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Cover picture was taken by Bill O’Connell, CPG-11284, on September 20, 2010. Bill is an Environmental Program Specialist with the ADEC Contaminated Sites program. The picture was taken from a helicopter during site visits to remote oil exploration sites that are undergoing site remediation.
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Mined in Pakistan

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Cover of IKONS Book
California
13.2cm tall

Rob Sielecki Photo
Arizona

Erick Weiland Elected Chair, Arizona Board of Technical Registration—In June of 2011, AIPG Member Erick Weiland, CPG-06892, started his second, three-year term as Geologist Member and is the newly-elected Chairman on the Arizona Board of Technical Board of Registration (AZBTR). The AZBTR regulates 10 individual technical disciplines with over 35,000 individual registrations. It is great to have a fellow AIPG member serving in such a distinguished role.

Mr. Weiland also has some other exciting news to report. In May of this year, Mr. Weiland accepted a new career role as Program Manager of Engineering for Freeport McMoRan Gold and Copper, Inc. (FMI) where he will work as part of FMI’s corporate research group. As part of a ten person life cycle analysis team, Mr. Weiland will be responsible for developing ways to improve processes to minimize environmental impacts at FMI mine sites including minimization of waste generation and/or reuse of 3 waste materials. Mr. Weiland states that he is enjoying his new job and likes that he can utilize his broad background in geology and geochemistry both from a technical perspective as well as program perspective.

ARIZONA SECTION FALL FIELD TRIP—Rosemont Copper Mine Project Tour fall field trip, held on Saturday, October 22nd, was attended by about 25 of our members and guests. The field trip was a tour of Rosemont Copper’s proposed open pit copper facility located southeast of Tucson. The Rosemont Copper property is situated near a number of large porphyry type producing copper mines operated by Freeport McMoRan and Asarco. Rosemont Copper conducted feasibility studies and published a preliminary assessment in 2006. The company is currently completing studies and submittals as part of the permitting process. The US Forest Service issued a Draft EIS in June 2011. The property contains three known potentially open-pit mineable copper/molybdenum skarn deposits. Rosemont Copper has a rare combination of copper, molybdenum, silver, and gold in what is believed to be one of the largest unmined surface deposits in the country.

The field trip led by Rosemont senior geologist, Jeff Cornoyer. We started the field trip at the core shed where Jeff provided a really interesting presentation of the site geology, the proposed mining operations, and allowed us to look at the core. Then we traveled by vans to see the mine site and the geology of the area. And, we had a chance to collect some rocks and minerals – always one our favorite activities. We also enjoyed a nice picnic lunch along some of the outcrop and what will be about the center of the pit. The field trip was very interesting and we appreciated the opportunity from Jeff Cornoyer at Rosemont Copper to be given the “geologists” tour.

Barbara Murphy, CPG-06203
Arizona Section Secretary

Colorado Section

 Participation in AIPG National Events, by Tom Cavanaugh, CPG 10493, and National Vice President.

I would like to start by thanking you for supporting my election to the 2012 National AIPG Vice President position. Although I have attended the AIPG National Executive Committee annual meetings previously, I went to the September meeting in Chicago as the Colorado Section representative to participate and facilitate a transition to the national position. I am currently and will continue in 2012 to be the CO-AIPG Vice President.

The Executive Committee meetings are open to AIPG members, and I strongly encourage you to attend to see the good work your organization is doing—you will be impressed with the well organized sessions. National ExComm meetings are scheduled in Tucson in February (same dates as Tucson Gem & Mineral show), in Colorado this summer, and the next Annual Meeting will be in Rapid City, SD September 22-25, 2012. The technical sessions and field trips are excellent and you will meet the area experts and geologists from around the world.

One of the most inspiration aspects of the Annual ExComm meetings are the reports from each State Section. Although Colorado has the most members of any state (the Northeast Section has more members, but from six states), we aren’t the most active or innovative. Many states are as spread out as Colorado and have bridged the gap and involved distant members in committees and meeting by tele- or video-conferencing technologies. This next year the Colorado ExComm will include a Grand Junction CPG. We hope to involve many more individuals from around the state. With excellent geologic societies in Grand Junction, Durango, and the Four Corners area, we as a state are blessed with active, expert geologists and schools, and some of the best visible geology anywhere. The AIPG National Headquarters are in the Denver area, but a new emphasis on utilizing the technologies for the website, webinars, and online training is making the AIPG more national in scope and relevance. Check out the classes available and grow in your expertise with continuing education credits.

I want to emphasize how important it is for each of you to renew your commitment to the AIPG and Geological Sciences. We as professional geoscientists need to pay more attention to the political scene, both nationally and locally. Our science and related industries are taking a back seat to the political will and media hype throughout the country. Remember Three Mile Island and the nuclear industry that dwindled for thirty years because of misinformed public and media hype. Compare it to the beating the Oil & Gas industry is taking over fracturing of resource rocks. In both cases the negative impacts of media on the public have been devastating when we need energy to get the country and economy back into a prosperous mode. Pay attention to the science and explain the realities to your friends and neighbors. As a professional, you must help to educate the public, alleviate their fears,
and promote the safe development of our natural resources.

People have been panicked about the balance of trade and excessive importation of petroleum products and don’t realize the 95% of our nuclear fuel (which provides almost 20% of our energy) and 95% of rare earth and strategic minerals are imported, and much from unfriendly countries. Wherever you and your industry are situated, it is important that we as geologists understand the generally negative and long term effects of politics and media are having on our vocations and country. Stand up and be counted – the next year is an important one.

**Colorado Section Luncheon was held January 17, 2012.** The topic was Hydraulic Fracturing 101: What is it? Why do we do it? And what work is going on at Mines?” The presenter was Jennifer L. Miskimins, Colorado School of Mines.

**Abstract:** Hydraulic fracturing is a stimulation technique used mainly in hydrocarbon-bearing wells. With the advent of unconventional reservoirs, this 60-year-old technique has received renewed interest during the past two decades, both domestically and internationally. Unconventional reservoirs, due to their low permeabilities, require some type of stimulation to produce economically, and hydraulic fracturing is generally the method of choice. This talk will discuss exactly what hydraulic fracturing is and why it is or isn’t used in certain reservoirs. Additionally, some of the research work that is being conducted at the Colorado School of Mines Petroleum Engineering Department with regards to hydraulic fracturing will be discussed. This work includes modeling of hydraulic fractures in various depositional environments, monitoring and diagnostic techniques used to track fracture growth, and the optimization of hydraulic fracture spacing in horizontal wells.

**Biography:** Jennifer L. Miskimins is an Associate Professor in the Petroleum Engineering Department at the Colorado School of Mines (CSM) in Golden, Colorado, USA. Dr. Miskimins holds B.S., M.S., and Ph.D. degrees in petroleum engineering. Prior to joining CSM, she worked for Marathon Oil Company in a variety of locations. Dr. Miskimins is the founder and Director of the Fracturing, Acidizing, Stimulation Technology (FAS'T) Consortium at CSM. She teaches a variety of courses including completion and stimulation classes, geologic field camps, and petroleum economics courses at CSM and as industry short courses. She is a member of SPE, SPWLA, AAPG, Sigma Xi, and ASEE. Dr. Miskimins served as the Executive Editor for the SPE Production & Operations Journal from 2008-2011 and was an SPE Distinguished Lecturer for 2010-2011.

Jim Burnell, MEM-0205
Colorado Section Editor

Georgia Section

**Georgia State News**—As the Fall semester nears the end, GSU AIPG Student Chapter had a meeting at Fernbank on November 18 along with our advisor Dr. Seth Rose. We enjoyed our social event, which included an IMAX feature film (Galapagos). Then, on November 19, some of our members enjoyed the visit to the Gem and Mineral exhibit at Cobb County Civic Center. As for December, some of our members will be attending conferences here in Georgia and in California. On December 3, at the Greater Atlanta Geomorphology Hydrology Research Conference hosted at University of Georgia, Semir Sarajlic, SA-1891, will be giving a talk on “Land cover change and mineral composite assessment of Tushka Lakes, in Egypt, using remote sensing and GIS,” and Ginny Mauldin-Kinney, SA-3003, will be giving a talk on “Examining variations in discharge estimates for Martian Outburst Channel.” On December 6, in San Francisco, CA, Rebecca Pickering, SA-3360, will attend AGU Fall Conference at which she will present a poster titled “No fault of their own: Increasing public awareness of earthquakes in aseismic regions,” and Laura Zaunbrecher, SA-3016, also will present a poster on “Natural enrichment of stable Cesium and weathered micaceous materials at Savannah River Site, South Carolina, and implications for Cesium 137 absorption.”

Sciencepalooza—Eric Lowe, MEM-0385, and Ron Wallace, CPG-08153, attended the first annual Sciencepalooza at McClure Middle School in Kennesaw, Georgia. The idea was to get students excited about science, so there were a number of experiments the students and parents could see. Our station was Rocks and Minerals, which turned out to be not as flashy as compared to some of the other stations such as Gummy Bear Explosion, Chemistry Explosions, Nitrogen, and Bubble Trouble.

The good news was we were across the hall from Gummy Bear Explosion, so when their room filled up, we would entice the overflow from their session. It was a fun evening to talk to all the students and parents. Next time we will “enhance” our name to compete with these catchy titles.

“Something like “Volcanoes, Earthquakes and Natural Disasters, What’s next?”

Ron Wallace, CPG-08153
Georgia Section President

Ron Wallace, CPG-08153

Eric Lowe explaining topographic maps to students and parents.
Following the social hour and dinner Dan Rogers presented his informative talk on “Why Geology and Chemistry Form the Foundation in Sustaining Urban Areas.” The Section business portion of the meeting followed the talk by Dan.

The Executive Committee announced the result of the election of Section Secretary; Tim Cullen, CPG-07027, will be joining the Executive Committee in 2012. Congratulations Tim! The Section Executive Committee also made a dual award for “Significant Contribution to the Michigan Section” to Kevin Lund, CPG-10052, and Sara Pearson, CPG-10650; the awards were presented by Adam Heft, CPG-10265. Kevin and Sara had organized the very successful In Situ Conference held in June 2011 at the RAM Center. In addition, Kevin is one of the Golf Outing Co-Chairmen, and Sara organizes the summer field trip for the Section. Both are past officers of the Michigan Section. Thanks to both Kevin and Sara for their ongoing hard work and dedication to the Michigan Section!

The Michigan Section also awarded three educational grants to Midland School system (Adam Elementary), West Middle School in Traverse City, and Kelloggsville Public School in Kentwood Awards given were in the amounts of $250, $500 and $500, respectively.

Michigan Section

Annual Section Meeting Summary—The AIPG Michigan Section held its annual meeting on Thursday, December 1st at Weber’s Inn in Ann Arbor. The meeting was well attended, and a number of students also were present. The Section Executive Committee held its annual student poster contest, and Erica Dalman, SA-5047, and her poster titled “Using a Rock Tumbler in Sedimentation Courses to Simulate Weathering and Erosional Processes” was selected as the winner of the annual $500 award.

Michigan Section Longevity Awards—With the new year comes the opportunity to acknowledge those individuals that have been members of AIPG for a number of years. Members reaching 10, 15, 20, 25, and 30 years of membership are listed below, and will be receiving a certificate documenting their longevity milestone.

10-Year members include: Bruce Beltman, Daniel Cassidy, Scott Cesarz, Tom Cok, Joyce Dunkin, Rick Dunkin, Ryan Dunning, Kristopher Nolan, William Prall, Matt Stuk, and Michael Zack.


The 20-year members are: Thomas Brunelle, Donald Carpenter, Michael Colvin, Curt Cramer, Tim Hebert, Virginia Himich, Erik Johnson, John Rodwan, Michael Serafini, Alan Trippel, and David Waltz.

Tim Cullen (our 2012 Secretary), Duane Jorgensen, and Kenneth Wiley have each been members for 25 years. Gary Dannemiller has been a member for 30 years.

Congratulations to all of our longevity milestone members, and thank you for your support of the Michigan Section AIPG over the years!

Adam Heft, CPG-10650, Michigan Section Editor
CTL Announces New Vice-President

CTL Engineering, Inc. (CTL) is pleased to announce Kevin Reichert, CPG-09484, as the new Vice President of CTL Engineering of Ohio, Inc. and officer of the corporation as decided by the Board on December 6, 2011. Kevin has long deserved this position. In his 25 years with CTL, Kevin has been instrumental in the establishment and growth of the Wapakoneta office in northwest Ohio.

Reichert has been a Certified Professional Geologist since 1995 and holds a BS in Geology from Ohio Wesleyan University. He has supervised environmental investigations and site assessments throughout the Midwest for large clients such as The Ohio Department of Transportation, Indiana Department of Transportation, Walmart Stores, Verizon, Bob Evans, Owens Corning, and Central Investments.

Formerly known as Columbus Testing Laboratory, CTL was established in 1927 as a private, independent engineering and testing laboratory. Initially, CTL focused mainly on soils, foundation engineering and construction testing, and inspection services. In recent years, the company expanded its services to include the metallurgical, non-destructive testing, mechanical, mining, roofing, and environmental service industries.

CTL regularly performs services throughout Ohio, the Midwest, and Mid-Atlantic. In addition to the corporate headquarters in Columbus, the company has regional offices throughout Ohio as well as in Indiana, West Virginia, and in India.

From Jim Jacobs, CPG-07760-I am here on my last Fulbright grant at SRTM University in Nanded, India at the Earth Sciences Department. I will be here for 6 weeks.

Yesterday I gave my first lecture on the BP Oil Spill of 2010 with 30 students and they were highly enthusiastic. I am here with another hydrogeologist, Steve Baker. We signed up 23 geology graduate students to work on a documentary media project with on-site interviews in local villages to develop a 5 minute, professional video on some of the more severe water issues in the Nanded area.

I will give a lecture on being a professional geologist, showcasing AIPG’s role in the professional life of the members. They have about 12 professors and about 50 graduate students. I will be setting up some projects here. I met the Vice Chancellor of a 350 university system in India, and this may be an introduction for our members to some very exciting educational, business and social opportunities.
Thank You for 25 Years!

The following members have received their 25 year pin and certificate. Your dedication to AIPG throughout the years is truly appreciated. It has ensured the growth and success of the Institute. Please join AIPG headquarters in thanking these members for their continuous support.

Jennifer S. Axtell CPG-07074
Greenville KY

David A. Baker CPG-07227
Canfield OH

Clayton M. Barnhill CPG-07145
Roswell NM

Emery P. Bayley CPG-07082
Bellevue WA

Brian A. Beck CPG-07011
Chino Valley AZ

Sally W. Bilodeau CPG-07121
Camarillo CA

William L. Boettner CPG-07129
Hutto TX

Nathan H. Brewer CPG-07042
Littleton CO

Steven L. Brewer CPG-07177
Irvine CA

David M. Brown CPG-07130
Tucson AZ

George B. Brown CPG-07092
Falls Church VA

Tom W. Carpenter CPG-07166
Powhatan Point OH

Douglas K. Childs CPG-07126
Denver CO

Gaylord Cleveland CPG-07199
Reno NV

Donald K. Cohen CPG-07179
Suffern NY

Benjamin I. Collins CPG-07066
Kailua-Kona HI

Bruce A. Collins CPG-07016
Silt CO

Jon L. Courtney CPG-07083
Lakeland FL

Timothy R. Cullen CPG-07027
Ann Arbor MI

Timothy Dahlstrand CPG-07128
Northbrook IL

Paul S. Darr CPG-07132
Grand Junction CO

R. Laurence Davis CPG-07105
West Haven CT

Peter M. Demicco CPG-07180
Newark DE

Peter H. Dohms CPG-07141
Pensacola FL

Kurt H. Fagrelius CPG-07149
Farmington NM

Jane M. Farris CPG-07003
Canyon TX

Madeline A. Fell CPG-07094
Coral Springs FL

Raymond M. Follador CPG-07093
Harrison City PA

John E. Frost CPG-07172
Houston TX

Herbert E. Fry CPG-07163
Grapevine TX

James M. Gibson CPG-07181
Kingwood TX

Howard J. Gordon CPG-07190
Boulder CO

Mark A. Gower CPG-07017
Haley ID

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Lakewood CO

Gregory W. Hartsough CPG-06996
Owensboro KY

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Sammamish WA

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Greeley CO

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Butte MT

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Steven J. Lambert CPG-07060
Albuquerque NM

Willem Loder CPG-07156
Golden CO

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Monroe City IN

C. George Lynn CPG-07198
Manchester MO

Michael R. Mann CPG-07206
Proctorville OH

Jan P. Mazgaj CPG-07019
Omaha NE

James P. McCammin CPG-07020
Crestone CO

Michael T. McCarrin CPG-07051
Grafton IL

E. Miranda Menzies CPG-07148
Eden UT

Mark F. Middleton CPG-07021
Elkhorn NE

Doral S. Mills CPG-07043
Milledgeville GA

John R. Morris CPG-07064
Lutz FL

David Muscalo CPG-07182
Lafayette NJ

Joel M. Nelson CPG-07218
El Paso TX

Thomas E. Newman CPG-07222
Ft. Collins CO

Robert M. North CPG-07150
Bayard NM

Kenneth P. Olson CPG-07053
Plymouth MN
Thank You for 25 Years!

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2012 Fulbright Award at the School of Earth Sciences at SRTM University, Nanded, Maharashtra, India

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It has been a great honor to represent the United States and be selected by the Council of International Exchange Scholars (CIES) for my fourth Fulbright Senior Specialists grant in Geology/Environmental Science. This six week award started on January 16, 2012 and ended on February 27, 2012. The School of Earth Sciences Department at the Swami Ramanand Teerth Marathwada (SRTM) University was the host institution. SRTM is a graduate university and is located in south-central India in Nanded, a "rural" town of 1.5 million people in Maharashtra State.

Over the six weeks, the goals of the Senior Specialists grant were to design, prepare and conduct a 7-day environmental workshop for graduate students and professors on subsurface environmental management, and deliver a dozen other lectures to a variety of departments including Earth Science, Life-Sciences and Physical Sciences. A request was also made to review the graduate geology, environmental science and geography curriculum for comments and recommendations. The concept of an interdisciplinary Environmental Field Experimentation Centre (EFEC) was developed and proposed during this grant period. The EFEC could be a place where student, professor and industry employees could receive up-to-date training using field conditions. The EFEC could also be used to provide research and publishing opportunities as well as document and test various types of environmental and geotechnical instrumentation. The EFEC could be used to bring teams from geology, biology, chemistry, physics, engineering and media studies together on selected projects to solve complex science and socio-economic environmental challenges.

On the way back to Mumbai, a one day environmental workshop at the Institute of Science in Aurangabad was also requested.

The 42-hours of teaching that was part of the International Workshop on “Risk-Based Subsurface Environmental Management and Sustainable Remediation” occurred on February 5th to 11th, 2012. Midway through the workshop, the School of Earth Sciences hosted a one-day field trip to the Lonar Meteorite Crater, which is an example of the Earth’s only crater caused by a hypervelocity meteorite impact into flood basalt. At the bottom of the 50,000 year old impact crater,
there are several 500 year old shrines as well as a variety of exotic animals, including monkeys and parrots. About 75 graduate students and professors attended the training workshop.

As in previous Fulbright grants, other American teachers donated their time and travel expenses to the project. A co-teacher on other international workshops, Chin Man Mok, Ph.D., P.E., P.G., of AMEC in Oakland, California provided about a dozen engineering and risk-based lectures for the workshop. He also presented additional lectures for the School of Physics at SRTM University and a local engineering college focusing on career development and interesting engineering applications to address environmental and geotechnical challenges.

Another American teacher, Stephen Baker, P.G., C.H.G., of Living Water Alliance in Nevada City, California, led several sessions about water resource allocation during the 7-day workshop. He conducted two recorded radio round table discussions featuring local Indian water professionals and professors who provided their philosophical perspectives and comments on two of the most vexing problems in water resources in the western United States. The panelists learned about the background and then discussed the water allocation challenges of the California Sacramento-San Joaquin Delta region. The second topic was related to water rights issues in Washington and Montana. Baker also worked on a media project to develop a 5-minute video with students from the School of Earth Science that demonstrated delivering positive messages that would connect science and technical information with the public. The media project emphasized the social component to applied scientific projects related to water and lifestyle changes needed in the smaller villages of Maharashtra, India. The media project scripting and filming was completed during the period in Nanded, and the final version will be finished in a few weeks, available for viewing.

Uncertainty and risk are major challenges for subsurface assessment and groundwater cleanup projects. The 7-day certificate class highlighted the main concepts of sustainable practices as used in California and risk-based environmental management of water resources. The workshop provided the tools to assess the environment for toxic chemicals, evaluate the risks to health and the biosphere, and to treat the contaminants as needed. The variations in the regulatory responses as well as the uncertainties of remediation success, create significant risk for most complex subsurface environmental projects. Successful management of subsurface environmental risks and obtaining case closure at sites with impacted soil and groundwater is challenging and costly. This workshop focused on issues related to water resources, risk assessment and site remediation of contaminated soil and water, case closure, and productive reuse of a contaminated property using an understanding of health risk assessment and developing remediation methods that minimize energy, water use, material resources, labor, as well as reduce waste disposal and lower the carbon footprint of the field activities. Although the case studies of industrial activities were from examples in the United States from the 1940s to the 1980s, the similarities to current Indian industrial practices were highlighted.

The workshop was focused on understanding exposure pathways, risk assessment, development of site conceptual models for fate and transport of contaminants and optimizes treatments for soils and groundwater to obtain case closure. Several teaching methods were used, including standard lectures, group projects, readings, and the interactive and popular “Smartest Scientist Show” featuring 5 contestants and 10+ questions on the topics to be covered, with the winner receiving the much sought after Smartest Scientist Award.
T-Shirt. Indians are polite and generally quite reserved. After the final lecture of the workshop was presented, their feelings became clear after 90 minutes of photographs with the teachers, shaking of hands and signing of autographs.

Later during the stay, at the request of Director R.R. Deshpande, Geology Professors S.M. Deshpande and P. Shinde of the Institute of Science in Aurangabad, Baker and Jacobs presented a one-day certificate workshop titled Risk Analysis and Sustainable Remediation of Environmental Resources on February 24, 2012 at the Institute of Science in Aurangabad, Maharashtra. About 100 student and professors participated in the event. The American teachers attended a K-12 public school to answer younger student questions about science and engineering. The school lectures were designed to encourage enthusiasm and passion in the students for taking their knowledge of science into the world to solve real problems. All Indians who participated in the workshops and lectures were engaged and interested in the topics. The teaching team was also interviewed by two Aurangabad newspapers wanting some insight into India’s water resource challenges. The optimization of water resources and environmental restoration will eventually come to India. Careful planning and integration of large-scale solid waste projects and waste water treatment, for example, are needed. The reuse and recycling of wood, paper, plastics, metals and glass are sorely needed, but these resource recovery programs cannot be successful without convincing the average Indian that the environment and ecosystems have value, and should not be spoiled.

Nanded is on the Deccan Plateau and is underlain by 66 million year old basalts. Due to these thick flood basalts, the water resources are limited to surface water bodies (rivers and lakes) and shallow fractured aquifers which are commonly 10 meters deep. Many small rural villages nearby Nanded have hand-dug water wells that are 3 to 5 meters wide. The village water wells are lined with tiles or rock near the ground surface and the well water is removed by hand using a water jug at the end of a rope. In India, 32 million households (or 17% of the country) get their water from water sources outside the home. Mostly a job performed by women and girls, the water is transported back to the houses by balancing the water jugs with about 12 liters of water on their heads. The water balancing task was tested at a well at a village near Kandhar by American Steve Baker for only a few minutes with assistance from SRTM University geology graduate student Pawar Ranjitsinh Subhas.

Although India faces massive challenges as it tries to modernize with a population of about 1.2 billion people, there must learn to manage water resources for future economic success.
are huge socio-economic opportunities for the nation. The take home message to most of the workshops and lectures is that students willing to address these important science-related water resource challenges will become future leaders of India. The response from the student participants in the workshops and lectures was enthusiastic to the American teacher’s message of hope and courage and the need for their active participation.

There are many wonderful and hospitable people in India, and a few individuals made the trip possible and extremely fruitful: Vice Chancellor Dr. S.B. Nimse, Director Dr. D.B. Panasker of the School of Earth Science, Professors Dr. K.V. Kumar, Dr. V. Wagh, Dr. S.K.G. Krishnamacharyulu as well as many other professors and students from SRTM University in Nanded, India. Director R.R. Deshpande, Geology Professors S.M. Deshpande and P. Shinde of the Institute of Science hosted our wonderful stay in Aurangabad. The Indians graciously invited the teaching team into their homes and provided hospitality and touring opportunities beyond our expectations.

From the Fulbright Program, Dr. Girish Kaul, Senior Program Officer at the United States - India Educational Foundation (USIEF) in New Delhi and Ms. Anneke Archer, Senior Program Officer of the Institute of International Education, Council for International Exchange of Scholars Division in Washington, D.C., provided assistance and suggestions.

The close technical interaction and educational exchange over the six week grant period was a terrific professional experience. The activities in India were sponsored and hosted by SRTM University. The U.S. Department of State through the Bureau of Educational and Cultural Affairs funds the Fulbright Program and CIES is a division of the Institute of International Education. The Fulbright Program is an important part of American educational exchange and is used to help build and maintain strong U.S. international relations throughout the world. Based on this six week grant, several future, long-term scientific Indian-American collaborations are being planned.
Greek Volcano Reawakens

Potential eruption wouldn’t be anything like Santorini’s storied Bronze Age blowout.

Precise measurements of the landscape at Santorini, Greece, using GPS stations (foreground) reveal that the volcano is slowly inflating, a possible precursor to an eruption. Georgia Institute of Technology The Greek islands of Santorini, site of one of history’s most colossal volcanic eruptions, are rumbling again.

Since January 2011, earthquakes have shaken the landscape and the Santorini volcano’s surface has lifted by about 140 millimeters — possibly because magma is rising from the deep and filling an underground chamber, scientists report in an upcoming Geophysical Research Letters.

It’s far from certain whether Santorini will erupt, the researchers say. Even if it does, the eruption won’t be anything like the infamous blast that occurred around 1600 B.C., says Andrew Newman, a geophysicist at the Georgia Institute of Technology in Atlanta. That eruption showered ash across the eastern Mediterranean, possibly contributing to the decline of the Minoan civilization and perhaps giving rise to the legend of the lost city of Atlantis.

“We do not think a Minoan-type eruption is likely,” Newman says.

If Santorini does erupt, it will probably be a small eruption like those seen there over the past few hundred years, most recently in 1950. Those eruptions have built up a pair of islands in the center of the now-drowned remains of the volcano, or caldera.

Newman and his colleagues, including several at the University of Patras in Greece, began studying Santorini in 2006. They set out Global Positioning System stations that precisely monitor tiny movements in the surface and can capture the volcano inflating as if taking a deep breath. The landscape moved barely at all until early 2011, when it suddenly awoke.

The amount of movement is consistent with a blob of magma about three football fields wide rising into a chamber and swelling the crust about four kilometers beneath Santorini, Newman says. “If we really start identifying that the source is migrating and becoming more shallow with time, then the hazard may increase,” he says.

Other calderas have shown similar inflation and earthquake swarms before without erupting. In the early 1980s, the town of Pozzuoli, Italy, rose nearly two meters but the Campi Flegrei caldera beneath it did not erupt, says Tim Druitt, a volcanologist at the Blaise Pascal University in Clermont-Ferrand, France.

“Only about 10 percent of cases of such unrest at calderas result in eruption.”

Greek officials have convened an expert committee to study how the volcano should be monitored. The committee head, Kosmas Stylianidis of the Aristotle University of Thessaloniki in Greece, says the group will continue to keep an eye on the current unrest. But for now the scientists won’t issue any specific alerts before they meet in Santorini on March 27.

References:
Fossil Pushes Back Land-Animal Debut

Five-toed foot among new finds that help fill in evolutionary picture

A foot buried beneath Scottish soil for at least 345 million years pushes back the timeline for the appearance of the first four-legged creatures that spent their lives on dry land.

“This is the earliest and smallest foot ever found with five digits,” says paleontologist Jennifer Clack of the University of Cambridge, England. “It tells us that terrestrialization occurred much earlier than we had a hint of before.” Feet with five toes tend to be good at bearing weight and rotating on land, she says.

The specimen, 20 million years older than any known five-toed fossil, is just 10 millimeters across and comes from an unknown species. It’s one of a slew of new finds described by Clack and colleagues online March 5 in the Proceedings of the National Academy of Sciences. New caches unearthed near rivers and coasts in Scotland and Canada are helping fill in a blank chapter in the evolution of life on land.

Before about 360 million years ago, fishlike creatures could drag themselves along the shores of their watery homes. Then a massive extinction wiped out half of all vertebrate groups on the planet. But by about 345 million years ago, the planet teemed with a variety of creatures that lived on dry land.

What happened to spur this exodus from water after the extinction has remained a mystery. Few terrestrial fossils have been found that date to between 360 million and 345 million years ago. Some have argued that little evidence has turned up because there is little to be found. A 2006 paper in the Proceedings of the National Academy of Sciences suggested that lower levels of oxygen during this time delayed the rise of air-breathing land creatures.

The new finds show that some terrestrial life had rebounded within 10 million years of the extinction. “This discovery clearly refutes the hypothesis of … low oxygen levels,” says paleontologist Philippe Janvier of the National Museum of Natural History in Paris.

At the same Scotland location that yielded the five-toed foot, researchers also found a jawbone from Crassigyrinus, a creature that grew up to 2 meters in length. Plants and small shelled invertebrates turned up at another new site called Willie’s Hole, which also held the remains of more than 100 four-limbed creatures.

“We’re seeing a different cast of characters showing up after the extinction,” says paleontologist Michael Coates of the University of Chicago.

Clack’s team needs to clean the fossils and take a closer look to chart the emergence of this diverse post-extinction ensemble. The researchers hope to identify which species ultimately gave rise to creatures that walk, crawl and slither the Earth today.

References:


Hydraulic Fracturing Guidance Offered to Policymakers By the National Ground Water Association


“The greater use of horizontal wells and the hydraulic fracturing technology has the potential to significantly expand natural gas and oil supplies, and hold down prices,” NGWA states in a new position paper. “However, concomitant with this enhanced production is the increased possibility for groundwater contamination and other impacts to drinking water supplies if best practices and proper procedures are not used, and if appropriate regulations are not in place.”

Hydraulic fracturing is a petroleum industry process in which fluids, commonly made up of water and a small percentage of chemical additives, are combined with sand and pumped at very high pressure into a geologic formation holding oil or gas. The resulting fractures allow the release of the oil or gas, which can be collected. NGWA recommends that policies be put in place and enforced, if they are not already, that promote:

- Disclosure of all chemicals used in the oil or gas well hydraulic fracturing process to the appropriate governmental entity,
- Proper construction and regular maintenance of oil or gas production wells to prevent the migration of natural and injected fluids that could endanger current or future drinking water sources,
- Best management practices or appropriate regulations to address surface spills and waste management related to hydraulic fracturing, and
- Development of water supply plans in areas where water is scarce or the potential for water use conflicts exist.

NGWA also says more study of potential impacts to groundwater used for drinking water supplies is warranted given the proliferation of horizontal wells and hydraulic fracturing.

“NGWA recognizes that hydraulic fracturing of oil and gas wells is a mature technology and has been a widespread practice for many decades. While no widespread water quality or quantity issues have been definitively documented...NGWA believes additional studies, research and monitoring related to the potential for groundwater contamination from the installation, hydraulic fracturing, operation, and maintenance of oil and gas wells are needed,” NGWA’s position paper states.

Other NGWA policy recommendations include:

- Proper construction and regular maintenance of water wells, including in areas of oil and gas well installation,
- Using certified laboratories to test water wells in proximity to oil or gas development prior to and after drilling and/or hydraulic fracturing,
- Development by state agencies of a recommended list of water testing parameters to assist household and public water system owners,
- Establishment of integrated groundwater monitoring programs using dedicated wells at the regional and local scale to establish baseline conditions.
- Monitoring, financial responsibility, and liability provisions related to oil and gas development that are cognizant of the actual travel-times observed in natural hydrologic systems.

“The need for increasing the nation’s energy supplies exists concurrently with the need to ensure adequate freshwater for drinking, food production, manufacturing, and ecosystem support,” NGWA concludes.


AIPG 50th Anniversary

AIPG National would like to receive your old photos for the upcoming 2013 TPG publications. Please email your photos with captions, if available to aipg@aipg.org

Help make the 50th Anniversary TPG publications a year to remember!

1975 AIPG Executive Committee
Unusual Volcanic Episode Rapidly Triggered Little Ice Age, Researchers Find

AGU Release No. 12-05-Washington, DC—New evidence from northern ice sheets suggests that volcanic eruptions triggered the multiperiod cool spell known as the Little Ice Age, and pinpoints the start of the climate shift to the final decades of the 13th century. Researchers have long known that the Little Ice Age began sometime after the Middle Ages and lasted into the late 19th century. But, estimates of its onset have ranged from the 13th to the 16th century.

According to the new study, the Little Ice Age began abruptly between 1275 and 1300 A.D., triggered by repeated, explosive volcanism and sustained by a self-perpetuating sea ice-ocean feedback in the North Atlantic Ocean. The primary evidence comes from radiocarbon dates from dead vegetation emerging from rapidly melting icecaps on Baffin Island, combined with ice and sediment core data from the poles and Iceland, and from sea-ice climate model simulations, said Gifford Miller, a geological sciences professor at the University of Colorado, Boulder (CU-Boulder), who led the study.

He and his colleagues will publish their findings on 31 January in Geophysical Research Letters, a publication of the American Geophysical Union (AGU).

During the cool spell, advancing glaciers in mountain valleys in northern Europe destroyed towns. Famous paintings from the period depict people iceskating on the Thames River in London and canals in the Netherlands, places that were ice-free before and after the Little Ice Age. There is evidence also that the Little Ice Age affected places far from Europe, including South America and China.

While scientific estimates regarding the onset of the Little Ice Age extend from the 13th century to the 16th century, there has been little consensus, said Miller. “The dominant way scientists have defined the little Ice Age is by the expansion of big valley glaciers in the Alps and in Norway,” said Miller. “But the time in which European glaciers advanced far enough to demolish villages would have been long after the onset of the cold period,” said Miller, a Fellow at his university’s Institute of Arctic and Alpine Research.

Most scientists think the Little Ice Age was caused either by decreased summer solar radiation, erupting volcanoes that cooled the planet by ejecting shiny aerosol particles that reflected sunlight back into space, or a combination of both, said Miller.

The new study suggests that the onset of the little Ice Age was caused by an unusual, 50-year-long episode of four massive tropical volcanic eruptions. Climate models used in the new study showed that the persistence of cold summers following the eruptions is best explained by sea-ice ocean feedbacks originating in the North Atlantic Ocean.

“This is the first time anyone has clearly identified the specific onset of the cold times marking the start of the Little Ice Age,” said Miller. “We also have provided an understandable climate feedback system that explains how this cold period could be sustained for a long period of time. If the climate system is hit again and again by cold conditions over a relatively short period — in this case, from volcanic eruptions — there appears to be a cumulative cooling effect.”

The researchers who contributed to the study include scientists and students from CU-Boulder, the National Center for Atmospheric Research in Boulder, the University of Iceland in Reykjavik, the University of California Irvine and the University of Edinburgh in Scotland. The study was funded in part by the National Science Foundation and the Icelandic Science Foundation.

As part of the study, Miller and his colleagues radiocarbon-dated roughly 150 samples of dead plant material with roots intact collected from beneath receding ice margins of ice caps on Baffin Island in the Canadian Arctic. There was a large cluster of “kill dates” between 1275 and 1300 A.D., indicating the plants had been frozen and engulfed by ice during a relatively sudden event.

Both low-lying and higher altitude plants all died at roughly the same time, indicating the onset of the Little Ice Age on Baffin Island — the fifth largest island in the world — was abrupt. A more gradual start of the Ice Age would have affected the upper-altitude vegetation first, since it would have been colder to start with at those elevations. The team saw a second spike in plant kill dates at about 1450 A.D., indicating the quick onset of a second major cooling event.

To broaden the study, the team analyzed sediment cores from a glacial lake linked to the 367-square-mile Langjökull ice cap in the central highlands of Iceland that reaches nearly a mile high. The annual layers in the cores — which can be reliably dated by using volcanic deposits, called tephra, from known historic eruptions on Iceland going back more than 1,000 years — suddenly became thicker in the late 13th century and again in the 15th century due to increased erosion caused by the expansion of the ice cap as the climate cooled, he said.

“That showed us the signal we got from Baffin Island was not just a local signal, it was a North Atlantic signal,” said Miller. “This gave us a great deal more confidence that there was a major perturbation to the Northern Hemisphere climate near the end of the 13th century.” Average summer temperatures in the Northern Hemisphere did not return to those of the warmer medieval times until the 20th century, he said.

The team used NCAR’s Community Climate System model to test the effects of volcanic cooling on Arctic sea ice extent and mass. The model, which simulated various sea ice conditions from about 1150-1700 A.D., showed several large, closely spaced eruptions could have cooled the Northern Hemisphere enough to trigger Arctic sea-ice growth.

The simulations showed sustained cooling from volcanoes would have sent some of the expanding Arctic sea ice down along the eastern coast of Greenland until it eventually melted in the North Atlantic. Since sea ice contains almost no salt, when it melted the surface water became less dense, preventing it from mixing with deeper North Atlantic water. Without mixing taking place, the water that flowed back to the Arctic was colder, helping sustain large areas of sea ice and creating a self-sustaining feedback loop long after the effects of the volcanic aerosols subsided, he said.

The researchers set the solar radiation at a constant level in the simulations, and Miller said the Little Ice Age likely would have occurred without decreased solar radiation at the time. “Estimates of the sun’s variability over time are getting smaller; it’s now thought by some scientists to have varied little more in the last millennium than during a standard 11-year solar cycle,” he said.
An anniversary is the time to commemorate or celebrate past events. Next year is the 50th anniversary of AIPG and is an excellent time to get involved in celebrating this special event.

Before 1962, many geological organizations promoted the science of geology, but some geologists at the time were concerned that there was a need to focus on geology as a profession. A steering committee was established in 1963, a founding convention was held, and AIPG was born (see Proctor, 2004 for details). Many of the founding members were members of AAPG (American Association of Petroleum Geologists) and prominent geologists of the day.

There are many ways for members today to participate and now is the time to get started. You can write histories of your AIPG sections. This is a great time for members, especially the founding members, to write short notes of why AIPG was founded and discuss some of the issues of the times. If you have photographs of past AIPG events, we would like to incorporate them in special issues of TPG next year. An update history from 2003 to the present needs to be written, bring Proctor’s (2004) history up to date. And don’t forget our annual meeting in 2013, which will be held in the Foothills of the Rocky Mountains, Colorado.

Some themes I hope we can publish in TPG next year include: How have geologists changed over the past 50 years? What does a geologist do? How have students changed? What were some of the geological issues of the past and how were they resolved or are they still pressing? What are the future issues? How can the profession of geology meet these issues? I am sure members can come up with more ideas!!!

So put on your thinking caps, get out your pens, and start writing and submitting ideas, photographs, and articles. Let’s make 2013 a year to remember and celebrate our anniversary in style! Our first issue will be the Student Issue in January.

1. Which of the following sedimentary rocks is detrital in nature, typically indicative of erosion of a granitic terrain and generally found in relatively close proximity to the source of its mineral components?
   a. Arkose.
   b. Quartz arenite.
   c. Coquina.

2. Of the following formulae, which indicates the chemical weathering of a “ferromagnesian silicate mineral” and oxidation yielding “magnetite”?
   a. \( \text{CaCO}_3 + \text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{Ca}^{2+} + 2\text{HCO}_3^- \)
   b. \( 3\text{Fe}^{2+}\text{SiO}_3 + \frac{1}{2}\text{O}_2 \rightarrow \text{Fe}_3\text{O}_4 + 3\text{SiO}_2 \)
   c. \( 2\text{KAlSi}_3\text{O}_8 + 2\text{H}^+ + 2\text{HCO}_3^- + \text{H}_2\text{O} \rightarrow \text{Al}_2\text{Si}_2\text{O}_5(\text{OH})_4 + 2\text{K}^+ + 2\text{HCO}_3^- + 4\text{SiO}_2 \)

3. In our efforts to globally correlate strata from different outcrops, we encounter fossil fragment of “Desmatosuchus”. Of the following choices, what other possible time-contemporaneous fossil might we expect in the rock sequence and where are we within the stratigraphic geological time scale?
   a. “Gallimimus” of Cretaceous age.
   d. Are you kidding me?

4. In our study of planetary geology, we wish to find the force “\( F_m \)” needed to keep the Moon orbiting about the Earth. Given that:
   • It takes 28 days for the Moon to make a full loop around the Earth.
   • The average distance between the Earth and the Moon is 3.85 * 10^8 meters.
   • The Moon’s mass “\( M_m \)” is 7.35 * 10^{22} kilograms.
   • Angular speed “\( \omega \)” is “\( \omega = \frac{d\theta}{dt} \)”, where \( \theta \) is angular displacement and “\( t \)” is time.
   • Centripetal acceleration “\( A_c \)” is “\( A_c = \omega^2 R \)”.  

Find force “\( F_m \)” (in newtons or “N” where 1N = 1 kg m/sec^2):
   a. \( F_m = 6.34 \times 10^{18} \) N.
   b. \( F_m = 3.21 \times 10^{19} \) N.
   c. \( F_m = 1.91 \times 10^{20} \) N.
   d. HELP!!!!!!!!!

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Communicating What Geologists Do

Barbara H. Murphy, CPG-06203
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As part of my responsibilities for AIPG, I recently participated in the organizing of and attended the 4th International Professional Geology Conference (4IPGC) in Vancouver, BC, Canada. The theme of the conference was Earth Science – Global Practice. The 4IPGC was organized by Geoscientists Canada, with AIPG, the Australian Institute of Geoscientists (AIG), and the European Federation of Geologists (EFG) as co-conveners. The 4IPGC organizing committee included members from around the world, using e-mail and web-based conferencing meetings to conduct much of the conference planning. The setting of conference calls certainly required a good knowledge of international time zones. The 4IPGC brought together practicing professional geologists and those involved in the operation of professional and regulatory bodies that govern the practice of geoscientists from across the world. Geoscientists from 17 countries participated in the 4IPGC, which was held in conjunction with the Association for Mineral Exploration of British Columbia’s annual Mineral Exploration “Round-Up”. Between these conferences, there were more than 7000 geoscientists in Vancouver for several days. I enjoyed bumping into old geology friends and contractors, as well as personally meeting other geologists with whom I had only met over the phone or internet. It was truly an example of how global the practice of geology is, and, in some ways, what a small community the geosciences profession is.

From the 4IPGC theme sessions, one of the common messages was that geoscientists still need to work on communicating what geoscientists do and the importance of what they do and how they do it, to the public, to government officials, to young professionals, and to students of all ages. What geologists do is generally not well understood. The public does not have an appreciation of the contributions of geoscientists and geosciences to society. The reasons may be that geoscientists are not good at self-promotion and with the diversity and overlap of the practice of geology with other more visible professions, such as engineering, the geoscientist may have to concede some aspects of practice by public perception or by professional regulation.

Social perceptions of some of the recent natural and man-made “disasters” and catastrophic events varies widely, because of how it occurred, the emergency preparedness and response, the risk of reoccurrence, possibly assignment of blame, because of how it is communicated by a global media. News reports from around the world seem to appear on the internet and television within moments of occurrence. We are all keenly aware that most of the reporting seems to be more entertainment based than delving into the actual facts or scientific theories. How often have you seen a geologist interviewed for technical or professional information instead of a bystander’s account or reporter’s quick assessment? Often this type of news story clearly illustrates the need for geologists to promote the profession so the public is aware of the importance of what we do. Maybe then the media will seek out a professional geologist to be an integral part of the report.

What needs to be conveyed to the public is that, as professionals, all geoscientists have a responsibility to safeguard the public, and to protect human health and the natural environment. Although there are differences in cultural and legal approaches to how the profession self-governs around the world, the key is to develop better communication and understanding of the professional practice, geoscience education, and work requirements in various countries, by various licensing and credentialing organizations, and to develop common standards of practice. Encouraging universities worldwide to require a rigorous geoscience program with requirements for other complementary sciences, math, computer, and language communication skills is essential. This promotes a common high standard and respect for the profession on a global basis.

The ways in which potential hazards are identified, risks are assessed, and the effects mitigated, the value of earth materials (and water resources) and processes and principles of sustainable development to meet the needs of society, as well as the way they are communicated to the public and policy makers is a very important role for the profession. Developing the skills and competencies that professional geologists require to undertake their work in a safe and professional manner is also important.

Communicating what geologists do is vitally important to the image and understanding of the geosciences profession. Increasing public awareness of the importance and diversity of the geosciences profession is one issue. We also need to encourage students to study geology, enter the profession, seek professional development and competency, and have career satisfaction. We need to encourage senior members of the profession to mentor the younger professionals, share knowledge and insight, learn new technologies, and work together for a stronger geosciences profession.

Part of what AIPG does and encourages its members to do, is to be an advocate for the profession of geology by “communicating” in a variety of ways. The seminars offered by AIPG and the new webinar series with the American Geosciences Institute (AGI) are offered.
to present topical and technical information to geoscientists, other scientists, policy makers, regulators, educators, students, and the general public. AIPG Sections offer field trips, professional talks and other programs for AIPG members and guests, members meet with students in the classroom and at career events, participate in science fairs, and similar programs, all of which serve to strengthen the profession and exemplify a bit of what geologists do. I encourage all of our members to “communicate” by participating in AIPG section activities and AIPG programs, consider volunteering some time to share your professional story with students, mentor younger professionals, present a talk at a technical meeting, submit an article to TPG, or work with policy makers, regulators, and the general public. Please consider being involved to strengthen the geologic profession and to help in communicating what geologists do.

Shale-Gas Development and Water Issues Conference
Presented by AIPG/AGWT
March 22 - 23, 2012
Austin, TX

Keynote Speakers:
* Dr. Charles “Chip” Groat
  Associate Director, Energy Institute, Jackson School of Geosciences, University of Texas at Austin
* Dr. Scott Tinker
  Director, Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin

Cooperating Organizations:
* American Geosciences Institute (AGI)
* Association of Environmental and Engineering Geologists Texas Section (AEG)
* Bureau of Economic Geology
* Energy Institute, University of Texas at Austin
* International Association of Hydrogeologists Commission on Groundwater for Decision Makers (IAHAIH)
* Society of Independent Professional Earth Scientists Houston Chapter (SIPES)

Solutions to Energy Industry Water Needs for Shale-Gas Development & Operation and Long-Term Water Resources Sustainability

Go to www.aipg.org for more information and to register.
Answers:

1. The answer is choice “a” or “arkose”. “Arkose” is a clastic or detrital sedimentary rock known as relatively immature sandstone because of its high content of feldspar (greater than 25%). Mineral grains tend to be angular due to the lack of significant transport. “Arkose” sandstones are generally found in continental and near-shore marine environments. These rocks are deposited relatively close to their source. With time, feldspars undergo physical and chemical weathering typically yielding “clay minerals”.

“Quartz arenite” is a mature quartz-rich (90% or greater) sandstone. The rock tends to contain rounded grains indicating significant transport and reworking. These deposits are found in beach, eolian and upper-shoreface environments.

“Coquina” is a soft and often porous limestone composed essentially of cemented shell fragments. “Coquina” forms near shore where wave action is strong and shell fragments become sorted. Well-cemented “coquina” is termed “coquinite”.

2. The answer is choice “b” or $[3\text{Fe}^2\text{SiO}_3 + \frac{1}{2}\text{O}_2 \rightarrow \text{Fe}_3\text{O}_4 + 3\text{SiO}_2]$. In the equation, “pyroxene” is oxidized and magnetite [$\text{Fe}_3\text{O}_4$] developed.

Choice “a” illustrates the chemical weathering and dissolution of “calcite” [$\text{CaCO}_3$].

Choice “c” illustrates the chemical weathering of “orthoclase” [$\text{KAlSi}_3\text{O}_8$] yielding clay minerals, soluble ions and silica.

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

“Desmatosuchus” was a Late Triassic herbivorous armored reptile with sharp spines running across its body. Similar to a crocodile with spines, the animal had a beak-like snout and peg-shaped teeth. This reptile measured about 16 feet in length. It had four short legs, a long tail and bony armor on its back. In turn, “Coelophysis” was a small carnivorous theropod dinosaur of Late Triassic and early Jurassic age. It could measure over 25 feet in length. The animal was ostrich-like with a small head and a toothless beak. It had long legs and a long tail with short arms. Its diet would have included plants, insects and meat.

“Dimetrodon” represents an older fossil, as it lived in the Late Paleozoic Era predating the Triassic Period of the Mesozoic Era. “Dimetrodon” was a carnivorous, mammal-like Permian reptile with a large sail-like flap of skin on its back. The sail was supported by long spines growing out from separate spinal vertebrae. Measuring about 11 feet in length, the animal had clawed feet and sharp teeth.

4. The answer is choice “c” or “$F_m = 1.91 \times 10^{20}$ N”. The proof follows:

Angular speed “$w$” is:

$$w = \frac{d\theta}{dt} \quad \text{(eq. 1)}$$

For our Moon:

$$w = \frac{2\pi}{28 \text{ days}} \quad \text{(eq. 2)}$$

$$w = \frac{2(3.1416)}{2.42 \times 10^6 \text{ sec}} \quad \text{(eq. 3)}$$

Now, centripetal acceleration is:

$$a_c = w^2R \quad \text{(eq. 4)}$$

For our Moon:

$$a_c = (2.6 \times 10^{-6} \text{ rad/sec})^2 \times (3.85 \times 10^8 \text{ meters}) \quad \text{(eq. 5)}$$

$$a_c = 2.6 \times 10^{-3} \text{ m/sec}^2 \quad \text{(eq. 6)}$$

From Newton’s second law of motion:

$$F = ma \quad \text{(eq. 7)}$$

In our case:

$$F_m = (Mm)(a_c) \quad \text{(eq. 8)}$$

$$F_m = (7.35 \times 10^{22} \text{ kg}) \times (2.6 \times 10^{-3} \text{ m/sec}^2) \quad \text{(eq. 9)}$$

$$F_m = 1.91 \times 10^{20} \text{ N}$$

Equation 9 above is our answer corresponding to choice “c” in our question.
The national executive committee held its first board meeting of 2012 on February 10th. Among the topics reported on was the continuing education program partnership with AGI to produce webinars on a regular basis and on a broad range of topical subjects.

As of the February 10th meeting, two webinars had been produced (one addressing the national energy situation and the other an introduction to strategic minerals and rare earth elements in relationship to national interest). The report was given and a discussion ensued regarding future topics and presenters.

The board and its guests energetically responded to recommend more topics, presenters, and ideas. As they engaged in this exercise, it occurred to me that AIPG is truly an organization of applied geoscientists, providing practical expertise in mineral resource development, energy extraction, water supply and protection, construction, remediation, and a host of other critical disciplines.

A perusal of the application for Certified Professional Geologist contains a list of specialty fields of practice. The list includes 54 specialty fields and represents the vast majority of AIPG membership.

AIPG was not founded as a technical or learned society, but rather as a professional organization. However, AIPG members since establishment have been applied geologists. This critical fact is a major reason for AIPG’s vibrancy and constructive impact upon affairs affecting the national economy and public health.

This is patently obvious though the success of AIPG members’ efforts at the section level and at the national level. The ability of AIPG to be thusly successfully engaged is due to the practical insight into so many areas of geologic practice.

I have been privileged to observe the commendable efforts of many AIPG sections as well as sister societies to explain to legislators, non-technical educators, civic groups, and the public at-large the type of work performed by geoscientists in support of public welfare. The ability of AIPG members to give insight into their work and the work of colleagues is based upon their real world experiences in the applied world.

A further aspect of AIPG members’ spectrum of disciplines is in the international recognition of the AIPG credential, Certified Professional Geologist. In addition to other recognitions (found on the AIPG website www.aipg.org), the AIPG credential is recognized through Canadian National Instrument 43-101 and Canadian National Instrument 51-101. Both national instruments recognize AIPG CPGs as Qualified Persons (QP) for purposes of reporting on mineral deposit valuation and oil and gas disclosure reports respectively.

Canadian National Instrument 43-101
Notice to Members and Colleagues: Please be advised that AIPG Certified Professional Geologists, with appropriate experience, are recognized as Qualified Persons for purposes of submitting economic valuations of ore deposits acceptable on the various Canadian stock exchanges.

Additional information is found on the AIPG website, http://www.aipg.org/About/Cooperation.html.
Oral But Not Written Disclosure to a Client about a Potential Problem (Column 127, May–June ‘10)

John Ward, CPG-6729, wrote, “We talked about this issue a while back. I had promised myself that I would complete this before New Years. (I didn’t slip too badly.) It took a while to get responses to my queries, and even longer for me to mull them over to decide whether there was anything new worth writing about. However, this is my take on the issue of the professional engineer (PE) who neglected to include in his report an opinion made by one of his employees about a threatened bird species on an adjacent wetland. I hope you enjoy it.

From your TPG column (127):

In the January 2010 issue of the Professional Engineer, which discusses the case of a PE, who was hired to evaluate a piece of property for its condominium development potential. A biologist was part of the PE’s evaluation team and noted the presence of a “threatened” but not “endangered” species of bird that lived in a wetland adjacent to the property being evaluated. The biologist believed that the proposed development would adversely impact the bird species. The PE orally informed the developer of the biologist’s opinion, but did not include it in his written report on the property, which was to be filed with a public agency. (NSPE) concluded that the PE’s action violated several parts of the NSPE’s Code of Ethics including the provisions to avoid deceptive statements, to include all relevant and pertinent information in reports, and to adhere to the principles of sustainable development in order to protect the environment for future generations.

“Your opinion was that the PE was at fault for his act of omission, and gave two justifications (emphasis mine):

One ... because the biologist was apparently professionally qualified, the information the PE received about the threatened bird species became part of his professionally obtained information that was relevant and pertinent to the property being evaluated and which should have been disclosed in the written report.

Two ... employer/client confidentiality is subsidiary to the protection of the public health, safety, and welfare provisions of the AIPG Code of Ethics, Canon 2 and Rule 2.1.3. ...

“Yes, we didn’t get any letters about that case, which might include questioning their judgment, after they had public officials responsible for the enforcement of such law or regulation.” Pursuant to Rule 2.1.3, an AIPG member involved in a similar property evaluation is required to include the observations and conclusions regarding the threatened bird species in the written report to the client,...

Initially, I had a big problem with how this case was decided, as I might have described to you earlier. Part of my problem has to do with having a couple of similar previous professional experiences, one of which brought out how political leanings trumped professional responsibility on the part of a colleague (also a biologist). I am most definitely biased. Specifically to this case, my objections to how it was decided were: first, the biologist’s observation did not rise to the level of ‘professionally obtained information’ and as such, was non-professional opinion and just plain gratuitous. It would have been professionally irresponsible and perhaps unethical for the PE to include such in his report. Second, the PE never violated any law or regulation; indeed, laws and regulations were not even mentioned.

“However, I wanted to explore the matter further. You sent me a faxed copy of the PE magazine page containing the column, titled ‘You Be the Judge’; the second heading is titled ‘What do You Think?’: Obviously, the columnist wanted to provoke thought and promote further discussion with letters to the editor, so I wanted to find out whether there had been any such follow-up letters and began looking for issues of PE Magazine. Not succeeding, I finally called NSPE, who requested that I directly contact the editor (Dave Siegel). In reply to my query, Mr. Siegel wrote:

“No, we didn’t get any letters about that particular case study. If you’d like to share your thoughts on this case, however, feel free to e-mail them to Arthur Schwartz. Art works with the Board of Ethical Review (BER) on these cases, and I know he’s interested in hearing feedback about BER opinions.

“That’s interesting: the columnist (Schwartz) also works with the BER. Did they really want feedback on a case, which might include questioning their judgment, after they had public officials excoriated a fellow member? Only slightly daunted, I took Mr. Siegel up on
his offer and sent the following email to Art Schwartz:

“On Dave Siegal’s recommendation, I am writing you concerning the case of Mr. Skip-a-fact, PE, (‘Bird Watching’, Jan/Feb 2010 issue of PE). ... The following points are my take on this.

1. The biologist, presumably verbally, transmitted his concern to the PE that a) it was a fact that OR he thought that there was a threatened bird species on an adjacent property, and b) the proposed development would adversely impact this bird species. The PE’s firm did not investigate the adjacent property, did not determine what a ‘threat’ consisted of, nor was the PE in any position to offer professional opinion on the matter because there was no analysis of the wetlands. In the PE’s opinion, the biologist’s statement may not have been ‘relevant and pertinent,’ nor ‘objective and truthful.’

2. Similarly, the biologist presumably had not studied the adjacent property, and was only offering a gratuitous opinion as to a threat, unsupported by quantitative data. The biologist may have considered his opinion to be professional, but there was nothing presented to indicate that the biologist conducted an analysis of potential threat to the bird species.

3. If the PE had included the biologist’s statement in his report to the owner, the PE could be rightly criticized for a) including a gratuitous statement not backed up by measurements or known facts; b) including a professional opinion about a property that was not investigated; c) a possibly litigious statement if the owners lawyers chose to contest the quality (or non-existence of) the analysis.

4. A registered professional must keep within his areas of expertise when giving his professional opinion. As principle of a multi-disciplinary firm, the PE must seal professional work done by others under his direction. A biologist working under him would presumably be non-registered. This can create a professional dilemma for the PE who has to supervise and review the methods and quality of the work. (In this case, however, there may not have been any work to supervise.)

5. Both choices open to the PE (either including it, or not, in the report) could create professional, ethical, or legal problems. Thus, verbally mentioning the biologist’s concerns to the owner might have been seen as a preferable middle ground. Although I think it should be incumbent on him to take positive steps to remove the dilemma facing him, perhaps poor judgment was the only thing he was guilty of.

“Mr. Schwartz replied to my email shortly afterward: ‘Thank you for your e-mail and comments. You have raised some interesting issues in connection with the subject case and I will share your comments with the NSPE Board of Ethical Review for their review and consideration.’

“Note that I did not ask BER to reopen the case, or to accept my opinion in refutation of their judgment; I was only sharing my thoughts,’ as Mr. Schwartz requested. I didn’t think I was going to hear from this group again; however, about 7 months later (June 2011) I received an email from Mr. Schwartz, which contained the responses from three BER members:

Board member 1: Well, I can’t resist commenting. Although the facts of the case don’t state exactly what was the scope of the ‘analysis’ which PE Fact’s firm was undertaking, the facts that (1) the property was adjacent to a known wetland and (2) that the firm had retained a biologist for the project, indicates that the work included the preparation of an Environmental Assessment. An EA must take into account the potential impacts of a development on adjacent lands and waterways. If indeed the biologist felt that the condominium development could threaten a bird species in the wetlands, it follows that the development was thought to have physical impacts on the wetlands habitat itself. It does not occur to me that the biologist’s opinion was necessarily gratuitous rather an observation that would certainly need to be taken into account by the public authority charged with reviewing the project proposal. It would therefore be incumbent on Fact to include this information in the EA... or risk being challenged publicly by the local Audubon and Sierra Club chapters who had likely completed their own extensive analysis of the impact of the proposed development on the birds’ wetland habitat months or even years earlier. Again the facts of the case don’t speak directly to such a scenario, but I think it reasonable a development adjacent to a wetland would undergo intense scrutiny. Mr. Ward raises some interesting arguments but I still think the original opinion in the case is sound.

Board member 2: I would agree the original option is the one to follow.

Board member 3: Good comments - I also agree with you and Bob...

“Other than thanking them, I did not follow up with more correspondence.

“The speculative wanderings of Member 1 are not very persuasive. I think it is a bit strange that this member went to some length to carry the argument that the PE had ‘retained the biologist for the project,’ which in turn indicated that the PE had conducted an EA. It is not only speculative, but his tortured reasoning appears to contradict the employment information provided in their own magazine article. Nor is the article clear on what type of investigation they were to conduct, notwithstanding Member 1’s speculation they did an EA with all the obligations that supposedly entails. If Member 1 is correct that the biologist was contracted to work on this EA, then the biologist neglected to include his analysis of the threats to the wetlands in his report, and the biologist’s later verbal statement on the same subject to the PE seems to be disingenuous.

“Further, Member 1’s speculation that the Sierra Club and Audubon Society have already completed analysis of the project’s impact on the wetlands months or even years earlier completely undercuts their case that the public authority in charge of approving the development wouldn’t otherwise be fully cognizant of this issue independent of the PE’s report.

“Member 1’s admission that the facts may not even agree with the scenario he invents, leaves me wondering whether this case is real or is an amalgamation of various ethical questions brought up to the BER.

“Finally, the issue of violating ‘principles of sustainable development’ deserves a few words. When a professional organization sets lofty (enlightened) ethical goals, they thereby set themselves up to a plethora of interpretations, legal exposure to their membership, and inevitably, to failure. It is also extremely disparaging to their own profession (engineers) who, more than most any other profession in human history, have raised our living standards while improving and sustaining our environment.

“My take on this is: ‘principles of sustainable development’ is a fallacy of argument by prestigious jargon, or more pointedly, environmental vigilantism. Practically, a third party can use this principal to attack any proposed construction project by claiming the PE
Just because a scope of work relates to political leanings trumping pro-Ward's much deeper review of the case matter, and his sending me the results. 127, his taking the time to inquire into the topic presented in column critical of a third party (NSPE)." as they could be interpreted as being suitable for discussion in a column, I don't think that my musings on the NSPE case are well-written (something many engineers have difficulty doing), but respect your fellow professionals.

The next issue involves scope of work. Just because a scope of work relates to a specified tract does not mean that vertical blinders exist at the tract's boundaries; geology does not know about nor respects human boundary lines, nor do birds or other wild animals and plants. The conditions on neighboring properties can and do affect what can be done on the property in question. Canadian National Instrument 43-101 reports require a discussion of adjacent properties if some characteristic of the adjacent property is going to affect the property reported on. If the toe of an obvious landslide approaches the property being studied, some questions about this landslide should be addressed—is the slide going to advance onto the property in question? Proposing to site a coal-fired power plant adjacent to a national park is going to create problems. A development adjacent to a wetland is most likely going to be perceived as impacting the wetland, regardless of the realities and the developer should know about all the objections that will be raised. We don't know the details supporting the biologist's opinion about a threatened species. In particular, we don't know whether the biologist's opinion about the threatened bird species was written and whether any previous studies of the bird's environment in the area had been made and were available to the biologist and others. But even a small amount of support for that conclusion should warrant a recommendation for further study.

In summary, while I very much appreciate Ward's inquiry into this issue, I stand by my original conclusions. Just because the wetland was on adjacent property does not mean that the proposed development will not have a potential impact on the wetland. Whether and how much impact the proposed development would have and potential impact mitigation should be addressed in the report, as recommendations for further work if nothing else. The written report should contain the biologist's legitimate observations, conclusions, and recommendations because the biologist was deemed a necessary member of the team for the scope of work. The NSPE reached the correct decision.

The consequences of living with geology: A model field trip for the general public

In the fall of 2002, David Noe of the Colorado Geological Survey and I put together a field trip for that fall's GSA annual meeting, "The consequences of living with geology: A model field trip for the general public," which was published in GSA Field Guides, 2002, http://fieldguides.gsapubs.org/content/3/1.full.pdf+html. The introductory paragraph to this field trip is, "This is a model for the type of field trip that we, as geologists, ought to be running far more frequently in each of our communities for the general public, religious groups, service clubs, politicians, school groups, etc. The geology of any particular area imposes constraints on what humans can do. These constraints are generally thought of as geologic hazards, but access to the natural resources we all use, from sand and gravel pits to water resources to oil and gas wells to large open-pit mines, may be local issues as well. Landfills and other waste-disposal sites also have both geologic and public-policy consequences."

I recently discovered that this field trip continues to be among the most downloaded articles from GSA's Field Guides, ranking #4 in December 2011. For a 10-year-old publication, Dave Noe and I are surprised and, I'll admit, pleased that this field trip continues to be of interest. I'd like to learn more about why this is so. I hope it is because others using this trip as a guide to preparing similar trips in their local areas. Please let me know if you are among those who've downloaded this field trip.

I also should point out that this field trip is out-of-date due to various changes that have occurred in the last 10 years. I've updated variations on this trip for various groups, the most recent update being in 2010, in case people are interested in following the trip as they come through the Denver area. Let me know if you'd like an updated version.
Dear President,

It was an unexpected and pleasant surprise the other day to receive the certificate and pin recognizing my 25 years as an AIPG member. I value my AIPG membership and CPG as much today as when I first applied back in 1986 (you will laugh, but I still have a copy of my application papers in my AIPG file). Back then there were very few state PGs, and having my CPG earned me the recognition similar to that of the PEs of the time, and it certainly helped me advance in my career.

Thank you for the support that AIPG has provided to the Geology profession over the past 48+ years. And thank you again for the recognition of my time as a member.

Sincerely,

Donald K. Cohen, CPG-07179

Dear President,

Please accept on behalf of AIPG my sincere appreciation for the 25-year service recognition. I will wear the wonderful lapel pin and display the certificate with pride.

Thank you very much and I look forward to seeing you in the fall—if not sooner.

Sincerely,

Larry Weber, CPG-07120

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Geologic Ethics & Professional Practices is now available on CD

This CD is a collection of articles, columns, letters to the editor, and other material addressing professional ethics and general issues of professional geologic practice that were printed in The Professional Geologist. It includes an electronic version of the now out-of-print Geologic Ethics and Professional Practices 1987-1997, AIPG Reprint Series #1. The intent of this CD is to collect this material in a single place so that the issues and questions raised by the material may be more conveniently studied. The intended ‘students’ of this CD include everyone interested in the topic, from the new student of geology to professors emeritus, working geologists, retired geologists, and those interested in the geologic profession.

AIPG members will be able to update their copy of this CD by regularly downloading the pe&p index.xls file from the www.aipg.org under “Ethics” and by downloading the electronic version of The Professional Geologist from the members only area of the AIPG website. The cost of the CD is $25 for members, $35 for non-members, $15 for student members and $18 for non-member students, plus shipping and handling. To order go to www.aipg.org.
What Are You Really Measuring?

William J. Stone, MEM-2164

Moisture content of soil or sediment is often a parameter of interest in hydrologic studies. The standard method for measuring moisture content involves weighing evaporation-protected samples as they come from the field (wet), drying them in an oven at 105°C overnight, and then reweighing them dry. The weight loss is attributed to soil-moisture content (interestingly, water content is reported as a percent of the dry weight).

I was at the Army’s Atmospheric Sciences Lab at White Sands Missile Range when weather satellites were just coming into use. The lab was involved in collecting various kinds of ground-truth data for calibrating the satellite instruments. One such parameter was soil-moisture content at various target areas near the missile range.

I noticed that unusually high moisture values were being reported for some samples, despite the arid setting. Why would soil moisture be locally elevated? Upon investigating I discovered the anomalous moisture contents were always associated with samples of the white sand itself.

Now this dune sand is unusual in that it consists of small cleavage fragments of gypsum, rather than the more usual grains of quartz. The grains are derived from the breakdown of selenite gypsum crystals that form with the evaporation of water in a playa west of the dune field. Gypsum has the chemical formula, CaSO₄ + 2H₂O. That’s anhydrite with water loosely attached.

I learned that all samples, including those of the white sand, had been analyzed by the standard oven-drying method. In the case of the white sand, that had not only driven off the soil moisture between grains but the chemical water in the grains themselves! The lab technicians who were making these measurements apparently never considered the material involved.

Interestingly, the process of baking the gypsum created a new material, so I gave a sample to the state mineralogist to analyze, without any particulars as to its origin. When he reported his findings he was very excited since it was a mineral (the name escapes me) which had not been previously reported in New Mexico. When I told him the source and that it really only occurred in a lab at White Sands Missile Range, he was disappointed. Tip: Think about any measurement method you use and consider its impact on the results.

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

### 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.

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**AIPG Section Websites**

AIPG Section Website links are on the AIPG National Website at www.aipg.org. Click on the top right drop down menu and click on Section Websites. If your section does not have a website contact AIPG Headquarters to get one setup (wjd@aipg.org). AIPG Headquarters will maintain a website for your section. Several sections (AZ, CA, CO, FL, GA, HI, IL Chapter, MI, MO, NM, OK, PA, and TN) are examples of websites hosted by AIPG National.
The delicious smell of my dad’s jambalaya is wafting in from the kitchen as the sound of him doing dishes rests somewhere between John Hartford’s quirky singing and the low hum of the wood-stove blower. I’m sitting at a ~100 yr-old roll-top desk recently retrieved from the family farm in northern Indiana, having just watched another beautiful Kentucky sunset and caught up on “Byron Crawford’s Kentucky” columns, now gracing the last page of Kentucky Living where David Dick’s “The View from Plum Lick” used to be. It is that time of year again: home sweet home for the holidays and thus, as David Abbott, CPG-04570, just pointed out in an e-mail, end-of-the-year reflection time.

A lot has happened since I was home this time last year, trying not to stress out over the impending I.S. (Wooster’s senior thesis program) deadline while attempting to figure out what I wanted to do with my life post-undergrad. Graduation, field camp, grad school…by the time you’re reading this, I’ll have done the first part of my fieldwork for my Master’s Thesis (Central America, here I come!). This break is a little more relaxing (though I don’t know that it will be quite as relaxing.

Homecomings tend to always incorporate reflection. I had a different homecoming of sorts several weeks ago, when I had the honor of attending the Ohio Section’s Annual Banquet. As I met new people and reconnected with those I had met at the last banquet I attended and at the AIPG National Conference in September, I felt like I was among old friends. Tom Berg, CPG-08208, who greeted me at the airport with big hug, surprised me by making a poster of all the columns I had written so far—talk about reflection!! I laughed as I read that first column, written exactly two years ago now about the state of geoscience education and coal in Kentucky, both at the slightly presumptuous tone of it and at the fact that my words were still way too relevant (in today’s Courier: Duke Energy announced it is shutting down those coal-fired units). And I held back a tear or two when I read last winter break’s article about the passing of a couple great storytellers. The keynote talk, given by Dr. P. Patrick Leahy, CPG-10507, Executive Director of the American Geosciences Institute, on the future of jobs in the geosciences, switched my gears from reverse to 5th. However, and I found myself again ready to take to the warpath in promotion of geoscience education and policy.

The trip to Columbus for the banquet gave me the opportunity to take a long weekend and visit Wooster. Though I didn’t make it to all my old haunts (see “Spring Reflections”, Jul/Aug 2011), I did check up on that stream at the park a few blocks from campus and yes, it is still fighting the good fight. It is a little windier (ever so slightly) than the last time a run brought me to it and I noticed that my thinking rocks in the bend have moved a little downstream.

It was a weekend full of great conversations and good friends, putting the time I spent in Ohio in perspective. While I was usually unsure that I was doing what I really wanted to be doing, looking back I don’t think I could have spent that time better. This is quite comforting when I start questioning this whole grad school thing, because I realize that though I work hard and learn a lot, it’s the relationships I develop that really make my time worthwhile. Maintaining those relationships, inherently involving catching-up and reflecting, are what homecomings are all about.

Stephanie Jarvis, SA-1495, sjarvis@siu.edu
How much technology should you be using in the introductory geoscience course(s) you currently teach? Good question. There is a fair chance that your answer may depend on a number of variables: the specific course in question, class size or whether you have a laboratory section, your definition of technology, how comfortable you are using technology, and maybe even the amount of preparation time you have available. Technology may take on any number of meanings, but usually refers to using a tool or technique to solve a problem or complete a task; and today, more often than not, people hearing the word technology envision something related to computers. We may not all agree on what technology is or the amount of technology we should use in our classes, but we probably all agree that we should be incorporating some technology. The following discussion deals with the importance of including technology in our courses to promote authentic science practices, foster technological literacy, and motivate our students.

Actively doing science involves the collection and investigation of data, and because scientists typically use technology to both collect and analyze data, infusing technology into any class is critical to fostering our students’ scientific skills. For this reason, and perhaps a myriad of others, we encourage our students to practice technological skills through classroom assignments, laboratory investigations, and activities. Everything from using stereomicroscopes for sorting sand grains, to using a GPS for mapping the topography behind the science building, to using a GIS software package for evaluating the relationships between two or more layers of data, constitutes technology use. The more exposure to, and practice with, these so-called “tools of the trade,” the more prepared our students will be for the workforce; and, let us not forget that while our students may struggle through using a new technological tool or technique, they learn the value of problem-solving on their own (or collaboratively) and become more technologically literate.

Many of us resist new technologies. Some of us are overwhelmed because we cannot keep pace with the ever-changing nature of technology. And, a few of us have reached a plateau on the technology learning curve. Wherever our level of technological prowess (or lack thereof) one thing is certain: technology will continue to forge ahead, and so will our students.

Anyone who has taught a college class recently has likely experienced firsthand the typical student’s affinity for technology; and, if you haven’t noticed it, look harder! It is there: students using phones to text each other during class, checking and posting to Facebook in class, and accessing the Internet for in-class research. Some of this behavior may be considered negative, some only perceived as negative, and some of it is even acceptable and encouraged! The point is that students are becoming more motivated to use any and all forms of technology. Hence, we owe it to them to recognize that technology is not only a data collection and analysis tool, but is also a motivational tool.

I invite you to ask yourself “how much technology am I using” in my class and “is it enough?” If your respective answers are “very little” and/or “probably not,” then consider trying out and incorporating one new tech-related activity in your class this semester. If you are not as tech savvy as you think you ought to be, or even if you already include a great deal of technology in your current courses, consider perusing the Earth Exploration Toolbox (described below) for new ideas.

**Featured Resource**

TERC’s Earth Exploration Toolbook: [http://serc.carleton.edu/eet/index.html](http://serc.carleton.edu/eet/index.html)

This issue’s featured resource is the 2011 (September) Science Magazine’s Science Prize for Resources in Online Education (SPORE) award winner. A collaborative venture funded by the National Science Foundation, the Earth Exploration Toolbox (EET) is a collection of mostly earth science-related activities uniting science content and internet-available datasets with an analysis software tool – all neatly packaged specifically for educators. While most of the activities – called ‘chapters’ – are tailored toward middle and high school levels, some of the activities purposely include the undergraduate college level (e.g., Tsunami Run-Up Prediction for Seaside, Oregon), and essentially all of them are adaptable for introductory college science content courses.

The goal of the EET is to illustrate how to authentically explore data. The EET chapters accomplish this by encouraging the investigation of specific science topics or issues using freely accessible analysis tools and following a set of prescriptive step-by-step directions. Users are walked through everything from downloading the software and data files to the exploration of data via charts, spreadsheets, and visual renderings and layering. Each chapter features a case study, teaching notes, details about the tool(s) and data, and ideas for going further. Students and instructors alike may use the chapters to gain skills or learn more about unfamiliar software applications.

Chapter topics are diverse and examples include: earthquakes, El Niño events, melting glaciers, renewable energy, tectonic plate motion, seafloor topography, tsunamis, biodiversity of forests...
(related to biotic and abiotic factors), carbon storage in forests, and climate change, to name a few. Software such as Google Earth, Google Maps, ArcExplorer, ArcGIS, My World GIS, ImageJ, and spreadsheets (e.g., Microsoft Excel) are used to analyze a variety of data housed at online reservoirs from such agencies as NASA, NOAA, and the USGS.

I have used several of the chapters within my own undergraduate and graduate classes with success. For instance, I have used the Investigating the Precipitation-Streamflow Relationship activity in an introductory college geology course and the Exploring Air Quality in Aura NO2 Data activity in a graduate level meteorology course for teachers. Through using the EET I have learned about a neat little piece of software called GeoMapApp, that I use to quickly draw profile lines when illustrating topographic differences across the United States and the world (see the Exploring Seafloor Topography chapter in the EET). I highly recommend checking out the EET if you are interested in getting ideas for easily incorporating more technology and data analysis into your instruction in undergraduate introductory geoscience courses.
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In a recent paleontology class for which I am a teaching assistant at my university, a student from the psychology department came to take notes for her project on the interactions between students who have declared their major and their professors in their field of study. I didn’t know what she was doing at the time, but I would be curious to know what predictions she had for her behavioral analysis.

At the beginning of lab, she sat quietly to the side as our professor briefly explained the procedure and objectives: a simple lab on Porifera and Cnidaria where students would do detailed sketches of specimens from various families, name and label their morphology. Students sat at their desks in front of the fossils, some flipping through or following along in the lab hand out, others attentively watching the professor as he spoke. After he was finished, students started choosing their sample to draw and we turned on the classic rock station on the radio.

I'll sheepishly admit that much of the conversation that followed wasn’t about fossils at all. We chatted about issues on campus and listened to our professor tell a candid story of a trip he took intro students on the day before. Sometimes, we would even stop what we were doing entirely, either jaws hanging open from our surprise at some shocking campus news or because we were in stitches as a funny story unfolded.

I don’t remember now if the psychology student ever cracked a smile or interjected during our off topic discussions, but I bet it was tempting. I wonder if we came across as if we weren’t “serious” about our study, because of course, we weren’t being all that serious at the time. It reminds me of a time I remember well and not so fondly, of being sternly told by a much respected professor that he was “disappointed” and that I had, in fact, behaved unprofessionally by missing an important deadline. I also remember thinking in my stubborn way, “Well you know what? I’m not a professional just yet.” It was one of those times I wish I had taken things a little more seriously.

It truly is a fine line all students should learn to tow. The skills we learn in our interactions with colleagues and professors carry over to how we will interact in the future. Professionalism spans farther than merely not plagiarizing, arriving to meetings and class on time, and producing quality work. It is conducting yourself as an honorable person, both as a colleague and a student, simultaneously.

Of course, I don’t know exactly what she deduced in those few hours, but I’m sure the student observing noticed that the environment on this particular day was pretty casual to say the least. Though our behavior was not always formal, hopefully she realizes, too, that there is a line between informal and unprofessional. In her observation, she should have seen that when the banter subsided, someone would ask a question about something in the Treatise. We had one copy of each, and students would cluster to read over each other’s shoulders, reading out loud and helping explain to each other what our professor or I had told them earlier, bouncing around ideas between one another. It was so nice to be a part of students practicing an important aspect of the science: sharing information; and not just randomly sharing information, but specifically in a way that benefits all of us.

We sometimes forget how equally important it is to act as a professional student. As an undergraduate, I like many have been disillusioned to think that I will be a true “professional” geologist when I finally know it all, which of course, as all undergrads know, comes with your PhD. A truly good professional scientist knows that in teaching we learn more about our own work and that there is always something to learn, even from the most unlikely source. We don’t become professionals when we graduate because we never stop being students; we become professionals when we choose to behave as such.

I don’t know if I’ll ever get to see the results of the observing student’s notes, but I suppose I did learn something about student behavior that day: we can be professional geologists, even, or maybe especially, without taking ourselves too seriously.

Krystyna Kornecki is a senior at St. Lawrence University, Canton, NY, majoring in Geology with a minor in Outdoor Studies. She plans to attend graduate school for Paleontology in the fall.
Earth Science Week 2012 Theme Announced: Discovering Careers in the Earth Sciences

Alexandria, VA—The American Geosciences Institute (AGI) is pleased to announce that the theme of Earth Science Week 2012 will be “Discovering Careers in the Earth Sciences.” This year’s event will boost awareness about the geosciences and the many exciting career and job opportunities in the field.

Earth Science Week 2012 materials and activities will engage young people and others in learning how geoscientists gather and interpret data about the Earth and other planets. Through careers in geology, geophysics, oceanography, hydrology, paleontology, Earth science education, and many other fields, they enhance our understanding of Earth processes and improve the quality of human life.

“With this year’s focus on jobs, Earth Science Week provides a great chance for teachers and guidance counselors to spread the word to students and parents about geoscience careers,” says Ann Benbow, AGI’s Director of Education and Outreach. “With over 150,000 positions expected to open in the next decade, opportunities for building an exciting and meaningful career in the geosciences have never been better, even in this tough economy,” says Christopher M. Keane, head of AGI’s Geoscience Workforce Program.

AGI leads Earth Science Week annually in cooperation with its sponsors and the geoscience community as a service to the public. Each year, community groups, educators, and interested citizens organize celebratory events.

Earth Science Week offers the public opportunities to discover the Earth sciences and engage in responsible stewardship of the Earth. Earth Science Week is supported by the U.S. Geological Survey, the AAPG Foundation, NASA, the National Park Service, ExxonMobil, and Esri.

Earth Science Week 2012 will be celebrated October 14-20. For more about this week and ways to get involved—including newsletters, local events, and classroom activities—please see the Earth Science Week web site at http://www.earthsciweek.org/.

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The Importance of Geologic Information Required for Trenchless Technology-The Role and Responsibilities of the Engineering Geologist

George H. Davis, R.G., CPG-10951, Geologist
Missouri Department of Transportation, Jefferson City, Missouri

Abstract

Trenchless technology denotes the equipment, supplies, and methods used for the installation, replacement, or renewal of subsurface pipe without the primary use of a trench. Trenchless technology minimizes surface disturbance associated with utility installations. The use of trenchless methods of utility installation, replacement or renewal decreases installation costs in the long term. Methods of pipe installation, pipe replacement, pipeline renewal and pipeline inspection have been greatly improved in the last ten years. This allows trenchless methods of pipe installation, such as horizontal directional drilling (HDD), to be competitive with open-cut installation. It should be emphasized that the use of trenchless technology drastically reduces or eliminates the possibility of trench accidents that annually cause injury and deaths in the United States.

Importance of Geologic Data to Trenchless Design and Installation

Most geologists are unfamiliar with these methods, the technology used, and the need for geologic input in the design process that precedes new installations. One method of trenchless utility upgrade, pipe bursting, requires geologic information for an upgrade to be successful. If pipe bursting is attempted where the original installation is made in a rock trench, the pipe burst may be impossible, or pressures may cause surface heaving. Geologic information may also be required for pipe relining if a structural pipe liner is used. The overlying weight of the soil on the utility product pipe should be known so that a pipe liner may be chosen of sufficient strength to perform the upgrade. Knowledge of soil conditions may also affect manhole renewal, and is essential for upgrade by pipe reaming.

The importance of geologic and soils map relationships used to plan a proposed utility installation’s alignment cannot be understated. Normally, three parameters are considered in advance of an installation: the depth of the crossing to be made, the length of the crossing, and the type of pipe to be used. If critical information is not interpreted correctly or ignored, problems may lead to cost overrun, or even termination of a boring. This information is essential for the owner to insure a successful boring and for the contractor to realize profit from the bore. A fourth parameter should also be considered: the type(s) of geology and soil(s) present in the path of the crossing, including the degree to which a soil varies between entry and exit. Knowing the geology prior to installation allows selecting tooling and method choices to decrease bid price. Issues of soil reactivity with certain types of pipes may also be addressed in advance, enabling the most suitable pipe to be chosen for an installation.

Trenchless Technology – An Introduction

Trenchless, or “no-dig” technology is used to avoid the social costs of open-cut underground utility installation/renewal, and where trenching is uneconomical or impossible. Despite additional short-term costs for some methods, trenchless installations are competitive when social costs are considered. Table I lists these social costs, which are problems that may be prevented by the use of trenchless methods (Najafi, 2004.)

Trenchless technology may be categorized into two areas: new installations and renewals. New installations use some form of horizontal boring. Renewals include pipe bursting and slip lining, manhole repairs and rehabilitation among others. Methods of trenchless technology that do not require the use of a trench at all for an entry or exit from the pipe may be referred to as ‘pure’ trenchless. Other methods do require some trenched access, but this is minor in comparison to the overall length of installation or repair. Geologic information is always useful in advance of a new installation. Geologic input is also critical for the renewal upgrade method of pipe bursting. Trenchless installations are normally concerned with the basic equipment selection parameters.
of the depth of the crossing or renewal, the length of the crossing or renewal, and the type of utility product pipe or repair that is used.

Assessment and analysis of the depth of an overall crossing or renewal depends upon the overburden weight of the soil, and the level of permanent groundwater, and whether that level fluctuates. The maximum possible length of a crossing depends on the type of materials to be encountered. Finally, the type of geomaterials present can directly influence the choice of utility product pipe that is put into service. Depth to rock is additional critical consideration in both choices of method and type of tooling, among others. Looking at the individual methods of horizontal boring and the possible geology they may encounter allows a designer to choose the type of boring best suited for an installation.

Methods of Horizontal Boring

Horizontal borings have been used for the successful installation of utility pipe for over a hundred years. The earliest installations were accomplished by hand tunneling. Methods used and precautions taken were comparable to those used in the mining industry at that time. Today, there are seven types of horizontal boring that are recognized by the trenchless technology community. Choosing a boring method is usually based on three criteria: the length of the crossing to be made, the depth of the crossing to be made, and the type of utility product pipe to be installed. It can successfully be argued that the type of soil and/or rock to be encountered in the bore path is an additional criterion that should be considered in this group.

Horizontal borings are classified according to their ability to steer along a curved line, whether or not they require human entry, and by their method of excavation or advance. Particular types of borings are used in different ground conditions relative to the percentage (and size) of coarse fragments in the bore path, and by the location of groundwater relative to the bore. Certain conditions make some types of horizontal boring impossible, while other conditions preclude the use of horizontal borings altogether.

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<thead>
<tr>
<th>Social Cost Category</th>
<th>Description of Potential Problems in Open-cut Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicular and Traffic Disruption</td>
<td>With open-cut construction, the public pays for the increased time spent in traffic delays, and by the use of detours. Costs include added fuel costs, additional motor vehicle maintenance and repair.</td>
</tr>
<tr>
<td>Road and Pavement Damage</td>
<td>Open cut installation increases the roughness of a pavement’s surface after repair, and may lead to structural failures. Poor restoration may lead to repeated repairs. Differential settlement, poor backfilling, patching, and successive utility cuts aggravate overall problems.</td>
</tr>
<tr>
<td>Damage to Adjacent Structures</td>
<td>Dewatering, excessive excavation, improper techniques in shoring and underpinning may cause uneven settlements and distress to structures as a result of open-cut underground utility construction.</td>
</tr>
<tr>
<td>Noise and Vibration</td>
<td>Vibrations and noise may lead to inconvenience and citizen complaints. These are more frequent in open-cut installation.</td>
</tr>
<tr>
<td>Air Pollution</td>
<td>Open-cut installations in dry periods may lead to excessive dust; heavy construction equipment uses more fuel and generates excess Cox, Nox, and hydrocarbon gases. All are of special concern in areas of close proximity to schools and hospitals.</td>
</tr>
<tr>
<td>Pedestrian Safety</td>
<td>Diversion of traffic onto residential streets increases hazards to pedestrians; open cuts are also safety hazards to pedestrians, especially children and the elderly.</td>
</tr>
<tr>
<td>Business and Trade Losses</td>
<td>Customers avoid open-cut construction areas that causing business and trade losses. These are matched by the concomitant decrease in government revenue from taxes on gross receipts and parking meters in areas with metered parking.</td>
</tr>
<tr>
<td>Damages to Road Detours</td>
<td>Detours caused by open-cut construction increase loads on the detour road, which may not be designed to accept heavy motor vehicle traffic. This decreases road lifespan and may lead to further damage.</td>
</tr>
<tr>
<td>Site and Public Safety</td>
<td>On-site accidents to construction workers and the general public increase in areas of open-cut construction.</td>
</tr>
<tr>
<td>Citizen Complaints</td>
<td>Disruptions to the normal flow of life caused by open-cut construction increase the frequency and magnitude of citizen complaints.</td>
</tr>
<tr>
<td>Environmental Impacts</td>
<td>Open-cut construction may permanently alter or damage sensitive affected areas such as rivers, streams, natural habitats, public parks, protected natural areas, wetlands, historic districts and buildings, etc.</td>
</tr>
</tbody>
</table>

Table 1. Social Costs of Open-Cut Construction (Adapted from Najafi, 2004)
Furthermore, it can be stated that the phrase “horizontal bore” means different things to different users. To be accurate in describing a horizontal boring, a geologist or engineer should denote the type of horizontal boring:

1) Auger Boring – The auger boring process employs simultaneously jacked steel casing while spoil is removed inside the casing using rotating continuous flight augers. Spoils are transported back to the entry point or bore pit where they are removed.

2) Pipe Ramming – In Pipe ramming, an enclosed hydraulic ram repeatedly strikes the end of a pipe to advance it through the soil. The pipe can either be rammed closed-ended or open-ended. The use of a jacking frame is not required as the pipe is connected directly to the pipe ram.

3) Pipe Jacking – Though ‘pipe jacking’ can be applied to the process of hydraulically advancing pipe with the use of a jacking frame, this process requires man-entry for spoil removal during the hydraulic advance of the pipe.

4) Horizontal Directional Drilling (HDD) – Horizontal directional drilling is a two-stage process in which a pilot bore is drilled along a predetermined path, followed by the installation of utility pipe as the hole is enlarged by backreaming with a larger bit.

5) Small-diameter displacement or compaction tools – Simplest of all horizontal boring methods, their use is limited to small pipe installation. There are three predominant methods used, the push rod method, the rotary rod method, and the percussion method which uses an impact tool, or “missile mole”. These are the most inaccurate of all horizontal boring methods.

6) Microtunneling- Micro-tunneling is a highly accurate method of installing pipe using a jacking frame without man-entry, and is remotely controlled and targeted using a laser and theodolite. It is extremely useful below groundwater levels because it provides continuous support to the tunneling face, which pipejacking does not.

7) Pilot tube microtunneling – This is a relatively new, highly accurate method of installation, that installs a product pipe to line and grade by use of a pilot tube followed by up sizing and additional soil removal to install the product pipe. Continuous flight augers are used to transport soil spoil, and a guidance system is used which involves a laser and a camera-mounted theodolite.
Microtunneling should have the most comprehensive geotechnical information available, to minimize the chance of unexpected obstacles requiring a time-consuming (and quite costly) change of cutter head or even a rescue attempt. A summary of the types of horizontal boring mentioned, along with their suitability for various ground types is shown in Table 2. Geologic variability necessitates a site visit prior to boring. Ground conditions

<table>
<thead>
<tr>
<th>Ground Conditions</th>
<th>Auger Boring</th>
<th>Micro-Tunneling</th>
<th>Pipe Ramming</th>
<th>Methods of Soil Compaction</th>
<th>Pipe Jacking</th>
<th>Horizontal Directional Drilling (HDD)</th>
<th>Pilot Tube Micro-tunneling</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soft to very soft clays, silts and organic deposits.</td>
<td>Y</td>
<td>Y to M</td>
<td>Y</td>
<td>N</td>
<td>M</td>
<td>Y</td>
<td>M</td>
</tr>
<tr>
<td>Medium to very stiff clays and silts.</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Hard clays and highly weathered shales; coals.</td>
<td>Y</td>
<td>Y</td>
<td>M</td>
<td>M</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Very loose to loose sands; Above the water table</td>
<td>M</td>
<td>Y</td>
<td>Y</td>
<td>M</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Medium to dense sands; Below the water table</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>M</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Gravel and Cobbles 50-100mm (2-4”) in diameter</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>M</td>
<td>Y</td>
<td>M</td>
<td>Y</td>
</tr>
<tr>
<td>Soils with significant cobbles, boulders, and obstruc-</td>
<td>M</td>
<td>M</td>
<td>Y</td>
<td>M</td>
<td>M</td>
<td>M to N</td>
<td>M</td>
</tr>
<tr>
<td>tions larger than 100-150 mm (4-6”)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weathered rocks, weathered shales, and well-consolid-</td>
<td>Y</td>
<td>Y</td>
<td>M</td>
<td>M</td>
<td>M</td>
<td>Y</td>
<td>M</td>
</tr>
<tr>
<td>ated soils such as glacial till.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slightly weathered and unweathered rock</td>
<td>Y</td>
<td>Y</td>
<td>M</td>
<td>N</td>
<td>N</td>
<td>M</td>
<td>N</td>
</tr>
</tbody>
</table>

Table 2 Suitability of Ground Conditions for Various Horizontal Boring Conditions (Table adapted for use from Iseley, D.T. et al., Trenchless Construction Methods and Soil Compatibility Manual, 3rd ed.)

Y = Yes – Method is suitable when performed by an experienced contractor with suitable equipment.
M = Marginal – Difficulties may occur for the contractor, some modifications of equipment or procedure may be required to successfully complete the bore.
N = No – This method is generally not useful under these conditions. Substantial problems will occur, and the method is not suited for and the equipment is unintended for the conditions present.
may be known to some degree, but geologic and soils mapping may not indicate the real materials underlying a crossing. Soils mapping may not indicate of the nature of, or the depth an underlying bedrock contact. Regional geologic mapping is normally on a topographic base, but it suffers from the inability to predict the types and the degree of variability of individual units that a localized map offers. A common example of potential misinterpretation from Missouri is depicted in Figure 1.

The upper part of the figure is a possible depiction on a soils map of an area. Normally it would be superimposed on an aerial photograph. Interpreting the soils map as three differing types of soils in the path of a horizontal directionally drilled installation, a contractor would bring soil boring tools, and possibly a smaller capacity rig to address what he might consider to be soft soil ground conditions.

The cross-section below the soil map illustrates the reality of the contractor’s predicament. Instead of bringing just soil tools on the HDD rig, the contractor should have rock tooling, perhaps even a larger thrust capacity rig, and even a down hole mud motor for cutting rock. His drilling fluid volume needs will be altered significantly by the gravel and cobbles at the base of the cliff, or he might need a pipe ram to drive a guide casing for his HDD tooling through these coarse fragments. Finally he may need to change his overall drilling fluid composition depending upon the depth at which he crosses the sand and clay.

Inaccurate interpretation of completed mapping is one difficulty that is often encountered in determination of an area’s suitability for a particular trenchless method. Another difficulty in geologic determination of the suitability of ground for the use of a trenchless method is the use or reliance on out-of-date or inaccurate mapping. One example pertains to Missouri, which is depicted on the map in Figure 2 as having no clays with shrink-swell potential. This map, from a Federal Highway Administration publication published in 1976, is inaccurate. Many soils in northern Missouri are composed of highly altered glacial loess, especially in the central northern part of the state. Clays of this region are montmorillonitic, with total clay sometimes higher than 70%. These overconsolidated clays also have a tendency to swell when in contact with drilling fluids, and actually can swell a borehole shut or make it difficult or nearly impossible to install pipe without additives in the drilling fluid.

**Pipe Bursting**

With the expiration of the British Gas patent for the process of pipe bursting in 2005, many utilities and contractors welcomed the opportunity to replace and upgrade existing water, sewer, and natural gas pipeline system elements by the process of pipe bursting. In some circumstances, such as manhole-to-manhole upgrades, pipe bursting can be considered a ‘pure’ trenchless technological upgrade or renewal without need for any excavated access. Pipe is broken by brittle fracture, supplied by a mechanically applied force from within the original pipe. As the original pipe is broken and the fragments of the pipe are forced into the surrounding soil, the replacement/upgrade utility pipe is pulled into place. A conically shaped tool (bursting head) is used to break apart brittle pipe, or cutting heads are used to break ductile iron and thinner steel pipe. The original composition of the in-place pipe determines the type of tooling used to break the pipe, but the geology determines the overall ability of the system to do the bursting job, whether drilling fluids are required, and if soil will heave above the newly installed pipe, damaging aboveground facilities.

One patented method used to prevent above-ground damage and damage to adjacent utilities is a method developed by John Nowak of Goddard, Kansas. This method, known as the InneReam™ method, uses a horizontal directional drill to remove the original utility pipe prior to a new pipe being pulled into place on the same pass. This method is highly preferred where the original utility was installed in a rock trench specially cut for the underground installation of utilities. Figure 3 illustrates a standard bursting configuration with a bursting head followed by the utility product pipe ready for installation. Figure 4 illustrates the advantage of the Nowak InneReam™ method in a rock trench, a method also known as ‘pipe reaming’ (Nowak, 2005).

**The Geologist in Trenchless Installations – Investigator and On-Site Troubleshooter**

The geologist plays a key role in the overall success of a trenchless proj-
A geotechnical investigation of a planned pipeline installation or replacement route is justified to insure success. There are many potential geotechnical hazards and normal soil and rock characteristics to consider for the installation that can be addressed by a well-planned investigation.

The length of the installation, the depth of the installation, and the type of product pipe being installed control pipeline installation. These three controls should also be addressed by the geotechnical investigation. If in a ‘difficult’ soil or rock, the possible length of the installation will be decreased. Weight of the overlying soil on an installed pipe is important so the possible depth at which the pipe can be installed can be determined. Issues of soil reactivity may affect some pipes, such as concrete or steel, and cause corrosion that can be accelerated in some soils with high conductivity. Investigating the planned route of a utility product pipe can be a challenging yet rewarding task as many different possible alternatives emerge, and potential geologic challenges to successful installation by trenchless methods are examined.

For instance, if a steel pipe of 36 inches diameter needs to be installed under an obstacle (such as a railroad track which cannot be closed due to traffic) with an approximate length of 125 feet, auger boring and pipe ramming are two methods which can be chosen for use, because both can be used with (in fact, require the use of) steel pipe. During the geotechnical investigation it is determined that the fill embankment through which the pipe is to be driven is largely composed of boulders with an average size of 18 inches. This determines that auger boring should not be used for the installation, since the average size of boulders in the path of the intended pipe installation are larger than that which can be transported back as spoil by the augers that are used. Pipe ramming, on the other hand, would either break the boulders with the reinforced steel leading edge band on the lead pipe segment, or it would swallow them whole, to be removed as spoil with compressed air at the end of the ram.

The types of information to be gathered by a geotechnical investigation of a utility product pipe route vary depending upon the needs of the particular type of horizontal boring chosen for use.

Figure 3. Bursting tool prior to pull-through. Note that the bursting head is at the bottom of the photograph, and that the pipe being burst into the surrounding soil. Photograph courtesy of TT Technologies, Inc.

Figure 4. Advantage of the Nowak InneReamTM method of pipe reaming over bursting in a shallow rock trench original excavation.

The amount of geotechnical information that needs to be obtained prior to a project varies with the length of the installation, the depth of the installation, and the complexity of the geology that might be encountered. Longer installations even in simple geology need verification that the geology remains simple over the stretch of the job. Deeper installations require deeper geotechnical borings to verify the local ground conditions. Geotechnical information bears directly on the choice of pipe for an installation (for instance, angular chert fragments in the soil can slice thin-walled polyethylene pipe and render it unusable) and any special coating or thickness requirements that are needed for installation.

Without accurate advance geotechnical information, unknown conditions may affect an installation and make it difficult or even impossible. For example, boulders greater than one-third the size of an auger boring make that method extremely difficult or impossible, since the augers must be able to transport spoil down their length for removal.

Table 3 is a good summary of the types of geotechnical laboratory testing that should accompany borings in a pipeline alignment. For instance, if a designer chooses pilot tube microtunneling for an installation and boulders are found in the chosen alignment for the installation, another method should be chosen based on the difficult geology present.

The geologist on a directional bore or trenchless installation site should be a troubleshooter, preventing difficulties with accurate knowledge of soil conditions on the site.

There are no publications that deal primarily with trenchless installation from a geologist’s perspective. Geologists should prepare themselves for this rapidly expanding field of utility installation by learning as much about the ground conditions that affect the installation process and some of the basics of soil-pipe interaction. There are several excellent textbooks that serve as an introduction to the field of trenchless technology, geared to a construction management and civil engineering audience, available for purchase online and listed in the references for this paper. The National Utility Contractors Association (NUCA) also produces a paperback text that addresses soil considerations in trenchless technology, also listed in the references. NUCA’s text (Iseley et al, 1999) serves as an excellent first reference in soil and rock investigation for utility product pipe installation.

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The author wishes to thank E. Baltzer, CPG-08861, U Kar Winn, CPG-11219, and John L. Berry, CPG-04032, for their thoughtful, prompt and comprehensive review of this article. Vickie Hill, Manager of Membership Services for AIPG did an outstanding job of
The following companies contributed photography to this article and are here thanked for sharing their expertise in trenchless installation as well as their photos: Akkerman, Inc. American Augers, a division of Astec, Inc., Barbo, Inc. The Charles Machine Works (Ditch Witch), Hammerhead Mole, Inc., Robbins, Inc. and TT Technologies.

References


Nowak , John, 2005. Personal communication.


Reviewed by AIPG Associate Editors: Ed Baltzer, CPG-08861, U Kar Winn, CPG-11219, and John Berry, CPG-04032.

<table>
<thead>
<tr>
<th>Type of Trenchless Installation</th>
<th>Geotechnical Characterizations Recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods of Soil Compaction</td>
<td>Atterberg limits for soil. Method best suited for stiff clays that are cobble and boulder-free. Presence of cobbles and boulders can cause deflection from intended bore path.</td>
</tr>
<tr>
<td>Pipe Jacking</td>
<td>Atterberg limits, direct or triaxial shear, unconfined compressive strength testing. Standard Penetration Testing if undisturbed samples not available. Boulders can cause pipe deflection leading to edge loading.</td>
</tr>
<tr>
<td>Pipe Ramming</td>
<td>Atterberg limits, direct or triaxial shear, unconfined compressive strength testing. Standard Penetration Testing if undisturbed samples not available. Pipe ram will break up and swallow boulders or cobbles. Need to know soil type to mix bentonite lubricant.</td>
</tr>
<tr>
<td>Microtunneling</td>
<td>Atterberg limits, direct or triaxial shear, unconfined compressive strength testing. Standard Penetration Testing if undisturbed samples not available.</td>
</tr>
<tr>
<td>Auger Boring</td>
<td>Atterberg limits, direct or triaxial shear, unconfined compressive strength testing. Standard Penetration Testing if undisturbed samples not available. Presence of cobbles/boulders greater than 1/3 diameter of the pipe makes auger boring impossible.</td>
</tr>
<tr>
<td>Horizontal Directional Drilling (HDD)</td>
<td>Atterberg limits, direct or triaxial shear, unconfined compressive strength testing. Standard Penetration Testing if undisturbed samples not available. Greater than 25% gravel in soil makes HDD difficult, greater than 50% makes HDD extremely difficult, even impossible.</td>
</tr>
<tr>
<td>Pilot Tube Microtunneling</td>
<td>Atterberg limits, direct or triaxial shear, unconfined compressive strength testing. Standard Penetration Testing if undisturbed samples not available. Best to use method in lean or fat clay soils, also silts. Cobbles or boulders can stop product pipe installation or break pipe.</td>
</tr>
<tr>
<td>Pipe Bursting</td>
<td>Atterberg limits, direct or triaxial shear, unconfined compressive strength testing. Standard Penetration Testing if undisturbed samples not available. The stiffer the soil, the more difficult the installation.</td>
</tr>
</tbody>
</table>

Table 3. Basic Recommendations for Geotechnical Characterization for Trenchless Installation.
Henry “Hank” David Olson, CPG-01276, age 85, passed away on March 7, 2011.

Hank was born in Kalispell, Montana, April 24, 1925. He was a veteran of World War II with service in the Pacific. He graduated from the Montana School of Mines and then joined Shell Oil where he worked until he retired in 1982. His job at Shell took him to Butte Montana, Casper Wyoming, and then finally Houston Texas in 1956 where he remained, except for a two year assignment in New Orleans.

Besides raising a large family, Frank became strongly involved in the Boy Scouts, helping to organize Troop 645. His service to the Boy Scouts continued throughout the rest of his life, becoming a Commissioner and earning numerous awards including the Silver Beaver. He also joined the Girl Scouts as an adult volunteer, leading back-packaging trips where he hiked more than 1,000 miles. Hank even found time while raising his large family to return to school and earn his Masters from Rice University. Even after he retired, Hank kept quite busy working with the Scouts, volunteering at the local schools helping kids learn to read, and volunteering at his church.

Dr. James Vladimir Taranik, CPG-02669, passed away on Tuesday, June 21 at the age of 71. He was born on April 23, 1940. He graduated with a BSc in Geology from Stanford University in 1964 and earned his PhD in Geology from Colorado School of Mines.

Dr. Taranik has served the State of Nevada, the University of Nevada, Reno, The Mackay School of Earth Sciences and Engineering and the Desert Research Institute well in his illustrious career. After four years with NASA and the Space Shuttle Program, where Jim was a senior scientist and Chief of NASA’s Non-Renewable Resources Branch, he came to Nevada in 1982 to serve as Dean of the Mackay School of Mines. As Dean of Mackay, he secured $28 million for a new Mackay School of Mines building and the modernization of major teaching facilities. He led the School of Mines as its Dean until 1987, when he was appointed by the Board of Regents as President and CEO of the Desert Research Institute. At DRI from 1987 to 1998, Jim helped it grow to one of the world’s foremost environmental research organizations with an international reputation. Again with his planning and fund raising prowess, he and his team secured $38 million for two major new Science centers, one in Las Vegas and the other in Reno. He became DRI Emeritus President in 1998.

Dr. Taranik returned to Mackay in 1998 and served as Regent’s Professor and the Arthur Brant Endowed Chair for Geophysics. During this time, Jim also founded and directed the Great Basin Center for Geothermal Energy at UNR. He brought in millions of dollars in research funding, taught numerous courses and mentored hundreds of students. In yet another time of change, in 2003, the University of Nevada and the Mackay School of Mines turned, once again to Dr. Taranik, asking him to serve as Acting Dean of the School. After major reorganization at the University in 2004, Jim became the first Director of the Mackay School of Earth Sciences and Engineering, where he again led the School until moving back into the academic department of Geological Sciences and Engineering in 2009. Dr. Taranik was planning to retire from the University of Nevada, Reno on June 30, 2011 as an Emeritus Regents Professor, and President Emeritus of the Desert Research Institute.

He began his career as a student at Stanford where he earned his BS in Geology he received a varsity letter as Captain of the water polo team. He joined the Iowa Geological Survey where he created the Iowa Remote Sensing Laboratory. His next career posting was to the U. S. Geological Survey, Earth Resources Observation Systems Data Center in Sioux Falls, South Dakota, where he was Principal Remote Sensing Scientist for Geological Applications. He became Branch Chief for Non-Renewable Resources at NASA Headquarters in Washington, D. C., and was NASA’s Program Scientist for the first two space shuttle flights, the second of which contained the first payload of scientific instruments ever flown on the Space Shuttle.

Dr. Taranik served as a Director of Newmont Gold Company from 1986 to 1998 and as a Director of Newmont Mining Corporation from 1998 to 2010. His tenure was the second longest serving Board member in Newmont’s corporate history. He served as a Director of Earth Satellite Corporation from 1997-2002 and currently serves as a director for Klamath Basin Geopower, Inc.

Dr. Taranik is a fellow of the Geological Society of America, the American Society of Photogrammetry and Remote Sensing (ASPRS), the American Association for the Advancement of Science, and the Explorers Club. He is an academy member in the International Academy of Astronautics and is an Associate Fellow of the American Institute for Aeronautics and Astronautics. He received the Bronze Star Medal for bravery and meritorious services as geologist for the U. S. Army Engineer Command in Vietnam and NASA’s Exceptional Scientific Achievement Medal for leading the Shuttle science team on Office of Space and Terrestrial Applications - 1. He is a Certified Professional Geological Scientist of AIPG and a Certified Remote Sensing Scientist.

Dr. Taranik is a member of the St. Mary’s Foundation, the Challenger Learning Center Foundation as well as many other national, state and local boards and foundations. He has received many other honors and awards.

Dr. Taranik was admired for his scientific accomplishments, leadership capabilities, mentoring of students and faculty, and easy-going, upbeat spirit by his friends and co-workers. His passing is an incredible loss to the State of Nevada, The University of Nevada, Reno, the Desert Research Institute, his current and former colleagues, dear friends and, of course, to his loving family.
Land Cover Change and Mineral Composite Assessment of Tushka Depression, in Egypt, Using Remote Sensing and GIS

Semir Sarajlic, SA-1891

In Egypt between 1998 and 2001, Tushka depression flooded from excess water being diverted from the Aswan High Dam, which resulted in the formation of Tushka Lakes. Using remote sensing (RS) and geographic information systems (GIS), Tushka Lakes and the surrounding area (4374.46 km²) were analyzed and mapped for land cover change and mineral composite (MC) characteristics (ferrous minerals (FM), iron oxides (IO), and clay minerals (CM)). Land cover change and MC maps were developed using Landsat TM image (November 7, 1998) and Landsat ETM+ image (March 18, 2003). The resulting land cover change map indicated increase in vegetation, potential agriculture land, and evaporite cover area over the five year period. Furthermore, using ArcMap 10, developed MC index maps were classified into seven classes by using the natural breaks method. The results from the MC maps indicated that the concentration of FM and IO are very low, but the concentration of CM was high, which indicates that CM might be smectite, illite, kaolinite, or chlorite since these CM have little or no iron content. The developed maps from this study are to be used as a guide for agriculture and environmental decision making, but they are not dependable for the modeling studies since the maps have not been verified with field data to determine accuracy of MC maps.

Key Words: Remote sensing, GIS, Tushka Lakes, land cover change, and mineral composite.

Introduction

In 1969, the Aswan High Dam was built, which created Lake Nasser that is the largest man-made lake (Elewa, 2006). A spillway was built for Aswan High Dam that would divert the excess water from Lake Nasser to the Tushka depression; consequently between 1998 and 2001, enough water was discharged from Lake Nasser that led to formation of the Tushka Lakes that changed the land cover area of Tushka depression from 1998 to 2006 (Elewa, 2006; Bastawesy and others, 2007). The land in the Tushka depression is developed for agriculture communities (part of the National Tushka Project initiated in 1996) that heavily rely on the surface water from the Tushka Lakes and the groundwater from the Nubian aquifer (Elewa, 2006).

From 2002 to 2006, droughts have caused the water levels for the Tushka Lakes to decrease considerably due to insufficient influx of water from Lake Nasser along with persistent evapotranspiration rates (outflux) that remain at 8 mm/day in winter and 35 mm/day in summer, which results in negative storage in the Tushka Lakes (Elewa, 2006). Using RS and GIS, Bastawesy and others (2007) were able to calculate an annual average of 2.5 meters/year of declining water level in Tushka Lakes for years 2002 to 2006. With Tushka Lakes being located in a depression, this creates a restricted basin environment for the lakes in which the circulation of water is limited to evapotranspiration as outflux and water coming from Lake Nasser as influx, and the high evapotranspiration rates cause an increase in the salinity of the water that precipitates evaporites when saturation levels are reached (Elewa, 2006; Prothero and Dott, 2010, p. 277; Andrews and others, 2004, p. 194). Also, evaporite minerals can be deposited within the salt flat muds, called a sabhka (Prothero and Dott, 2010). With decreasing water levels, the evaporite deposition has increased since 2001 in the Tushka area (Bastawesy and others, 2007).

In addition to land cover change, the soil chemical composition changed throughout the Tushka area, which is less noticeable in Landsat images compared to water level and vegetation presence. Nonetheless, soil chemical composition change is very important, because it affects the quality and quantity of agriculture production. Important constituents of agriculture soil are clay minerals (CM) and iron containing minerals. CM are structurally complex hydrous phyllosilicates that have a diameter of 5µm (Walther, 2005, p. 158; Dogan, 2009). CM can retain moisture and plant element nutrients effectively due to their high porosity, low hydraulic conductivity, and high capillary force, which result in higher field capacity and wilting point (Asgarzadeh and others, 2010; Dogan, 2009). As a result, clay content in soil is crucial for plant and productive agriculture (Dogan, 2009). Furthermore, iron is an important constituent in soil since it plays a vital role in chlorophyll synthesis and growth of plants (Dogan, 2009) (Mengel, 1994; Katyal and Sharma, 1980). Soils with poor iron content result in chlorosis of plants, which is the yellowing of the leaves with green veins that suppresses full development of plants (Dogan, 2009; Mengel, 1994; Katyal and Sharma, 1980). In RS, a tool for identifying mineral composite (MC) in an image can be used to identify the spatial distribution of ferrous minerals (FM), iron oxides (IO), and clay minerals (CM). The spatial distribution of these minerals is important for environmental and agricultural modeling...
studies that can be performed using geographic information systems (GIS) and RS (Dogan, 2009). Utilizing RS and GIS, scientists were able to apply the tools successfully in assessing the following: mineral composition of Kelkit Basin in Turkey (Dogan, 2009), salt affected soils (Farifteh and others, 2006), metamorphic rocks (Longhi and others, 2001), and porphyry copper alteration at the Meiduk area in Iran (Tangestani and Moore, 2002).

The objective of this study is to develop a thematic map that depicts the land cover change for the Tushka area from November 7, 1998 to March 18, 2003, and to quantify the land cover change. A second objective is to present the spatial distribution of MC of the Tushka area for March 18, 2003, and quantify the difference in the MC cover area from November 7, 1998 to March 18, 2003 for Tushka depression. The produced maps will be an excellent guide for environmental and agriculture decision making.

Study Area

Main part of the study area is in the south eastern part of Egypt, between latitudes 22°50’ E – 31°30’ E and longitude 30°50’ E – 31°30’ E (Fig. 1). The study area focuses on the eastern side that is 4374.46 km², which consists of the Lakes 1, 2, most of 3, and small portion of Lake 4. The lakes are located in the hyper-arid zone, which receive precipitation once every two to three decades (Bastawesy and others, 2007). The evaporation rates are 8 mm/day during winter and 35 mm/day during summer with a monthly overall average of 189.7 mm (Bastawesy and others, 2007; Elewa, 2006). The topography is mostly flat with sand dunes and small hills in the western part, and elevation ranging from 77 m – 326 m above mean sea level (Bastawesy and others, 2007). The geology of the Tushka depression is mostly underlined by impervious Palaeocene Esna Shale that reduces the infiltration of water from the lakes to the Nubian aquifer in which the groundwater salinity is <1,000 ppm in the east and >3,000 ppm in the west, with groundwater flow from southwest to northeast (Bastawesy and others, 2007; El Shazly, 1977). The surface geology of the study area is dominated by low–lying exposures of Precambrian basement rock and interfingering sandstone and mudstone (Nubia Formation), which also represents the geology of the Nubian aquifer. Also, the Nubian aquifer thickness is lower in the study by a factor of ~0.3 when compared to the surrounding areas (Kim and Sultan, 2002). Karst topography covers part of the study area that is Tertiary limestone.

Methods

Two images were downloaded from Earth Explorer¹, one image from November 7, 1998 was provided by Landsat TM and second image from March 18, 2003 was provided by Landsat ETM+. The methodology is broken into two parts: one for the land cover change analysis and the second for the mineral composite analysis.

<table>
<thead>
<tr>
<th>Indices</th>
<th>Equations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalized Difference Vegetative (NDVI)</td>
<td>(band 4 - band 3)/ (band 4 + band 3)</td>
</tr>
<tr>
<td>Band 1</td>
<td>0.45 - 0.515 Visible (Blue)</td>
</tr>
<tr>
<td>Band 3</td>
<td>0.63 - 0.69 Visible (Red)</td>
</tr>
<tr>
<td>Band 4</td>
<td>0.75 - 0.90 Near Infrared</td>
</tr>
<tr>
<td>Band 5</td>
<td>1.55 - 1.75 Mid Infrared</td>
</tr>
<tr>
<td>Band 7</td>
<td>2.09 - 2.35 Mid Infrared</td>
</tr>
</tbody>
</table>

¹ Earth Explorer is serviced by USGS: http://earthexplorer.usgs.gov/.

Figure 1. Atmospherically corrected subset of the study area with latitude and longitude coordinates.

Table 1: Equations for the indices, and band information used for the Landsat - ETM+ (Dogan 2009: ERDAS 2010).
classes are grouped together, and then eliminate was performed on the images, which is a process that removes clumps that are smaller than a user-specified size (2 acres for this study) and backfills at these locations with class information from surrounding clumps (ERDAS, 2010; Lillesand and others, 2008, p. 580). The purpose of clump and eliminate tools is to smoothen the classified image so that it does not have the "salt and pepper" appearance (Lillesand and others, 2008; ERDAS, 2010). Accuracy assessment was processed on eliminate images to check the accuracy of the classification of the images, in the report accuracy and Kappa coefficient are calculated (Table 2). The differences in these two calculations are normal since accuracy report overlooks the random agreement in the error report whereas the Kappa coefficient takes that into account (Kiage and others, 2007; Lillesand and others, 2008; ERDAS, 2010). Last tool used is matrix, which is used to detect change between the two images, and the output file is imported into ArcMap. In ArcMap, a layer is created from the change detection that consisted of water, evaporite, vegetation, and potential agriculture land that is shown in Figure 2.

Mineral Composite

Next, using similar methodology as Dogan (2009) and ERDAS Imagine 2011, index maps for FM, IO, and CM were created from the atmospherically corrected images and the related algorithms (Table 1). Developed index maps were reclassified in ArcMap using the natural breaks (Jenks) method (Fig. 3). Natural breaks method was used because the class boundaries are set where there is significant change in data (Dogan, 2009) (Longley and others, 2005, p. 277).

Results

Land cover detection results (Table 3) are based on the 1998 and 2003 classification images with accuracy of 96% and 92%, respectively, and Kappa coefficient 0.8188 and 0.8509, respectively (Table 2). The results indicated that there was 235.18 km² of additional lake water available in March 18, 2003 as well as 250.41 km² of vegetation coverage available, 197.05 km² of agriculture land available, and 456.78 km² of evaporite coverage.

Spatial distribution maps of FM, IO, and CM were developed (Fig. 3), and, using Dogan’s (2009) interpretation method, seven index classes have been interpreted into five categories: very rare, rare, medium, high, and very high (Table 4). The scale for the five categories varies for FM, IO, and CM because the scale is based on the index values that are represented by the five equal sized data subsets, or quintiles. Based on the spatial distribution of FM, the concentrations are considerably low throughout the study area, and 99.96% of the study area was assessed in very rare category. Spatial distribution of IO was

## Table 2: Accuracy Assessment results.

<table>
<thead>
<tr>
<th>Image</th>
<th>Accuracy Assessment</th>
<th>Kappa Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>7-Nov-98</td>
<td>96%</td>
<td>0.8188</td>
</tr>
<tr>
<td>18-Mar-03</td>
<td>92%</td>
<td>0.8509</td>
</tr>
</tbody>
</table>

## Table 3: Area for different classes from land cover change.

<table>
<thead>
<tr>
<th>Class</th>
<th>Pixels</th>
<th>Hectares</th>
<th>km²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water to Water</td>
<td>380992</td>
<td>34289.28</td>
<td>342.8928</td>
</tr>
<tr>
<td>Water to Barren Land</td>
<td>3763</td>
<td>338.67</td>
<td>3.3867</td>
</tr>
<tr>
<td>Water to Evaporite</td>
<td>1649</td>
<td>148.41</td>
<td>1.4841</td>
</tr>
<tr>
<td>Water to Vegetation</td>
<td>1586</td>
<td>142.74</td>
<td>1.4274</td>
</tr>
<tr>
<td>Barren Land to Water</td>
<td>248717</td>
<td>22384.53</td>
<td>223.8453</td>
</tr>
<tr>
<td>Barren Land to Barren Land</td>
<td>3163449</td>
<td>284710.41</td>
<td>2847.1041</td>
</tr>
<tr>
<td>Barren Land to Evaporite</td>
<td>505891</td>
<td>45530.19</td>
<td>455.3019</td>
</tr>
<tr>
<td>Barren Land to Vegetation</td>
<td>276527</td>
<td>24887.43</td>
<td>248.8743</td>
</tr>
<tr>
<td>Barren Land to Agriculture Land</td>
<td>218942</td>
<td>19704.78</td>
<td>197.0478</td>
</tr>
<tr>
<td>Evaporite to Water</td>
<td>12591</td>
<td>1133.19</td>
<td>11.3319</td>
</tr>
<tr>
<td>Evaporite to Barren Land</td>
<td>36672</td>
<td>3300.48</td>
<td>33.0048</td>
</tr>
<tr>
<td>Evaporite to Evaporite</td>
<td>4465</td>
<td>401.85</td>
<td>4.0185</td>
</tr>
<tr>
<td>Evaporite to Vegetation</td>
<td>4375</td>
<td>393.75</td>
<td>3.9375</td>
</tr>
<tr>
<td>Evaporite to Barren Land</td>
<td>636</td>
<td>57.24</td>
<td>0.5724</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4860255</td>
<td>437423</td>
<td>4374</td>
</tr>
</tbody>
</table>
Figure 3. Ferrous minerals (a), iron oxide (b), and clay minerals (c) index maps of Tushka area.
better than that of FM, in which 72.76 % of the study area was assessed in very rare category, 17.01% of the study area was assessed in the very rare-rare-medium category, 3.48% of the area was assessed in rare-medium category, 3.33 % of the area was assessed in medium-high category, and 3.42% of the area was assessed in the high–very high category. On the other hand, CM concentrations were much higher than that of FM and IO.

The results for CM are: 13.39% of the study area in very rare category, 1.02% of the study area in the very rare–rare category, 4.85% of the study area in the medium category, 26.83% of the study area in the medium – high category, 45.35% of the study area in the high category, and 8.55 % of the study area in the high – very high category. The concentration of FM and IO have not changed as much from November 7, 1998 image to March 18, 2003 image, but the concentrations of CM have changed drastically from 1998 to 2003 (Fig. 4).

Table 4. Cover area for FM, IO, and CM for the study area along with the interpretation of classes.

<table>
<thead>
<tr>
<th>Class</th>
<th>Index Values</th>
<th>Cover Area km²</th>
<th>% of the study area</th>
<th>Category</th>
<th>% of the study area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferrous Minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0-0.5</td>
<td>565.72</td>
<td>12.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.5-1.2</td>
<td>1866.34</td>
<td>42.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1.2-2.1</td>
<td>1938.31</td>
<td>44.31</td>
<td>Very Rare</td>
<td>99.96</td>
</tr>
<tr>
<td>4</td>
<td>2.1-4.2</td>
<td>2.53</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>4.2-6.9</td>
<td>0.86</td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6.9-11.5</td>
<td>0.56</td>
<td>0.01</td>
<td>Very rare - rare-medium</td>
<td>0.03</td>
</tr>
<tr>
<td>7</td>
<td>11.5-23</td>
<td>0.14</td>
<td>0.00</td>
<td>Medium - high- very high</td>
<td>0.00</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4374.45</td>
<td>100.00</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Iron Oxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.4-5</td>
<td>2127.67</td>
<td>48.64</td>
<td>Very rare</td>
<td>72.76</td>
</tr>
<tr>
<td>2</td>
<td>4.5-14.8</td>
<td>1055.05</td>
<td>24.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>14.8-26.7</td>
<td>581.81</td>
<td>13.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>26.7-36.2</td>
<td>162.31</td>
<td>3.71</td>
<td>Very rare - rare-medium</td>
<td>17.01</td>
</tr>
<tr>
<td>5</td>
<td>36.2-53.1</td>
<td>152.24</td>
<td>3.48</td>
<td>Rare - medium</td>
<td>3.48</td>
</tr>
<tr>
<td>6</td>
<td>53.1-72.1</td>
<td>145.61</td>
<td>3.33</td>
<td>Medium - high</td>
<td>3.33</td>
</tr>
<tr>
<td>7</td>
<td>72.1-105</td>
<td>149.76</td>
<td>3.42</td>
<td>High - very high</td>
<td>3.42</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4374.45</td>
<td>100.00</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>Clay Minerals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0-0.3</td>
<td>585.80</td>
<td>13.39</td>
<td>Very rare</td>
<td>13.39</td>
</tr>
<tr>
<td>2</td>
<td>0.3-0.7</td>
<td>44.70</td>
<td>1.02</td>
<td>Very rare - rare</td>
<td>1.02</td>
</tr>
<tr>
<td>3</td>
<td>0.7-0.9</td>
<td>212.26</td>
<td>4.85</td>
<td>Medium</td>
<td>4.85</td>
</tr>
<tr>
<td>4</td>
<td>0.9-1.1</td>
<td>1173.72</td>
<td>26.83</td>
<td>Medium - high</td>
<td>26.83</td>
</tr>
<tr>
<td>5</td>
<td>1.1-1.2</td>
<td>1193.14</td>
<td>27.28</td>
<td>High</td>
<td>45.35</td>
</tr>
<tr>
<td>6</td>
<td>1.2-1.3</td>
<td>790.81</td>
<td>18.08</td>
<td>High - very high</td>
<td>8.55</td>
</tr>
<tr>
<td>7</td>
<td>1.3-1.75</td>
<td>374.02</td>
<td>8.55</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>4374.45</td>
<td>100.00</td>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>

Figure 4. FM, IO, and CM class covers for 1998 and 2003 of Tushka study area.
Discussion

Land cover change indicates a successful rehabilitation of 669.77 km² of barren land into water, vegetation, and potential agriculture land. However, with persisting droughts since 2001, there is an increase of evaporite deposits, which totaled to 455.30 km². Bastawesy and others (2007) suggest that Tushka Lakes water level will continue to reduce until it eventually vanishes by year 2020. In the process, the increase in the salinity in the lakes will harm the aquatic habitat that has been established, and the precipitation of evaporites will reduce the amount of potential agriculture land. Furthermore, the agriculture communities will not be able to use the surface water due to high salinity, and the groundwater from the Nubian aquifer will not be able to sustain the demand due to lower aquifer thickness in the area of study and also the higher saline water in the west will migrate to east, which would contaminate the water wells.

The results for the mineral composite maps indicated that majority of the area has clay minerals, but poor ferrous minerals and iron oxides. This indicates that the dominant clay minerals have low to no iron content, which would mean that the clay minerals could possibly be smectite, illite, kaolinite, or chlorite in the study area. This outcome was supported by a similar study by Dogan (2009) in which mineral composition of the Kelkit River Basin was assessed and results indicated that clay minerals had negative correlation with ferrous minerals and iron oxides.

Conclusion

Using Landsat TM and ETM+ images, a land cover change for the Tushka Lakes between November 7, 1998 and March 18, 2003 was calculated in which 235.18 km² of vegetation, 197.05 km² of potential agriculture land, and 456.78 km² of evaporite land cover area was generated. The mineral composite maps indicated that clay minerals are predominant throughout the study area with very small concentration of ferrous minerals and iron oxides, which would indicate that the clay minerals may be smectite, illite, kaolinite, or chlorite throughout the study area. The maps developed in this study are reliable to be used as guides in environmental and agricultural decision making, but they are not dependable for the modeling studies since the maps have not been verified with field data.

Acknowledgement

I gratefully acknowledge the use of Georgia State University’s Petit Science Center Visualization Wall equipped with ERDAS Imagine 2011 and ArcGIS 10. The Visualization Wall’s high resolution tiled display provided 200 million pixels that permitted visual analysis at a high level of precision.

References


Semir Sarajlic, SA-1891, is currently a second year Geology M.S. student at Georgia State University, conducting research on application of geoinformatics resources in the field of contaminant hydrogeology. Semir has received a GIS certificate from Georgia State University.
Robert A. “Bob” Northcutt, CPG-02704, passed away on December 2, 2011. He was born on May 22, 1928 to Clarence and Marie Northcutt of Ponca City. He attended New Mexico Military Institute graduating Junior College in 1950. He attended the University of Oklahoma and graduated with a Petroleum Geology degree in 1956. He married Annette Marie Taft in 1951. He served With Distinction in the Korean War. He began his career as a geologist with Pan American in Mississippi. He was co-founder of Davis, Northcutt & Cochrane in Oklahoma City. He joined Mich-Wis Pipeline in Houston in 1977, Bass Enterprises in 1981 and finally went back to his love of being an independent geologist and remained a mentor even after he semi-retired. He worked with the Oklahoma City Geological Society and was the editor of the Shale Shaker for many years. He received the Martin C. Van Couvering Memorial Award for Outstanding Contributions from AIPG and was presented with the Oklahoma City Geological Foundation “Legends” Award in 2008. He was an honorary member of both AIPG and AAPG.

He loved his single malt, his Oklahoma Sooners football, trips to the cabin in New Mexico and being called Papa or G-Pa.
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