Mexico Tech, Socorro, NM

This piece is long overdue to appear in the TPG, as I originally put my thoughts on paper immediately after my first time participating in an AIPG annual meeting, in Grand Junction, Colorado. After all, it is better late than never. "Here" in this article refers to the United States and "There" refers to Ghana, my home country.

On the dawn of October 2nd 2009, waiting in the cold autumn weather at the Denver airport for the next available bus to take me to the Greyhound Station, I was full of excitement to partake in the annual meeting. I had a lot of wishful thoughts about how the meeting was going to be and how I will get along with it. I had seen photos of the annual meetings in the TPG but had never been part of it before. For the first time, I was privileged to be part of the meeting. I was so excited that I had finally made it.

While sitting in the bus from Denver to Grand Junction, I was still thinking about the meeting, but I could not help gazing all around at the geological features along the road. I was amazed at the Rocky Mountains. To me it was rocks in prints! It was the first time seeing such wide and massive rock exposures. Hardly do you see outcrops in the tropical rain forest of Ghana, and if you do, they are mainly found along road cuts or at the coast. If you have been to the part of the world where I come from, you would understand my point.

My first day at the meeting was a memorable experience considering the warm reception I received from members who I did not know from anywhere. It was then that I remembered the saying: "Geology is a profession of comradeship." Geologists have one thing in common; they speak the same language-ROCKS!

I felt at home immediately but to my complete surprise, about 90% of those at the annual meeting were older geologists. Then I asked myself, where are the young geologists like myself? Aren’t there any young geologists "here"? I kept asking myself these questions with the hope that the situation might change but there was no change till the end of the meeting. Back "there", there are many more younger geologists as compared to older geologists. There is hardly a geological meeting organized and if it is, it is full of young faces. I was happy to see these old “Geos”, full of geological experiences and more than willing to share with me their stories. I have longed for this “there” but never had it until I got “here”. In all, I had an unforgettable experience at the meeting and would never want to miss one such as that.

Coming back to my questions and trying to find answers to them, I could not help but ask the people I met at the meeting. I then realized that others have the same worry about the situation as me. This is what compelled me to write this piece for my younger colleagues. My little experience as a young professional is that the university prepares you with academic knowledge but not professional knowledge. No amount of university education can make you a professional. Professionalism is attained by practice and tutelage.

The situation “here” is that there are many professional tutors (older geologists with long experience) with few students or young geologists under their tutelage. It is not that there are no young geologists “here” but in my opinion, we, the young geologists do not see the need to be under tutelage. Moreover, the essence of professionalism may not have caught up with us. There are professional meetings and organizations to help us accomplish our career goals but there is a problem of making appropriate choices.

On the contrary, back "there", it is the opposite of what is “here”. There are few older “Geos”, no effective professional umbrella organization, hardly are there professional meetings, and no knowledge of professional development. The fate of the young geologists is in their own hands.

Thus, I have learnt that, “some have food but have no mouth, while some have mouth but have no food”. I always reminisce about the article I read in July-August, 2010 TPG by Andy Johnson, CPG 07072 “Who Will Speak for Minerals?” My paraphrase has been; “Who Will Speak for Geosciences?”

Dear colleagues, the geological society is aging and there is a need for the young geologists to hold up the mantle and champion the course of geosciences. If no one takes up the challenge, geology will be relegated to the background in the future and it will take a battle to win the acceptance we are now enjoying. A vast majority of our older geologists in AIPG are ready to transfer all their knowledge at no cost to us, so what are we doing about it? No condition is permanent! Will you speak for geosciences? If you are interested, sign up as a student or member of AIPG so that together the flame of geology will continue to light.
Education and Training of Geologists; Is Field Camp Still Relevant?

Peter H. (Pete) Dohms, CPG-07141
Pensacola, Florida

This article summarizes the discussion that has developed over the last six months within the AIPG group on LinkedIn.com about field camp and whether undergraduate (summertime) field training is still necessary for basic qualification as a geologist. As you will see in the following, several interesting and relevant sub-discussions also started, and the conversations occasionally veered in somewhat unexpected directions. Some strong opinions were expressed (including by the under-signed), but in every case the postings were friendly and constructive.

The rest of this article begins with the “original” posting, then continues with examples of replies and other discussions. An attempt has been made to “group” the discussions by topic.

Original Post: Is There a Role for Field Camp in the Training/Education of the Modern Geologist?

“I posted this in a petroleum group and was curious whether the AIPG members had a different view...

“When you are looking to hire a Geologist, is Field Camp optional? nice to have? important and valued?

“Who are the successful Geologists in your organization - did they experience Field Camp? What are their thoughts on this topic (a good water cooler question).

“When hiring someone right from school, are your most successful candidates specialists or generalists (classical)?

“Why (or why isn’t) Field Camp important?”

“Thanks! I look forward to hearing from you!” – Peter MacKenzie, CPG-10698, Columbus, Ohio

Replies were immediate. Some were short and to the point:

“A geologist without field camp is not a well trained geologist. No university should be cutting back on field study they should be increasing it! I would never hire a geologist without field camp.” – George H. Davis, CPG-10951.

“Field camp separates us from the engineers. There is no substitute for bumbling in the field until you figure out what you are really looking at.” – Robin Dornfest, CPG-11282.

Some replies were longer:

“Throughout my career, I continue to come back to experiences and lessons I learned through Geology Field Camp. Without a doubt, the most valuable class I ever took was field camp. Camp experiences teach problem solving and geologic understanding that can’t be done elsewhere. The vigor-and-pursuit aspects of investigation are often of the most important traits that gets developed at field camps. Without having the appetite for hard work in the field, the understanding of geology would be much less.

“I completed field camp at the LSU Camp in Colorado Springs. When I left there in 1980, the camp had rosters of previous classes painted on boards hung in the rafters of the mess hall that went back to the 1920’s. As I remember, looking through those names, many of those geologists went on to teach across the country, to discover many new oilfields, and to ensure the wise use of our mineral resources. I have to believe that they would agree that their experiences at field camp led them to successful careers in Geology, to which we all have benefited from. I am certain that the many other university field camps around the country have alumni with similar accomplishments and beliefs. Field camps are most certainly one of the most important experiences for students of geology.” – George Conger, Ph.D.

Two important sub-discussions occurred recently. The first was on the “cost” of field camp, and the second was related to issues of “liability” for incidents and accidents. Example posts on each topic follow:

Cost of Field Camp

“Personally I feel that field camp is quite important and extremely beneficial, if you want to be a geologist; but if you're afraid to get dirty and don’t love to just touch rocks, you're in the wrong career. That said, as a current student at UT Austin with the required course load, the cost of field camp (tuition $3,489, camp cost $2,100, plus cost of gear) and the need to work part-time to keep the lights on it is rather prohibitive. As it is most students will take a full course load in the Fall and Spring and then take

1. The social media site “LinkedIn” (www.linkedin.com) has developed into a powerful tool for business networking. A few minutes is required to set up a basic profile for yourself, and to begin to build up a “network” of contacts. As time goes by, you will find yourself prompted to “complete” your profile, and to expand your network outward. Powerful search capabilities allow you to obtain contacts with a variety of professional interests literally anywhere in the country. One of the options for networking is to link yourself to a “group;” AIPG is one that is available. One of the options for a “group” is for one of its members to start a discussion thread on LinkedIn, to which other group members can reply.
IS FIELD CAMP STILL RELEVANT?

Mike

“...obviously finances are a major factor, budget tightening departments looking for places to trim and improve income and expense metrics per unit hour...

“Coupled with the modern field camp expectation. You may be surprised, well, I am certain you will be surprised, at the relative improvement in comforts in the modern field camps...Old timers who may have camped, later may have lived in primitive cabins, then rented apartments or dive motels, then today resort hotels, it has (d)evolved. Old timers may have prepared all their own food, whereas today catering and restaurants. Old timers may have driven to the field, today fly. Old timers were 19 and single, today there are many non-traditional students who must work summers to support families and still go to school. Things are quite different today, personally I think in not a great way. I do wonder about the kid that wants to do field camp, but doesn’t want to sleep in a tent on the outcrop...or worse have never been camping, or seen a mountain...why geology? Has the science (d)evolved...what is a modern geologist? I personally think the train is off the track in many ways...

“In short, the costs of field camp today are high(er) than in the past, I think students are clients rather than plebes...

“A reason this conversation is important is to inspire professionals to reiterate the importance of the rocks and relationships, and to engage the schools with high quality field programs, to help them design and maintain the programs to meet our expectations. To do that we need to get involved, get our companies involved, and support, financially those quality camps with funding, scholarships, and grants...

“It is important, even in the world of the Modern Geologist (which Geology as we know it may not be recognized as a big component...).” – Peter MacKenzie, CPG-10698.

“...I wasn’t in a position then to go on into academia and thus had to switch gears to a mix of engineering and environmental geology with some emphasis on hydrogeology in Michigan. At that time there were no hydrogeology field camps although there is a good one now at Western Michigan Univ. Consequently I urge students starting out to look seriously at the field camp experience recognizing that they will likely never get another shot at it.

“At the same time I also recognize the financial burden it creates as does all higher education today. That is something for which we all need to seek a solution. It’s approaching the point where the middle class is being cut out financially (too poor to afford it, too rich for financial aid) and expenses are rapidly outrunning what financial assistance is available to the talented student. All I can suggest is to persevere and leave no financial stone unturned. In the long run you’ll be glad you did.” – Lawrence M. (Larry) Austin, CPG-05181.

Liability Issues

“WOW I can’t even believe the question came up! It’s like eliminating internships from a medical degree.... But unfortunately the question is all too valid. I am meeting a LOT of geology students who have never seen the field because of budget constraints yes, but also because of LIABILITY! Apparently they might trip and fall and sue the college - ergo it is safer to read a book.... I bet if we were able to meet we could spend a week telling stories about our “field scars” - TRUE? Where does this insanity end? Will we all be relegated to remote telemetry in the safety of our sterile labs? – Melinda Hamsher, PG, MEM-1088.

“Melinda: I agree completely: liability is a scourge of getting many things done, especially with field-based education of any sort. Liability with field camps, though, is a far more complicated beast than a student twisting an ankle. In 2003 one of UT-Austin’s vans flipped over early on in field camp, killing a student and a professor (Geotimes, July 2003 has a story on it). In 1999 two students at IUGFS were killed when they lost control of a carry-all while free-wheeling and drunk on a Saturday night, which resulted in the field camp director constantly being in court or in legal meetings for the next two years, and a strict, bordering on draconian, enforcement of behavior at the next year’s field camp, which I attended. Both of those situations were hell for all involved. Given that we’ve evolved into such a litigious society, it’s no wonder a college administrator would look at how a field program is conducted in the light of the above incidents and want to shut it down, or modify it to the extent that it would be impractical to run. On countless fieldtrips and camps over the years I repeatedly witnessed students doing downright dangerous things they were told explicitly not to do (exploring abandoned minshafts, free-climbing fractured quarry walls above a large group, crossing 4 lanes of interstate traffic without looking, etc....). As an experienced field geologist myself, I look at this behavior and think to myself “This is a lawsuit waiting to happen.” – Joe Kopena, Geologist, MEM-0953.

This article needs to conclude with some of the “best” comments on the value of field camp, in terms of what it prepares us for when we get started in our careers in the “real world.”

“I’ve seen an increasing trend among young geotechnical engineering professionals to do ‘desktop studies’ in preparation of extensive reports, and I always insert a word of caution to them that they cannot adequately address a site without a visit. Desktop studies are great in the research phase or when planning for a field visit, but until you see the rock and get an assessment of site conditions, local geology, unique problems in the area, and the degree of competence of the workers doing the job, you really haven’t addressed a problem adequately.

“Sometimes it’s fairly simple. Any time it gets more complex than layer-cake geology of unweathered rock, you
need to see what is going on, and characterize it accurately and concisely.

“Field camp is an essential step in the educational process for refining young professionals into competent working professionals. Without it, substantial time is spent in training them into a mode of thinking and action which they don’t understand.” – George H. Davis, CPG-10951.

“I believe field camp and other field experience is more important now than ever because of the availability of computer programs and models. Engineers sometimes are frustrated that geologists cannot give an answer and then follow that with a 100% guarantee. I believe that frustration results from a lack of understanding regarding stratigraphic heterogeneity (I work primarily in Florida). I would be concerned if a geologist was conducting a modeling exercise without the benefit of field experience because he/she would likely not understand geologic complexity and the potential error in data used in their models.” – John Herbert, MEM-1252.

**The Future of Field Camp**

So, where do we go from here? Re-reading the discussion thread for this paper has confirmed what my gut was telling me; field camp continues to be an essential component of the basic training that will (coupled with appropriate post-educational experience) yield a competent professional geologist. All too many of the postings, however, referenced situations that threaten the continuation of field camp training, for a variety of reasons.

Larry Austin, CPG (quoted above) indicated that he is working with the AIPG Executive Committee to update the Institute’s “Education for Professional Practice” white paper, that he will see to it that the consensus on the value of field camp is incorporated, and that it is the expectation of the Institute that field camp will continue to be required. I offered the suggestion to the group that all of us need to get involved with our colleges and universities and keep them advised of the necessity for intense field training of young geologists. Some AIPG members are involved with the organizations that accredit the undergraduate geology, hydrogeology, and geological engineering programs; that is a perfect avenue for strongly encouraging the schools to continue their programs.

As of the date this article was prepared, there were between 45 and 50 replies to the original posting. The discussion continues at LinkedIn. I recommend that you seek it out and join in with your own comments and war stories.

Peter H. (Pete) Dohms, CPG-07141, attended the Michigan Tech field camp in the summer of 1965, living in a tent as the base of operations moved from the Houghton campus to the Huron Mountains north of L’anse, then to Ishpeming, before ending up near Sagola. Since graduating in 1967, Pete has been based in Arizona, California and Florida, where he currently resides. His career has included mineral exploration, mine development, and (for the last 25 years) environmental consulting. The accomplishment Pete is most proud of is over 43 years of continuous employment as a geologist without a single day of unemployment.

Ben’s Letter—Continued from Page 9

Benjamin Liu:

Congratulations on your interest in geology and specifically in the lee Ages and the creatures that existed in that time. Geology has many fascinating aspects. I’m sure you’ll identify several that excite you.

Let me address your questions:

1. How did you get interested in geology?

   I was born in Noranda, Quebec, Canada which is a mining community in northwestern Quebec Province. It has a number of mines that have operated in the area since the 1920s and also a copper smelter for the production of raw copper. Geology is an essential part of mining, particularly exploration for new mines, which is the area of geology I am most interested in. Many field of geology involve out-of-doors work. I like that aspect too.

   That part of Canada, like your home area, was affected by the last ice age. Many of the rocks are covered by soil scraped by the ice and moved south and now cover areas where you live. A type of mineral prospecting that involves looking for indications of minerals in this glacial cover and then tracing in the direction that the ice came from has proven to be helpful in mineral exploration. I am particularly interested in those aspects of geology.

   Geology is interesting as part of earth history. It also has many applied aspects that contribute to our standard of living: mining, oil and gas, construction materials, environmental preservation, etc.

2. What was your favorite animal in the ice ages?

   I don’t have a favorite but there have been some interesting discoveries of mammoths here in Colorado recently. I’ve attached several articles and pictures describing this work that I thought you would be interested in.

3. Would you like living in an ice age?

   I think I would prefer the climate we have today. However, we must adapt to the situation we are born into.

4. In your opinion, what do you think would be good about living in an ice age?

   It would certainly be a more challenging than the time humans currently live in. We have many more people on the earth today than we had in the last Little Ice Age. Depending upon how much of the earth’s surface was covered by the ice sheets, it could be more crowded and competition for food and other materials needed for survival would be much greater.
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 2011 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:___________
Address:_____________________
Fax:_____________________
E-Mail:_____________________

NAME OF PERSON MAKING
THE NOMINATION:____________
Address:_____________________
Fax:_____________________
E-Mail:_____________________

Signature:_________________
Date:______________

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

DEADLINE: Completed nominations must be received by January 15, 2011.
Entering the Geoscience Working Community: Best Practices and What to Expect

Dr. Richard B. Schultz, CPG-10188

Because this issue is the Student Edition, it is pertinent to make a few recommendations targeted to tomorrow’s geoscientific workforce. As most current students are probably aware, the vast majority of geoscientists work in the petroleum industry, mining industry, environmental firms, and some in government agencies. In the past, the petroleum industry had employed the largest number of geoscientists. Currently, in the neighborhood of 40% of geoscientists are employed in the exploration and production of fossil fuels. The environmental industry, especially by way of consultants, now employs nearly 20% of geoscientists. While mining was once a dominate geoscience employer, today only about 10% of geoscientists work in private industry related to mining (Bureau of Labor Statistics, 2008). Alas, mining is not once what it was, but still remains an opportunity industry for future employment for geoscientists since precious metals seem to be on the upswing with gold currently at record levels on world markets. Government agencies employ another 10% of geoscientists, including most oceanographers and atmospheric scientists, with those areas increasing in employment opportunities with time because of their highly technical nature and interdisciplinarity. Geoscientists in the government work in many different capacities, from pure research to the discussion and development of current policy. Another 5% of geoscientists work as educators, but that number may well increase with time as well. This opinion piece is geared specifically for those who are either thinking about a career in the geosciences in the future and/or those who are just about to enter into the field now and provides some best practices for current students as well as advise for those currently preparing to embark on a job search in a downturned economy.

Not unlike many other sciences and engineering-oriented fields, the geosciences have seen an increase in the diversity of the workforce. Today almost 20% of geoscientists are female with females beginning to be more prominently seen in the upper levels of management. The age distribution of the geosciences is strongly dependent on the industry examined. For example, the petroleum industry has a large number of geoscientists approaching retirement, as well as a saturation of workers in the 30-40 year old range as a result of past economic downturns. This is a unique opportunity for those currently entering into the workforce to capitalize on a worker shortage in the market. Emphasize technical skills and experience with such tools as GIS, which older workers may not possess.

The geosciences, not unlike engineering and other technical fields, remains a competitive market. However, there are a number of preparations students can make now to make themselves more marketable in a downturned economy. Respect for authority and appreciating diversity are two principal traits that employers are seeking in their employees. Learn how to communicate effectively both in the written and spoken word and develop your people skills, particularly by developing and maintaining a personal network of contacts in your particular area of emphasis. Not only should students become members of professional organizations, but they should be active members and attend conferences on a regular basis to make themselves visible and known. One never knows about a looming internship or part-time project work opportunity and where it can be obtained. Being in the right place at the right time is half the battle, but one has to be “out there” in the first place. Seek out opportunities such as student chapters and serving as student members on committees. It goes without saying that displaying skill sets in terms of presenting research and/or striving to have it published represents a major arrow in the quiver of one’s experience. Another strategic aspect of improving your marketability is to develop strong technical skills, especially in terms of geospatial skills and identify a unique, but relevant, niche of expertise and skill sets that few others consider. Highlight your strengths and play to those. Don’t de-emphasize your weak areas, but rather look at those as areas to better yourself and take every step through professional development to do that. View weaknesses as “opportunities” and convey this to a potential employer. Also the development of an understanding of the business issues of the company and industry in which you are looking to work conveys to the potential employer that you can hit the ground running when starting your new position. Understand the economic aspects of your discipline, particularly how the science is applied to add value to

the company and the corporate “brand”. Once you are involved in a company, work close to the foundations of the corporate mission and develop skills that are indispensable to the business, thus making your job non-disposable. Additionally, learn the statistical skills and quantitative background of your industry on both a local and global scale. People are hired in industry to help companies make money, save money and solve problems. Know how your background and your geoscientific abilities contribute to those goals. Realize that much of what you learned in school was not just textbook jargon, but the ability to think critically, analytically and hone your problem solving skills. All employers love good problem solvers and those who can “think outside the box”.

Because of the multifaceted nature to the geosciences and the interdisciplinary spin, geoscientists are often exceptionally attractive to employers, attesting to the unique blend of analytical skills most geoscience training provides. The geosciences are not a purely quantitative science; it is still heavily dependent upon high level skills of observation, careful deductive reasoning, and interpretation of complex data. These types of skills are often critical for effective problem solving in real world situations, even outside of the geosciences. Know that you have a multitalented skill set that can be indispensable to numerous employers and industries.

Above all else, be a team player. Everything nowadays is based on teamwork and providing your input into a larger project. The need to work collaboratively with others will always be a part of your career. Learn that now and hone your team skills. To have a successful career requires that you learn how to work effectively with in many different situations. Most work efforts are highly integrated, requiring the cooperation and input from a variety of workers in many disciplines. Understanding and appreciating different perspectives and work cultures is a skill that must be learned and implemented to be successful in today’s and in future workplaces.

We have all heard the term “globalization”, but its effects are true today more than ever before. Celebrating other cultures and using others’ input, who may come from a totally different perspective, is what can get you and the company you are working for, ahead in the long run. It is no longer a secret that we all live and work in a multi-cultural world. To be a part of a profession that is truly global in perspective requires that we understand and celebrate people different from ourselves. This effort needs to begin in school as student and continue throughout one’s life. The workforce is increasingly diverse, and although this requires challenges in understanding one another, it offers a rich source of new ideas and new perspectives on geoscience issues (AGI, 2010). The richness of diversity can be a major tool in collaborative, creative problem-solving, particularly when you may be the “outsider” in a project that is in a foreign country. There’s no quicker way to make yourself valuable than speaking another language and being able to communicate with those in other lands.

According to the U.S. Department of Labor, Bureau of Labor Statistics, although employment growth will vary by occupational specialty, overall employment of geoscientists is expected to grow much more slowly than average for all occupations through 2014. However, due to the relatively low number of qualified geoscience graduates and the large number of expected retirements, opportunities are expected to be “good” in most sub-disciplines of the geosciences. Keeping in mind the skill sets and traits of an effective employee can be a big step in landing that first job or moving up the corporate geoscientific ladder.

White Paper issued by AIPG.

Importance And Future Roles Of State Geological Surveys.

The white paper is available on the AIPG website (url: http://www.aipg.org/Membership/Role%20of%20State%20Geological%20Surveys%202010-11-30%). Please contact AIPG headquarters with questions or to comments.

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Summer Job with the National Park Service

Jason J. Testin, SA-1814

Key Words: National Park, Park Ranger, Summer Jobs, Geoscience Internships

Working a summer seasonal job at a national park is a great opportunity for students in all science fields, including the geosciences. This past summer I had the opportunity to work as an interpretive ranger at Badlands National Park. Depending on the park and the position desired, the exact process of obtaining a seasonal position and the duties performed may vary; however, here is a summary of the position I had and some hints for obtaining a position of your own.

My position at Badlands was termed a STEP (Student Temporary Employment Program) position. Keeping the position for next summer is contingent on remaining in school. I had originally applied for an internship in the park through Geocorps America. I was interviewed by the park paleontologist, and most likely would have been hired for the position shortly thereafter, but was unable to accept any offer before mid-June due to a conflict with a geology field camp. Fortunately, when a seasonal ranger position became available, it was offered to me first. This position was funded by a grant that involved an erosion study in the park and the start time was flexible, allowing me to start at the park immediately following field camp.

What kinds of duties might a seasonal interpretive ranger expect to perform? Again, this will vary depending on the park. At Badlands there is a general routine. All interpretive rangers are expected to put in a few hours a day staffing the desk at the Ben Reifel Visitor Center. From this post you are the “go-to” person for visitor questions, comments and complaints. Common questions include “Where is the restroom?”, “How did these formations form?”, “Where can I see bison?” to “Are there any open camp sites in Yellowstone?” You will also often get children and adults interested in the Junior Ranger Program, so checking Junior Ranger booklets, giving the Junior Ranger oath, and handing out Junior Ranger badges are important visitor center duties.

Most days an interpretive ranger is expected to deliver one or two interpretive programs to the visiting public. These programs require the ranger to become familiar with all aspects of the natural resources and cultural history of the park. At Badlands we deliver walks and talks teaching the public about park geology, fossils and the prairie combining information regarding Native culture and early settlement into the story of the Park. Other ranger programs include evening programs as well as the ranger-led Junior Ranger Program, which can be completed in lieu of the Junior Ranger activity booklet. Topics for these programs revolve around a ranger’s own interest in the park and might include information on prairie animals, Native culture, and early settlement. None of the ranger programs are scripted; it is expected of the ranger to learn about the topic and create their own, individualized program to meet the criteria expected.

Another important duty that a ranger is expected to perform is roving, when the ranger can walk the hiking trails, stroll through the campground, or visit favorite overlooks. This time is intended to give the ranger and the visitors a chance to interact with each other in an informal way. Roving rangers should be prepared to answer questions, listen to comments and concerns, and “just chat” with visitors as they enjoy the park. Roving is also a great opportunity for the ranger to get visitors interested in the many ranger-led programs going on throughout the day, and help visitors plan their visit to the park.

Finally, each ranger is assigned a project in the park to work on and at least a few hours a day are written into the ranger’s schedule as project time. Projects vary, but are usually aligned with the ranger’s experience and interests. Examples of projects currently in progress by rangers at Badlands include: helping launch the Junior Paleontologist Program, updating the park webpage, doing Lakota cultural demos, and sorting through “Artist in the Park” submissions. My project revolves around an erosion study underway in the Badlands, writing press releases, summarizing the project, and handing out Junior Paleontologist Program, updating the park webpage, doing Lakota cultural demos, and sorting through “Artist in the Park” submissions. My project revolves around an erosion study underway in the Badlands, writing press releases, summarizing the project, and making the project progress by rangers at Badlands include; helping launch the Junior Paleontologist Program, updating the park webpage, doing Lakota cultural demos, and sorting through “Artist in the Park” submissions. My project revolves around an erosion study underway in the Badlands, writing press releases, summarizing the project, and making the project progress.

Hints on Obtaining a Position:

Geocorps America (http://www.geoscience.org/geocorps/index.htm)

This program is run by the Geological Society of America (GSA) and places college students, as well and professionals...
and retirees, into temporary geoscience positions through the National Parks Service, Bureau of Land Management, and USDA Forest Service. Participants receive a stipend for subsistence; housing and/or housing allowance, and work on a specific geoscience project chosen by the park. Note: You must be a member of GSA to apply for Geocorps positions.

National Park Service (http://www.nps.gov/aboutus/workwithus.htm)

By going to the National Park Service website, you can get lots of information regarding open positions in the parks, both seasonal and permanent. You can also get information involving volunteer opportunities in the park, which is a great way to get your foot in the door, and perhaps move into a ranger position the following season. Some volunteer positions even include housing and a stipend for subsistence. The National Park Service webpage is also a great starting point for finding other resources concerning positions in the park service.

USAJobs (http://www.usajobs.gov)

USAJobs is your portal to all government jobs, not just those in the park service; it is a great place to begin if you are interested in a job in any government agency. To Be warned – some of the jobs are only open to individuals who already have some experience in the government and have obtained a “GS” rating of a certain level.

Still not finding a position that interests you? Maybe you can’t find a position at your favorite national park…visit the web site of the park and contact the park directly. Make the staff familiar with your name and qualifications. It might just pay off, if a position becomes available and they think of you first, you may become the first choice even before the position is advertised.

In conclusion, a summer position at a national park is a great opportunity for students in the geosciences, or indeed any field of study. These positions provide the student with “real world” experience relating to the public and experience in their field of interest. Not to mention, a summer position in a national park might lead them to a permanent position with the park service after graduation.

Acknowledgements:

The author would like to thank the staff of Badlands National Park, in particular Dr. Rachel Benton, Aaron Kay and Julie Johndreau for giving me the opportunity to spend my summer as an interpretive ranger. I would also like to thank my wife Krista for love and support and allowing me to spend my summer away from home “playing Park Ranger”.

After 5 years of Teaching High School Earth and Space Science in Minnesota I am currently working on my second Bachelor’s Degree in Geology and Paleontology at the South Dakota School of Mines and Technology. I will graduate in spring 2011, and plan to remain at SDSM&T to get a Master’s degree in Vertebrate Paleontology. It is my goal to continue working summers with the park service, and would enjoy getting a full time career as a park geology/paleontologist after completing my PhD. I currently live in Rapid City, SD with my wife Krista. Our first child is expected in June.
Energy Futures and Geoscience Education

Michael Urban, MEM-1910 and Bill Hoyt, CPG-07015

Introduction

Geoscience students currently enrolled in college or graduate schools today face an increasingly bewildering yet exciting array of possible career choices. At least compared to 1970, when the second author graduated from college or even 1999, when the first author graduated from college, the variety of geoscience energy careers possible today is vastly expanded. The purpose of this paper is to investigate new energy careers available or emerging and ask the question whether students planning to go into the energy field today might be wise to consider additional course work and experiences in order to be better prepared.

Predicting exactly when and to what degree hydrocarbon reserves will be substantially replaced by other sources of energy production has been slippery at best, but there are some well-understood foundations that strongly suggest it is inevitable. Geophysicist M. King Hubbert studied historical production curves for oil wells and concluded that after the production peak for a field is reached, declining production will ensue (Hubbert, 1956), regardless of increasing effort and a multiplicity of secondary and tertiary recovery strategies, directional drilling, or other efficiencies we might develop. Hubbert’s research predicted that U.S. oil production would peak about 1970, but that was summarily dismissed by those in the oil industry. He turned out to be quite right, and by implication his work suggests that on a global scale, oil production follows a similar trend of inevitability. Estimates for the year of peak world oil production have varied from 2004-2011, with a decline to half of that peak global production by about 2040 (Deffeyes, 2001, among other authors). How humans plan to replace that very large loss in petroleum-based energy production is unknown, but it certainly ranks near the top of serious issues facing humanity.

Sources of other fossil fuels such as natural gas and coal will likely be around much longer than crude oil, but even the extraction of those reserves will become harder and much more expensive as time advances. Even the very abundant and longer-lasting global coal reserves will be subject to the payment of additional costs to arrest airborne mercury coming out of the stacks and perhaps carbon emission taxes of some sort in the future. Though we have a few frontiers left for oil and gas development in previously hard-to-reach areas such as the former Soviet republics and deep-water outer continental shelves, those are subject to the same limitations as all previous fields.

During the summer of 2010 we witnessed a sobering illustration of how perilous and expensive production in these frontier areas might be: the blowout of the Macondo Well at the site of the Deepwater Horizon. The bad press and environmental damage caused by that event is hard to even imagine, let alone calculate, but one thing is clear: American society and global investors/producers are beginning to question whether ever-increasing effort in ever riskier frontiers is where we should invest. Since we are consuming oil and gas reserves faster than they are being replaced (e.g., Copley, 2006), alternative energies must enter into the energy production equation eventually.

Alternative Energy Strategies

In Table 1, we list commonly reported alternative energy strategies and their relative importance (2008 data). Included in this table are energy-production strategies which are not petroleum-based (e.g. hydrogen fuel cells are not included because the primary energy used to refine the hydrogen is petroleum). These are clearly the areas in which we will concentrate our efforts and have jobs in the near future in order to replace the energy lost from petroleum sources.

Table 1. Common alternative energy strategies and their characteristics.

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>% Global Production</th>
<th>Mining Needed</th>
<th>Environmental Damage</th>
<th>Growth Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustible, Renewables &amp; Waste</td>
<td>9.9</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Nuclear</td>
<td>5.8</td>
<td>High</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Hydroelectric</td>
<td>2.2</td>
<td>Low</td>
<td>Moderate</td>
<td>Low</td>
</tr>
<tr>
<td>Wind</td>
<td>~0.2</td>
<td>Moderate</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Solar</td>
<td>~0.2</td>
<td>High-Moderate</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Geothermal</td>
<td>~0.1</td>
<td>Low</td>
<td>Low</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ocean Energy</td>
<td>~0.1</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>All Others</td>
<td>~0.1</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>TOTAL</td>
<td>18.7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(After data in Key World Energy Statistics, 2010)
may continue to have difficulty growing because of public opposition. Notice that the top three alternative energy sources on the list (combustible, renewables & waste, nuclear, and hydroelectric) all result in moderate environmental damage, or at least the perception of it. Biomass and waste combustion produces lots of smoke and carbon dioxide gas, which are both negative attributes. Fear and opposition to nuclear power generating stations is particularly widespread in the United States. Ecological damage to aquatic species and commercial fisheries make emplacement of new hydroelectric plants unlikely in most areas of the world.

Many of the alternative energy sources in Table 1 make frequent news headlines announcing a promising line of research or pilot testing of new equipment. As prices of producing global energy continue to rise, pressure and investment money builds to find solutions to the global energy crisis. This problem will not go away without herculean effort over decades. The students of today will be the practitioners of tomorrow—and we hope many of them will find practical solutions to these serious challenges.

Skills of a Successful Geoscientist

The skills necessary for geologists to capably function today are more far-reaching than those needed just a short time ago. It is no longer sufficient to simply understand geologic principles. Geologists are now expected to be geoscientists who are well-versed in the complex interactions and interdisciplinary problems that occur within the natural sciences, and keenly attuned to any and all potential environmental implications of their job responsibilities. There are a variety of essential skills necessary for geologists to be competitive in the energy production and management realm in the twenty-first century. In addition to the excellent foundation that a geoscience education currently provides in college, what are the types of work skills and new foundations students need to enter the energy workforce in 2015 and beyond?

In general, the desirable proficiencies for geologists can be categorized into five broad sets of skills: applied content, communication, technology, problem-solving, and professional. Each will be considered in turn, and then examined with respect to the traditional and emergent perspective of the geologist.

Applied content skills involve a technical reliance on the fundamental aspects of the science of geology. Examples include knowledge related to both the theoretical and practical components of the geological disciplines. An ability to use content knowledge, field mapping and surveying techniques, make connections to prior experiences, and perform mineral, rock, and structural identification would constitute applied content skill.

Communication skills include oral and written forms. Geologists may be called on to write technical reports, apply for grants, advise private and government panels, and interact with the public on a regular basis.

Technology skills encompass a multitude of relevant everyday activities as well as those of a more technical nature. Certainly capabilities related to word processing, spreadsheets, and the internet would be included here, as would skills related to using global positioning systems (GPS), geographic information systems (GIS), numerical modeling, and digital mapping.

Problem-solving and the ability to critically analyze or evaluate data, situations, and circumstances are necessary to excel at any job. Quantitative aptitude is important; many geologists rely on algebra and trigonometry to perform their work activities. It is also useful for a geologist to be able to think spatially (in the four dimensions of space and time) in order to visualize structures and events.

Professional skills are necessary for any job. For the geologist, these may reflect professional attitudes about management, commitment, ethics, interpersonal interaction, willingness to travel, and physical stamina (related to field endurance and long hours).

The Traditional Geologist

Traditional natural resource extraction skills are still paramount despite the many emerging and diverse needs of the oil industry of tomorrow. Essentially gone are the days when surface indicators (e.g., anticlines) and geologic map interpretation prevailed for the identification of oil resources, making way for more advanced techniques relying on seismic information, gravitational fluxes, and computer modeling. Even so, a firm grasp of geoscientific concepts related to sedimentology, stratigraphy, structural geology, mapping and interpretation, and geophysics are critical (Heath, 2005).

Oil companies expect petroleum geologists to have a strong understanding of geology and geophysics, possess problem-solving and interpersonal skills, and demonstrate computer proficiency (Heath, 2003). Such skills enable geologists to reconstruct past events, solve applied problems, draw conclusions from minimal data, work collaboratively in teams, and utilize a plethora of technological tools for modeling, digital mapping, and remote sensing. Our increase in technological prowess now allows previously unrecoverable petroleum reserves to be extracted for profit, and properly equipped professionals are still needed in this industry.

Tomorrow’s Geologist

The number of different jobs for which students trained in geology are prepared is steadily on the rise. Disasters like the blowout of the Macondo oil well off the Gulf Coast of the United States have fueled an already fervent concern for the sustainability of our natural environment. Consequently, oil companies are under more scrutiny from regulating agencies and will be held to higher standards of risk management. Training in jobs pertaining to natural hazard-reduction, environmental remediation, and the mitigation of energy by-products are increasing. These factors, along with the push for better hybrid fuels and alternative energy sources, have ushered in a newly emerging perspective of the geologist. In this view, more and better skill sets in ethics, cost-benefit analyses, regulatory understanding, microeconomics, statistics, and even interpersonal conduct, are needed.

The environmental sector, state and federal governments, engineering firms, water management agencies, and private industry are all viable potential employers, and all look favorably on individuals with well-rounded backgrounds. Consider the employability of someone with preparation in law (Gibbs, 2006), economics, or public speaking for working with public policy issues; the value of someone with knowledge of accounting and business to private companies; understanding of risk management and statistics in the environmental sector. Add to any one of these positions a supervisory role, and immedi-
atley the benefit of psychology for motivating and evaluating employees can be seen (Megill, 2006). The list goes on.

Final Thoughts

This discussion should not be viewed negatively; in an era where multitasking abounds, one may find great satisfaction in the myriad facets of the geoscientist’s job today. As you prepare to begin or continue your education in the geosciences, take a moment to reflect on the diversity of job opportunities and just how many more employment possibilities might exist for a broadly trained student; then, take an active role in planning for your ideal future by using your imagination and conducting a little further research into the prospects and expectations of your intended employer(s). We encourage students to engage their professors in discussions about future career paths and changes in the energy industry that are happening. We find that most geoscience professionals are thinking long and hard about the future of the profession; your role in that future is full of promise.

References


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How We Write

Robert A. Stewart, CPG-08332

I recently saw a television news item that profiled an innovative program to improve reading and writing skills at a chronically underperforming middle school or high school. The story was probably no more than five minutes, and I didn’t catch the name of the school system or the TV network. The method behind the school’s program was to have the kids write about absolutely everything they did during the school day, in all classes, and outside of class. Initially the kids hated the work. Reading and writing did not come easily, and expository writing was tough, especially as the subject matter varied from activities in P.E. classes to describing what was for lunch and between-class conversation. The administration and teachers were relentless, and over the months, the kids became more proficient, writing became fun, skills improved further, and a positive feedback loop developed.

One of the few constants through my university training as a geologist, and three different geologic careers, is the need to produce a report upon completion of a project. Academic research as a student requires a term paper, thesis or dissertation. As a university professor the work product was a publication, preferably peer-reviewed in a recognized journal, and grant proposals leading to external funding. While working in mineral exploration, my report was often a geologic map, with a suitable explanation. Presently I write and review illustrated reports dealing with the investigation and remediation of contaminated sites. Now, the key to success is to prepare a concise report quickly and accurately.

Before university I had the benefit of a good public school education that gave me an adequate preparation in English grammar and composition, bolstered by eight years of French. My undergraduate and graduate education included innumerable field trips, plus summer field camp (as a student and instructor), experiences that paralleled the school program profiled on TV: I was constantly updating a field book, which was reviewed and graded. Our field book prose (often as an outline) was expected to be clear, and supported by sketches. Some of my descriptions of more spectacular outcrops waxed eloquent to the point that my advisor pointedly remarked that I didn’t have to emulate Steinbeck, but write the field notes as if I had to return the following year leading the same trip. This was excellent advice that has stayed with me.

Some years ago a colleague passed on a faint copy of a copy entitled The Doctrine of Completed Staff Work, by Col. Archer L. Lerch. I had no idea of the origin until the internet arrived, and a quick search revealed that Colonel Lerch wrote the doctrine for the Provost Marshal General during World War II.1 The doctrine continues to resonate even if you’re not in the armed forces. I want to emphasize two points here; refer to the source material for the complete doctrine. First, completed staff work consists of complete study of a problem, followed by presentation of a completed action (e.g. map or report) in a form that simply allows the decision maker to either approve or disapprove it. The second point is the final test of completed staff work: if you were the supervisor, would you be willing to sign the report prepared by your subordinate and stake your reputation on being right?

As professional geologists, regardless of specialty, we are constantly faced with the final test of completed staff work. As supervisors, we rely on our junior staff to execute a scope of work to achieve a goal, and our reputation is at stake. And very often, despite utterly sound technical work, it’s the way we write our reports that makes all the difference to the client. In the private sector, the ultimate conclusion is always the same, regardless of the details – do we spend more money, or not? Just as important is the way in which we express our conclusions and recommendations.

One of my previous employers had a contract with a large state agency involved with infrastructure improvements. Occasionally, the agency acquired property for its projects through eminent domain (condemnation). Our task was to evaluate soil and groundwater quality at such sites, and estimate the cost of remediation, as most of the properties were used for commercial or industrial purposes, and commonly had some history of oil or chemical spills. Our task was not to determine comprehensively the three-dimensional degree and extent of contamination over an entire property, but rather to examine the likely areas of concern (AOCs) – underground storage tanks, motor fuel dispensers, documented spill areas, and so forth – and estimate the cost for cleanup based on reasonable assumptions and caveats.

Our work product consisted of a Phase I and Phase II environmental site assessment, plus a technical memorandum that presented our estimated remediation costs, assumptions, and caveats. The memorandum was meant to be just that, and not a blow-by-blow recapitulation of the supporting Phase I and II reports. The state agency was required by the state and federal government to consider the remediation costs as a deduction against the fair market value of the property. The property owners almost always contested our estimates.

One of my staff was responsible for the investigation and remediation estimate at a gas station property to be acquired by the government. The gas station had been on the property for over 30 years, and unsurprisingly had a long list of spills and leaking UST systems. My subordinate did excellent

Continued on Page 41.

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2009 EXHIBITORS

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TEST YOUR KNOWLEDGE

Robert G. Font, CPG-03953

1. This orthorhombic, copper-rich mineral (chrysocolla) exhibits vitreous to earthy luster, conchoidal fracture, has a hardness of 2.5 to 3.5, specific gravity of 1.9-2.4, is characterized by blue-green color and white to blue-green streak. Which of the following choices apply in defining its chemical formula?

a) \( \text{CuSiO}_3 \cdot n\text{H}_2\text{O} \)

b) \( \text{Cu}_2\text{CO}_3(\text{OH})_2 \)

c) \( \text{Cu}_3(\text{CO}_3)_2(\text{OH})_2 \)

2. This type of lake or glacial pool typically fills in a depression (like a cirque) caused by glacial erosion of bedrock in Alpine areas or mountain-glaciated terrain:

a) Tarn lake

b) Kettle lake

c) Playa lake

3. The term which describes a submerged flat-topped seam mount is:

a) Barchan

b) Guyot

c) Tombolo

4. We are studying the elastic deformation of rocks. Given the relationship between “Poisson’s Ratio” (\( \sigma \)), Bulk Modulus (\( K \)) and Young’s Modulus (\( E \)), where \( \sigma = (0.5 – E/6K) \), what is the “compressibility (\( \beta \))?"

a) \( \beta = E/3(1-2\sigma) \)

b) \( \beta = 3(1-2\sigma)/E \)

c) \( \beta = EK/\sigma \)

d) Are you kidding me?

5. For a given earth material tested in the lab, the coefficient of friction is found to be 0.5317. At what angle \( \Theta \) (with respect to the minor principal stress direction \( P_3 \)) would one expect a shear fracture to develop?

a) At 29 degrees

b) At 59 degrees

c) At 10 degrees

d) Help!

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Students – You Are Our Future!

Samuel W. Gowan, CPG-07284

Geology has always been important to society and, in some ways, is more important today than at any other time during the history of modern humanity. However, I suspect you already know that, otherwise you might not be reading this. This article is primarily for the students among us who are studying geology and hopefully will soon be starting a career as a professional geologist.

I read, hear or see some form of local, national and world news every day. It is a rare day that I do not come across items directly involving geology in some form or another. These range from global, such as the team of geologists, engineers, and drillers that designed and implemented a plan to save the miners in Chile; to regional references, such as public concerns for producing unconventional gas using the slick water fracturing process; and to local issues, such as the need for water supplies for developing communities. As our world population approaches seven billion, our need for natural resources, clean water, protection of the environment and places to live that are ever closer to areas prone to natural disasters, will only put more demands on geology.

It would seem that geologists of all specialties would be in great demand, but that does not appear to be the case. There were approximately 31,290 geoscientists (exclusive of academics) working in the U.S. as of May 2007, based on U.S. Labor Department Statistics. This is a modest number that actually declined slightly to 31,260 by 2008, which is the most recent date for which data are available. These numbers are quite disturbing when considering that the petroleum industry alone is projected to need close to 50,000 geoscientists worldwide by 2020, based on American Geological Institute projections. The U.S. and worldwide employment of geologists and other geoscience professionals should be climbing rapidly.

There are a multitude of possible reasons for the current lack of demand for geologists. The “great” recession is the obvious reason for the recent decline; but there must be other fundamental reasons why geologists are not being called upon. Two other reasons that come to mind include a lack of properly educated geologists and uneducated clients (a client is anyone that uses the services of a geologist) that do not understand the value of a geologist in solving a natural resource or environmental issue. Both of these conditions can work together to act against demand. A poorly educated geologist leads to poor performance, which, in turn, will lead to client dissatisfaction. Dissatisfied clients seek remedy by using other professionals. The engineering profession is often the remedy of choice, but others are often called.

The solution to the forgoing problem is up to us, both students and professionals, to solve together. My recommendation to the students, based on my direct experience, is to develop a solid educational background and familiarize oneself with the work of professional geologists. A solid education in the fundamental or core courses in geology cannot be obtained from every institution offering a degree in the earth and environmental sciences. In fact, there have been many recent cases where universities are either cutting geology out of their curriculum or subsuming departments into a broader environmental science program that involves eliminating many core courses that are fundamental to geology. It is often up to the student to determine what is required, seek out those institutions offering those courses, be prepared to undertake a rigorous set of courses and be willing to apply oneself.

My personal experience is that the rewards may not be instant, but the long term results are likely to be satisfying. Knowledge of what constitutes a fundamental background for the practicing professional geologist can be obtained by investigating the requirements for licensing by governmental regulatory bodies, the requirements for certification through professional organizations such as AIPG, or the general description of tasks of a professional geologist by the National Association of State Board of Geology (ASBOG; www.asbog.org). Student development should not stop there. Attendance at meetings and lectures where the student can learn about the practice of geology and network with practicing professionals is highly beneficial. This is one of the few avenues open to the student to obtain direct knowledge of the professional world of geologists beyond the academic profession. These meetings provide added benefits of developing long term professional friendships and providing leads for jobs during professional development.

The professional geologist is the other key ingredient in strengthening our profession. Professional geologists accomplish this through advocacy and outreach to our prospective clients and students. Advocacy of our profession typically means recommending or promoting the science of geology, but a more subtle approach might be more effective. Professionals that continue to pursue education, improve their capability, and strive to produce a more effective product will satisfy clients and prove the worth of the profession. I am pleased to hear of geologists being heralded for helping save the miners in Chile, addressing resource development issues...
in the unconventional shale gas development or addressing other geologic concerns around the world. It is better to demonstrate through effectiveness than attempt to sell through explanation. Our professional society (AIPG) is focusing ever more energy on continuing education for our professional membership and technical seminars and other informational programs for our clients (general public, industry and government). These programs demonstrate that we are knowledgeable professionals with skills that are beneficial to society. AIPG will be moving aggressively forward with these programs in 2011.

AIPG is also focused toward the students and we will continue to push the development of outreach programs. We are working hard to reach out to you and help you understand what is needed and available to help you become a working professional. I recently sent out a questionnaire to our student members asking for advice on how best to communicate and what types of information are of greatest value. We greatly appreciate the responses and will be moving forward to improve our efforts. You are our future and we look forward to helping you get there. Please do not hesitate to identify the professional geologists in your area and reach out to them. Most of us will be happy to answer questions and give you guidance if requested.

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IN MEMORY
Thomas P. Ryavec  CPG-09091  Member Since 1993  October 2010  Nicholasville, Kentucky

Clement B. Thames, Jr.  CPG-00927  Member Since 1965  August 22, 2010  Marble Falls, Texas
Answers:

1. The answer is choice “a” or CuSiO₃ ⋅ nH₂O, as “chrysocolla” is a hydrated copper silicate.
   Choice “b” is “malachite” or Cu₂CO₃(OH)₂ (or a hydrous copper carbonate) which is monoclinic, generally bright to dark green in color, with a hardness of 3.5-4.0, a light-green streak and specific gravity of 3.6 to 4.0.
   Choice “c” is “azurite” or Cu₃(CO₃)₂(OH)₂, which is generally a monoclinic specimen of hydrous copper carbonate that is blue in color, with light-blue streak, hardness of 3.5-4.0 and specific gravity of 3.73 to 3.78.

2. The answer is choice “a” or “tarn lake”.
   Choice “b” or “kettle lake” refers to a lake or water-filled depression created by the melting of partially-buried or trapped ice blocks, generally found in the outwash plain of receding ice sheets.
   Choice “c” or “playa lake” defines shallow and temporary pools that form on a flat valley floor in dry or arid regions following rainstorms.

3. The answer is choice “b” or “Guyot”. “Guyots” were once volcanic islands where erosion through wave action flattened their tops, as the islands sank below sea level.
   “Barchan” refer to crescent-shaped sand dunes, higher in the center, with tips or horns pointing downwind. These are generally found in areas of relatively constant winds and limited supply of sand.
   “Tombolos” describe sedimentary ridges that connect a former island to another island or to the shore land itself.

4. The answer is choice “b” or [\( \beta = 3(1-2\sigma)/E \)].
   The key here is that “compressibility” (\( \beta \)) is the reciprocal of the “Bulk Modulus” (K). Thus:
   \[
   \sigma = 0.5 - \frac{E}{6K} \\
   6K\sigma = 3K - E \\
   3K - 6K\sigma = E \\
   K (3 - 6\sigma) = E \\
   K [3 (1 - 2\sigma)] = E \\
   K = E/(3(1 - 2\sigma)) \\
   \beta = 1/K \\
   \beta = 3(1 - 2\sigma)/E
   \]

5. The answer is choice “b” or “at 59\(^\circ\)” (\( \Theta = 59\(^\circ\) \)), since we can prove that \( \Theta = 45^\circ + \Theta/2 \) (see below).
   By definition, the coefficient of friction “\( f \)” is:
   \[ f = \tan \Theta \]
   where \( \Theta \) is the angle of internal friction.
   If “\( f \)” = 0.5317, then \( \Theta = 28^\circ \) and \( \Theta = 45 + 28/2 = 59^\circ \).

From the Coulomb-Mohr fracture criterion, we can derive:
(\( P_{1} - P_{3} \)) \cos 2\( \Theta \) = - (\( P_{1} - P_{3} \)) \sin 2\( \Theta \) \tan \Theta
Thus,
\[
\cos 2\Theta = -\sin 2\Theta \tan \Theta \\
-\tan \Theta = \cos 2\Theta / \sin 2\Theta \\
-\tan \Theta = \cot 2\Theta \\
-\cot \Theta = \tan 2\Theta
\]
From trigonometric identities, we know that:
- \( \cot \Theta = \tan (90^\circ + \Theta) \)
Then:
\[
\tan (90^\circ + \Theta) = \tan 2\Theta \\
2\Theta = 90^\circ + \Theta \\
\Theta = 45^\circ + \Theta/2
\]
EXECUTIVE DIRECTOR’S COLUMN

The Counselor

William J. Siok, CPG-04773

If this column had been entitled ‘The Mentor’, you may very well not have bothered to read further. I am personally jaded by the repetitive use of some commonly seen buzzwords, among them ‘mentor’ and ‘buzzword’. I guess mentor will be used nonetheless.

It wouldn’t surprise me if every professional society has a program to mentor students and young professionals. Thinking professionals, I believe, all have an innate desire to help students and entry level practitioners and to guide them when they are making career decisions.

The concept of mentoring is excellent. But the challenge to successful mentoring is in how to actually implement a program which will be sought after and truly helpful to the young graduate. The efficacy of formal programs through professional societies may not be as high as those which are built upon the informal relationships which serendipitously arise between practitioner and student.

It has recently been my privilege to assist a graduate student in her efforts to make a few career decisions. Those of us who have been in the workplace for a decade or more sometime forget that the perspective we each hold cannot be assumed to apply for someone else. Students and recent graduates in particular generally have a limited view of their real prospects as a practitioner in the workplace, which is the arena in which we are able to offer substantive insight.

Assisting an undergraduate or a recent graduate to assess graduate opportunities, either in academe or in industry, requires that the mentor stand back, not dwell on reminiscent ‘war stories’, and strive diligently to be objective.

Of course each situation is unique, and each requires a tailored approach. It’s fascinating that we can do so much to help a recent graduate by merely introducing him to some of the contacts from the professional network we have all developed.

I realize that I’m preaching to the choir here, and that many of us do whatever we are in a position to do to assist aspiring geoscientists. Perhaps one of you student readers will peruse this column, take the initiative, approach someone who’s been working in the profession for a while, and request some help.

It’s daunting to look in the mirror and realize that many of us are nearing the end of a career which we once perhaps thought to be limitless. We owe it to those about to enter the workplace to offer them the benefit of experiences working in the profession on the chance that our insights might help them to avoid pitfalls and to take timely advantage of opportunities.

Many of you student readers will be graduating soon. Please accept my heartfelt wishes for good health and a long, satisfying career in the geosciences.

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Field Camp: It’s Not Optional for the Professional

In column 128 (Jul/Aug ’10) I discussed the topic of “The changing face of academic geoscience training” and noted academia’s apparent change in the importance of field camp as part of professional geoscience training and the firm opinions of a number of practicing professional geologists who contributed to a discussion of the topic on LinkedIn.com that field camp is not an option, it is a requirement for basic professional geoscience training. So far (as of November 5th) there have been 46 comments posted; see http://www.linkedin.com/groupAnswers?viewQuestionAndAnswers=&discussionID=17818767&gid=1776965&trk=EML_anet_questionAndAnswers=&discussionID=17818767 (remember to run the whole address together). Peter Dohms, CPG-07141, has compiled a summary of this discussion organized by topics that appears elsewhere in this issue.

Everyone commenting agrees that field camp is important. However, Mike Dobbins commented that the University of Texas’s 6-week course costs about $5,600 for tuition, equipment, etc. and cuts into the summer that could otherwise be devoted to taking other courses allowing graduation in 4 years or having a summer job to help pay for everything.

Dobbins agrees that field camp is important but feels that a 3-week hydrogeology camp will better suit his needs.

While I agree with Dobbins’ concern about costs, I, and I expect everyone else who commented, believes that you should experience a wide range of field problems, not just the area in which you intend to specialize. As many of us who’ve been geoscientists for a while know, you often have to switch from one area of geoscience to another in order to keep employed.

Stephanie Jarvis’, SA-1495, “North to Alaska!” student’s voice column in the Sep/Oct ’10 TPG provided an excellent description of the myriad things she learned spending 2 weeks in the vicinity of the Mendenhall Glacier. It wasn’t just the technical details pertaining to her research topic, it was dealing with devil’s club, working in the rain, interacting with a wide variety of other researchers, and I’m sure other things that gave her an important part of her professional training.

One year, I was the graduate assistant for the Colorado School of Mines’ 6-week undergraduate field course. While I had a variety of camp chores—the position was informally known as “ash and trash”— also had the opportunity to go out mapping with a number of different professors while checking on the undergrads and mapping the field problem of the week.¹ This allowed me to see the different ways each professor used to approach the field problems and made their field maps. These differing approaches reflected both the professor’s interest and the areas they worked in (desert, rain forest, etc.) From each I learned something useful.

The American Geological Institute published Status Report on Geoscience Summer Field Camps by Margaret Anne Baker in 2006. http://www.agiweb.org/workforce/fieldcamps_report_final.pdf. This report notes the importance of field camp for geoscience education for basic geoscience training but cites a number of reasons for the 60% decline in the number of colleges and universities offering a field course in the last 20 years to less than 15% of the 695 schools listed in AGI’s Directory of Geoscience Departments. Cost being the chief reason. Nevertheless, “a majority of the Bachelors of Science degrees in geology/earth science require field experience as part of the core curriculum. Many schools are allowing for field experiences other than formal field camps to be used to fulfill this requirement.” Just how good these alternatives are depends on the program. Many schools lacking a formal field camp encourage students to take one at another institution and most institutions offering a field camp accept outside students for their field camps, allowing the transfer of credit back to one’s home school. The AGI report contains a listing of institutions offering formal field camps.

Clearly, most geoscientists agree that field camp is an important core requirement. As a CSM geology club T-shirt stated, “He who sees the most rocks wins.”

Since graduating, I’ve also participated in lots of field trips offered in connection with geoscience society annual meetings and local geoscience organizations. Such field trips are not a substitute for field camp but are important supplements to field camp and are an important
part of continuing professional development for all of us.

My Favorite Frauds

Peter Hahn, CPG 10923, wrote thanking me for my article on frauds in the May ‘10 TPG and the follow up articles in column 129 and “Michigan’s Mythical Gold Mines,” both in the Sep/Oct TPG. Hahn provided references to two additional papers on the topic, Lechler, P.J., 1997, Gold from water (and other mining scams): Nevada Bureau of Mines and Geology Special Publication 22, and Lechler et al, 2010, Geochemical sampling of selected playas in Nevada: Nevada Bureau of Mines and Geology Open File Report 10-1. The promotion of schemes involving “unassayable” precious metals is a continuing problem. If you become aware of such a scheme, please let your state securities agency, whose name or agency varies by state, and also the enforcement staff at the US Securities and Exchange Commission know about these schemes. It’s part of our duty as geoscientists in protecting the public.

The Role of The Professional Geologist (column 128, Jul/Aug ‘10)

Barton Stone’s, CPG-11114, article, “Drilling: the most cost effective technique for mineral resource evaluation,” which appeared in the Sep/Oct 2010 issue of the TPG, is an excellent example of the types of useful, practical papers published in the TPG that I discussed in column 128. The “scientific” journals don’t bother with such useful information. I also recommend Stone’s article to any geoscientist doing any type of drilling, not just those in the mineral exploration business.

Ethics Training

George T. Fitzgerald’s, CPG-6582, article, “Ethics Training,” in the Sep/Oct 2010 issue of the TPG provided an interesting outline for an ethics training session specifically designed to meet the requirements for ethics CPD required annually for Texas-licensed geologists. It can easily be adapted to similar requirements for other states. From time to time I’ve been urged to prepare an on-line ethics training session for meeting such requirements. I’ve never done so. I have given half- and full-day ethics training sessions in various places. While I prepare PowerPoint™ slides posing various ethical situations, I find that the discussions by the various participants about these slides provide the most important part of the session. I trust that those of you who’ve been reading this column over the years, or those of you who’ve used the regularly updated index of these columns posted on AIPG’s website, have learned that any particular topic that isn’t pretty black and white provides a number of gray areas worthy of exploration.

Receipt of an Unexpected Bonus after Work is Completed

Matt Shumaker, CPG-07319, sent me the following hypothetical ethics question. An AIPG member, who is also a state registrant, has completed a fixed price contract, or a contract with an hourly fee. In both the AIPG Code of Ethics and the State’s governing law, the member-registrant is not permitted to take on the case with a fee contingent on a favorable outcome. That is fully understood by both parties, and fully accounted for in a plainly written contract. The work is completed. The member-registrant has done a good job. The client is extremely happy with the outcome. So happy is the client, that unexpectedly and fully outside the expectations of the member-registrant, and not expected under the terms of the contract, the client sends the member-registrant a large bonus check. Can the member-registrant accept this monetary bonus? What do you think? Do you know of anyone who has encountered this situation?

I sent Shumaker’s hypothetical question regarding the unexpected receipt of a bonus from a client after the completion of a study for a client to members of the Ethics Committee and received a number of diverse replies.

John Rold, CPG-00448, responded, “In this hypothetical situation I don’t feel that there are any problems or ethics violations with accepting the bonus. The contract clearly states that it was not a fee based on the outcome.”

John Gustavson, CPG-02637, provided a similar response, “Yes, because this bonus was neither in the contract nor expected. The situation is similar to valuable Christmas gifts from clients. Taxable, but not unethical.”

Fred Fox, CPG-01273, has a different view, “The answer, unfortunately for the consultant, is no. The project is key to it, having been negotiated, signed and completed. The consultant has been paid for his work, and that’s what he does on a professional basis. Accepting additional remuneration for that project would be unprofessional, and therefore unethical.

“Actually, I was going to say that this scenario would be extremely unlikely, but I remember that I was involved in something somewhat similar. Many years ago I discovered a commercial deposit on a piece of property under lease. A lawyer for the owner offered me a form of remuneration that truly was uncalled for. I sorely needed the money (I think he knew that) but could not in good conscience accept it (and did not). I was paid a salary by my employer, that was what I did for a living, and I had been paid for my work. Later on I got into studying philosophy and ethics, and found that I had done ‘the right thing’ intuitively. Conscience can drive one to the proper ethical decision. All you have to do is stay on course.”

Perry Rahn, CPG-03724, agreed with Fox stating, “The AIPG member should not accept this bonus check. It just doesn’t look good. Rather than pay him a bonus with cold cash, it would look a lot better if the client hired the member again on some other project.”

Michael Ruddy, CPG-09741, concurred with Fox and Rahn, ‘No, under no circumstance should this ‘hypothetical’ situation allow the registrant to accept the bonus or gratuity, after. The individual’s recognition of the work performed should be this person’s bonus, not a monetary bonus. This person was working on a fixed price contract/hourly fee. This is this person’s profit, nothing else. The individual should look at his bonus as continued work (revenue) for the job well done. Accepting a large monetary bonus is not only unprofessional, it is also unethical, no matter how you look at it. It would be further aggravated if this individual did not claim this on his/her income tax statement. As this pans out, if the individual accepted the bonus and understood the meaning of not taking contingency fees or favorable outcome on his behalf, then I seriously doubt this individual would claim this on income tax.

“I have been working for the State of Missouri for quite some time now. I have had shoddy business owners try to bribe me (with money), to turn my head, or to overlook the violation(s). The only favorable outcome for me, was to take it to the federal authorities which in turn,
assessed large fines, and one business owner to close the doors altogether. Perhaps your question asking if anyone is aware of a similar situation can be answered as yes, by me. Not only were the bribes, intentions that I encountered to turn my head—an insult to my integrity, it was also an insult to my status of CPG, PG, and RG.”

Ruddy’s experience deals with bribes, which are clearly unethical and illegal. As posed in the hypothetical, the bonus was unexpected and received following completion of the report so that it cannot be really viewed as an inducement to write a favorable report and therefore a bribe. The question of whether the bonus was reported to the IRS as income was not part of the hypothetical, but clearly it should be.

Rima Petrossian, CPG-10038, wrote, “I have not heard of a case like this for geologists, but in other professions bonuses like this are more common. I think this case as written sounds ethical as long as there was no verbal understanding or implied reward for ‘good’ results, but then who could ever prove that one way or another? It would be up to the individual to give back the bonus if they felt it was bribery for future transactions. I believe that, due to contractual agreements and relatively high professional rates, happy customers should tell others and hire you again as a reward, not with additional money. It sounds like it depends on the finances of the giver, a lot to a consultant might not be much to a wealthy financier who may not have to go through litigation due to the outcome.

“I might feel some sort of future obligation by accepting a large gift, but another person might not. Ultimately, a token gesture is more appropriate to keep future transactions honest, but on the face of this one contract, the consultant completed the analysis before receiving a bonus and nothing unethical transpired.”

A colleague recounted a situation similar to the hypothetical question. In this case, the geologist prepared a report on a prospect and received, as per the contract for the work, a smaller cash fee and warrants for the client company’s stock that had an exercise price significantly above the then current trading range. The warrants were good for two years and expired because the exercise price was never reached. Recently, because the prospect had finally resulted in a significant discovery, the client company awarded the consultant new warrants that allowed the consultant to receive additional compensation for the work on the prospect. The client company had made millions on the deal and believed that the consultant should receive additional compensation reflecting the prospect’s success. The consultant has no expectation of doing similar work for the client in the future and appreciated receiving the new warrants.

This discussion highlights a couple of important points. First, the hypothetical assumes that the bonus was entirely unexpected and therefore the consultant’s work was not affected by the receipt of the bonus. Unless the report was done as part of an audit, which is subject to stricter no conflict rules, there is nothing illegal about accepting the bonus. However, accepting the bonus has the consequence of potentially influencing future work for the client due to the possibility that another bonus may be forthcoming if the report is positive. If the consultant has no problem with this being the only job that will ever be done for the client, acceptance may be okay. As Petrossian points out, such bonuses may be more common in other industries.

However, the “optics” of accepting the bonus present a problem. How will others who become aware of the situation feel about it? Would you like to see the situation described in the newspaper? This is the point Fox and Rahn raise. Particularly if the consultant expects that there may be future work from the client, the bonus cannot be accepted because of the perceived conflict of interest arising from the potential receipt of a similar bonus following future work on successful prospects. Ron Yarbrough, CPG-06545, and Larry Davis, CPG-07105, also believe that the “optics” of the situation should be avoided and feel that the best “bonus” is additional work from the client and/or recommendations to others that the consultant be retained. While the “optics” of a situation is clearly something to consider in assessing an ethical situation, there is no clear provision of the AIPG Code of Ethics prohibiting the acceptance of the bonus, especially when the consultant does more work for the client.

Having said that, I recognize that many in the petroleum and mining industries agree to work on a prospect for a reduced, or sometimes even no fee, in exchange for an overriding royalty or stock interest in the client company. If this arrangement is clearly disclosed in the report, the conflict of interest is made known and those relying on the report can act accordingly.

Further comments on this issue will be welcomed.
November 22, 2010

Dear Mr. Siok:

In The Professional Geologist, May/June 2010 edition, page 26, I was disappointed to read the paragraph on “Current and Future Unconventional Oil Plays”. I have spent over 35 years of my professional career working on the oil shale deposits of the United States, especially those of the western United States. I currently consult to a number of companies attempting to develop oil shale resources in both Colorado and Utah. I am also completing my third year as Chairman of the National Oil Shale Association (NOSA).

My disappointment has to do with the discussion of oil shale in the cited paragraph. The article states “Oil shale mining in the western USA has been essentially ruled out because it requires more water than is available and leads to a 50% increase in the volume of rock, which could not thus be re-buried in the pits from which it was mined.”

There are a number of companies that are currently planning to mine and process oil shale and they estimate the water needs are in the range of 1.5 to 2.0 barrels of water per barrel of shale oil produced; each of the companies is securing reliable water supplies for its project in advance and no project will be built unless it has a secure water supply. I don’t understand the 50% increase in volume of rock; the authors of the section will have to explain how that is possible. Years ago there was a myth that oil shale swells when it is retorted and that is simply not true; although there is a bulking effect when any rock is mined and crushed. While some mines will be open pit, much of the resource will be developed using underground mining.

The National Oil Shale Association has just released a new publication, Oil Shale, America’s Untapped Energy Source, wherein we try to educate the public about the many benefits to developing this very large and important domestic resource. We also try to dispel some of the false information about oil shale. I have enclosed a copy for AIPG’s reference files. This publication can be viewed on NOSA’s website (http://www.oilshaleassoc.org), which is a site I encourage AIPG members to visit.

NOSA agrees the USA and the world are facing growing energy demands and that we are approaching a time when the supply of conventional petroleum will not be able to meet those demands. The USA for reasons of national and economic security must look at developing all domestic energy resources, including oil shale. I encourage AIPG members to learn more about our domestic oil shale resources and what the development of these resources could mean to the well-being of the nation.

Very truly yours,
Gary D. Aho, CPG-10426
Lacking Elevations for a Datum, Use the Water Table

William J. Stone

Cross sections are useful tools in both geology and hydrology. They not only show the extent and variation in stratigraphic units beneath the surface, the nature of any folding or faulting in the area, but also the relationship of the water table to the geologic framework, all based on well-log data. However, care must be taken to assure that such illustrations faithfully depict the setting along the line of section.

The key to this is hanging the well logs on a reliable datum, such as elevation. Depths to tops of units are normally converted to elevations, based on (subtracted from) the ground-surface elevation at the well. These tops are then used to plot the contacts between strata penetrated in each well. However, ground-surface elevation at each well may not be available as soon as one would like. So, what else can be used as a substitute datum?

Upon completing a project in South Australia, I needed to make a cross section of the well logs, but ground-surface elevation at the auger holes had not been determined. Since surveying was not likely to be done for some time, and this was before the advent of GPS equipment, I needed to come up with an alternative datum.

All the bore holes penetrated the water table. Furthermore, they were aligned more or less parallel to water-table contours in the area. So, I had a revelation. Since elevation is constant along a contour, the water table in each well log was essentially an elevation datum.

Therefore, the well logs were hung on the water table to permit constructing a cross section. There was no need to convert depths to elevations. Water-table position, as encountered in each hole, was made a horizontal datum and the well logs were spaced along it. Positions of tops of stratigraphic units were determined using raw depths as distance above or below the water table. When contacts were drawn by connecting corresponding tops of units, a realistic picture of the subsurface emerged. As usual, a depth scale was placed at the edge of the section for reference. Tip: If the surveyors are pokey and your line of section parallels water-level contours, hang well logs on the water-table.

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 by e-mail: wstone04@gmail.com.

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Invitation from AIPG to Submit Articles

You are invited to submit an article, paper, or guest column based upon your geological experiences or activities to the American Institute of Professional Geologists to be included in “The Professional Geologist” (TPG) bi-monthly journal. The article can address a professional subject, be technical in nature, or comment on a state or national issue affecting the profession of geology.

Article submissions for TPG should be 800 to 3200 words in length (Word format). Photos, figures, tables, etc. are always welcome! Author instructions are available on the AIPG website at www.aipg.org.

Please contact AIPG headquarters if you have any questions. AIPG email is aipg@aipg.org or phone (303) 412-6205.
As I look out the plane window at drainage basins (if you can call anything this flat a basin) clearly cutting their crooked way through the square plots of farmland outside of Chicago on my way to Denver for the Annual Geological Society of America Meeting (GSA), I realize this article marks a year since I first submitted an article to *TPG*. That first article for the student issue was about GSA and how much I loved it. I'm really excited to be heading back, though maybe a little anxious (hooray for oral presentations!). As the student issue has rolled back around, and I've learned a lot in a year, I figured I might share some of my insight and offer what advice I dare to give.

Of course, there's the advice we're all tired of hearing, like not to procrastinate (for example, don't start thinking about an article two days before it's due, maybe try to have your presentation together before you leave for a conference, it might be a good idea to have some concrete grad school/job thoughts together before November, and it probably isn't a good idea to register for the GRE two weeks before you plan to take it and then wait until the morning of to take a first look at that vocab...), be proactive (maybe send some e-mails to potential advisors or employers, possibly make a few phone calls), and it's never too late to start planning (don't fall into the “I have too much to do this week to be thinking about next year” trap, no matter how true it may seem). I'm probably not the one to be giving this sort of advice, so I won't go into it.

What I can speak to, though, is seeking out and taking advantage of opportunities. The words of my first swim coach (“Go for it, Jarvis!”) are often ringing in my head, and I've landed in some pretty interesting places because of them. A scholarship from an organization you've never heard of? You've got nothing to lose, and you might just end up writing for them and getting invited to local chapter meetings. Go. A summer research position? Apply (for lots). And then take what you get and go to a conference with it. Your school wants its name out there and will likely help you get there, and you might discover something you didn't know you were so interested in. A job offer in an unlikely (for you) field? Sure—a different point of view is an important thing to have, and you might just change your mind. A professional or academic organization in line with your interests? Join. You'll get their publications and may find a random ad in the classifieds for a field camp in Chile over winter break. Why not? Where there's a will (or a whim) there's probably a way.

As a student, seeking out and taking advantage of opportunities is probably one of the most important and influential things you can do, and I've seen many of my peers not get as much out of their time in school as they could have because they weren't paying attention. Opportunities take some work at first, but the more you run with, the more that seem to come around. And the more you take the more flexible (i.e., the more planning leeway you can afford to have later) you are. You'll make contacts, build your experience repertoire, expand your knowledge, and, most importantly, learn a little about yourself. While it may complicate your efforts to hone in on what you want to do later by giving you so many options, you'll be a much more well-rounded citizen, scientist, and student for it. Besides, all that planning stuff is way overrated anyway. So go for it.

Stephanie Jarvis, SA-1495, sjarvis11@wooster.edu
Up until the end of my junior year I had never considered that I would have had an interest in pursuing a second degree in Geology. I came to the University of the Pacific for a degree in International Relations and Global Studies and had thoroughly enjoyed the program. My first encounter with Geology was a summer introductory course prior to my junior year. At the time, I simply loved the outdoor opportunities that Geology provided; however, I never realized the lasting impression which just one course could have on me.

As a requirement for my International Relations degree I had the opportunity to study abroad in Paris the summer of my junior year. During my time abroad I decided to construct a research topic in conjunction with an International Diplomacy and French language course, examining the French nuclear program. Through my studies at University of the Pacific I had become exposed to different issues facing the world, one of which being the problem of supplying enough energy for current consumption patterns. France currently has a vastly different energy program from the United States as they produce 78% of their total energy through nuclear processes. With the U.S. not being particularly enthusiastic about nuclear energy, it interested me how and why a nuclear program was so successful in France, as well as the possible costs and benefits of the nuclear program.

In order to even begin understanding the program, I had to spend a tremendous amount of time learning fundamentals of science such as chemistry and physics. My thesis began developing more and more into the scientific realm as I became fascinated by the topic of energy independence and environmental security. I felt that it was morally irresponsible to judge the efficiency or evaluate flaws with the program without understanding the basics of radioactive decay or uranium enrichment.

Through completing my research, I realized that I would like to pursue a career in energy resources and management. I began to see that many of the jobs that interested me required a B.S. rather than a B.A. I also realized that I would not feel qualified to develop and construct environmental policy without a thorough understanding of science. Not having a B.S. did not remove the possibility, but I had a personal dilemma with my ability to judge what would be efficient and sustainable policies without understanding the science behind them. That is why, entering my senior year, I decided to pursue a B.S. in Geology.

Although I knew that the second degree would be extremely challenging, the realization of exactly how challenging the next two years would be did not take long to reveal itself. The degree required a year of chemistry, physics, Calc II as well as upper division Geology courses, none of which I had taken or even considered taking at Pacific. Being an International Relations and Global Studies major, my one and only science course had been a four week Introduction to Geology course, and prior to that, high school. All of a sudden the skills I had been developing for the past three years seemed of little value. As I can now see how well the two different degrees complement one another, the different approaches to learning provided quite the initial shock.

It was also quite a shock to my ego during the transition from being successful in one program to a feeling of constant inadequacy in another. Luckily I was fortunate enough to have two incredible fellow students with me in the program, Gabby McDaniel and Luke Crawford. They were there every step of the way, helping me through the topics that I felt I would never understand. If it wasn’t for their patience and kindness, I still don’t know if I would have gotten past the initial frustrations and been able to develop a deeper appreciation for geology.

Needless to say the first year as a geology major, which also happened to be my senior year in college, was a struggle. Taking an overload of courses as a Division I basketball player made for an interesting and challenging year. However, as of today it appears that all obstacles have been met, and that I will have completed the degree this June. Working on the final year I am starting to look ahead at the possible options for me. Where I was once intimidated by the idea of entering the job market, I have a new-found confidence in my skills and abilities. Geology provided me with a concrete skill set, which I feel balances my degree in International Relations perfectly for working abroad.

As I look forward in life, I am trying to decide which avenues would bring the most self-fulfillment. From the experience that I gained through my research project I developed a passion for energy independence and environmental security. I believe that environmental policy would be an ideal way to combine both degrees, as well as an avenue that would allow me to feel that I was helping to make positive changes.

Growing up in California I have also developed a strong interest in the issue of water. How the limited water supply is managed and distributed will be important decisions in the next few decades. The current system of pumping water down to Los Angeles is not sustainable as it is causing environmental degradation on the deltas throughout Northern California. As water continues to run low, tough questions will have to be asked in California as well as other parts...
of the world. Current levels of consumption and pollution are rapidly diminishing current water resources. As water is not an unlimited resource, it will be one of the largest issues facing California and the world. The issue requires both politicians and scientists who are able to work with one another and understand the different perspective from which the other is coming from.

However, energy is where I find myself focusing the most. Along with water, energy drives society as our current lifestyle of cars, computers, and cell phones would not exist without a proper energy supply. As current resources are depleting, new technologies must be developed and utilized efficiently to balance out current consumption patterns.

The study of geology gave me a new set of skills beyond my International Relations degree, and I now realize how well the two degrees actually complement one another. Through the two very different and sometimes clashing perspectives, I now have a unique niche from which I can help advocate changes on a larger scale. I know that my knowledge from the two outlooks can begin to help bridge the gap from scientists who understand the fundamentals of an issue to policy makers who know how to find and coordinate the resources to solve the issue. While I once thought I was lacking a skill set, I am now confident with a specific expertise with which I can apply to an array of different situations.
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## Student Application Form

American Institute of Professional Geologists Student Membership Application

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ATTESTATION: I attest that I meet the requirements for AIPG Student Adjunct (currently enrolled in a geological science degree program) and agree to abide by AIPG Bylaws and Code of Ethics.

Applicant Signature:    Date:    

Print Faculty Sponsor: Name:

Faculty Sponsor’s Signature (Required):    Date:    

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Applicants for certification must meet AIPG’s standards as set forth in its Bylaws on education, experience, competence, and personal integrity. If any Member or board has any factual information as to any applicant’s qualifications in regard to these standards, whether that information might be positive or negative, please mail that information to Headquarters within thirty (30) days. This information will be circulated only so far as necessary to process and make decisions on the applications. Negative information regarding an applicant’s qualifications must be specific and supportable; persons who provide information that leads to an application’s rejection may be called as a witness in any resulting appeal action.

*Due to the availability of AIPG’s online directory, new member address information will no longer be printed in TPG. If you need assistance locating this information please contact Headquarters.

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**Applicants for Certified Professional Geologist**

AK-Bruce M. Gamble  
PA-Gerard B. Leclerc

**New Certified Professional Geologists**

AK-Aaron T. Banks  CPG-11385  
CA-Paul J. Dockweiler  CPG-11379  
FL-Ricardo A. Bastida  CPG-11384  
NY-Jeffrey A. Bohlen  CPG-11381  
NY-Jo Ann Robertson  CPG-11387

**Applicants Upgrading to CPG**

TN-James Venendall  MEM-1612

**New Members**

CO-Brooke J. Miller  MEM-1945  
FL-Andrew T. Sway  MEM-1944  
FL-April Breton  MEM-1947  
FL-Eric R. Brown  MEM-1951  
FL-Michelle Allard, P.G.  MEM-1946  
MI-Mark T. Theobald  MEM-1948

**New Student Adjuncts**

KY-George P. Whallen  MEM-1874

About two years later I learned that the property owner had challenged the remediation estimate, and the case was going to court. I was retained by the state agency to act as a fact witness to support the remediation estimate. I met with the assistant attorney general handling the case, and in reviewing his files, saw to my considerable dismay the technical memorandum prepared by my subordinate, with the original language and all its “potentials”. My subordinate had not been able to convince himself to make the change I recommended.

In advance of the trial, I was deposed by the property owner’s lawyer, who questioned me about the remediation estimate but did not comment on the grammar. He was holding that trump card to play later. During direct examination at trial, my testimony included the following exchange with opposing counsel:

> “Dr. Stewart, I want to bring your attention to the second paragraph on page two of your technical memorandum. Do you see the one I mean?”
> “Yes, I do.”
> “Good. Now, Dr. Stewart, do you agree in that single paragraph the word ‘potential’ is used 15 times?”
> “I’d like a moment to read that paragraph again.”
> “Please do so.”
> (After reading the paragraph in question) “No, I don’t agree.”
> “And why is that?”
> “I count the word ‘potential’ only 13 times.”
> I was being honest, the judge and audience snickered, and the lawyer made his point – we had no confidence in our remediation estimate. Since then, I have never allowed a repetition of that mistake, and I don’t give subordinates a choice in the matter if my name is on the report. Would better wording have changed the outcome? I don’t know. I was involved with four condemnation cases for the state agency, and in each the court took a dim view of deductions against the fair market value, regardless of soil and groundwater contamination. Nonetheless, I believe that our remediation estimates would have been viewed more credibly had the written presentation been better.

Clear, concise technical writing is a valuable skill. This talent extends to discussing geological uncertainties clearly and confidently. Hand-wringing, waffling and indecisiveness does not lead to effective decision-making and written reports, often with embarrassing results.
ment to outreach and mentoring ensures Price’s “ceaseless commitment to outreach and mentoring ensures subsequent generations working toward the same ends.”

James E. Martin
Paleontology Research Laboratory Naming Announced

A campus email from SDSM&T President Robert A. Wharton, Ph.D. this week announced that the South Dakota Board of Regents has authorized the request to rename the Paleontology Research Laboratory in honor of Dr. James E. Martin, CPG-07367, (Geol71) and his contributions to the field of paleontology, the School of Mines, our students, and the state of South Dakota. Dr. Martin received his B.S. in Geology (with honors) and his M.S. in Paleontology from the School of Mines in 1971 and 1972, respectively. He earned his Ph.D. in Geology from the University of Washington in 1979. He returned to the South Dakota School of Mines and Technology in 1979 as an assistant professor of geology and director of the field station. During his career, Dr. Martin discovered, excavated, and characterized numerous fossil sites throughout North America, Antarctica, Argentina, Europe, and Australia. He also served as a consultant to the U.S. Corps of Engineers, the Bureau of Land Management, the South Dakota Geological Survey, the R.M. Rangle Corporation, Parsons Engineering, Inc., the John Day Fossil Beds National Monument, the Black Hills Natural Sciences Field Station, the Archaeological Research Center, the Wind Cave Natural History Association, Mobil Oil Company, and the Georgia Southern University Museum. He is the author or co-author of more than 180 papers and abstracts, and eight geological maps. Dr. Martin has brought national and international recognition to the School of Mines and the state of South Dakota. He received the International Discovery of the Year Award in 1999 from the Royal Geographical Society of London/Discovery Channel Europe and the Department of Defense Antarctica Service Medal. He served as elected president of the South Dakota Academy of Science from 1989-1990 and as a panel member for the National Science Foundation’s Biological Research Collections Program in 2004. He is the recipient of grants from the National Geographic Society, the National Science Foundation, and the Bureau of Land Management. Dr. Martin received the 2004 School of Mines Distinguished Alumnus Award and was inducted into the South Dakota Hall of Fame in 2008. An event is planned to formalize and celebrate the renaming of the building in the spring or early summer of 2011.

Geologist Kathy Lehnu
Joins Stantec

Geologist Kathy Lehnu, CPG-11294, has joined the Hartford office of engineering and design firm Stantec as a Project Coordinator. Lehnu specializes in environmental investigation and remediation projects, specifically in soil and groundwater contaminated by oil or other hazardous materials. She has assessed dozens of potentially contaminated sites throughout Connecticut and Massachusetts.

Lehnu holds bachelor’s degrees in both geology and environmental sciences from the University of Massachusetts Amherst, and a master’s degree in geology from the University of Connecticut.
Bedrock Identification Methods at Contaminated Sites

Thomas J. O’Brien, CPG-07270.

Introduction

The best way to understand the character of subsurface geologic materials, particularly bedrock, is to obtain samples by drilling and coring. All geologists need to understand several drilling techniques and the use of specialty equipment. This paper describes one way to obtain representative soils and bedrock information; however, many other drilling methods are also available. It is the geologist’s responsibility to subcontract with qualified drilling firms who can meet the objectives of a given project. Remember, properly documented boring logs by a geologist, geotechnical engineer or others trained in soil and bedrock identification, document the characteristic properties of the various geologic materials encountered in a boring. For example, on the east coast, we can encounter a wide range of conditions ranging from clastic rocks (mudstone, shale, sandstone and conglomerate) and carbonate rocks (limestone, marble), to crystalline igneous and metamorphic rocks such as basalt, diabase, granite, gneiss and schist. Complicating matters is the fact that most bedrock in the glaciated northeastern United States is covered by glacial deposits that include glaciolastrine clays, fine to coarse outwash, end moraines and dense glacial till. Residual soils can also overlie bedrock and complicate contaminant migration pathways.

The collection of representative soil samples and in particular bedrock cores are critical to environmental site investigations because geologic logs and samples are used to identify the following:

1) Depth to Bedrock
2) Type of Soil and Bedrock
3) Fracture Density
4) Fracture Orientation
5) Ground Water Occurrence
6) Ground Water Level (Head Pressure Vs. Depth)
7) Ground Water Quality

Surface and downhole geophysical techniques are important adjuncts to soil borings and bedrock coring, and provide supplemental details in addition to those items listed above; although the details are beyond the scope of this paper, Groundwater and Wells (2007) gives a useful overview. Additionally, some bedrock investigations are best handled by using an air rotary drilling rig where “chips” are logged and the open borehole used to define the hydrogeologic conditions.

Soil Sampling & Bedrock Coring

The primary purpose of this paper is to describe a very useful and cost effective way to define the hydrogeologic properties of bedrock at contaminated sites. The author’s choice is to use mud rotary drilling methods, combined with split spoon capability and wire line core drilling (Figure 1). Rotary drilling provides the most flexibility for characterizing contaminated sites underlain by bedrock, while at the same time characterizing the hydrostratigraphic conditions of the soil overlying the bedrock.

First, identifying the characteristics of the soils overlying the bedrock is necessary. The typical method is to collect continuous split spoon samples (See ASTM Method D1586) to refusal. Briefly, refusal is defined as 100 blows or more to achieve an advancement of six inches or less by a 140 pound hammer used to drive the split spoon sampler. Refusal sometimes identifies the depth to bedrock; however, in many east coast sites refusal is encountered in areas underlain by dense residual soils, glacial till, or boulders in various glacial deposits. It is sometimes worthwhile to switch to a 300 pound hammer to collect additional samples for identification purposes.

The soil samples and blow counts obtained while advancing the test boring will identify the soil types, density, and soil contamination if present, and whether the soils above the bedrock are water-saturated. Once the conditions of the unconsolidated soils are understood, the geologist can decide to install a monitoring well in the unconsolidated soils, if they are saturated, or continue to drill into the bedrock.

At this point the driller will typically drive a nominal four-inch diameter steel casing with a 300 pound hammer to refusal or use hollow stem augers (See ASTM Method D6151). Typically, the...
wire line coring apparatus (ASTM Method D2113) is advanced inside four-inch casing, and after coring the bedrock, the borehole needs to be reamed to a nominal four-inch diameter if a monitoring well is to be installed in the borehole. It is the author’s experience that 1 ¼ to 2” diameter well screen and riser can be successfully installed inside the nominal four-inch borehole. The driller will then set up a mud tub and use mud rotary methods to clean out the casing of soils and prepare to core bedrock (Figure 1). The core sample will confirm the nature of the bedrock and its depth below grade. When coring, do not be surprised to obtain a core of a boulder and then soils beneath it! This condition is not uncommon in the northeastern United States, where glacially-transported boulders are abundant. Note this important condition and proceed with coring. Two inexpensive coring methods are popular, although others exist and can obviously be used (air coring, etc.).

A core drill string is a series of long, connected hollow tubes (rods) with a barrel at the end that is connected to a cutting bit, usually diamond-tipped, at the bottom of the tools. As the drill moves further into the bedrock, the driller adds rods at the top of the drill string. When the driller wants to remove the bedrock core itself, the entire assembly of core barrels must be removed from the boring. This is very time-consuming because each rod must be removed to retrieve the core barrel and rock core. A much better method is to use the wire-line drilling method.

When using wire line drilling, a core barrel can be removed from the bottom of the borehole without removing the rods. Bedrock cores can be collected continuously and retrieved quickly. The wire line method is used to drill relatively small diameter cores in the bedrock. Unlike most air rotary drilling (chips only) the primary objective is to retrieve an intact core sample that can be evaluated for lithologic and hydrogeologic properties.

In many east coast locations, the upper bedrock is highly fractured and may localize and concentrate contamination. For example, the Newark Group is typically highly fractured in the upper ten to fifteen feet in contrast to deeper, less fractured and more competent rock of the same lithology. Hard basalt, diabase and other crystalline rocks typically have fewer fractures, even at the surface. In fact, contaminant transport in these more dense bedrock units usually follows the bedrock surface, which may outcrop or be buried by surficial deposits. Identification of the thickness of the upper highly fractured zone and the depth where bedrock becomes more competent can be the key to remediation of a contaminated bedrock site. Remember, we are developing a hydrogeologic model for the fate and transport of contamination. We need to know the type of contaminant(s), the nature of surficial deposits upon bedrock, and then the possible migration pathways into and through the bedrock via primary and secondary porosity (fractures, bedding planes, etc.).

**Rock Quality Designation**

A measure of fracture density is rock quality designation (RQD), which compares rock core pieces greater than four inches to the total length of the core run. RQD is defined as a percentage:

\[
RQD = \frac{\text{Sum of Cores longer than 4 inches}}{\text{Total Length of Core}} \times 100
\]

For example, a core of 60 inches was advanced and the total of all core fragments larger than four inches equals 20 inches.

\[
RQD = \frac{20 \text{ inches}}{60 \text{ inches}} \times 100 = 33\% \text{ RQD}
\]

From the RQD index, the rock fracture density and some hydrogeologic interpretations can be made. (See Table)

In addition to recording RQD the professional geologist needs to describe the lithology of the rock core, the formal name of the bedrock, if known (e.g. Stockton Formation), as well as other significant features (color, nature and attitude of structural features, physical condition including hydrothermal alteration and/or weathering, and any other special hydrogeologic features pertinent to the interpretation of contaminant fate and transport (Figure 3).

Once the bedrock has been characterized, the geologist needs to meet with the team and decide if the information collected satisfies the scope of work, meets the goals for future remediation design, and has been completed on budget and schedule.

---

**Figure 2** - Conceptual hydrogeologic model showing how a gasoline leak migrates vertically downward, intercepts and follows the bedrock surface, enters the fractures, intercepts the ground water and migrates from the source in the direction of ground water flow (Active, 2010).

**Figure 3** - Bedrock cores of the Stockton Formation, in this case very highly fractured sandstone, with horizontal fractures dominating. The RQD is less than 25%, so very significant contamination can migrate through this fractured bedrock.
Closing

Supervising a drilling operation, describing and sampling soil and bedrock, maintaining a written log, and deciding how to install monitoring wells are huge responsibilities for any geologist. It takes several years to learn the various drilling techniques, where best to apply them and most importantly, describe the subsurface materials so future remediation designs and construction work can be completed. Each company will have their own drilling log format that you will need to understand. The author has learned that the driller is very knowledgeable and can help you obtain some of this important information. Lastly, after the work is done, the geologist and driller will be the only ones who will know the geologic conditions at the boring location. Knowing that I am the only one who really knows the geologic condition at that boring location still excites me when I document drilling activities.

References


Thomas J. O’Brien, P.G is the technical director at Active Environmental Technologies Inc.; an environmental consulting and construction company specializing in the delineation of contamination, design of remediation programs, the actual remedial construction and performance monitoring. Mr. O’Brien specializes in characterizing contamination in fractured bedrock aquifers and has designed and implemented several successful remediation construction projects in Pennsylvania, New York and New Jersey over his 25-year career as a professional geologist.

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- Cretaceous shales in the north-central Texas area give rise to engineering problems. This online short course covers:
  - Regional geologic setting, structure and stratigraphy.
  - Specific material geotechnical properties including:
    - Clay mineralogy, values of Atterberg limits and indices, potential volume change, shear strength, etc.
  - Engineering problems and solutions concerning:
    - Accurate shear strength determination as dictated by field conditions, mass wasting, swell pressures and more.

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Introduction

The author would like to use his personal experience as an example of how a geologist can become involved with technology. The job market has changed remarkably for geologists in the past few decades. In the 1970s, geology used traditional technology. At the time, practicing geologists used aerial photographs, level transits, plane tables and alidades to record field data, and maps were prepared on Mylar or vellum. Maps were completed with Leroy lettering sets and colored pencils. Those were invaluable lessons that led to a better understanding of those new technologies that were to come. In the end, the demand, available jobs, and technology changed, requiring the geologist to learn new skill sets.

Often, the new technologies come from those in the user community thinking outside of the box. Speaking from experience, curiosity has been a routine factor used while developing technologies. This natural curiosity was employed not only for the development of hardware, but also included the development of software and enhancing existing methodologies. Innovative thinking has not only been beneficial in studying basic geology, but also in developing new technologies to change how humanity interacts with the planet.

The author has been witness to the development of the first computers used in the field, from early x86/DOS models, to the increasingly powerful machines used for a variety of geological modeling, and visual presentations in Geographical Information Systems (GIS).

The Technologist

The Free Dictionary defines a technologist as a person who uses scientific knowledge to solve practical problems. As geologists, we are natural technologists who routinely have to apply technology or science to examine our natural environment or apply our knowledge, through engineering, to that environment. So, in short, technologists take a thought or idea and translate that into a real object or method that interacts with the natural environment in some way.

The author has been witness to the development of the first computers used in the field, from early x86/DOS models, to the increasingly powerful machines used for a variety of geological modeling, and visual presentations in Geographical Information Systems (GIS).

Geologically Related Technologies

Geologists have been involved with technologies and have been influencing technologies for decades if not centuries. A few examples include field and laboratory instrumentation, software and hardware associated with:

- Geoscience databases
- Geological mapping
- Exploration and development of metallic and non-metallic resources, oil and gas, and water supplies
- Engineering geology
- Environmental investigations and remediation of contaminated land

The typical geologist is at least aware of most, if not all, of the aforementioned applications, and probably has used several in the course of a career. Often, necessity is the mother of invention when it comes to learning and using these technologies to maintain and advance one's professional standing.

Although people that we would classify as geologists have been applying technologies since antiquity, in the 19th and 20th centuries the application of technology has accelerated as our search for natural resources has intensified. The geologist of the late 18th century would be amazed at the science presently applied to find answers for problems of a geologic nature. There are numerous examples of technologies that are being used by geologists today that could scarcely have been anticipated 100 or even 50 years ago. For instance, geophysical methods traditionally used to explore for water supplies or petroleum, such as resistivity, seismic reflection and refraction, and electromagnetic methods, have now evolved into applications used to locate buried underground storage tanks, contamination plumes, unexploded ordnance (UXO) and other explosive remnants of war (ERW) in near surface environments.

Newer technologies that are becoming widely used by geologists include:

- Robotic Sensors
- Unmanned Vehicles
- Digital imagery from aircraft and satellites
- Software Development
- Telecommunications
An Example Of A Non-Traditional Technology Area

An example of a “Non-Traditional Technology Area” is the field of Munitions and Explosives of Concern (MEC), including Explosive Remnants of War (ERW). The 2003 United States Department of Defense (DOD), Defense Science Board (DSB) Task Force on Unexploded Ordnance (UXO) estimates that costs for remediation of today’s known UXO sites are approximately $20 to $50 billion. These estimates are based primarily on remediation of UXO found in the terrestrial environment and do not reflect the added complexity associated with aquatic or marine environments. The 2003 DSB Report states that an assessment of the total extent of the underwater UXO problem is needed to complete the full picture of the national UXO problem.

There are five technology thrust areas related to MEC:
- Countermine mission
- Explosive Ordnance Disposal (EOD)
- Humanitarian Demining/Explosive Remnants of War (HD/ERW)
- Active Range Clearance
- Environmental Remediation

In addition, there are nine separate technology functional areas for MECs that include:
- Detection: The location of MEC in the subsurface
- Location: The ability to apply the correct geographic coordinates
- Access: The ability to safely acquire MEC
- Identification/Evaluation: The ability to properly classify MEC
- Neutralization: The ability to prevent explosive accidents
- Recovery: The ability to put MEC into a controlled environment
- Disposal: The ability to destroy MEC
- Breaching: The ability to safely penetrate mine fields
- Training: The proper education of those involved with MEC remediation

In regard to monies that are planned for terrestrial cleanup, the FY2006 Military Munitions Response Program (MMRP) Site-level Obligation Amounts by Component (millions of US Dollars) has been projected as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>FY2010</th>
<th>FY2011</th>
<th>FY2012</th>
<th>FY2013</th>
<th>FY2014</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Army</td>
<td>$210.96</td>
<td>$283.22</td>
<td>$326.36</td>
<td>$360.46</td>
<td>$1,654.65</td>
<td>$3,032.08</td>
</tr>
<tr>
<td>Navy</td>
<td>$40.07</td>
<td>$54.66</td>
<td>$55.98</td>
<td>$57.02</td>
<td>$279.80</td>
<td>$619.48</td>
</tr>
<tr>
<td>Air Force</td>
<td>$105.21</td>
<td>$108.59</td>
<td>$212.05</td>
<td>$242.19</td>
<td>$724.51</td>
<td>$1,496.32</td>
</tr>
<tr>
<td>FUDS*</td>
<td>$77.63</td>
<td>$75.51</td>
<td>$81.73</td>
<td>$80.72</td>
<td>$12,078.89</td>
<td>$12,639.52</td>
</tr>
<tr>
<td>Totals</td>
<td>$433.87</td>
<td>$521.98</td>
<td>$676.12</td>
<td>$740.39</td>
<td>$14,737.85</td>
<td>$17,787.40</td>
</tr>
</tbody>
</table>

*Formerly Used Defense Site. MMRP obligations in millions of dollars.

Today, geological activities are intertwined with MEC technologies. The use of robots to collect geophysical data, explore abandoned mines, recover unexploded ordnance (UXO) from the seafloor, and using magnetic recovery systems to lift UXO from subsurface materials are just the latest incarnations of technologies exploited for more traditional geological activities. Numerous firms are performing MEC cleanup. Many, if not all of those firms, contract geologic or geophysical firms, and/or have geologists and geophysicists on staff.

Underwater Military Munitions

DOD is faced with the expensive challenge of characterizing locations in U.S. coastal waters and removing underwater military munitions (UWMM) determined to pose a risk to human health and the environment. The John Warner National Defense Authorization Act for FY 2007 (NDAA), 109-364, Section 314, requires DOD to identify sites where UWMM were disposed in U.S. coastal waters and to research the effects of these munitions on the ocean environment and those who use it.

There is limited information quantifying the extent of underwater munitions. The DOD has been focused on land known or suspected to contain UXO and other MEC. Investigation of munitions response sites, or portions of such that are within water bodies, lag behind. In the particular case of ranges located along the coast, discarded military munitions (DMM) and UXO deposited in the water may surface under climatic influences such as hurricanes or the pumping action of groundwater during water table fluctuations. There are four types of military activities that could result in munitions being found underwater. These include:
- Live-fire test and training
- Munitions handling and transfer
- Authorized or unauthorized disposal or dumping of munitions.
- Acts of war

Divers have traditionally been used for underwater detection and recovery of munitions using hand-held, watertight instruments. A search pattern is established using a grid delineated by surface buoys or a circle with a single buoy anchoring the center. This is time consuming, as divers swim grids carrying equipment, especially in waves, tides, and currents. Visual identification of hazards is difficult due to sediment, low visibility, and biological and mineral coatings. These factors can make the determination of whether a munition is a fused, potentially armed UXO, impossible.

The important factors therefore become munition size, type, orientation, and water depth. In addition, the quality of any geophysical data generated during UWMM surveys are affected by the sensor and platform selected, and the prem-
GEOLOGISTS ARE NATURAL TECHNOLOGISTS

The selection of a system as a technology component, as opposed to a full system, is dependent on whether the system combines three key abilities: locomotion, detection, and navigation/location. The following sensor platforms represent those most often used during underwater UXO surveys.

- Surface Sensor Platform
- Submerged Rigid Sensor Platform
- Submerged Free Floating Sensor Platforms
- Bottom Traversing Sensor Platforms
- Airborne Sensor Platforms

**Examples Of MEC Technology Development**

The author has had the privilege of working on several technologies related to the mapping and recovery of UXO. The following subsections describe some of those examples, along with both advantages and limitations.

### The Kinematic Induction Magnetic Survey System

In the late 1990s, the author assisted UXB International, Inc. (UXB) in the development of a flexible multi-sensor geophysical mapping platform. The author was the project manager of the KIMS development program. This platform, known as the Kinematic Induction and Magnetic Survey (KIMS) system, employed a centimeter-accuracy global positioning system (GPS) in conjunction with a laptop computing and geographic information system (GIS) to perform geophysical mapping. The system was portable and allowed for the rapid collection and analysis of geophysical and topographical data. The system required the development of new software, UXB-Surveyor, which combined Commercially Off-The-Shelf (COTS) software and customized software, drawing upon the strengths of both approaches.

The KIMS system used an all-terrain vehicle (ATV) with a low magnetic signature to transport four, one-meter Geonics, Ltd. EM61 coils. The use of GIS, combined with high precision GPS capabilities, made the localized coordinate system and physical string survey guidance unnecessary where GPS was available. Typically, geophysical surveying workflow is characterized by gathering measurements on a data collector that is connected to the instrument. In the office, digital information from the data collector is downloaded into a desktop computer for processing and display using software provided by the instrument vendor. There is a benefit to performing some of the data processing and display portions of the workflow in near-real time at the surveying site, as the data are being collected. Incorporating this concept into the KIMS system not only reduced or eliminated time consuming steps associated with office post-processing, but improved the overall quality of the survey by providing a real-time graphical feedback of the data being collected. Implementation of this concept resulted in a rapid collection of geophysical data that was geographically-referenced to real-world coordinates with real-time and near-real-time display and analysis capabilities in the field. Figure 1 shows the KIMS being used on a target mound during winter months in New England.

A computer display was used as the basis for a highly interactive survey planning capability. The job planner established a survey area and alignment lines at a specified resolution. Job planning was accomplished while viewing existing site diagrams and pre-established work areas. Laying out survey lines was accomplished using any combination of three methods provided by the program:

- Individual Layout of Survey Lines
- Parallel Copying of a Selected Survey Line
- Automatic Placement of Survey Lines Perpendicular to a Specified Baseline

The KIMS System was used by UXB on several UXO remediation projects in the continental USA, and for the United Nations in Eritrea, as a mine avoidance variant. Although the system was functional and robust, it was not purchased by other UXO remediation firms. UXB was able to use the system to their competitive advantage for performing remedial jobs. The system continues to be updated as newer and different technologies are developed and incorporated into the KIMS package. Additionally, developers that produced components of the KIMS have also continued development and have sold variants of those components to other clients.

### The Magnetic UXO Recovery System: A System in Use

The Magnetic UXO Recovery System (MURS) was developed by the Air Force Research Laboratory and the National Defense Center for Energy and the Environment, with NDCEE. The MURS marries an electro-magnet with a remotely operated Caterpillar 325 Excavator. The design considered lifting requirements to extract ferrous UXO from the ground. The MURS can be operated remotely or with an operator on board to navigate previously mapped targets for the ultimate purpose of UXO recovery. The MURS was developed in fiscal years 2004 and 2005, and consists of the following components:

- Automated Ordnance Excavator (AOE), equipped with:
  - Caterpillar 325L hydraulic excavator
  - AFRL remote operation control system
- Walker Magnetics 57-inch diameter electromagnet
- 20 kilowatt (kW) power source

The system uses a Caterpillar 325L excavator with a remote control system, and includes real-time video cameras.
It weighs 60,000 pounds and the mechanical boom is capable of reaching out to 25 feet and digging to a depth of 15 feet. EOD technicians can safely operate and manipulate all functions of the AOE from as far as two miles via remote control. Additionally, AFRL has upgraded to a mass excavation boom with a lift capacity of approximately 10,000 pounds and has enhanced the AFRL AOE with an Automated Digging Mission Module (ADMM) developed under contract by Caterpillar Inc. The ADMM provides automated digging commands to the AOE in a wide variety of soil conditions to specified depths.

A Walker Magnetics Scrapmaster® D series 57-inch magnet was selected to maximize the lifting capabilities of the MURS. The electromagnet contains sealed coils and terminals to ensure watertight construction and low maintenance costs. The electromagnet is capable of generating a magnetic field with an intensity of over 500 Tesla. A magnetic field of this magnitude is used commercially in scrap and steel yards to lift heavy ferromagnetic objects and materials.

Underground removal is enhanced by the ability to couple with conventional excavation processes (i.e., adding “teeth” and using the AOE to scrape the ground surface to loosen buried objects). The high lift-to-weight ratio of this electromagnet allows the retrieval of a greater quantity of heavier targets. The Scrapmaster® D series magnet has a rugged ribbed steel case, heavy manganese-steel bottom plate, and welded watertight construction. Figure 2 shows the MURS being tested at Tyndall AFB, Florida.

The use of MURS technology has been advantageous for removal of UXO at Base Realignment and Closure (BRAC) sites and impact areas DOD-wide. Advantages include a more efficient cleanup and an improved response to the UXO problem as a whole through this new methodology for cleanup of range debris. This robotic technology is comparable to bucket-type excavating technologies with an added capability of magnetic recovery. The proposed MURS prototype comprises a system of off-the-shelf technologies suitable for a variety of recovery activities. The system is easily expandable and has the capability to loosen buried ferro-metallic objects through a hydraulic claw incorporated into the AOE boom, in concert with the magnet.

Current technology for UXO removal is focused on detecting where the hazard is. In order to remove the hazard, EOD technicians are sent into the field to extract and dispose of the UXO. MURS’ greatest advantage is in taking the human out of harm’s way by sending a robotically-driven piece of equipment into the area to perform excavation.

Limitations of the MURS included an inability to extract UXO buried greater than 12” using magnetic attraction alone, and limited use of the MURS in wooded areas due to restricted mobility. These limitations experienced during the demonstration may be mitigated through additional demonstrations, the validation process, and successive future design iterations.

The Remotely Operated Underwater Military Munitions Recovery System (ROUMRS)

In 2009, Army issued a Performance Work Statement (PWS) for the design, development and demonstration of a remotely operated underwater munitions recovery system (ROUMRS). The Virginia Company, ARA Inc. (ARA), established a team with Oceaneering International Inc. and has collaborated extensively in the development of the management and technical approaches to accomplish the contract objectives.

The technologies applied to ROUMRS are readily available COTS components that are in daily use by the oil and gas industry to water depths of 10,000 feet, with regular use for search and recovery to 20,000 feet. The US Government has identified a demonstration site at Ordnance Reef, off the west coast of the island of Oahu in Hawaii, and the National Oceanic and Atmospheric Administration (NOAA) has performed a site survey of the location.

Because it is difficult to obtain precise coordinates for underwater targets of interest, the platform for the system must have the maneuverability to perform a search around the provided coordinates (± 5 meters). A tethered, but free “swimming” platform, otherwise known as a remotely operating vehicle (ROV), is preferred, as the working environment at Ordnance Reef, as well as other potential work areas, are ecologically-sensitive, and soft bottom sediments may be present. Either factor may limit or prevent bottom contact. The ROV is capable of working to depths of 300 feet. Figure 3: shows an early conceptual drawing of the ROUMRS system.

The ROV is able to lift munitions of up to 150 pounds and move these munitions to lift cages for transport to the surface and disposal. In addition, for munitions that are encrusted with marine growth and/or attached to the reef, the ROV is able to settle onto the bottom and act as a base for the manipulators to extract the munition and lift the munitions to the baskets for travel to the surface. The power and other support for the ROV is provided from a surface ship equipped with the command and control equipment as well as power.

The ROV is able to lift munitions of up to 150 pounds and move these munitions to lift cages for transport to the surface...
generators and compressors to provide air as necessary to the subsystems. Figure 4 shows the front of the Comanche ROV equipped with cameras.

The manipulators for ROUMRS are mounted on the operations platform, are electrically-operated, and capable of fine operations. The manipulators are capable of grasping, manipulating, and lifting a variety of munitions and debris ranging from small arms ammunition, medium and large caliber projectiles, up to eight inches in diameter, and bomb shapes that weigh up to 150 lbs.

The ROV tracking is accomplished through a GPS that is located on the surface vessel. The GPS gives the position of the surface vessel. In turn the surface vessel, whose position is known through the GPS, communicates location to the ROV through an ultra-short baseline (USBL) tracking system. USBL is a common tool used with ROVs to determine the depth, slant range and bearing of the ROV.

Topside equipment includes those instruments required for recording and managing the data feed from the platform, sensors, cameras, navigation equipment, etc. Topside equipment is housed in a standard 20 foot CONNEX shipping box. As necessary, the equipment also includes a power supply, control consoles, air compressors and navigation equipment for the support vessel. The support vessel is capable of maneuvering to and from the load-out facility and nearest harbor.

The system is capable of delivering munitions to the surface and to move recovered munitions underwater to another underwater location for destruction in the form of an independent lift package (e.g., baskets, bags, or containers) that can be filled at depth by the manipulators and delivered separately to the surface.

Conclusions

The development of technologies that are to be used in the natural world can receive a major boost if the development team involves those persons most likely to use those technologies. The development team should include, and often does include, geologists. The adaptability of geologists to the environments that they study translates into technologies that can easily move into the environments for which they are designed.

There are no guarantees that a technology being developed will be successfully transferred to the user community. However, if the user interface is kept relatively simple, the technology uses COTS components, and the user community is made aware of the technology during development, there is a fighting chance that the technology can be successfully transferred to the user community. The following common threads can be found in successful technology development:

- It is more efficient than others available
- There is a “deep pockets” government sponsor
- COTS components are readily incorporated
- Independent validation has been performed
- Relative ease of use

Certain facets of the KIMS and MURS technologies have been successfully transferred to the user community. However, intact systems have not been accepted on a wider commercial basis. The ROUMRS technology has the potential to make the breakthrough to be such a technology for UWMM remediation.

References


Mr. Bowers resides in New Germany, PA with his wife and two children. Mr. Bowers has over 20 years of professional experience as a program and project manager, geophysicist, and environmental geologist. Currently, Mr. Bowers is the Project Manager for the Remotely Operated Underwater Munitions Recovery System (RUOMRS) project for ARA Inc. of Fairfax, Virginia. Mr. Bowers has acted as a geoscience and geophysics subject matter expert for the National Defense Center for Energy and the Environment. Mr. Bowers has managed numerous studies related to hazardous waste and unexploded ordnance (UXO). Projects have included an underwater weapons assessments in the Pacific Basin, DoD and other technology development projects, numerous site assessments including; superfund projects, those related to the NATO Response Force operations, and the Kaho‘olawe Island cleanup.
In over 50 years as a geologist I have observed a drastic change in the employment base for geologists. From a profession in which energy and mining companies were almost the sole private employers of geologists, a broad-based employment spectrum has evolved where environmental and water resource consulting firms predominate as employers of geologists.

During the transition from energy resource development to environmental problem-solving, technical approaches used by geologists also evolved. Traditional geologic techniques for assessment and analysis of the geologic framework controlling distribution and migration of contaminant bodies have been largely replaced by dependence on geotechnical and engineering approaches to developing solutions.

One of the greatest deficiencies I have seen in new geology graduates is a poor understanding of the advantages which a geologic training offers those involved with environmental investigation and remediation. Since we are not viewed as “true scientists” by many in the pure sciences, e.g. physics and chemistry, nor engineers due to our relatively lower emphasis on mathematical analysis, geologists are often viewed primarily as technicians. Since we incorporate basic proficiency in many different science and engineering areas as part of our working philosophy, our education and training actually produces an ability to integrate multiple disciplines into our work, a special advantage when we consider the multi-disciplinary requirements of field of environmental consulting.

One example of a difference is the description and interpretation of soil samples. A geologist should examine a rock or soil sample to determine its origin and its stratigraphic position with respect to a suite of associated rock or soil types (facies). A sample classified as SP in geotechnical terms may be a sand dune, a beach sand, a point bar or a complex in which a lower portion of the same unit may be of one origin and the upper a second, e.g. prograding sand dune on a beach. Each interpretation produces a different probable orientation of the overall sand body with up to 900 differences in preferred fluid flow pathways and geomorphic shape. Proper identification of the framework controlling the dynamics of the geologic setting can increase significantly the efficiency and effectiveness of any remedy selected.

In my experience, many geologists graduated in the past 20 to 25 years are deficient in their ability to identify and interpret the lithologic units and characteristics of common sedimentary facies associations. In addition, there is a lack of appreciation of the effectiveness of traditional stratigraphic analysis tools such as those listed in Table 1.

<table>
<thead>
<tr>
<th>Table 1 – Basic Stratigraphic Analysis Tools.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Well Log or boring log with Factual Observations and Geologic Interpretations</td>
</tr>
<tr>
<td>2. Stratigraphic Cross-sections</td>
</tr>
<tr>
<td>3. Structure Contour Maps</td>
</tr>
<tr>
<td>4. Isopach and Isolith Maps</td>
</tr>
<tr>
<td>5. “Slice” Maps (Paleogeologic Maps on Critical Surfaces/Geologic Facies)</td>
</tr>
<tr>
<td>6. Groundwater Table Fluctuations and Dynamics (=Slice Map Timelines)</td>
</tr>
<tr>
<td>7. Contaminant Characterization Maps</td>
</tr>
<tr>
<td>8. Saturated Thickness Maps for Present and Past Water Table Positions</td>
</tr>
</tbody>
</table>

Another aspect of geologic analysis to which geologists often give lip service, but tend to ignore when involved in an environmental project, is the role of time. The integration of time into any environmental analysis is critical when evaluating long-term solutions to problems, particularly when complex environmental systems are involved.

Although the time element involved in environmental problem-solving is normally not that of the traditional geologist, (i.e. shorter than eons), it is still critical when placed in the context of natural or anthropogenic fluctuations of groundwater tables or depositional dynamics of streams, lakes and features associated with engineered structures such as dams, landfills, docking piers, waste disposal sites and surface impoundments. All of these features can produce modifications of preferred flow paths, chemical retardation characteristics and other contaminant migration controls that are significant in selection and implementation of effective assessment and remediation solutions.

The ability to integrate stratigraphic analysis tools with an understanding of the dynamics associated with fluctuations of site conditions through time will provide a geologist with
a significant advantage in assessment and solution of envi-
ronmental problems. Some case history examples illustrating
this concept are discussed below. Although the examples are
generalized to respect client confidentiality, all basic essentials
of site geology and contaminant distribution are included in
each example.

Example 1 – Vertical and Lateral Migration Controls
on LNAPL\(^2\) in a Meandering Stream
Facies Association.

This site involves two retail service stations separated
by a paved street. Gasoline was identified under both sta-
tions, although only one station had a reported release.
Groundwater flow is easterly toward a surface stream located
approximately 950 feet away. Both facilities were under orders
to remediate the LNAPL (gasoline) and faced fines for continu-
ing trespass of the product plume. The surface area of each site
was approximately 100 x 150 feet with a total involved area,
including the street, of approximately 300 x 250 feet.

Boring log data from both sites were used to prepare clay
and sand isopachs for the underlying strata at each site. The
results, in conjunction with information on local geologic con-
ditions, indicated that the units involved were coarse channel
sands and fine-grained silty clays associated with a cut-off
stream meander located east of the northern site. The water
table intersected the clays and produced a transient impound-
ment of the product plume, forcing it to the south and under
Site 2. Based on the results of this study, Site 2 was dropped
from the order and Site 1 was assessed all cleanup costs. The
figures below illustrate the interaction of the plume, facies
elements and the hydrodynamics of the area. Figure 1 shows
the hydrologic barrier to easterly flow at high groundwater
stages with southerly diversion of LNAPL. Figure 2 shows the
effects of lower water table elevations, which allowed seasonal
easterly product migration from the release on Site 1.

Example 2 – Vertical Migration Controls with
Fluctuating Water Tables in a Marginal Marine
Facies Association.

Example 2 involves a more complex facies grouping associ-
ated with an ancient prograding shoreline. The site footprint
is approximately 20 acres and the surface elevation is approxi-
mately 100 feet above mean sea level (msl). An electronics
manufacturing facility that used chlorinated solvents in their
cleaning process formerly occupied the site. An east-west
trending stream valley is located south of and parallel to the
site with a stream surface approximately 60 feet below the
elevation of the facility. Contamination occurs in all lithologic
units with the majority of the mobile DNAPL\(^3\) (PCE) and dis-
solved phase PCE contamination in the lower sand unit.

Analysis of samples from approximately 20 boring logs at the
site indicate that geologic strata shown in Figure 3 underlying
the site are, from bottom to top , a dark bluish, fossiliferous
marine clay, overlain by a clean, well-sorted fine to medium
sand with sub-rounded to well-rounded grains. Overlying this
sand is a gray, sandy silt with some clay. This sedimentary
horizon contains a lens of fine to medium grained, moder-
ately to poorly sorted silty sand with some wood fragments
and scattered iron staining. The exposed unit at the site is a
dark-gray to black, fine grained malleable clay with abundant
fossilized burrowing molluses.

Geologic interpretation of data from site boring logs, struc-
ture contour maps and isopach maps, in conjunction with data
from boring logs at three other sites within ¾ of a mile north
and east of the site and aerial photographic analysis of the
area, indicate that the sand bodies underlying the site have
different origins.

The shallowest sand body is silty with low to medium
permeability, probably deposited in a slow-moving, north-
south trending distributary channel. The deeper sand unit
represents a probable beach/barrier island depositional envi-
rnment whose east-west orientation suggests deposition in a
shallow east-west oriented marine embayment.

This marine embayment interpretation is supported by the
abundant burrowing fossils, high organic content of the dark
grey clays overlying the surface of the site, the blue marine
clay underlying the lower sand unit and the character of
similar sand bodies occurring at the other sites mentioned
above . Orientation of the shallow distributary channel sand
is essentially perpendicular to the existing topographic valley
whereas the deeper sand body is subparallel to the existing
valley.

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2. LNAPL - Light Non-Aqueous Phase Liquid – A pure contaminant that is less dense than water and floats, e.g. gasoline, diesel,
kerosene, etc.

3. DNAPL - Dense Non-Aqueous Phase Liquid – A pure contaminant that is denser than water, e.g. chlorinated solvents such as PCE,
TCE, TCA, etc.
The DNAPL contaminant migrated from multiple minor spills vertically into the shallow sand body. The DNAPL continued vertical migration through the distributary sand unit into the deeper sand body and then laterally along the basal contact with the low permeability marine clay toward the modern stream valley located to the south of the facility.

Due to the meteorological and geological conditions at the site, relatively rapid seasonal fluctuations of the water table are common. When these fluctuations occur, dissolved phase PCE in solution migrates with normal groundwater flow, and is exposed to preferred pathways of migration with contrasting hydraulic properties, as well as differing orientations and configurations of the sand bodies. DNAPL contamination will not be as affected by the preferred pathways since the tendency for DNAPL migration is downward, with density-driven migration to the lower sand unit, and lateral movement toward the valley along the south-dipping basal contact between the barrier/beach sand and the underlying marine clay. Figure 3 illustrates the generalized vertical section across the area from east to west.

Figure 4 shows slice line C, when the prevailing water table is near the top of the uppermost silty sand, which will facilitate dissolved-phase contaminant transport along with the lower medium sand. Figure 5 (slice line A) depicts the water table at a depth 10 feet lower than in Figure 4; here, the dissolved plume is largely limited to the lower, fine to medium sand. Figure 6 (slice line B) represents the water table 10 feet lower than in Figure 5, and the preferred pathway is now along the lower contact of the sand and the underlying clay. These fluctuations will not affect DNAPL but will affect dissolved phase constituents from various parts of the plume.

**Example 3 – Contaminant Migration Controls with Transient Water Table Pathways.**

Example 3 is based on an approximately six acre site, also involved in electronics manufacturing, but with additional copper plating operations. At this site, the primary problem was first identified as metals contamination associated with the plating operation. During site assessment, a dissolved phase chlorinated solvent plume was identified. Metals contamination was isolated to the vadose zone and was effectively immobilized by the alkaline soils resulting from the chemical spillage associated with the plating activities. However, the chlorinated solvent problem was more extensive and required active remediation.

Interpretations of test boring logs, in conjunction with cone penetrometer testing (CPT) results allowed construction of structure contour maps, isolith maps and the cross-sectional interpretation shown in Figure 7. The geology underlying the site consists of two, moderately to well-sorted gravelly sand bodies, the upper of fresh water origin and the lower of marine origin, separated by low-permeability silty clay of apparent overbank origin. Hydrologically, the site contains a shallow, transient (perched) water table in the upper sand body that is...
hydraulically isolated from a regional water table located in the lower clean, beach sand unit. Data from water samples indicate that the silty clay was effective in minimizing vertical migration from the transient water table into the deeper regional aquifer.

Groundwater flow direction in the shallow “perched” saturated zone is to the south. Information from published reports generated by state and local agencies indicate that the flow direction in the deeper saturated zone is westerly, reflecting the regional pattern.

Contaminant migration in the shallow zone is controlled by gravity flow in channels incised into the base of the upper sand body and is almost 90° to the westerly regional flow direction. Figure 7 illustrates the generalized relationship of the aquifer units underlying the site.

Summary:

1. Maintaining a geologic perspective is vital in developing efficient and effective assessments of environmental problems in consulting.
2. Understanding of facies relationships and lithologic characteristics will significantly enhance problem-solving efforts in environmental consulting.
3. Use your geologic perspective in evaluating modern problems, whether global or local in areal extent and impact.

Dr. Howard obtained degrees in Geology from Dayton, Houston and Indiana Universities with additional studies at Duke University and Ocean Springs Marine Laboratories. He has been a professional consultant since 1972, specializing in Marine Geology, Hydrogeology, Site Assessment and Remediation on projects in 38 states, Canada and the Caribbean. He has also served as Associate Professor, Adjunct Professor or Lecturer at over 15 colleges and universities and presently serves as a destination lecturer on cruises to Central America, Bermuda, Alaska and the Caribbean. His special interest is applying stratigraphic analysis to the solution of complex environmental problems.
Mackay Rockhounds

The Mackay Rockhounds are the student chapter of the AIPG out of the Mackay School of Earth Sciences and Engineering at the University of Nevada, Reno. This year, the Mackay Rockhounds have 36 members majoring in various fields including Geology, Geological Engineering, Mining Engineering, Civil Engineering, Biology, Hydrology, and Geophysics. Although its members have a variety of disciplines, we all have something in common—they love the geosciences and they love rockhounding!

The Mackay Rockhounds enjoy two geological weekend camping trips (one each semester) to different areas around Nevada and California. In previous years, the club has visited Death Valley, Lassen National Park, the Virgin Valley opal mine, and Yosemite. This semester, the Rockhounds went to the mountains surrounding Elko, Nevada. Highlights of the trip included digging for carbonate fossils at Fossil Hill, north of Elko on Mountain City Highway, learning about the structural geology and glacial features of Lamoille Canyon in the Ruby Mountains, lead by Dr. Mike McFarlane of Great Basin College, and digging for fish and leaf fossils at Coal Mine Canyon, northeast of Elko. The Rockhounds that went on the trip returned not only with further geological knowledge, but also with several bags of samples containing garnets, vesuvianite, and fossils.

The University of Nevada, Reno student chapter has been very successful at fundraising for its activities this semester, thanks to the generosity and support of many individuals and organizations. First of all, the chapter had an on-campus mineral sale thanks to the minerals donated by Harvey Gordon and the W.M. Keck Museum. The chapter also held a mineral auction at the Geological Society of Nevada’s October meeting in Reno with minerals donated by Harvey Gordon and Mark Stock, CPG-07867, along with a gold splatter donated by Newmont Mining Company. The Rockhounds are very appreciative to everyone who has supported the club by donating or purchasing items for the mineral sale and auction, and are also very thankful for the Reno AIPG section for helping sponsor the fall field trip and club dues.

The members of the Rockhounds also attend local conferences and meetings related to the geological industry. The club encourages all its members to join and attend meetings of the Geological Society of Nevada, the Reno chapter of AEG, and to attend conventions such as the Northwest Mining Association Conference. By attending these meetings, the student members learn about issues related to the geosciences and mining and gain valuable connections with professionals in their fields of study.

The best part of being a member of the Mackay Rockhounds this year is the positive experiences it provides. Through the club, students are able to share their passion for geology, take trips and go new places, gain leadership experience, and meet others with similar interests, not to mention the fun things in between, like holding barbeques and socials, attending the AIPG Christmas party, and geologically-themed movie nights throughout the school year. Thank you, AIPG, for making this possible for us!

Submitted by the Student Chapter Officers

Moraines, Cirques, and Clamosauruses, Oh My!

On Friday, October 1st, the Mackay Rockhounds assembled to depart for Lamoille Canyon in the heart of the Ruby Mountains, 20 minutes south of Elko, Nevada. The Ruby Mountains attracted the Rockhounds with their drastic metamorphic core complex, glacial valleys and proximity to fossil collecting areas.

On the journey to Elko, we stopped at the structural enigma of Thunder Mountain near Winnemucca but soon departed for Fossil Hill. We were eager for the chance at fossil hunting at Fossil Hill, north of Elko. This locality provided a chance for the collecting of death assemblages, crinoids, horned coral, gastropods, brachiopods, and other fossils, tenderly deemed “clamosauruses” by geology professor John McCormack. From Fossil Hill, the Ruby Mountains waited in the distance. The Rockhounds made camp as darkness settled with only the jagged outlines of the canyon walls clearly visible; sadly, the innate beauty of the site would have to wait for morning.

As Saturday dawned, the canyon’s walls came to life. Monoliths of multicolored rock towered over us with the entire valley engulfed in gold, red, and green aspens turning colors for fall. The Rockhounds prepared for an early start to meet their intrepid guide, Michael McFarlane, who attended the Mackay School of Mines in 1975. Mike McFarlane began our discussion on the Ruby Mountains outside the canyon to show the episodes of glaciations as well as the range front normal fault at the mountain’s toe. The Ruby Mountains are composed of all three major rock classes, of which mostly metamorphic and igneous rocks were clearly present.

Upon entering the canyon, lesser grade metamorphic rocks were mylonitic due to stretching of the outer area of the metamorphic complex. As we proceeded, examples of sedimentary rocks metamorphosed to mylonitic marble and quartzite. Within the quartzite we found a white feathery mineral known as sillimanite. Sillimanite is a high pressure and high temperature alumino-silicate, which is distinguished by its high-grade metamorphism. Continuing up the canyon, we made several stops to analyze the changing metamorphic core complex as well as look at glacial features such as terminal moraines, cirques, glacial striated rock, and glacial polished rocks. The Rockhounds proudly lived up to their natural beauty of the site would have to wait for morning.

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name whenever the opportunity arose for rock and mineral collecting: many representative samples of metamorphic rock and glacial features were collected by club members.

Mike McFarlane made sure to emphasize the main structures of the area including the range front fault as well as the detachment faults due to elongation of the area. A spectacular seven-mile long recumbent fold held us transfixed in thinking about its origin. The magnitude of the recumbent fold can be viewed from the end of the road of the canyon, where the Rockhounds began a short hike. While hiking along the stream leading to Island Lake, we saw granitic boulder erratics and a granite pegmatite sill containing a xenolith. Close to this area, the most notable find of the trip were the garnets, which were approximately two centimeters wide. The garnets were found along with epidote, and vesuvianite. Mike McFarlane explained that these garnets were perhaps mistaken for rubies, thus giving the Ruby Mountains their name.

After breaking for a late lunch, the Rockhounds broke into groups. One group ventured into the canyon, hiking to some of the lakes closer by. On the hike, waterfalls graced the landscape and provided an exotic perspective to Nevada that few students had seen before. Meanwhile, the second group traveled to the little town of Lamoille to visit the Harvest Festival there. Everyone convened for a barbeque dinner and shared the home baked apple pies purchased at the festival.

Sunday arrived, and a bittersweet feeling washed over the group at the prospect of leaving this singular landscape of Nevada; however, class was still in session at the University of Nevada at Reno, so we had to return. The last stop on the way back to Reno was another promising fossil deposit north of Rynden, which is about 10 minutes east of Elko. In the Elko Formation, a Late Eocene-Early Oligocene lacustrine environment, the Rockhounds hammered away at the cliffside looking for fossilized fish known to reside in the thinly layered beds. Some fossil collectors were luckier than others were, but no one left empty handed because the fossilized plants were plentiful. Numerous evaporitic rocks and rocks in various stages of diagenesis were studied, in addition to minerals such as anhydrite, gypsum, and ulexite. After everyone had their fill collecting fossils, we headed back to Reno.

Upon arrival back at school, the extravagant number of bulging sample bags was proof of a very enjoyable trip. The trip also offered hands-on experience in the field, and a chance to learn about the incredible geology of eastern Nevada. Without AIPG’s generous contribution, the Rockhounds would not have been able to have such a successful field trip.

**SECTION NEWS**

**California Section**

We had a successful meeting November 3, 2010: California Section AIPG Meeting with UC Davis Student Chapter. About a dozen students were in attendance and four AIPG members and a UC Davis Professor, Dr. Magali Billen, MEM-1901, Dr. Robert Zierenberg, another AIPG Student Advisor, was unable to attend this meeting. We had a pot-luck dinner to start off the meeting.

The UC Davis Student Chapter President, Allison Price, SA-1798, gave some introductory remarks, and then the main “speakers” David Sadoff, CPG-09933, Rob Sydnor, CPG-04496, and Jim Jacobs, CPG-07760. We set up three workshop stations and the students, in groups of four to each of the “speakers” and we answered questions about career choices and options. I think it was valuable and we all had a good time and the meeting lasted about two hours. We will meet next in January, 2011. We are hoping that other colleges and universities will consider AIPG Student Chapters.

**Jim Jacobs, Section President**

**Florida Section**

**Field Trip To Central Florida’s Sand Mining District**-On October 16, 2010, the Southeastern Geological Society (SEGS) and the Florida Association of Professional Geologists hosted a field trip to Central Florida’s Sand Mining District. Unusually cool and dry Fall weather was perfect for vis-
iting sundrenched sand mines along the scenic Lake Wales Ridge (Ridge). Forty-seven attended, including 24 students from the University of South Florida (USF), several of their professors, and a variety of SEGS regulars.

The first stop was at E.R. Jahna’s Haines City Mine, a dredging operation, located on the eastern flank of the Ridge. Kirk Davis and Wink Winkler gave an overview of dredge mining, sand processing methods, and sand products, followed by a presentation on site geology that included a cross section that they have developed of the Lake Wales Ridge. After questions and answers, they turned the visitors loose on a freshly-sloped reclamation area, to search for fulgurites (fused silica resulting from lightning strikes) and trace fossil structures. Numerous fulgurites were found. Consequently it was difficult to persuade the crowd leave for the next stop.

A short drive to the south on the Scenic Highway, through the citrus groves along the crest of the Ridge, led to C.C. Calhoun’s Pit #1, a relatively-deep, dry excavation. Pit #1 is located high on Iron Mountain, near the City of Lake Wales and Bok Tower, in an area where the water table is unusually deep (80+ feet deep). Marc Hurst, MEM-1100, gave a brief presentation on the geology and evolution of the Ridge; and USF assistant professor Matt Pasek spoke about fulgurites. The shallower units exposed in the mine were found to contain the limonite-rich concretions that give Iron Mountain its name. A brilliant white, crossbedded, fine-grained sand unit, freshly exposed by mining in the deepest part of the pit, was found to contain an unusual concentration of fulgurites. Again, it was difficult to coax the field trip participants to leave the pit. Apparently they preferred fulgurites to lunch.

The third stop was at the old Sandland Mine, located on the eastern flank of the Ridge, a couple of miles to the east and about 100 feet lower in elevation from the previous stop. The Sandland Mine currently is under reclamation by Vulcan Materials Corporation (VMC). Kenny Smith and Tony Hayes greeted the visitors and gave a presentation on sand mining in general, and reclamation in particular. They discussed traditional reclamation of sand mines as lakes, as well as innovative reclamation plans involving water-front housing developments. A number of subjects were addressed during an extended question and answer session, in response to particularly good questions from the audience concerning technical aspects of the sand industry. Due to a shortage of time we were unable to take the tour of the nearby Diamond Sand Plant that the VMC representatives offered.

Our caravan proceeded north from Lake Wales to the fourth stop, at C.C. Calhoun’s Pit #4, located a couple of miles south of Haines City. Pit #4 is another relatively deep, dry excavation, situated near the crest of the Ridge in another area with an unusually deep water table. Many fulgurites were found. And again it was difficult to round up the crowd when it was time to go.

The fifth and last stop was at C.C. Calhoun’s Pit #7, another deep, dry excavation, located adjacent to the previous stop. Mined-out parts of the pit are being reclaimed in a rather unique way. The facility is permitted for mining and for Construction and Demolition Debris Landfilling. Sand and fill products are

The search for fulgurites at C.C. Calhoun’s Pit #1.

Group photograph of field trip participants.

Some of the fulgurites that were found.
sold from the mine, and construction-related waste materials are trucked in. Debris is carefully sorted and recyclable materials are salvaged for reuse. A crushing facility is planned to allow recycling of concrete debris. (Recycling of aggregate is a cutting-edge green technology). Unsaleable materials are used to back-fill the mine excavation.

Field trip participants were treated to a beautiful Fall outing. They were introduced to Central Florida's Sand Mining Industry by some of its leading experts. And hopefully they learned a little about the geology of the Lake Wales Ridge.

**FAPG-AIPG 2010 Hero Of The Industry Award**—The FAPG-AIPG Hero of the Industry award is presented this year to an outstanding geologist who has worked most of his career in the Florida phosphate industry. In 1987, three professional societies active in the phosphate industry (SME/AIME, FAPG-AIPG, and AIChE) started the “Hero of the Industry Award” to honor society members who made significant contributions to the phosphate industry. This year’s winner is Curt Simmons, CPG-10136. He has held positions as exploration and mining geologist in the central Florida Phosphate District. He has also worn the hats of hydrogeologist, process engineer, and mine planner in Florida and Ohio. He received his Geological Engineering B.S. degree from the Univ. of Missouri, Rolla and his M.S. in Hydrogeology at Wright State University.

His decades of mining related work have utilized his excellent abilities of project budgeting, personnel training, plant and mine process engineering, hydrogeology, mine site dewatering, reserves analysis, ore deposit modeling, drilling methods, logging core, and report writing. He has researched much of the geologic, hydrological, and mine engineering literature. He applies himself tirelessly to his duties and truly loves to recover the best products from his ore deposits. His illustrative cross sections and his daily visits keep him in constant contact with the dragline operators. He is always requesting mine management to set water jacks or install dewatering wells to better recover the phosphate. He is always planning strategies to conquer poor mining conditions.

He has been an integral part of best mine site dewatering methods in our mine district throughout his career. His master’s thesis studied well screen sizes and gravel pack sizes for dewatering the high gradient karst area at South Fort Meade/ Lake Henry Ridge. His dewatering methods and mine plans have allowed recovery of phosphate in areas previously ignored areas due to deep, saturated, or highly transmissive overburden, and highly disturbed old mine dumps which contained mineable phosphate debris and remnant matrix berms. His prospecting and dewatering efforts made these areas mineable and extended the mining life of several mines.

His list of employers cover the width and breadth of the Central Florida Phosphate District – Swift Chemical, Delta Drilling, Mobil Mining and Minerals, IMC, Regulatory Support Services, BCI, and Penn Pro Services. Outside of our industry he has served Standard Sand and Silica, Panterra Group, Lutz PEI, and a summer college job with AMAX Coal.

**Joe Fuhr, Section President**

**Georgia Section**

**Field Day at the Tellus Science Museum**—On October 9, 2010, the Georgia Section of AIPG in conjunction with the Georgia Geological Society (GGS) co-sponsored a Field Day for over 125 students, professors, and geologic professionals.

The Field Day was designed to provide a real life, hands-on experience to educate all participants. A total of 16 exhibitors from private industry donated their time, personnel, experience and equipment for the Field Day. The participants were divided into eleven separate groups of 8-10 individuals and rotated through eleven stations. Stations included topics such as hollow-stem auger and direct push drilling rigs, portable vacuum remediation systems, in-situ chemical oxidation and surfactant treatments, laboratory analytical studies, soil descriptions, sampling equipment selection, ground penetrating radar, slug testing and groundwater sampling. The groups were rotated approximately every half hour between the stations.

The event took place on the grounds of TellusScience Museum (Tellus) located in Cartersville, Georgia. The event took place on the grounds of TellusScience Museum (Tellus) located in Cartersville, Georgia.
success. Feedback from students and their professors indicated that the Field Day was helpful in applying some of their textbook concepts to real life situations.

After the field station rotations were completed, the participants were given tickets to visit the exhibits inside. There are three main exhibit halls (minerals, fossils and transportation), a planetarium, lecture hall/theatre, panning for gold and fossil dig activities for the children and numerous educational classrooms. If you are in the Cartersville/Atlanta area of Georgia, the Tellus Museum is a must-see attraction. More information can be found at their website http://www.weinmanmuseum.org.

That evening our section bought pizza for everyone and gave us an opportunity to talk one-on-one with some of the students to discuss careers. We received invitations from two departments to demonstrate direct push drilling on their campus next spring. We will discuss proper soil screening, sampling, and description along with groundwater sampling.

We would like to give a special thanks to the AIPG members that were exhibitors including: Tom Brown, MEM-0840, David Goodrich, MEM-1354, Sam Almaee, CPG-06310, Ken Summerour, MEM-0794, Dan Centofanti, MEM-0394, Mark Mitchell, MEM-0855, Henry Esterly, MEM-0992, and Tim Beck, MEM-0713. Without their participation this would not have been possible.

Eric Lowe, Section President, Ron Wallace, National Vice Pres.

Ron Wallace (AIPG National VP), Eric Lowe (President AIPG Georgia Section) and Glen Faulkner (Georgia Section Treasurer) interact with the public during Field Day.

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Michigan Section

Part 201 Amendments Pass the Senate and Await Decision in the House—Long awaited amendments to Part 201 may soon become official. This message was reported to AIPG by Michigan Department of Natural Resources and Environment Remediation Division (MDNRE RD) Division Chief Lynelle Marolf at our September 23, 2010 meeting.

In fact, Division Chief Marolf had provided testimony the morning of the 23rd to the House New Economy and Quality of Life Committee. The following is a brief description of some of the major changes that are expected to be passed as early as November or December of this year and will take effect immediately.

The Baseline Environmental Assessment process will be based on the federal rule for All Appropriate Inquiries (AAI) with the addition of requirements for sufficient sampling to document facility status. The petitions and associated fees will no longer be part of the process.

Due Care provisions will be expanded to align with the federal rule for Bonafide Prospective Purchaser, which means that the new owner will need to cooperate with persons conducting cleaning, comply with restrictions, and not interfere with restrictions or response activities. The due care exemption for local governments that use, or invite the public to use, contaminated property owned by the local government will be eliminated. For example, if a formerly contaminated property is converted to a public park owned by the local government, the local government will no longer be exempt from exercising appropriate due care responsibilities.

The reports required under Part 201 will be referred to as Response Activity reports. Self-implementation is still allowed and encouraged except for specific situations, which are mostly unchanged from current requirements. The DNRE RD will still need to provide input and/or approvals for local ordinances, mixing zones, in-situ remedies, groundwater cleanup waivers, and calculation of site specific cleanup criteria. The timeframe for which the DNRE RD will have to review the reports will be reduced from 180 days to 150 days. If the review is not conducted within the timeframe, an approval will be granted by operation of law. The ability to appeal technical issues will be handled by a new Response Activity Review Panel that will be comprised of 15 technical professionals with only 5 members assigned to specific appeals based upon their technical expertise and the issue being appealed. A fee of $3,500 will be charged for the appeals. The panel is advisory and makes recommendations to the director.

The new amendments also provide for No Further Action Reports. When all cleanup requirements have been satisfied, the party may submit a report to get a No Further Action determination. The reports will require affidavits from the submitter and the environmental professional. It allows for departure from standard and post closure plan requirements and is subject to the statutory review period and may be approved by operation of law if the timeframe is exceeded. There are also provisions for reopening sites if conditions are not addressed, the remedy fails, etc…Appeals over technical issues in the No Further Action Report can be brought to the Response Activity Review Panel.

Another major change is the groundwater/surface water interface (GSI) implementation. There will be modifications to the rules related to site-specific monitoring points. The amendments also include a statement that Water Quality Standards are GSI Criteria.

For further details on the new amendments, refer to Senate Bills 437, 1345, 1346, 1347, 1348, and 1349. Links to the bills are provided on the AIPG Michigan Section website.

Watch for DNRE listserver notices and the website for updates and information as progress is made toward implementing the bills when they are passed.

Sara Pearson,
Section Past President

Ohio Section

Ohio Section Welcomes Nominations—The AIPG Ohio Section welcomes candidate nominations to run for 2011 office. Offices up for election include President-Elect, Treasurer, and Secretary. Three member-at-large positions are also up for election. The office of President-Elect is a three year commitment. The primary duty of the President-Elect is to serve as the Section’s program chair, to organize and arrange speakers for Section luncheon and dinner meetings, and to organize field trips. In the second year, the President-Elect advances to the office of President. The President serves as spokesman for the Section, presides at all meetings, sets the agenda, and signs all official correspondence. In the third year as Past-President, this officer serves as a voting member and advisor to the committee.

Member-at-Large is also a voting member of the committee, serving a one year term with a limit of two consecutive terms. Three Members-at-Large serve the President with specific assignments. The offices of Secretary and Treasurer are comprised of two year terms. The Secretary is a voting member of the committee, records meeting minutes, and files official correspondence. The Treasurer is also a voting member of the committee, and handles the Section’s finances.

Matt Justice,
Section Past President
AIPG STORE

LOOK FOR SALE ITEMS

SALE SALE SALE
BOOK-Learn about the Geology of Northern Arizona with maps, photos and expert descriptions! This 6”x9” paperback has 321 pages that are packed with detailed information about Northern Arizona Geology. Price $10

SALE SALE SALE
BOOK-An excellent resource, the Second Edition of Roadside Geology of Colorado is a great book to add to your backseat. So pickup this book and hit the road. Price $10

SALE SALE SALE
BOOK-If you have wondered about the actual dangers of asbestos, radon, earthquakes, etc., that are not explained very well in the news, then this book is for you. Price $12

New Coffee Mugs


Roadster Mug-Get exclusive double-wall insulation that keeps the “hots” hot and the “colds” cold. Discover the comfortable handle with thumb grip and spill-resistant lid with thumb-slide opening. It even fits easily into automobile cup holders. Product Size: 16 oz. Price: $7.50

Outback Hat-The “down under” styling adds a sense of adventure to any outing. Heavyweight 100% cotton canvas; drawstring with cord locks and fashion brass eyelets. Two side snaps give the option of wearing the brim up or down. Available Colors: Canvas/Canvas, and Canvas/Navy. Price $18.00

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