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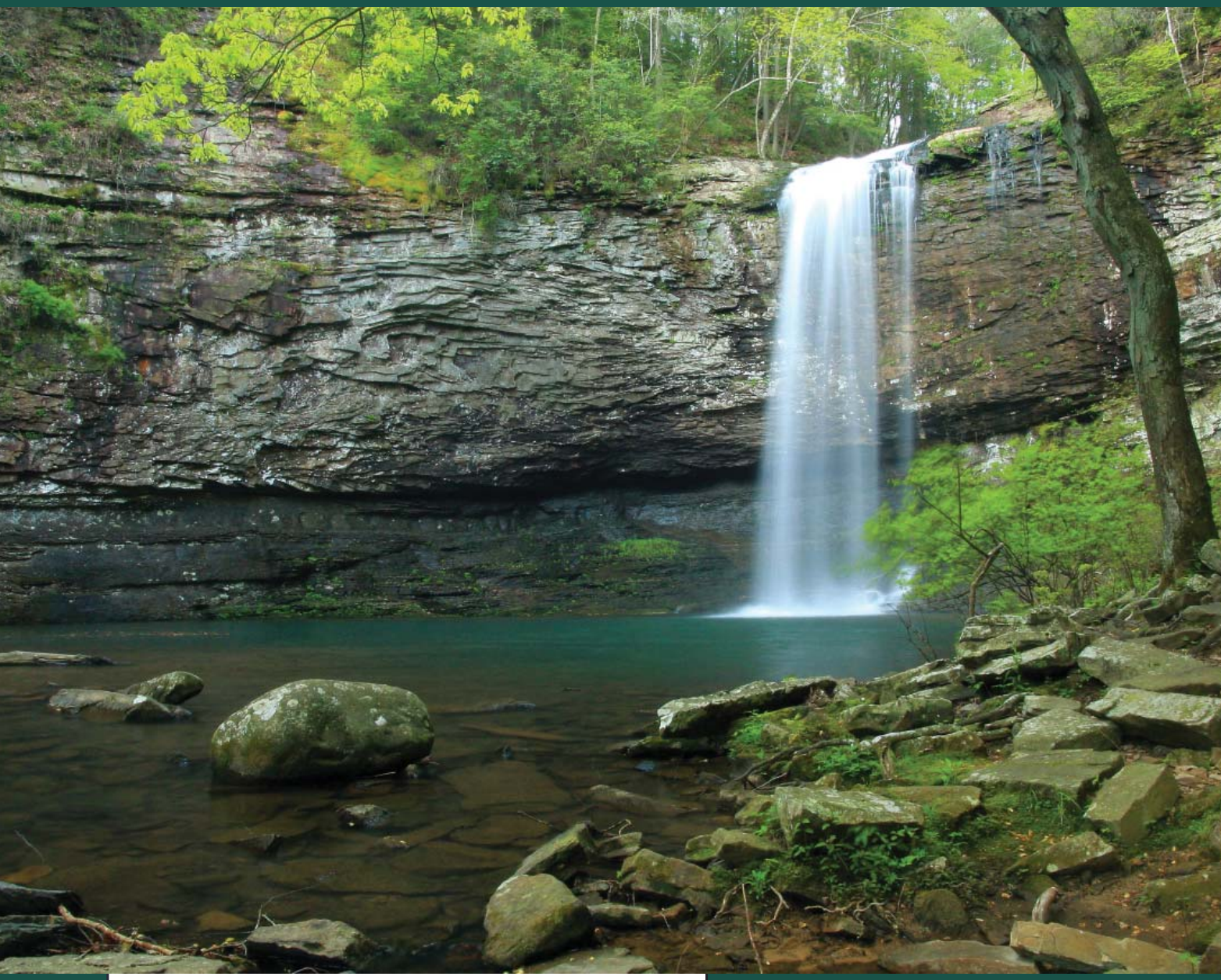

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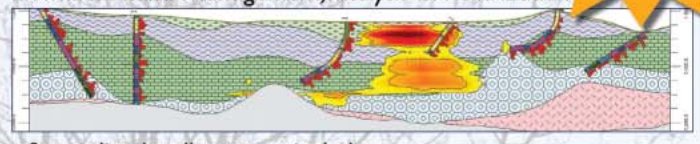

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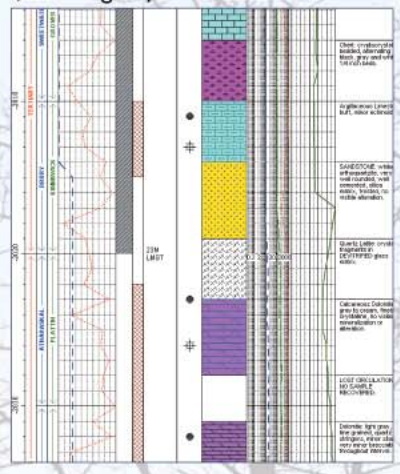

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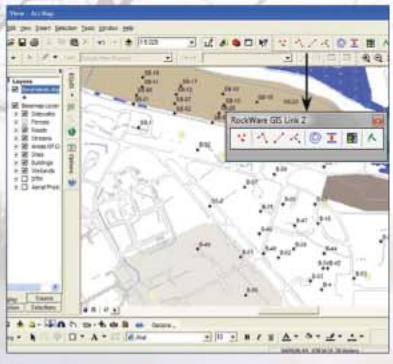

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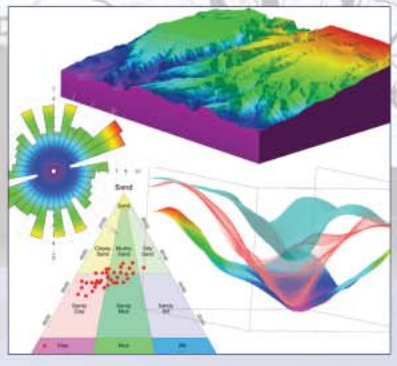

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Inside This Issue

FEATURES

ON THE COVER -Upper Falls along Daniel Creek at Cloudland Canyon State Park in Rising Fawn, Georgia. Photo by Kelly B. Adams.

DEPARTMENTS

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

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

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Eyewitness to the Haitian Earthquake of January 12, 2010

James K. Adamson, MEM-1532

I will always remember where I was at 4:53 pm on Tuesday January 12th; I was on a small boat that we hired to transport us to remote villages along the southeast coast of the island of La Gonave in the Republic of Haiti. I was on assignment working for Concern Worldwide. I later learned we were about 20 miles from the epicenter of one of the most devastating earthquakes in history. I was in Haiti on assignment with a co-worker assisting in the design of water systems for rural and severely impoverished coastal populations. We felt nothing on the boat when the quake hit but were notified dramatically as we arrived moments later at a small coastal village on the island. The next coming days were to unfold beyond anything I have ever experienced or will ever experience.

Back on land, I felt a large aftershock and only then realized how large the main quake must have been, especially if the epicenter were near Port au Prince or a major city center; it is no secret that Haiti was ill equipped to handle such an event. Radio feeds from Port au Prince started to paint a picture of the damage and we scrambled to communicate with our family to let them know that we were ok. It wasn't until the next morning that we were able to send an email, and I later learned the night to be an agonizing one for my wife and family. It was also an agonizing one for the ten million people in Haiti, some dying, some frantically trying to rescue survivors as the rest of the country helplessly slept outside in

fear of the aftershocks and in anxiety about the fate of their families and loved ones. After a night filled with aftershocks and unsteady rest, we arose in the morning to find the entire island village in agony; screams of mourning filled the air as people learned of deaths in their families. Our team members from Port au Prince told us of family that had died and the countless others they hadn't heard from. As a geologist, I believed I knew which fault system contributed to the event and I tried my best to educate people on what had occurred, and what may be expected of the aftershocks. My messages with well worn maps, hand gestures and patchy Creole attracted a large crowd of curious villagers who were only looking for something to distract them from their preceding thoughts.

Thursday the seas calmed down and our team was able to board a boat back into Port au Prince. We had to get our Haitian team members back so they could search for their loved ones and we had to check on several friends in Port au Prince. Nothing could have prepared us for what we were about to witness and experience. Only three days earlier, I was in Port au Prince and it was as bustling, prosperous and as safe as I had ever seen it. Now as we traveled south into the city it quickly became apparent that it was decimated beyond recognition and was now a place of sadness, survival and desperation. The entire city seemed to be a pile of concrete rubble, dusty stale air and dead bodies. The city smelled like pure death and it was nearly unbearable to breath, locals had white toothpaste under their noses, some had leaves jammed into their nostrils. The streets, courtyards and open areas were filled with somber people both injured and physically well. They were all waiting for help, for something to happen. It was the only time in my life I wished that I were a doctor. Distinctive and powerful prayers in Creole echoed through alleyways and streets. The expressions on everyone's face were an unexplainable mix of fear and sadness, but strength and faith shined through. Slow tears rolled down the faces of all and everybody. I will never forget and always be inspired by the residents of Port au Prince that day. What was most astonishing was that it was two days after the earthquake and we did not seem to see one organized relief effort. We at first thought that most of the rescue efforts had already occurred but that was not at all the case, they had yet to begin. With no communication network and our contacts in Port au Prince missing, we left Port au Prince to head north into Pignon to start coordinating a relief effort from the head office of Haiti Outreach, a small NGO that is very active across the country. Two water trucks were immediately mobilized to Port au Prince to make 24/7 water deliveries to the city. Logistics were then handled to transport a Washington, D.C. based Trauma team to the country through the Dominican Republic and further coordination efforts were

initiated with UNICEF, the Haitian Government and Concern Worldwide. Haiti Outreach mobilized their drilling equipment to begin water relief efforts by drilling new wells and repairing ones damaged by the earthquake. It was evident in my short time with Haiti Outreach after the earthquake that the smaller organizations have played a critical part in the relief effort and will continue to play a direct role in the rebuilding efforts.

My co-worker and I were evacuated out of the country on Saturday, January 16th, but leaving Haiti was the hardest thing I have done in my life. Upon returning to the USA, I was once again reassured as to why I am married. The support of my wife was unexplainable and she tearily supported my return to Haiti to help in the relief efforts. Stuart Dykstra and I from V3 Companies immediately joined a relief effort to focus on water supply for Port au Prince and all of the surrounding damaged areas and are in the process of returning as I scramble to draft this article.

The directly affected population of the earthquake lives off an average wage of $3 per day (before the earthquake); most of the people have saved money their entire lives to build homes and businesses, building brick by brick as they were able. The capital region of Haiti is in peril; every government building is severely damaged or completely destroyed. The country of 10 million people is centralized through Port au Prince, and the entire country relies on Port au Prince for commerce, fuel, imported food and aid dollars. The country has no means to recover without the international community; Haiti heavily relied on aid even before the earthquake. The much needed focus and attention on the Port au Prince area will hopefully not disguise the help that the rest of the country still needs.

I write this article of my experience to bring awareness. The Haitian people are extremely inspiring and they are all victims of this catastrophe. I learned more from them in one day than I have in all of my education and career. The future of Haiti depends on the international response involving the Haitian people and immense support after the relief effort and after the media coverage dissolves. It is also critically important to encourage international investment into the country after the relief efforts subside. Haiti has suffered greatly and it is my hope that the rebuilding effort is the beginning of reestablishing Haiti as the "Pearl of the Caribbean".

James Adamson, MEM-1532, is a senior geologist with V3 Companies, Ltd. He has been working on water supply projects across the entire country of Haiti since 2006.

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GEN	General Geology
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Artificial Recharge in the Southwestern US: The Problem of Emerging Chemical Contaminants

Frank Butterworth, Kenneth Janecek, and Edward Wolfe

Abstract

There is growing concern worldwide about aquifer pollution by large numbers of emerging, anthropogenic chemicals (ECs) that escape standard wastewater treatment. Inasmuch as the rapidly-growing, arid Southwest uses such effluent to recharge depleting aquifers, there is an acute need for a better understanding of and a more complete treatment process to protect human and environmental health. Important among these contaminants is a broad suite of endocrine-disrupting chemicals (EDCs) that include natural or synthetic hormones as well as compounds that mimic hormones and may interfere with the operation of endocrine systems even at concentrations of parts per trillion. Indeed, evidence now indicates that some aquatic organisms are adversely affected at these levels where treated wastewater is discharged into streams. The paper will elaborate on these points building a case that this issue deserves attention.

Key Words

Artificial recharge, effluent, endocrine disruptors, emerging chemicals, wastewater treatment

Introduction

The warm and sunny climate that attracts many to move to the Southwest is the very reason why it is arid. Rapidly increasing populations are creating water scarcity. For example, cities in the Colorado River watershed that use its surface water (SW) are finding it is becoming oversubscribed, and as a result communities are using groundwater (GW) to a greater extent. Indeed, many communities are totally dependent on pumped groundwater for their domestic water. To compensate the resultant GW overdrafts, reclaimed wastewater is used to recharge the rapidly depleting aquifers. Furthermore this usage is employed to increase more development through auctions of wastewater effluent credits. However, the practice has the potential to impact groundwater quality. Thus, water problems and rapid growth are on a collision course.

The Problem

Emerging chemicals (ECs): Literally thousands of anthropogenic compounds are already in our environment. The number continues to increase as we demand better, more useful, more attractive personal products. Other ECs are indirectly needed in the manufacturing process because we want better plastics, cheaper food products, better packaging, etc. In addition the chemical industry continues to make more ECs for newer drugs, improved function and use of other ECs, but also to avoid regulation.

The ECs we want and need are in various categories: *pesticides* including lindane, carbaryl, and dieldrin; *pharmaceuticals* such as analgesics, birth control pills, hormones, antibiotics, antihistamines, along with antiasthma, anti-inflammatory, antidepressant, and antiepileptic drugs; *industrial chemicals*: including plasticizers, surfactants, antioxidants, detergents, disinfectants, flame retardants; *personal care products* such as fragrances, surfactants, deodorants; *food additives* such as anti-mold agents, antioxidants, and food additives to keep components in suspension, some of which are listed in the ingredients. All this comes with a price: many of these compounds have not been adequately tested for safety nor has their use been regulated, and, although we inadvertently consume these products, we know very little about what effect they have on the environment.

Usually ECs enter our bodies through the digestive tract, skin and lungs; some are stored, others are partially metabolized; and finally, they enter the waste stream as a mixture of original compounds and metabolites. Animals that are part of the human food chain as well as pets also receive large amounts of ECs that may become part of the waste stream. However, with food animals and to some extent pets, these ECs are not subject to municipal wastewater treatment (WWT) and become part of wet-weather runoff—carried directly into streams or infiltrating to the aquifer system as natural recharge. ECs contained in agricultural pesticides may be redistributed to streams and aquifers either from runoff in wet weather—infiltrating to aquifers as natural recharge—or by in-situ infiltration of unconsumed irrigation water (incidental recharge).

Our desire for ECs and our desire for product safety have sometimes led us into ironic situations. For example, safety groups demanded that products such as carpets, bedding and clothes should not burn rapidly if exposed to fire. And that demand is now law. For example, a class of ECs, polychlorinated biphenyls (PCBs), was used as flame retardants fitting the requirements of the law. But as the evidence accumulated that PCBs were harmful, they were banned; and the chemical industry responded with com-

pounds such as polybrominated diphenyl ethers (PBDEs) as a replacement. The chemical structure is very similar, and because halogenated hydrocarbons are usually toxic, it is likely at some point they, too, may be banned.

Although all the congeners of PCBs are no longer manufactured and the sales of existing PCBs are banned in most parts of the world, they resist destruction in the environment. As a result they continue to enter the waste stream and the environment, albeit in lower amounts. This scenario may become similar to the fate of other ECs, and as the list of ECs continues to grow. The hope that toxic ECs will disappear is problematic.

What happens to ECs after they leave our bodies? In 2002 a landmark paper, Kolpin et al. (2002) showed that a surprisingly high number of chemicals including many ECs are not decomposed by the WWT process. The researchers followed the fate of 95 compounds after they passed through 139 WWT plants throughout the US. They found a median number of seven, one or more in 80% of the sites and as many as 38 in a few water samples. Some of these compounds are in relatively high concentrations (e.g. 800 ppt of 4-nonylphenol). Most of the 95 compounds are anthropogenic including antibiotics, prescription and nonprescription drugs, pesticides, steroid hormones, detergents, and other industrial chemicals. They concluded that these compounds survive WWT and are entering our SW and GW.

Some of the more threatening ECs are the endocrine disruptor chemicals (EDCs). For some background refer to (Colborn et al. 1996; Naz, 2004). Defined by the World Health Organization EDCs are "*Any compound or mixture that alters the function of the endocrine system that causes an adverse effect on an organism or its progeny*". Thus, EDCs can act by modifying hormone production in endocrine glands or they can mimic or counteract an organism's normal hormones at the target tissue. A probable mechanism is that the EDC binds the hormone-receptor site in the target tissue by modifying the tissue's response.

Although only a small part of the EC menagerie, EDCs were among the first noticed in the 1960s with the pesticide dichloro-diphenyl-trichloroethane (DDT). The 'wonder' compound DDT was for years applied widely to control mosquitoes and agricultural pests. But then, linked to eggshell thinning in raptors such as the bald eagle, it was banned in 1972. DDT is fat soluble and resistant to metabolic destruction—attributes that caused it to become biomagnified up the food chain. When these birds of prey ate fish laced with the compound, the concentration was high enough to affect the ovary's ability to make tough eggshells.

A few other EDCs have been banned or regulated including chlordane, lead, and mercury. As a result, in some cases, newer less stable replacement ECs have been created. Most recently the USEPA established a safe level of the chemical perfluorooctanoic acid (PFOA) as a provisional health advisory of 400 ppt in drinking water as an acceptable maximum level. PFOA that is now in the GW has been linked to cancer and birth defects in animals. It has been found in virtually all Americans, as well as in marine organisms and even Arctic polar bears. Its omnipresence is understandable: it is a key processing agent to make Teflon.

The EDC bisphenol A (BPA), a widely-used plasticizer in metal can liners and plastic baby bottles, is found in the urine of virtually every American. The Kolpin group found it at a median concentration of 140 ppt in about 85% of the WWT plants studied. But this chemical is not banned, yet. The USEPA deemed it harmless, finding that only at high concentrations did it cause a decreased weight in rats, enlarged livers in mice, and very low rates of multinucleated giant hepatocytes only after very long exposures. The Federal Food and Drug Administration (FDA) reached the same conclusions. But recently an entirely different story has emerged. Lang et al. (2008) in a major epidemiologic study showed that higher urinary concentrations in humans were associated with increased cardiovascular diagnoses and diabetes. Vom Saal and Myers (2008), briefly reviewing the animal and human studies on effects of BPA, concluded along with various expert panels in the US and the Canadian government (which has recently banned its use in baby bottles), that BPA has serious medical effects, especially if exposure occurs during fetal/neonatal life. The authors go on to question the methods of assessment of toxicity by the EPA, FDA and the European Food Safety Authority, namely that they adhere to the principle that toxicity increases with concentration. Instead, as often found when testing endocrine-related compounds, the dose-response curves are biphasic (i.e. nonlinear).

In addition to the above studies with BPA, some EDCs have been linked to testicular cancer, abnormal sexual development in men, and accelerated puberty in girls. But linking the effect of an EDC to a disease in human populations is problematic. A review by Safe (2005) summarized numerous studies that, despite conclusions reached in earlier work, found that exposure to PCBs and dichlorodiphenyldichloroethylene (DDE) could not be linked with breast cancer and lowered sperm counts.

Can highly diluted EDCs in effluent have biological effects? Studies by Jobling et al. (1998) indicate that they do. The paper described intersex characteristics (male fish exhibiting female characteristics) in a particular fish species, the roach (Rutilus rutilus), upstream and downstream from WWT plant outfalls in various rivers in Great Britain. Intersex features appear spontaneously in these fish at a range of 5-15 percent in control water. However, in effluent-influenced rivers, the percentage of affected fish is much higher, ranging from 15-100% down stream and 25-50% up stream from the outfall. Presumably, the higher-than-normal intersex percentages in the upstream fish is due to migration, or because the contamination level is simply higher than that of the control waters. Assuming that effluent from British WWT plants is no different from that studied by Kolpin et al. (2002) in the US, it would seem that EDCs are in the effluent and that they act in exceedingly low concentrations.

But in the Jobling study, there was a mixture of probably thousands of ECs and their metabolites, some of which could be the causative agents, suggesting that estrogenic EDCs may be among the culprits. The most common include natural, animal-based and plant-based (phytoestrogens) estrogens; and also anthropogenic- or xeno-estrogens, all found in WWT effluents (Kolpin, et al. 2002). From this mixture could a single, intersex-causing EDC be involved?

To answer this question more specifically, Kidd et al. (2007) added the birth control chemical 17 α-ethynylestradiol (EE2) to a small lake in southwestern Ontario, Canada until the average concentration throughout the lake reached six parts per trillion (6 ng/L). Within

two years the population of the resident fathead minnow was reduced to virtually zero. In a control lake nearby the fathead minnow population remained unchanged. These results demonstrated that even one estrogenic contaminant in wastewater may be sufficient to effect populations and even communities of exposed organisms. Importantly, wastewater contains multiple types of estrogenic compounds, and removing just one may not be sufficient to fix the problem of negative exposure outcomes. Kolpin et al. (2002) found EE2 to have a median concentration of 73 ppt in WWT outfalls throughout the US.

How are chemicals in ppt concentrations or lower measured? The answer is that concentrations at these levels are both difficult and expensive to measure. Most equipment and tests at those levels will register 'non-detect'. But in actuality as Kidd, et al. (2007) showed these low concentrations are definitely present, and do have a biological effect. Applying Avogadro's constant, one liter of water with a concentration of one part per trillion of EE2, contains a trillion molecules of EE2.

Five chemical methods of detecting and measuring ECs and EDCs are referred to in the Kolpin et al. (2002) study, and were chosen because of their sensitivity and reliability. A cheaper method, the yeast-estrogen screen (YES) technique is a molecular biologically-devised technique that measures only estrogenic activity (Conroy et al., 2007). The technique is widely used for estrogens (or YAS for androgens) but it has certain specificity drawbacks requiring appropriate controls.

Given the problems with *in vitro* assays, one technology, biomonitoring, has great promise because it has the potential to test the toxicity of effluents containing mixtures including ECs and EDCs. Here whole organisms are specially selected (or designed) to detect 'unfriendly' changes in their environment as a biological, early-warning system (BEWS). One example is the *in situ* fish-development monitor used in the Jobling and Kidd studies. In other cases the biomonitor has been especially selected based on the animal's biology or specifically designed for a particular endpoint. There are various categories and examples listed in Butterworth, et al. (2000) with nonlethal biochemical, developmental, genetic and behavioral endpoints. Some, particularly with behavioral endpoints, can be applied to automated, continuous, and remote-measuring systems. Since there are so many ECs, a whole-organism system (as the above, *in situ* fish monitor) will be the best way to indicate toxicity (at bioactive concentrations) before committing more costly methods.

The general principle of biomonitoring is that smaller animals and plants can be used to warn us of toxics before they enter our bodies, but the principle can be applied to us as a biometric after toxics have entered our bodies—in effect, a body-burden test for EC exposure. This would be a great aid to the medical and regulatory communities. But with the large number of ECs, finding a quick, inexpensive body-burden test may be a challenge.

Another promising approach is the lab-on-a-chip technology under development to detect specific compounds such as estrogens. Still in the prototype stage, such techniques are probably years away from application or USEPA approval. However, the benefit would be an inexpensive, automated, real-time detection in WWT plants to control the treatment processes or monitor effluent outfalls; or at source-water intakes.

Are there any pristine areas, including aquifers, in the world that are EC free? Probably not, given the fact ECs are found even in polar bears. However, a likely place to look is in areas that have relatively low populations. One such place might be the upper Verde Watershed in Central Arizona. Once populated with free-range cattle and pronghorn antelope, it is now becoming urbanized, and GW is essentially the sole source of water. Recharge with treated wastewater has begun, but only recently.

Year-round flow in the upper Verde River (see figure 1), the uppermost reach of one of Arizona's few remaining perennial rivers, issues solely from springs in the upper few miles of the river that are supplied predominantly by discharge of GW from two GW sub-basins: the Little Chino Sub-basin and the Big Chino Sub-basin (Blasch, et al., 2006). Hydrologic estimates are that the GW discharge from the Little Chino Sub-basin comprises about 14 percent of the water issuing from these springs (Wirt, 2005) and discharge from the Big Chino Sub-basin comprises 80 percent or more (Wirt, 2005; Erroll L. Montgomery and Associates, 2007).

The City of Prescott, the Town of Chino Valley, the Town of Prescott Valley (in part), several private water companies, and numerous homes supplied by individual wells obtain virtually all of their water supplies from wells in the Little Chino Sub-basin. So far, GW pumping in the Big Chino Sub-basin has supplied only extensive agricultural irrigation, one golf course, and numerous individual homes and several developments in the southern (down-valley) end of the basin. However, demand for GW from the Big Chino Sub-basin is developing both for importation to the Prescott area to support development there and for development of the extensive private lands in the Big Chino Sub-basin itself. Barring successful mitigation, the continuing GW demand in the Little Chino Sub-basin combined with the expected demand in the Big Chino Sub-basin will eventually eliminate the springs that supply the upper Verde River.

Arizona law currently limits pumping of GW for new development in the Little Chino Sub-basin. However, return of treated wastewater from municipal WWT plants to the aquifer provides credits that can be used by municipalities to pump additional GW in quantities equal to the quantities of their recharged wastewater. Indeed one municipality in the area has recently sold its wastewater credits to a developer.

Such a pumping limit does not presently exist in the Big Chino Sub-basin, but it is to be expected that the pressure to mitigate the eventual effects of GW

Figure 1. The headwaters of the perennial upper Verde River flowing through Nature Conservancy property, the Verde River Springs Preserve. Here the river, fed solely by springs most of the year, is home to a wide variety of plants and animals including beaver.

pumpage there, whether for importation to the Prescott area or for extensive development in the Big Chino watershed itself, will eventually lead to massive recharge of treated wastewater there as well.

If some part of the perennial GW discharge to the upper Verde River can be preserved, a threat remains from water tainted with ECs and EDCs that enter the aquifer from the recharged wastewater. The good news is that this area is fairly well studied regarding fish, birds and other riverine animal populations. Thus these data could serve as a baseline to compare with adverse changes that may take place in the future. Few specifics exist regarding EC content, but the river and its immediate watershed is regarded by many to be so far, relatively pristine.

The Solution

Given the threat from ECs and EDCs, given the huge numbers of these compounds (and that the numbers are going to increase) and given the fact that our current waste-treatment technology cannot trap or destroy these compounds completely, an improved removal process is paramount.

Current wastewater treatment practices. The average WWT plant is allowed to discharge specified levels of pollutants just as long as simple criteria are met regarding the clarity and pathogen content of the water, the levels of standard pollutants such as nitrogen and phosphorous, and the rate at which microorganisms use up oxygen (biochemical oxygen demand or BOD) as a general measure of remaining organic content of the effluent. These amounts are spelled out in the plant's National Pollutant Discharge Elimination System permit (NPDES). The assumption is that once the clarity, pathogens, nitrogen, phosphorus, and BOD reach satisfactory levels, all is OK. And even if other pollutants are discharged, they would be diluted by the receiving body of water, usually a river. But NPDES rules have not taken into account the ECs explosion. Nor did the NPDES rule makers realize that EC-contaminated effluent would be used for artificial recharge.

Currently wastewater treatment varies throughout the US including the arid Southwest. The main determining factor of the process used is the size of the municipality. For most, it usually consists of primary and secondary treatment using an activated sludge process. Occasionally tertiary treatment is required depending on the quality of effluent required in the NPDES permit. However, this may well change as we gain more knowledge of EC toxicity, about the problems of effluent recharge, and as community populations expand. In smaller communities relatively primitive methods are still employed such as sewage lagoons. And for outlying individual homes using septic tanks the WWT process is the most primitive.

Tertiary treatment may be required to meet the NPDES permit limits and can take various forms. For example, either granular, activated-carbon filtration or lime coagulation plus sand filtration might work. Other forms of tertiary treatment are nitrification-denitrification steps and aerobic-anaerobic treatment.

The final step in the WWT process is oxidation. Ordinarily it is done to kill the pathogens remaining after the digestion steps, but it also is a way to destroy remaining organics in solution. There is a variety of choices. Chlorination is traditional: it is cheap but it produces toxic trihalomethanes. Other more recent choices are ozonation, hydrogen peroxide treatment, ultraviolet radiation at a wavelength of 254 nm or a combination of all three, sometimes in different sequences.

At the end of the process the liquid is discharged into a receiving body of water and the solid fraction (sludge) is digested further, dewatered and spread on the ground, often at farms as mulch or fertilizer. However, as often happens in the arid Southwest, the effluent is discharged to a dry river bed or a recharge pond.

What is happening to all the ECs? Why is it that, as we learned from the studies by Kolpin et al. (2002) in the US and Heberer (2004) in Europe, many, if not all ECs are not completely degraded to simpler compounds? Some WWT plants in Arizona, for instance, claim a 90% removal rate of estrogens. But the remaining 10 % leave the plant unchanged either in the liquid effluent or in the sludge often spread on farm fields. Can one assume that estrogens are a bellwether, surrogate EC and that 90% of all the other ECs have been removed? Clearly, the effluents need to be monitored for a suite of ECs to answer this question. To what extent can tertiary processes, such as nitrification followed by denitrification, be improved to approach 100% removal? Or have we reached a technological limit? And if it is doable, one is still left with the EC-containing, dewatered sludge.

Successful WWT removal of ECs can depend on whether contaminants are hydrophilic or hydrophobic. Hydrophobics are traditionally removed by adsorption beginning with clarification during primary and secondary treatment. Hydrophilics will not be adsorbed and they along with the unadsorbed hydrophobics can be removed at all phases by chemical degradation. So, one is left with a conundrum. In order to produce clarified liquor, one will have removed the sludge including significant amounts of hydrophobic ECs that might leach into the GW/SW from the spreading fields. True, there may be sufficient adsorption and bioremediation in the fields to prevent this leaching, but these are unknowns and may vary considerably according to conditions.

In some cases filtration of effluent with granular, activated carbon could remove hydrophobic byproducts to reduce ECs in the effluent. Perhaps the final oxidation stage is the last chance to remove hydrophilics and unadsorbed hydrophobics. Possibly the right combinations of oxidants (chlorine, ozone, and peroxide) with UV-254 can synergistically produce powerful hydroxyl radicals that break down virtually all organic compounds. Cost for such oxidation processes is very sensitive to the concentration to be destroyed. Now given a pure effluent, the remaining challenge would be the remediation of ECs in the spread sludge, untreated animal waste, leaky sewer pipes and septic tank fields.

What is the fate of the remaining ECs once the effluent is returned to the alluvial basins of the arid Southwest? The question is being answered by various laboratories such as Traugott Scheytt's laboratory at the Technical University of Berlin and Robert Arnold's group at the University of Arizona. The latter group (Zhang, et al., 2008) studying estrogenic compounds and polybrominated diphenyl ethers (PBDEs), are finding that there are reductions up to 90% in the top two feet of the alluvium. Presumably the mechanism of removal is a combination of biodegradation and adsorption. Their work suggests that bioactivity continues to degrade the target compounds for many years, but nothing is known about the fate of thousands of other compounds that are recharging at ppt levels.

Hydrophobic chemicals would appear to be removed from the waste stream

during WWT by adsorption and absorption, but Scheytt et al. (2005) found that their escape into the GW depends on pH and ionic conditions. Compounds such as two anti-inflammatory drugs, ibuprofen and diclofenac, and the antiepileptic/ADD drug, carbamazepine, ordinarily described as hydrophobic, are found widely distributed in European GW perhaps because they become more hydrophilic in the neutral pH of waste- and groundwater. In the US carbamazepine was found at 455 ppt in the GW some distance from the outflow of one of the Tucson WWT plants suggesting that the physical conditions there facilitated its escape. The Kolpin study did not measure carbamazepine or diclofenac but found median levels of ibuprofen at 200 ppt in US rivers near WWT outfalls.

GW has a complex biology which we are just beginning to understand (Griebler et al., 2001). However, the bioremediation of ECs is entirely possible but largely unknown within the alluvium through which effluent must pass to reach the GW. Inasmuch as the biology of GW and alluvium is likely to vary with location, predicting the natural, remediative process is far into the future. Do the ECs diffuse throughout the aquifer? Are they acted upon by the microbial population in the alluvium or aquifer? Does domestic water pumped from an aquifer that contains treated sewage contain ECs? What steps are planned to monitor and remove them before human consumption?

One of the unintended consequences of effluent recharge is that the siting of recharge basins above alluvial aquifers is typically in areas of coarse sand or gravel for the fastest recharge. Such deposits are poor natural adsorbents, and with their high permeability the contact time will most likely be insufficient to achieve adequate adsorption or biodegradation. Furthermore, if ECs are adsorbed onto alluvial particulates in the first wave, they could get washed off by more hydrophobic compounds in subsequent waves, perhaps creating pulses of concentrated, sorptive fluid in transit to the aquifer.

In summary, there are substantial unresolved problems with the current system of recharging WWT effluent to the aquifer. There is no assurance that the tertiary process can be improved sufficiently to mitigate the risk of ECs. Further, the sludge containing hydrophobics may have to be treated as toxic waste.

Current state of the art: Scientists at Water Factory 21 (WF-21) considering the above problems and questions have raised the bar on effluent purification in California's Orange County. It is perhaps one of the boldest and most innovative plans in operation to date to protect the GW *(http://gwrsystem.com/about/overview.html* and plant operations engineer M. Patel, personal communication). In its most recent form, WF- 21 processes 85 million gals of sewage per day. After conventional secondary treatment, the effluent is microfiltered, treated by reverse osmosis (RO), and finally subjected to peroxide and 254 UV. This process is now in use in other municipalities such as Scottsdale, Arizona. The WF-21-processed water, 70 million gallons per day, is pumped from its Fountain Valley location to a recharge lake, Kraemer Basin where, it is mixed with a significant buffering fraction (17%) of fresh canal water. The concentrated retentate from the RO process, approximately 15 % of WF-21 influent, along with other effluent from the secondary treatment plant is pumped into the ocean. WF-21 water costs the Orange County taxpayer approximately the same as importing canal water.

California now requires that the total organic carbon (TOC), a crude surrogate for ECs, of effluent to be used as recharge cannot exceed 0.5 ppm, virtually forcing a municipality to use RO to treat its effluent for recharge. The TOC at the WF-21 plant is somewhat less at about 0.4 ppm. Achieving a TOC to near zero through a more intense oxidation step will be, according to Mr. Patel, extremely expensive. Although the WF-21 process is a vast improvement over most WWTPs, and although most ECs have likely been removed, the potentially toxic load, using TOC levels as a measure, is still one hundred thousand times higher than the 5 ppt level of EDCs that can impact aquatic life. The relationship of TOC level to the biological impact of effluent particularly that in the WF-21 effluent, is unknown.

Conclusions and Final Remarks

Society has been left with a problem and many questions. Recently the USEPA has recognized the EC issue and has identified 87 potentially dangerous organic compounds to possibly regulate, from 7500 candidates. But it may be many years before any comprehensive regulation is feasible. What should be done with newly created ECs? Should the government make the chemical industry go through a safety-test protocol for each chemical they wish to introduce (the current FDA drug- testing model)?

More advanced WWT can be expected for all communities, but the possibility for success will be challenging given the questions raised above. Certainly it would entail having tertiary treatment and all NPDES permits would require testing for a suite of ECs. At this point in time, the WF- 21-type option might be one of the better choices if cost and economies of scale can be adapted to smaller communities. In any case advanced monitoring technologies for SW/GW and WWT effluent will be needed.

Until a 'best EC removal plan' is in place, pristine areas of the environment need to be exceedingly well-catalogued, inventoried as to the biota, water quality, and EC status because eventually with the current scenario, they are likely to become polluted (if not already).

Another threat to GW is the waste from food-animals in feedlots. This waste is only partly regulated, and these animals receive their share of ECs. Routinely they are fed chemicals including steroids, pharmaceuticals, and growth factors. They are also exposed to pesticides. The waste from feedlot operations is usually collected in lagoons lined with impervious membranes. However, the liners can leak, and rain-caused overflow events do occur. Food-animal waste is not an insignificant problem. In the case of dairies alone (not to mention pig and chicken farms) a single cow produces the waste equivalent of 24 humans. In California in 1999 the dairy herd (about 1.3 million head) waste output nearly equaled that of all Californians (Hundley, 2001). Should animal waste receive the same scrutiny as that of humans?

Finally, if we continue to pollute the GW, what will be the repercussions? And since EC concentrations in GW are so low, at what level will there be an impact on the human body? A recent information publication by the National Academy of Sciences stated, perhaps prematurely, that the concentrations are too low to be a threat. And if worse comes to worst, can't we just drink water from plastic bottles made without BPA? Does it matter if aquatic populations crash? And at what concentration of EC contamination does it become unethical? In the final analysis it will depend on the cost society is willing to bear.

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The Changing Face of Academic Geoscience Training...Continued

Robert A. Stewart, CPG-08332

In my previous column I discussed the matter of minimum academic requirements for certification and licensure as a geologist. Not long after, coincidentally, AIPG had a request from an academic department that offered a major program in marine and environmental science. The chairman wanted to know whether his students could apply for AIPG's scholarships, after noting that the school's program was recognized as a "geoscience" program by the American Geological Institute (AGI) and the American Geophysical Union (AGU). I reviewed the department's curriculum, which included only a single, traditional geology course – introductory physical geology. Related courses in physical sciences included oceanography, coastal processes, methods of water sampling and analysis, and meteorology; all courses can reasonably be included under the "earth science" umbrella, and the requirements for collateral sciences were generally comparable to those found in more traditional geology curricula.

From an academic and professional standpoint, I think few would quibble over the status of marine science as a subset of earth science – AGI and AGU certainly did not – and on this basis the students would be unequivocally qualified to apply for AIPG scholarships. For AIPG, the larger issue is whether the same students can qualify for more than student membership, as AIPG's general member status requires a degree in geology, with 36 semester hours or 54 quarter hours of geology coursework. My assessment of the marine and environmental science program discussed above yielded – generously – 26 credits at most that could be counted toward the AIPG minimum.

The intent of AGI and AGU is to be inclusive of geoscientists, and AIPG shares this goal; however, our central mission of professional certification differs, specifically for the credential of Certified Professional Geologist (CPG). Interdisciplinary academic programs in the geosciences are increasingly the rule and not the exception at many colleges and universities, and traditional geology programs often struggle to survive in the face of unenlightened administrators forced to confront shrinking budgets.

How should AIPG react to this situation? The general membership category first became available over 10 years ago to strengthen the organization with professional geologists in addition to those seeking certification, or already certified as CPGs. Part of the reason for the change was the increasing popularity of professional licensure at the state level, which reduced interest in AIPG membership and certification. Perhaps now is the time for AIPG to reconsider the requirements for general membership. Some aspects to consider:

- Should AIPG even be considering this? After all, AIPG is the American Institute of Professional Geologists.
- How should a degree program be recognized as a geoscience program – by AGI, AGU, by criteria to be developed by AIPG?
- Especially within interdisciplinary geoscience degree programs, what constitutes an appropriate breadth and depth of coursework?

We welcome your comments.

Re-Designing AIPG's Emblem – We Need Your Input!

Joey Fiore and I have received a number of thoughtful comments about the proposed, new designs for the AIPG emblem that were published in the January/February *TPG*. We'd like to return to the drawing board soon to incorporate the various suggestions, so please tell us your opinions!

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.

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AIPG Energy Statements

Part 1 of 2

The following is part of the individual Energy Statements in their entirety. The remainder statements will be published in the May/June issue of *TPG*. These statements are also on the AIPG website.

BioFuels

By Keith Long, MEM-0795, Other Resources Subcommittee, Energy Subcommittee, AIPG

Reading the pros and cons of biofuels from different viewpoints reveals numerous claims and counterclaims. This paper examines testable hypotheses from these claims and reports results of studies that may prove or disprove these hypotheses. Definitive proof is largely elusive due to limitations of data, research methodology, and poor handling of uncertainty. Costs and benefits of biofuels production and use are almost entirely estimated using assumptions, approximations, and increasing obsolete data. Unfortunately, these estimates are usually reported as single values, giving the reader no indication of the degree of uncertainty or range of likely values involved. Thus, the reliability of estimates is difficult to assess. The ethanol industry is undergoing a period of rapid expansion and technological innovation. Like other new industries in the past, innovation will lead to lower costs of production, lesser environmental impacts, and increasing efficiency at all levels, from crop production to consumption. Many problems cited below are likely to be solved or mitigated in the next 25 or even 10 years. The future of the industry depends on how well it can compete with other energy sources. The value to society of these subsidies and government policies that support the industry will only be definitively determined with better research that rigorously addresses the uncertainties involved.

Description of Resource

A *biofuel* is any fuel, in solid, liquid, or gaseous state, that is derived from recently dead biological materials. Fossil fuels, derived from long-dead biological materials, are not biofuels. There are many varieties of biofuel, ranging from dried animal dung used as a cooking fuel in some traditional societies to experimental advanced biofuels derived from algae. This paper will treat those biofuels of current and foreseeable future significance to meeting the energy needs of industrialized societies. These are (1) biodiesel, a fatty-acid methyl-ester derived from animal fats, vegetable oils, and a wide variety of plants, suitable for use as a diesel fuel; (2) bioalcohols, mainly ethanol derived from corn and other crops, used as a transportation fuel; (3) biogas, chiefly methane derived from landfills and processing of organic wastes; and (4) various advanced biofuels, such as that derived from algae, currently under development.

Biofuels are directly derived from biological materials and hence are a renewable energy resource. However, significant amounts of non-renewable resources are used in the production of biofuels. The most important are agricultural land, non-renewable fuels used in planting and harvesting, mineral-based fertilizers for the production of biological materials, metals and other minerals used for production and transportation facilities, and the energy used to process and transport biofuels, which may not be from a renewable source.

Technology

The technology of biofuel production and use is diverse and complex and is the subject of ongoing research and innovation. Two technologies, however, dominate current and near-term biofuel production. The first technology is to develop and grow crops high in sugar or starch and use yeast fermentation to produce ethanol. The second technology is to grow crops with high oil content which are processed to produce biodiesel and related fuels. The technology for producing ethanol from plant cellulose, which could make use of significant amounts of agricultural waste, is not currently technically feasible but many promising approaches are under investigation. Research into the production of biofuel from algae is at a very early stage but is promising.

Production Requirements

As of March 31, 2009, the United States had a production capacity, installed or under construction, totaling about 14.4 billion gallons per year ethanol. To produce this much ethanol requires consumption of about 5.1 billion bushels of corn, approximately 20 percent of the US corn crop. Some ethanol plants use cereal grains instead of corn as a raw material and a few pilot plants use corn stover [those parts of the corn plant remaining after harvesting] and other cellulosic feed stocks. The Energy Independence and Security Act of 2007 sets a target of 36 billion gallons of domestic biofuel production by 2022.

To meet increasing demand for corn as an ethanol feed stock, acres of corn planted in the US expanded from 317,000 square kilometers in 2006 to 376,000 square kilometers in 2007, a 19 percent increase that came largely at the expense of soybean planting, which decreased 17 percent during the same period. It had been expected that much or most of the land added for corn production would come from land idled for the Conservation Reserve Program rather than land used for other crops. However, due to the high cost of restoring long fallow land to production and of the acquisition of additional machinery, most land owners have opted to keep these marginal farmlands in the Conservation Reserve Program (Tomson, 2006)

Fuel is required for the boilers used in producing ethanol, to power other plant machinery and infrastructure as well as for transportation of corn into the plant and ethanol to markets. Natural gas and coal are low-cost fuels suitable for ethanol production, electricity provides the balance of plant power and diesel is the principal transportation fuel. Biomass has been proposed as an alternative boiler fuel.

Ethanol plants require 12 to 19 liters of good quality water per liter of ethanol produced. This translates to 1.0 billion to 1.7 billion liters of water per year for an 340 million liter

per year ethanol plant. Most of the water used is released as water vapor from the boiling process, making recycling difficult. Table 1 compares water consumption for ethanol fuel production with that of other major fuels.

ENERGY SOURCE	WATER CONSUMPTION liters per 1,000 kilowatt-hours energy consumed
Ethanol	32,300 to 375,900
Natural Gas	38
Hydroelectric	260
Coal	530 to 2,100
Solar	2,970 to 3,400
Petroleum	15,500 to 31,200
Nuclear	31,000 to 74,900

Table 1. Comparison of water consumption for ethanol fuel production with that of other fuels (Hill and Younos, 2008).

Output

According to the Renewable Fuels Association *(www.ethanolrfa.org/industry/statistics)*, as of March 31, 2009, the United States had 193 ethanol production facilities with a design capacity of 12.4 billion gallons of ethanol yearly. Some 24 plants then under construction would add 2.1 billion gallons-per-year ethanol capacity. Domestic production of ethanol in 2008 was 9 billion gallons, more than double the 3.9 billion gallons produced in 2005.

Transportation

Ethanol is highly corrosive and must be transported by truck or rail using special stainless steel tankers. Pipeline transportation is not technically possible due to water contamination. Hence, ethanol plants must be located where ready access to railroads and highways is available. Given that corn is the largest cost in the production of ethanol, location of ethanol plants near to sources of corn, namely the corn-producing belts in the Midwest is economically advantageous.

Environmental Impact

Ethanol plants use large amounts of water (Table 1) which is mostly vented to the atmosphere as steam. The remaining water is waste that is discharged. The distillation process and burning fuel for boilers generates carbon dioxide which is vented into the atmosphere. Other greenhouse gases emitted from ethanol plants are methane and nitrous oxide. Growing corn and other feedstock crops with fertilizer produces nitrogen pollution of surface waters and some emission of greenhouse gases.

Khanna and Dhungana (2007) estimate carbon emissions from ethanol production from corn as 5.25 kilograms equivalent carbon dioxide per gallon of ethanol, compared with 7.15 kilograms per gallon of gasoline. They show that the use of switchgrass or miscanthus would result in a net carbon credit to ethanol production. These kinds of estimates are subject to considerable uncertainty and variation, depending on assumptions made and how much of the overall life-cycle of ethanol production is analyzed. In theory, burning biomass should have no net impact on carbon emissions because during their life the biomass absorbs as much carbon dioxide as it gives off when burned. Practical mass production of biofuels, however, leads to positive carbon emissions due to energy consumed during production, transportation, and from clearing of grasslands and forests to expand land under biomass cultivation.

Burning of biofuels does result in significantly less SO_2 emissions than for fossil fuels. However, much of this advantage may be lost through a complicated system of biofuels production and distribution dependent on fossil fuels. Biofuels could displace nonrenewable fossil fuels, improving sustainability, but again this depends on the amount and nature of the energy used in the production and distribution of ethanol. Net energy ratio (NER) is the ratio of biofuel energy content to energy consumed for its production and distribution. Positive environmental benefits are obtained when the ratio exceeds one. Estimates of NER for biofuels vary, with some production systems achieving an NER less than one, meaning more energy is consumed to produce biofuels than is obtained from it (Johnson, 2006). In even the best of circumstances, NER for biofuels is significantly less than that for gasoline (about 5) and other fossil fuels. Variation in NER for biofuels is chiefly due to fuels consumed for transportation, with varying transportation distances, which have often been underestimated (Wakeley and others, 2009). In fact, long-distance transportation of ethanol can negate the economic and environmental benefits of using ethanol.

The effects of widespread ethanol production and consumption on ozone layer depletion, acid rain, heavy metal and dioxin emissions, and increased pesticide and fertilizer use have not been adequately evaluated.

Economics

Hauser (2007) reports an estimated break-even wholesale price for ethanol as of 2007 at US$ 1.62 to US$ 2.07 per gallon when corn costs US$ 4.00 per bushel, or US$ 0.86 to US$ 1.31 per gallon when corn costs US$ 2.00 per bushel. These estimates factor in a Federal ethanol subsidy of US$ 0.51 cents per gallon paid as a tax credit to distributors. In general, cost of feed stock accounts for about 40 percent of the final of cost of ethanol, making the industry vulnerable to swings in raw materials prices (Petrou and Pappis, 2008).

Although the Federal ethanol subsidy is paid directly to distributors as a tax credit, the benefits of the subsidy are widely distributed between producers and consumers. The amount of subsidy captured by producers or consumers depends on relative bargaining positions. Those persons owning the scarcest resource, in this case agricultural land, which is often *not* the farmer, can be expected to have the best bargaining position. Other Federal subsidies include renewable fuel standards, the small producer ethanol credit, tax credits for ethanol infrastructure, oxygenated fuel requirements, and tariffs and quotas on imported ethanol.

Data on capital costs for new ethanol production capacity are elusive. A review of financial statements and public announcements of leading ethanol producers revealed little useful information in this regard. Eidman (2007) estimates investment costs of US$ 8.65 per liter of design capacity for a 150 million liter per year ethanol plant and US$ 6.92 per liter of design plate capacity for a 385 million liter per year ethanol plant. At that time (2006) capital costs were rapidly escalating due to increasing costs of materials for construction, fuel, and labor.

The most recent study (Perrin and others, 2009), using data from the latest ethanol plants built in the US, found that these plants were earning more than enough to recoup their capital investments prior to the collapse in oil prices during the second half of 2008. With the drop in oil and ethanol prices, operating margins are now about zero, despite subsidies. This latest generation of plants, however, is significantly more efficient than those built in the past, and better than previously estimated, consistent with the expectation that ongoing technological innovation will reduce operating costs over time.

Data on production capacity and local economic benefits have been made available by operators. A typical example is a plant recently completed in Madison, Illinois, with a capacity of 340 million liters per year ethanol, produced from cereal grains. The plant has a foot print of 32 hectares, employs 60 persons with a combined annual payroll of US$ 4 million. The plant will consume 870,000 metric tons per year of grain (Abengoa Bioenergy press release, September 9, 2008). The plant received a US$ 4 million grant from the Illinois Renewable Fuels Development Program, equivalent to the first year's payroll. Low and Isserman (2007) notes that the small positive economic impact of these plants may not warrant significant subsidies or enticements by local governments.

Many studies (such as Goldemberg and Guardabassi, 2009) show dramatic improvements in efficiencies and environmental impacts from using sugar cane as a feed stock instead of corn. In fact, ethanol produced from sugar cane in Brazil is the only form of ethanol currently produced that is proven competitive with gasoline *without* subsidies (Henniges and Zeddies, 2007). Simply put, it makes more economic sense to produce the world's ethanol from sugar cane in Brazil and other sugar cane growing countries than from domestically produced corn. Such a strategy would reduce costs to US consumers and taxpayers as well as provide substantial benefits to poorer sugar cane producing countries, particularly Colombia and the Caribbean islands.

Costs and Benefits

The long-run price of corn averaged about US$ 2.40 per bushel until about 2006 when increasing production of ethanol and other factors pushed the long-term equilibrium price of corn to an estimated US$ 3.50 per bushel, a 50 percent increase (Good and others, 2007). The net effect of this increase in corn prices is to increase food prices, in particular for meat, and reduce production of other crops, such as soybeans, wheat, and cotton, decreasing exports of those crops. A fundamental assumption of this estimate is that the acreage of suitable farm land is fixed, particularly in the short run, otherwise overall farm output would rise to meet the combined demand for ethanol and food without increasing prices of either.

This estimate of future prices, even if the assumption of a fixed supply of land holds, is subject to a high degree of uncertainty. Factors that could significantly influence long-run prices of corn, grain, and ethanol include crude oil prices, foreign demand for food crops, variations in foreign crop production, adoption of further ethanol usage requirements, changes to subsidies and import tariffs. An increase in the ethanol yield, from the current 2.8 gallons per bushel to perhaps 3.1 gallons per bushel, an 11 percent increase, would reduce the pressure for additional corn acreage. Likewise, average yields of corn per acre can be expected to continue to increase, again reducing demand for corn acres.

Given the relative inelasticity of demand for corn by ethanol producers, short-run volatility in corn prices will significantly increase. Increasing corn prices and ethanol subsidies can be expected to bid up the price of agricultural land.

Large scale ethanol production from food products carries a risk of short- and long-term reduction in global food production. Assessing this risk requires making many assumptions and forecasts. Goldemberg and Guardabassi (2009) posit a plausible scenario for greatly expanded production of Brazilian ethanol, holding US ethanol production at current levels, without any significant effect on world food supplies. Ethanol production can only be expanded at a limited rate, hence effects on food supplies might only become gradually apparent. All agricultural commodities, including derived products such as ethanol, are subject to weather and climate risks, which raise serious questions about the reliability of ethanol supply.

Reserves

Agricultural land of sufficient quality for production of biofuel feedstocks is the scarcest resource for biofuel production. According to the 2007 Census of Agriculture, total cropland in the United States was about 163 million hectares, down from about 174 million hectares in 2002. These figures include land used for everything directly connected to farming, from harvested cropland to farm buildings, pasture to wind breaks, and so on. Some 124 million hectares were devoted to harvested crops, of which about 35 million hectares were used for corn. A bit over 14 million hectares of farmland was enrolled in the Conservation Reserve Program as of September 30, 2006. About 9 million hectares of farmland was devoted to soybeans in 2007. Given that lands in the Conservation Reserve Program are either unsuited or too costly for corn production, and assuming substantial conversion of soy to corn production, an upper limit of 36 to 40 million hectares of corn can be planted. With a hectare producing about 505 liters of ethanol, and using the entire corn crop for ethanol, ultimate production capacity would be about 127 billion liters per year, assuming one crop per year. It is difficult to envision how a 138 billion liter ethanol requirement can be met by 2022 or at any time given these limitations on available acreage.

Around the world, farmland is largely devoted to food production. A recent study has estimated available abandoned agricultural lands globally at 385 to 472 million hectares, which could be used for the production of at most 8 percent of current global energy requirements through biofuels (Engelhaupt, 2008).

Mineral Requirements

No studies could be found of the net impact of increased ethanol production from corn and other biomass upon demand for phosphate and other mineral fertilizers or on any other mineral product used for ethanol production.

Human Resources

Countries with well developed agricultural, food processing, and chemical industries will have no problems securing capable and experienced labor and management for a biofuels industry. Examples include Brazil, which has been a pioneer in the production of ethanol from sugar cane.

Forecast

The current recession has reduced demand for gasoline to such an extent that it is doubtful that Federally-mandated ethanol usage can be met using the current standard of 10 percent ethanol in gasoline. It is generally thought that cars and trucks designed to use gasoline cannot tolerate more than 10 percent ethanol in gasoline. Pure ethanol has a very high octane rating of 106, hence engines designed for lower octane gasoline will perform more poorly, in terms of fuel efficiency, energy output, and other factors, when using gasoline with significant additions of ethanol. Ethanol producers are lobbying for the EPA to increase the mandated use of ethanol in gasoline from 10 to 15 or 20 percent or more. These producers cite studies that found that *some* cars can tolerate up to 60 percent ethanol before the check engine light comes on due to a fuel mixture fault. The National Renewable Energy Laboratory (Knoll and others, 2009) recently tested 16 representative gasoline vehicles with up to 20 percent ethanol in gasoline. With a 20 percent blend, the average loss of fuel economy was 7.7 percent and exhaust emission temperatures (which may affect catalytic converter and exhaust system performance) increased by up to 70°C, but no significant changes were found in regulated tailpipe emissions and no durability or material compatibility problems were found during life-cycle testing of engines. More extensive testing with a larger sample of vehicles is probably required before performing a nationwide experiment with higher ethanol contents in fuels.

Given limitations on available domestic crop land, it is difficult to foresee how domestic production can meet the EPA's long-term ethanol usage requirements regardless of the price of ethanol. In the short- and medium-terms, consumers would be better served by lower prices, and ethanol usage perhaps expanded beyond EPA requirements, by importing lower-cost ethanol from sugar-cane producing countries. In the long-term, a viable domestic ethanol industry that does not constrain food production may be possible based on production of ethanol from agricultural waste, cellulosic materials and algae.

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Carbon Dioxide Statement

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Man-made emissions of carbon dioxide result primarily from fuel use. The Energy Information Agency's (EIA) *2008 International Energy Outlook* estimates annual world carbon dioxide emissions were 28.1 billion metric tons in 2005 and are expected to grow to 42.3 billion metric tons by 2030. Although there is no universal consensus, and while the theories and data concerning the impact of carbon dioxide on the environment continue to be debated, policy makers are moving forward with discussions concerning cap-and-trade legislation as it pertains to the future emissions of carbon dioxide in the atmosphere.

In 2008 the U.S. Department of Energy's National Energy Technology Laboratory (NETL) estimated that the annual carbon dioxide emissions from all stationary sources of carbon dioxide emissions (coal, natural gas, cement manufacture, refining / chemical, etc.) totaled 3.2 billion metric tons in the United States and Canada.

Up to 12,900 billion metric tons of geologic carbon dioxide storage resource potential has been estimated to exist in the United States and Canada (*2008 Carbon Sequestration Atlas* published by the NETL). This capacity for geologic storage, if utilized for stationary sources of carbon dioxide emissions, could stop substantial quantities of carbon dioxide from being put into the atmosphere and mitigate the effects of increasing global use of fossil fuels. The location of major stationary sources of CO_2 and potential reservoirs for the storage of CO_2 are given in *2008 Carbon Sequestration Atlas*.

The United States Department of Energy has currently targeted 2011 as the date for at least one large-scale demonstration of carbon dioxide storage ($\geq$1 million tons carbon dioxide per year). Outside North America, in Norway and Algeria for example, a large number of programs are in progress to develop geologic storage of carbon dioxide. Started in 1996, the Norwegian Sleipner project annually injects about 1 million metric tons of carbon dioxide. Begun in 2004, the Algerian *In Salah* project annually injects approximately 1 million metric tons of carbon dioxide a year. It is critical to note the size and the associated cost of the present projects and that they will have to be replicated thousands of times at locations all over the globe to make a meaningful reduction in atmospheric carbon dioxide emissions.

Although the geologic storage of carbon dioxide is well understood in general, an enormous amount of work remains to be done before substantial quantities of carbon dioxide can be stored in the United States and elsewhere. One example of the lack of detailed site evaluation for geologic storage is given in the article on the Michigan Basin referenced at the end of this article (Smith, 2008).

Geologic storage on a scale that would substantially reduce carbon dioxide emissions will depend on a detailed characterization of the particular geologic reservoirs for thousands of carbon dioxide storage sites. Protocols need to be developed for each carbon dioxide geologic storage site for

- monitoring
- remediation
- verification
- risk assessments.

A review of the development of the above protocols is given in a recent publication by the National Technology Laboratory (2009) and in a recent presentation by V.A. Kuuskraa (2007) on remediation.

Legal and regulatory issues remain to be addressed by the local jurisdictions and the Federal governments as noted in the recent article by Moore (2007). In addition, public acceptance for storing huge volumes of carbon dioxide will have to be obtained.

In order to realize the potential of using this abundant resource of geologic storage for carbon dioxide, the following must be accomplished:

- Focus of work on geologic storage must shift from general descriptions of geologic storage potential to characterizing the geology of specific sites where carbon dioxide sources exist. A suggested methodology for this characterization is discussed in the recent publication by the United States Geological Survey (Burruss et al. 2009).
- Regulatory certainty must be established for the geologic storage of carbon dioxide storage.
- Long term liability for carbon dioxide storage while still providing adequate protection of human health and the environment must be considered.

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Ocean Energy Alternatives A short summary

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Energy resources associated with the oceans are normally divided into three categories: Tidal Energy, Wave Energy and Physico-chemical Energy sources.

A. Tidal Energy Sources

All coastal areas consistently experience two high and two low tides over a period of slightly greater than 24 hours. The methods of converting the energy associated with these tidal fluctuations can be classified into two different approaches, barrage (dam) technology, and tidal fence/tidal turbines, each using slightly different methodology.

Barrage or dam technology utilizes traditional permeable barriers to allow entry of flood tide water into holding basins and releasing it under controlled conditions to operate traditional turbines producing electricity. Tidal fluctuations must have high and low tide differentials of at least seven meters (~23 feet) to implement this technology. Existing facilities using this methodology are the La Rance Estuary, France (240 Megawatt equivalent (MWe) production capacity; Annapolis River, Canada (20 MWe) and several smaller facilities in China (total 5 MWe). Three other sites in Wales are presently in development for a total of approximately 500 MWe capacity.

It is estimated that about 40 sites on Earth have tidal ranges great enough to be utilized for tidal power generation using this technology. Major locations are under study in the Severn River in western England (est. potential production of 12 Gigawatts), the Bay of Fundy, Canada, Cook Inlet, Alaska and the White Sea in Russia.

Implementation of barrage technology requires a tidal range of at least 7 meters; topographic configuration allowing construction of semi-permeable structures allowing containment and controlled release of water on a diurnal cycle; a facility for storage of energy during the low-tide portions of the cycle to permit flow of electricity on a continuing, 24-hour basis; a distribution network capable of delivering the electricity produced by the facility must be constructed to provide the power to points of need; and all structures must be able to withstand high-impact events of storm surges or waves.

Tidal Fence / Turbine Technology both utilize ocean currents to produce electricity. Tidal fences resemble giant turnstiles and would be best located across channels between small islands or straits between the mainland and an island. The turnstiles spin via tidal currents typical of these topographically constrained areas. Some of these currents run at 5–8 knots (5.6–9 miles per hour) and generate as much energy as winds of much higher velocity because seawater has a higher density than air, and ocean currents carry significantly more energy than air currents (wind).

Tidal turbines resemble wind turbines. They are arrayed underwater in rows, similar to some wind farms. In currents of 5.6–9 miles per hour, a 15-meter (49.2-feet) diameter tidal turbine can generate as much energy as a 60-meter (197-feet) diameter wind turbine. Ideal locations for tidal turbine farms are close to shore in water depths of 20–30 meters (65.5–98.5 feet) with constant current flow.

Tidal power plants using tidal fence or tidal turbine technology have the following requirements:

1. The tidal fence turnstiles and tidal turbines function best where coastal currents attain velocities ranging between 3.6 and 4.9 knots (6.45 to 8.0 kilometers per hour ((kph)) and due to structural stresses on the turbine structures 2 and 2.5 kph, respectively. These velocities require location at sites where tidal currents are topographically restricted allowing diurnal channel flow, which can attain the desired flow velocities. *Tidal fences* are best located in tidal passes while *tidal turbines* would ideally be located off-shore in water depths of 20 to 30 meters due to the potential optimal radius (15 meters) of the turbines and constancy of adequate current velocity e.g. Gulf Stream off North America or the Agulhas Current off South Africa.
2. All methods of converting tidal energy to electrical energy will require the development and use of corrosion-resistant materials, e.g. stainless steel, high-strength plastics or other alloys to survive the marine environment.
3. All structures must be designed to withstand the high-impact of storm surges or waves.

Economics

Barrage technology economics are controlled by the ratio between the length of the barrage in meters to the annual energy production in kilowatt hours (the Gibrat ratio). The smaller the Gibrat ratio, the more favorable a site will be for development as a power source. The ratio of the La Rance estuary site is 0.36 and for a proposed tidal barrage site in the Bay of Fundy is 0.92. Actual electricity production costs for the La Rance plant *after payoff of the original construction cost* is now 0.2 Euros/kwh. The facility averages approximately 68 MWh on a 24 hour basis and its production comprises about 1% of the electrical power used in France.

Tidal fence and the tidal turbine technology economics are highly dependent on the velocity of the current or stream in which the facility is located. No full scale commercial installations are yet in operation although numerous facilities ranging up to 10 MWe are in various stages of planning and pilot testing. The Electric Power Research Institute, Offshore Wave Power Feasibility Demonstration Project, (January, 2005) estimated a 2006 levelized cost at 8-12 cents/kWh for tidal energy generation off the Oregon and Washington Coasts with potential for dropping to 4-6 cents/kwh with broader usage of the existing technology. Preliminary investigations indicate that a 1-km line of permanent turbines in the Agulhas Current could generate 100 MWh of power per day.

B. Wave Energy Resources

Basic Discussion

Waves are generated by wind passing over the sea and as long as the waves propagate slower than the wind speed just above the waves, there is an net energy transfer from the wind to the most energetic waves. Both air pressure differences between the upwind and the lee side of a wave crest, as well as friction on the water surface by the wind shear stress causes the growth of the waves. Wave height increases with increases in wind velocity, time duration of the wind blowing, fetch (the distance of open water that the wind has blown over), and water depth (in the case of shallow water effects, for water depths less than half the wavelength.

Technology status/requirements

Wave power methodologies are generally categorized by the method used to capture the energy of the waves. Method types are point absorber or buoy; surfacing following or attenuator; terminator, lining perpendicular to wave propagation; oscillating water column; and overtopping. They can be located either on shoreline, nearshore and offshore. They can also be categorized by location and power take-off system. Types of power take-off include: hydraulic ram, elastomeric hose pump, pump-to-shore, hydroelectric turbine, air turbine, and linear electrical generator. Some of these designs incorporate parabolic reflectors as a means of increasing the wave energy at the point of capture. Some examples of different wave power systems include *Pelamis Wave Energy Converter, Wave Dragon Energy Converter, PowerBuoy, AquaBuoy, SeaRaser, and CETO Wave Energy Converter.*

Locations with the most potential for wave power include the western seaboard of Europe, the northern coast of the UK and the Pacific coastlines of North and South America, Southern Africa, Australia and New Zealand. The north and south temperate zones have the best sites for capturing wave power since the prevailing westerlies in these zones blow strongest in winter. (Figure 1)

Figure 1: Global Wave Energy Power Generation Potential

Status of Wave Power Development

The world's first commercial wave farm opened in 2008 at the Aguçadora Wave Park near Póvoa de Varzim in Portugal using three Pelamis P-750 machines with a total installed capacity of 2.25MW. Future expansion plans will increase the installed capacity to 21MW.

A funded 3MW Wave Farm in Scotland and a Wave Hub off the north coast of Cornwall for a total of 24 MW to provide power for up to 7,500 households. A pilot CETO wave farm of the coast of Western Australia is now ready for further development.

Reserves

Theoretical Deep Water Wave Power resources are estimated to be between 1 Terawatt (TW=10^{12} watts) and 10 TW. The usable world-wide resource has been estimated to be greater than 2 TW.

C. Ocean Thermal Energy Conversion (OTEC)

Basic Discussion

The total insolation received by the oceans = (5.457 × 10^{18} MJ/yr) × 0.7 = 1.9 × 10^{18} MJ/yr (taking an average clearness index of 0.5). Only 15% of this energy is retained as thermal energy. Since the solar intensity decreases exponentially with depth, solar absorption is concentrated at the top layers. In the tropics, typical surface temperature are in excess of 25 °C, while, the temperature is about 5 - 10 °C at depths of approximately one kilometer. This differential can be enhanced when the bottom waters are affected by polar currents generated by the *thermohaline* deep oceanic current system.

Neither convection nor physical mixing mechanisms of heat transfer are operative in the oceans, resulting in a stable thermal stratification with the upper layers remaining hot and the lower layers remaining cold. This stratification results in a practically infinite heat source/heat sink system separated by approximately 1000 meters of ocean water, allowing the potential application of heat engine technology. The tropics are considered to be the best locations for development of OTEC technology as can be seen in the map of oceanic thermal differential below developed by the U.S. Department of Energy's National Renewable Energy Laboratory. (Figure 2)

Designs for OTEC facilities fall into three different types, Closed, Open and a combination of the two processes called a Hybrid, Cycles based on the process used to generate power from the temperature differential at the site and dispose of final water.

Closed/Anderson Cycle

This technology was developed starting in the 1960s by J. Hilbert Anderson of Sea Solar Power, Inc. In this cycle the heat is transferred in the evaporator from the warm sea water

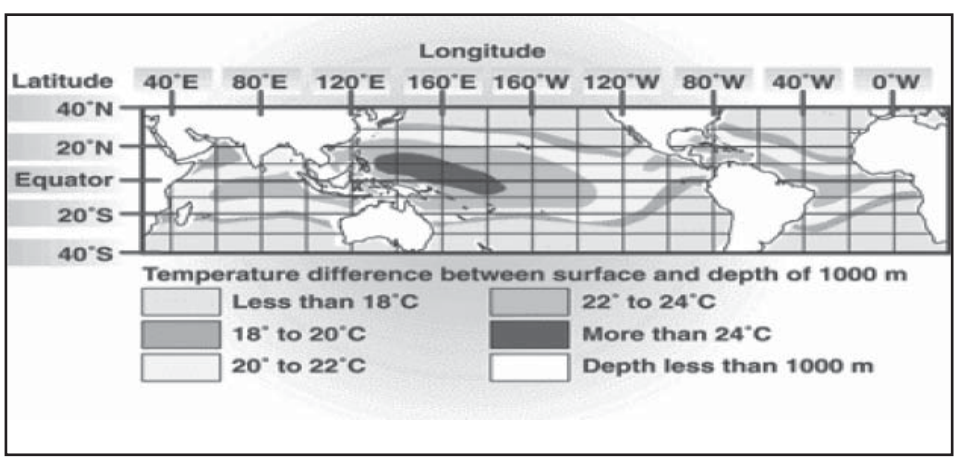

Figure 2: Global Thermal Energy Conversion Potential

to the working fluid (ammonia, CHCs, petroleum products or water). The working fluid exits from the evaporator as a gas near its dew point. The high-pressure, high-temperature gas then is expanded in the turbine to yield turbine work. The working fluid is slightly superheated at the turbine exit and the turbine typically has an efficiency of 90% based on reversible, adiabatic expansion.

From the turbine exit, the working fluid enters the condenser where it rejects heat to the cold sea water. (Figure 3) The condensate is then compressed to the highest pressure in the cycle, requiring condensate pump work. The Anderson closed cycle is a Rankine-type cycle similar to the conventional power plant steam cycle except that in the Anderson cycle the working fluid is never superheated more than a few degrees Fahrenheit.

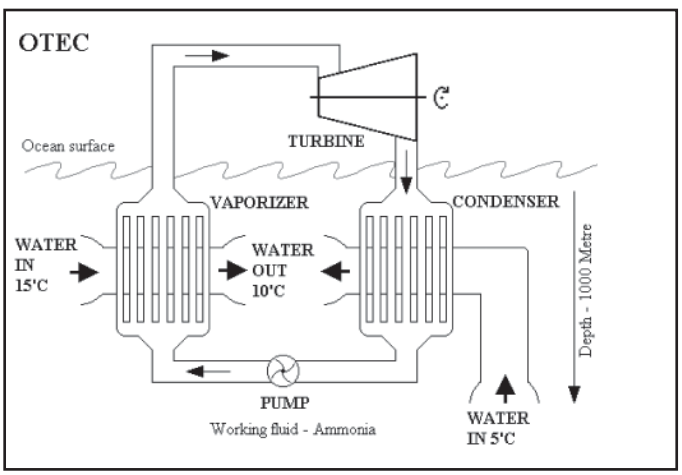

Figure 3: Diagram of a closed cycle OTEC plant.

Open/Claude cycle

The Open Cycle technology is similar to the closed cycle except that the liquid used is steam and is available for other uses after the power generation cycle is completed. When warm seawater is placed in a low-pressure container, it boils. The expanding steam drives a low-pressure turbine attached to an electrical generator. The steam, which has left its salt and contaminants behind in the low-pressure container, is pure fresh water and is condensed back into a liquid by exposure to cold temperatures from deep-ocean water. This method has the advantage of producing desalinized fresh water, suitable for drinking water or irrigation.

Technology Status

The majority of testing of the process has been conducted by the U.S. Natural Energy Laboratory of Hawaii since 1974. Pilot plants have been constructed in Cuba in 1930 (22 kW generated), Nauru, Japan in 1970 (100 kw generated), Tamil Nadu, India Pilot study (1 MW) and Keohole Point, Hawaii (50 kW generated). The Natural Energy Laboratory in 1999 tested a 250 kW pilot closed-cycle plant, the largest of its kind ever put into operation. Present projects in design and development include one for the U.S. Navy base at Diego Garcia, (13 MW design capacity w/1.25 Mgd fresh water as a waste product, and a 10 MW proposed plant at Guam.

Reserves

Existing estimates of global energy reserves from OTEC vary widely. The lowest reasonable value is 3 TW/yr from modeling studies. The highest projection by reasonable authority is 100,000 TW/yr produced by the U.S. Department of Energy.

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Other Resources Subcommittee

Authors: Art Becker, CPG-09001, Gary Edmondo, CPG-11089, Rich Greiner, CPG-08681, Don Harris, CPG-10819, James Howard, CPG-02536, Keith Long, MEM-0795, Joel Renner, Michael Root, CPG-06386, and Claudia Stone, CPG-06048

Biofuels, biomass, hydroelectric, solar, geothermal, and wind make up the largest renewable energy resource group in the Unites State and the world (Table 1). These resources are renewable and sustainable, so a statement of current reserves is generally hard to estimate, with limiting factors such as water, land and the materials required to build a facility often more important than the resource. Additionally, aside from biomass and biofuels, these energy resources do not produce a carbon footprint, except during construction.

Of the US energy consumption in 2007, 7% came from renewable sources, (Figure 1A) with the following distribution: hydroelectric (36%), biomass (53%), geothermal (5%), wind (5%), and solar (1%). This represents an 11% overall growth in the use of renewable resources since 2003.

Historically, renewable resources have been used for electric generation (hydroelectric, biomass, geothermal, wind, and solar), heat generation (solar, biomass, and geothermal), and fuel (biofuels). However, they generally constitute only a small percentage of overall energy generation because of costs compared to traditional sources (coal and petroleum), technology availability, and reliability (Table 2). Additional research and development is paramount to making these more cost effective in the future. At present the national average cost of electricity is $0.121/kWh. Key problems facing alternative energy are: intermittency, specialty metal requirements, water consumption, land use, and distribution.

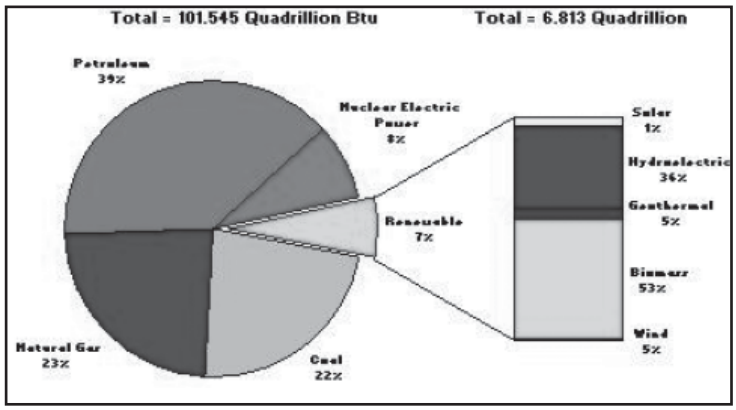

Figure 1A. The Role of Renewable Energy Consumption in the Nation's Energy Supply, 2007.

Existing Resources

Hydroelectric generation remains the largest source of renewable energy in the US (2007). However, overall contribution to the energy grid is declining because no new facilities have been built since the 1980s, and US electricity consumption continues to rise. At present there are 2,378 hydroelectric plants online in the US, down from 3,100 in 1940. Only 3% of the dams in place within the US currently have hydroelectric capability. The National Hydropower Association estimates that an additional 4,300 MW of capacity could be brought online from existing facilities. Additionally, the Idaho National Laboratory states that of the approximately 300,000 MWa of US natural stream energy resources, only about 10% has been developed. From this 300,000 MWa, about 30% is located in areas where development is unlikely, and the remaining 60% has not been developed as an energy source. Hydroelectric power in the US, including both small and large scale projects, is largely untapped because of the environmental and social stigma associated with this resource. INL also states that of the 60% of untapped resource, approximately 100,000 MWa could be feasibly developed using low power and small hydroelectric projects. Large projects have been under taken in China and Africa in the past 10 years. However, social and environmental stigma associated with these projects prohibit development in the US. Production costs are low, since most of the capital is required for dam building. Some development of turbines in fresh water streams (Hudson and Mississippi) is currently underway in the US. However, this is largely an untested and untapped resource in the US.

Biomass electrical and heat generation is the second largest source of renewable energy in the US. This requires combustion of organic material for generation of heat and/or electricity, which produces many of the same emissions as fossil fuels.(Table 3) The

Energy Source Quadrillion Btu	**2003**	**2005**	**2007**	**Growth 2003-2007**
Fossil Fuels	84.078	85.816	86.253	2.6
Coal	22.321	22.795	22.786	2.1
Natural Gas	22.897	22.583	23.625	3.2
Petroleum	38.809	40.393	39.818	2.6
Nuclear	7.959	8.160	8.415	5.7
Biofuels	0.414	0.595	1.018	145.9
Biomass	2.002	2.156	2.165	8.1
Geothermal	0.331	0.343	0.353	6.7
Hydroelectric	2.825	2.703	2.463	-12.8
Solar	0.064	0.066	0.080	25.0
Wind	0.115	0.178	0.319	177.4
Total US	98.209	100.503	101.605	3.5

Table 1. US Energy Consumption by Source.

Sources: Non-renewable energy: Energy Information Administration (EIA), Monthly Energy Review (MER) March 2008, DOE/EIA-0035 (2008/03) (Washington, DC, March 2008,) Tables 1.3, 1.4a and 1.4b. Renewable Energy: Table 2 of this report.

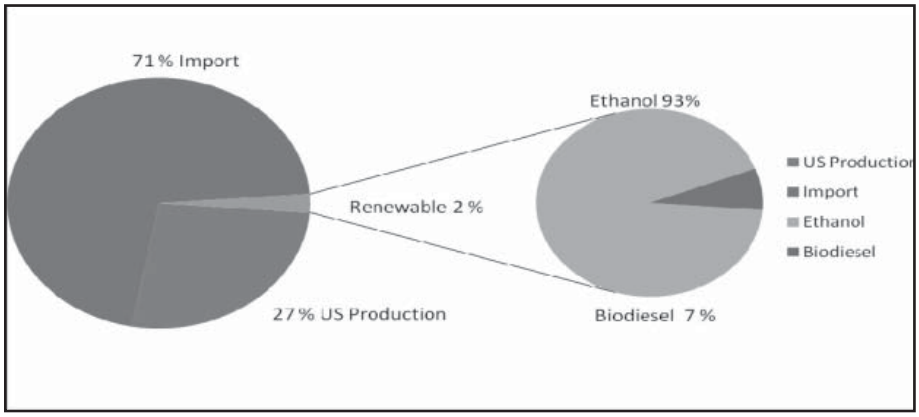

Figure 1B. US Consumption of Hydrocarbons as a Energy Source.

profitable venture. Increased production capacity (4x since 2003) has resulted in increased corn and soybean prices, which translates to increased production costs and increased food costs. At present the US goal is to double biofuel production by 2022, but rising costs and availability of agricultural land may limit growth. Water use (3-7 gallons/gallon of fuel produced) and available agricultural land are two major concerns identified with biofuels. Land use and competition with food crops is the most serious issue facing future development of biofuels. Use of nonrenewable resources such as stainless steel, fertilizer, and other products is also important. Biodiesel also cannot be used in the bulk of the US passenger car and small trucks, which rely on unleaded gasoline. Additionally, both biomass and biofuels face problems with distribution to a larger market, away from source materials.

Geothermal energy is the fourth largest source of renewable energy in the US, but along with biomass has not seen the significant growth of other alternative sources. At present the US is the world leader in online capacity, how-

	Cost/Gallon to Produce	Federal Subsidy	US Yearly Production Capacity	US Capacity under Construction	Plant Construction Costs
Fuel					
Ethanol	**$1.62-$2.07**	**$0.51/gal**	**12.4 G gallons**	**2.1 G gallons**	**$1.80-$2.25/gal**
Biodiesel	**$3.00**	**$0.89-$1.47/gal**	**2.24 G gallons**	**1.23 G gallons**	**$1.00-$2.00/gal**
Electrical	**Cost/ KWH to Consumer**	**Federal Subsidy**			**Plant Construction Costs**
Hydroelectric	**$0.006-$0.04**	**0**			**Unknown**
Biomass	**$0.06-$0.09**	**0**			**$1.5/MW**
Geothermal	**$0.088-$0.092**	**0**			**$3.40/MW**
Wind	**$0.04-$0.09**	**$0.015/kwh**			**$1.00/MW**
Solar	**$0.20-$0.50**	**$0.081/kwh**			**$300M/75MW**

Table 2. Cost to Produce. Costs to produce are operating costs only, and do not include capital. Capital costs are estimated from recent startups (2003 to 2008) in the U.S.

contribution to US energy use via biomass rose slightly from 2003 to 2007, but has not experienced the rapid growth of other renewable energy sources as a result of carbon dioxide generation and product requirements. In the US, biomass energy is generally produced either from combustion of municipal waste (trash) or trees/saw mill waste. Some research shows promise for use of grasses and other fast growing organics. Environmental concerns have prevented biomass energy generated via timber harvest in the US from being a larger more economical source. At present, this resource is largely untapped in the US.

Biofuels, specifically biodiesel and ethanol, is currently the third largest source of renewable energy in the US. This energy source requires conversion of recently harvested biological materials into a usable fuel source. These two sources are popular alternatives to traditional petroleum-based fuels, but production costs are generally much higher. There is no reduction of carbon dioxide with these fuel uses, but there is a reduction of foreign oil dependence (Figure 1B). Federal subsidies have been required to make this a

Alternative Energy	Sulfur dioxide per kWh (lbs)	Nitrogen oxide per kWh (lbs)	CO_2 per kWh (lbs)	Toxic metals
Wind Farm	**0**	**0**	**0**	**0**
Hydroelectric	**0**	**0**	**0**	**0**
Solar	**0**	**0**	**0**	**0**
Geothermal	**0**	**0**	**0**	**Unknown**
Biomass and Biofuels	**Similar to Coal Plants**			
Coal	**.0134**	**.0076**	**2.13**	
Oil	**.0112**	**.0021**	**1.56**	
Natural Gas	**.000007**	**.0018**	**1.03**	

Table 3. Air Pollution Production from Use. Sources: California energy commission, Wind Energy comes of Age, Paul Gipe, 1995, American Wind energy association, EIA Annual Energy Review, 1998. Some geothermal systems contain toxic metals within the steam or fluid, these may plate out on operating components of the geothermal plant.

ever, only six western states (AK, CA, HW, ID, NV, and UT) currently have geothermal power. There is also a small experimental plant operating in Wyoming at this time. Geothermal power relies on heat energy stored in the earth, with the deeper the source point, the greater the energy potential. At present there are two types of geothermal energy, low and high temperature. Low temperature resources are generally used for local heating and cooling of space through heat pumps or direct heating by circulating the geothermal fluid through heat exchangers. High temperature is generally from deeper sources, and uses the geothermal fluid to produce electricity, usually via steam turbines. Geothermal power is capital intensive (5-7 times a fossil fuel system), but has a low operation and maintenance costs. It is estimated that $800 million to $1 billion in capital expenditures will be required to increase US geothermal use from 3 to 10%. Estimated geothermal resources are 130,000 times current development in the US. Traditional geothermal resources have been estimated to be as large as 150,000 MWe with an additional 100,000 MWe from heat co-produced from oil and gas operations and from geopressured-geothermal in the Gulf Coast. Experts have estimated that more than 60,000 MWt of energy are available for direct use and greater than 120,000 MWt can be saved by using geothermal heat pumps. Beyond these conventional resources, are so called Enhanced Geothermal Resources, or resources without adequate fluid for traditional recovery methods. A Massachusetts Institute of Technology led group estimated that 100,000 MWe of base-load electrical generation could be on line in the United States by 2050 with a reasonable investment in R&D. For comparison, 150,000 MWe with 40% efficiency will supply electricity to approximately 44,500,000 homes a year. The use of hydrocarbon fluids and bromine based heavy liquid in geothermal plants as a fluid agent to spin the turbines is an additional requirement.

Wind generated energy is the fifth largest source of renewable energy in the US. This source has experienced almost 200% growth over the last five years. Capital costs for a large wind farm have been steadily declining from $2,500/kw in the early 1980s to the current range of $900 to $1,200/kW, but this still represent approximately 70% of the total investment over the life of the plant. Intermittency is the biggest issue regarding wind energy. Wind generated energy is dependent upon wind conditions, which behave erratically by nature. Support of a wind based system, with other energy generation sources is required to keep a stable electrical grid. Storage studies have been under taken, but the associated batteries require metals production not currently available in the US (lithium, nickel). Resources are unlimited, but capacities are generally in the 20-35% range, compared to conventional sources (95%), as a result of the unpredictable nature of the energy generation source. Use of nonrenewable resources such as steel, copper, and petroleum based products is important to consider. Land use and visual impacts have also been important for the wind farm industry.

Solar generated energy is the lowest source of renewable energy currently in mass use in the US. Growth has been steady over the last five years, but solar has not experienced the exponential growth seen in other sectors. Energy generation growth in 2008 was approximately 9%, as solar panel capacity increased 78% from 2007. However, no new plants came on line during 2008. At present, large plants are 30% efficient, and construction costs are similar to traditional coal or gas plants. Current plants are in the 30-100 MW generation capacity, and require $200-400 million in capital. Lead time for materials manufacturing and construction is also long, with a concentrated solar power (CSP) plant taking 6 years and a photovoltaic facility requiring 4 years to complete. Upfront capital costs are high, as are electrical generation costs (20-50 cents/ kWh), which makes it difficult for solar generated energy to compete with other renewable sources. However, costs have been in steady decline as a result of increased efficiency, technology improvements, and economy of scale. Intermittency, as with wind, is one of the biggest issues facing solar energy. Use of specialty metals and other nonrenewable resources, and land use are important concerns. All exotic metals required are currently mined abroad, not in the US. Water use, and other heavy liquids, used in CSP plants are an important concern, as most areas of high solar activity are also low in available water. Tax benefits, incentives, cash rebates, and net metering help make solar installations more economically attractive to homeowners.

Developing Resources

There are other sources of renewable energy that are currently under investigation in the US. These range from algae based biofuels to tidal generated power. At present these sources are generally higher cost then traditional sources and are in the early development stages.

Tidal energy contains significant potential, as all coastal areas experience two high and low tides over a 24-hour period. However, to be effective, tide differences must be at least > 16 feet. Nearly 40 sites on Earth have fluctuations this large, including Hawaii, the Atlantic Northeast, and the Pacific Northwest. There is no current capacity in the US.

Ocean energy, which uses wave energy and turbines, also contains potential for isolated island regions, such as Hawaii, Guam, Canaries, Azores, South Pacific, where other sources of energy are limited. As with tidal energy, this is in the development stage and is 10-15 years from full production.

Biodiesel production from algae is also being evaluated. Limited production is underway in Florida and the southwestern US. Research into commercial production is a very early stage, with cost generally significantly higher than traditional biodiesel sources from corn.

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Sunsetting the Global Climate Change Committee

John C. Lorenz, AAPG President

The AAPG Executive Committee met at the International Conference and Exhibition in Rio de Janeiro in November to discuss a variety of issues, among them the role and activities of the AAPG Global Climate Change Committee. This standing committee was formed several years ago with the mission statement "to promote and facilitate various fields of geologic study that relate to global climate change and potential solutions." Its unstated mission was to improve AAPG's image after a public relations setback.

The talented and passionate individuals on this committee have served under the able leadership of committee co-chairs Priscilla Grew and John Armentrout, and they have organized several well-attended forums. The committee discussions have been impressive in their range and professional tone. Scientific balance on the issues has been the committee's goal, and over the years this committee probably has come as close to balance as is possible given the nature of the debate.

The committee activities have indeed advanced the goal of improving the public perception of AAPG, but recent developments suggest that they have reached the limit of what can be done without becoming a distraction and undoing that progress. The issue before the Executive Committee in Rio was whether or not the Global Climate Change Committee's discussions and goals are continuing to serve the petroleum-geoscience interests of the AAPG membership.

People on various sides of the climate change issue have argued that AAPG has a moral obligation to take a stand on the climate change questions, and by sponsoring specific forum themes we have in fact implied that AAPG endorses specific viewpoints. But that presumes that AAPG is the keeper of the climate change truth. In fact, during the Executive Committee review, we asked questions such as: Does AAPG have experience or credibility in that field? Will taking a stand help us find oil and gas? Will continuing to be publicly involved create or save jobs in petroleum geology? Does either side have a politically winnable argument? Will staying involved help our public image?

The answer to all these questions was a definitive "No." Unless one merely wants to irritate the opposition, arguably not our mission, there was no advantage to inserting AAPG more deeply into the climate change debate. Climate change is peripheral at best to our science. Moreover, the debate is becoming political rather than scientific, with less-than-scientific passion on both sides. AAPG is not designed to be a political organization.

AAPG, as a scientific association of petroleum geologists, has the mission to foster and disseminate solid geoscience relevant to finding the oil and gas that power today's civilization, and we're very good at it. Our knowledge, expertise and credibility regarding climate change are concentrated in our familiarity with the marvelously wild changes in climate that are documented in the sedimentary and stratigraphic record. Moreover, we are the most knowledgeable people in the world about subsurface fluid flow in heterogeneous geologic media, whether that fluid is oil, gas, or sequestered CO_2, and therefore we can contribute to potential climate change solutions when they are needed. AAPG can and has creditably published on those subjects. In contrast, as a group we have no particular claim to knowledge of global atmospheric geophysics through either our education or our daily professional work.

For our members who want to follow the climate change discussions there are numerous, easily accessed Web sites. If there's a demand, and if it helps us to find hydrocarbons or characterize potential sequestration reservoirs, AAPG can host climate-related technical sessions at our meetings – but like our other sessions, they should be composed of presenters who are doing the primary research.

In the meantime, the Executive Committee saw no advantage and several significant potential pitfalls in maintaining an AAPG Global Climate Change Committee. The AAPG Global Climate Change Committee has fulfilled its mission with passion and energy, providing lively debate. The members are sincerely thanked for a job well done.

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SME to Honor Members

SME Symposium will Honor Professor Haydn H. Murray, CPG-02795, 1991 past AIPG National President, for his life-long contributions to the Industrial Minerals Industry.

Haydn Murray is a highly respected researcher and teacher. He has published over 200 years peer reviewed papers, numerous book chapters and several books including the recently published "Applied Clay Mineralogy." During his career he has advised and mentored over 90 PhD and Master students as well as numerous post-doctoral students. Many of his students have held influential positions within the mining industry and particularly for companies that mine and process industrial minerals.

He was elected to the National Academy of Engineering in 2003 and he is the recipient of numerous other awards including the Hardinge Award, the University of Illinois Department of Geology alumni Achievement Award, Clay Minerals Society Distinguished Service Award, and the pioneer in Clay Science Award. He has served as president of the Clay Minerals Society, SME and AIPG

Also being honored at SME is Douglas C. Peters, CPG-08274, with the Distinguished Service Award and Abani Samal, CPG-11143, with the Young Scientist Award.

James Norris Joins Clear Creek Associates

Clear Creek Associates is pleased to announce that James Norris, CPG-09396, has joined the firm and is based in our Tucson office. Mr. Norris is a highly regarded Senior Hydrogeologist with over 30 years of experience. He provides project management and senior level professional services for contaminant investigations, water resource assessments, permitting, and litigation support. Formerly a Vice President at Hydro Geo Chem, Inc., Mr. Norris' experience and professional interests further broaden Clear Creek Associates' expertise in these areas and we are excited to have Jim as an integral part of our team.

STUDENT APPLICATION FORM

American Institute of Professional Geologists
1400 W. 122nd Ave., Suite 250, Westmisnter, CO 80234
303-412-6205 • Fax 303-253-9220 • aipg@aipg.org • www.aipg.org

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Complete ALL sections. Read the Bylaws and Code of Ethics. If applying between November 1 and June 30, the application fee is **$20;** if applying after June 30, the fee is **$10**. Please PRINT or TYPE.

Current academic standing: ☐ Sophomore ☐ Junior ☐ Senior ☐ Masters Candidate ☐ Doctoral Candidate ☐ Post-Doctoral

Last Name: First Name: Middle Initial :

College/University: Geological Degree: ☐ BA ☐ BS ☐ MA ☐ MS ☐ PhD ☐ None Year:_____

Address: City: State/Zip:

School Phone: Home Phone: E-mail:

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

Applicant Signature: Date:

Have your faculty sponsor complete the statement below before submitting **OR** AIPG will contact your sponsor(complete name & ph. #)

Faculty Sponsor's Statement

I certify that I am a member of the faculty of the _____ department at _____ _____, with the rank of _____, and that the statements made by the applicant in this application are true to the best of my knowledge or belief. I am ____/am not ____ the applicant's faculty advisor.

Name: Phone:

Sponsor: Signature: Date

Robert G. Font, CPG-03953

1. Laboratory tests and analyses show that we have found an orthorombic mineral specimen with a specific gravity of about 3.5 and whose chemical composition is $Al_2SiO_4(OH,F)_2$. What specific mineral have we found and what "hardness" would we expect for it to exhibit?

   a) Kaolinite; hardness of 1-2.
   b) Topaz; hardness of 8.
   c) Albite; hardness of 6.

2. Which of the following geographic features identifies an area where we may go to specifically study concordant plutons?

   a) Henry Mountains, Utah.
   b) Vosges Mountains, France.
   c) Picos Hill, Brazil.

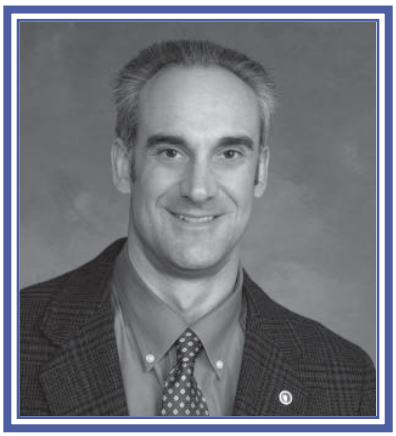
3. Our field work leads us to the recognition of specimens of *Parawocklumeria* in a shale. What likely geologic stage of the stratigraphic column defines our finding?

   a) Rhaetian.
   b) Tithonian.
   c) Fammenian.

4. In our studies of structural geology and tectonics, it is sometimes important for us to define a normal vector to a given surface at a particular point. This may be done utilizing the mathematical concept of "gradient." Thus, for the surface defined by $X^2+3Y^2+2Z^2-6=0$ what is the normal vector "Vn" at point P: (2,0,1)?

   a) Vn = 4i+4k
   b) Vn = 8i+2j+4k
   c) Vn = 4i+4j+6k

Answers on Pages 38



Arouse and Fulfill

Michael D. Lawless, CPG-09224

How often have we all heard from clients, colleagues or coworkers that if we had only communicated more clearly problems could have been avoided or at least resolved more quickly? Poor communication often results in conflicts. Given that the purposes and goals of AIPG involve communication of some sort either internally (with fellow members) or externally (with the general public, legislators or representatives of sister societies), clear, concise communication is directly linked to AIPG's success.

Many of the issues that are in the news every day, including those relating to energy, natural resources, water, and environmental concerns, whether at the local or national level, are related to the geological sciences and the solutions for addressing these issues would benefit from the geologist's perspective. The challenge is establishing a network of contacts to communicate with and then following through with an informative message.

Although geologists may be more imaginative or creative than other scientists based on our training in three-dimensional thinking and our perspective of deep time, we are still trained as scientists; and, this can get in the way of successfully communicating our message, particularly to the general public or elected officials. Randy Olson explores the issue of communicating scientific information in his new book, *Don't be Such a Scientist.* Olson was a marine biologist who left a tenured position at the University of New Hampshire to "go Hollywood" and make movies. *Flock of Dodos* about the evolution/intelligent design conflict and the Dover trial is one of his films. His book talks about how scientists are trained to question everything, evaluate detailed data, and present accurate conclusions. Scientists are also trained to write papers for peer-reviewed journals in a particular way that is clear, concise and accurate, but usually dry and indigestible by most non-scientists. This training interferes with communicating scientific concepts to the public. Don't get me wrong, I understand that details and accuracy are important, often critical, but it can turn people off if that is what they hear first.

Olson introduces a communications strategy he calls "arouse and fulfill." The information, data, and details of science are not particularly interesting to a general audience. A hook is needed, a story, or creative approach, to grab their attention and interest before presenting the supporting data; and even then the data needs to be presented in the context of a story. This has always been true to some degree; we are after all story-telling animals. But it is even more critical in today's "infotainment" age. Once the audience's attention is grabbed (the arousal component) they are more likely to be invested in the message and interested in the details (the fulfill component).

This is not a recommendation for the further "dumbing down" of science. It is simply a recommendation to know your audience and adjust your communication style or strategy accordingly. We all do this in our professional lives. We communicate in the details, data and TLAs (i.e., three letter acronyms) with our coworkers and colleagues; we communicate at a more general or conceptual level using less jargon with our nonscientific clients. We need to realize that when communicating with our elected representatives (who are after all members of the general public and most of the time nonscientific) we should use the latter approach, and carry it even further using the arouse-and-fulfill strategy; hook them with relevant, provocative concepts and follow that with the more detailed information to the degree that time allows. When we are speaking to a school group or a community group (e.g., Rotary or Lions Club), we may have 30 minutes or more to convey our information; however, when we speak with our elected representatives we are more likely to receive an audience for only 5 or 10 minutes. This brief time period makes it even more critical to avoid the details, focus on concepts and relate those concepts to important and relevant issues. It is also important to use this opportunity to begin building a relationship with your elected representatives, and develop a rapport and trust so that when they need data or more detailed information they will come to you. This approach will not guarantee success, but it has a better chance of being successful than communicating with overly technical or detailed information.

While the characteristics of the general audience may have changed over the past several decades given the proliferation of information sources and electronic gadgets, their appetite for and interest in scientific information (when appropriately packaged) remains high. This interest is illustrated by the success of such television shows as CSI, MythBusters, Numbers and The Big Bang Theory. The proliferation of information outlets and electronic gadgets also presents us with new communication tools for us to spread our message if we can adapt our communications strategies to the general audience. Of course, all this comes with both positive and negative aspects.

The bad news is that for many of us the arouse-and-fulfill method of communication does not come naturally, and

our training as geologists has moved us farther away from easily communicating in this manner. The good news is some us can naturally communicate this way and we can all retrain ourselves through the awareness of needing to adapt our communications strategy to each audience. The better news is that the geological sciences are filled with some of the most interesting stories around (and I'm not just saying that as a geologist) so the raw materials for success are readily available.

I'm not sure I have "practiced what I preached" in this article, but hopefully you persevered and found at least a bit of useful information. As Olson writes, when you are not quite connecting with the public try to not be such a scientist.

OPUS

Invitation from AIPG to Submit Article

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) 412-6502.

Climate Change and Society Governance

William J. Siok, CPG-04773

There have been a number of columns, opinion pieces, and letters to the editor (about climate change) appearing in the *TPG* during the previous two years. The AIPG Executive Committee established an ad hoc committee to fashion a position statement which would adequately represent AIPG membership about the topic.

It seems that AIPG was inadvertently following very closely in the footsteps of our sister society, AAPG, which also published columns and letters to the editor while simultaneously establishing a Climate Change Committee to write a position statement which could be said to represent the association's membership. Unfortunately, there was anthropogenicity to consider.

The issue of anthropogenicity is contentious enough an issue that it began to polarize the AAPG membership. Because so many geologists have an unflinching point of view about this issue, the conviction with which these points of view are held had (has) the potential to seriously disrupt the governance of any otherwise cohesive scientific society.

This excerpt from AAPG President John Lorenz's column (EXPLORER, January 2010) could easily be a description of AIPG's struggle to address climate change:

"People on various sides of the climate change issue have argued that AAPG has a moral obligation to take a stand on the climate change questions,… Unless one merely wants to irritate the opposition, arguably not our mission, there was no advantage to inserting AAPG more deeply into the climate change debate." AAPG has retired its Climate Change Committee. (The AAPG EXPLORER is accessible through the AAPG website, and John Lorenz's article appears in this issue of *TPG* on page 28.)

The recent history at AAPG is now being relived at AIPG, albeit on a less formal level. Well intentioned members have been arguing about a decision by the AIPG Executive to cease the publication of articles and opinion pieces concerning climate change in the AIPG news journal The Professional Geologist. There are members with opposing points of view who feel that AIPG should take a position. I urge all to read John Lorenz's column in its entirety and to recognize that for AIPG to go further in trying to come to an internal agreement about climate change phenomena is not reasonable.

AIPG's mission is to advocate and educate. AIPG participates in efforts to address statutory and regulatory issues on the state and national levels which impact the profession. AIPG cannot, particularly when the broader scientific community cannot, adjudicate the current scientific debate regarding climate change and its causes.

AIPG members will continue to put forth particular points of view, which is their purview, and the AIPG Executive Committee will soon recommend a mechanism for the scientific technical debate to continue informally and unofficially.

The question of anthropogenicity of climate change is contentious. The debate should not become so heated as to destroy associations' collegiality or effectiveness at representing membership and the profession.

The Geological Survey Program, South Dakota Department of Environment and Natural Resources (DENR), has an opening for an entry level Geologist. The position will be based out of Vermillion, South Dakota. The starting wage is $19.86 per hour. The official job posting, and instructions on applying for the job, can be found at *http://bop.sd.gov/workforus/*.

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

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

AIPG E-Mails with Job Vacancy Announcements

One of the services AIPG provides for its members on both a national and sectional basis is providing announcements of job openings. These job announcements can be included in the *TPG* or Section newsletters or in the e-mail distribution lists used by some Sections. The AIPG group on LinkedIn.com has a job board with one posting as I write this. In the current challenging economic times, such job announcements are generally welcomed. For those AIPG members who have job openings, using AIPG to advertise your position can be time and cost effective, particularly when e-mail is used.

However, AIPG occasionally receives a message from an employer who is upset that these AIPG job announcements are trying to poach her/his employees. It can't be both ways; either we distribute job announcements or we don't. Most members prefer that we distribute them. For those employers concerned about losing employees, I have several questions. Are you providing a working environment that your employees value and enjoy? Do your employees believe that they are being compensated fairly? Do you recognize that there are times when someone is going to leave you regardless of working conditions or work environment? The point being that an employee who looks at the job market and elects to stay with the current employer will know why he or she is staying and will most likely be more content with the position. Those looking to leave will do so sooner or later.

My personal observation is that both you and your employees ought to be aware of what's happening in the job market. During my 21 years as a geologist for the US Securities and Exchange Commission, I periodically received calls from head hunters and saw various job opening announcements. It was 21 years before a consulting job became more appealing than continuing with the SEC. Others would have made different choices that reflected their personal employment goals and other factors.

Issues Presented by Climategate

The so-called "Climategate" issue arose from the hacking of the Climate Research Unit of the University of East Anglia's computers and the downloading of 160 MB of data including more than 1,000 e-mails and 3,000 other documents related to climate research in mid-November 2009.[1] Some of the e-mails included discussions of how to combat the arguments of climate change skeptics, unflattering comments about skeptics, queries from journalists, drafts of scientific papers, and discussions of efforts to shut out dissenters and their points of view, and destroying various files in order to prevent data being revealed under the Freedom of Information Act. Several aspects of this incident are troubling from an ethical perspective.

The first issue is that the information was obtained by hacking, the unauthorized access to the Climate Research Unit's computers. British police authorities confirmed that they were "investigating criminal offences in relation to a data breach at the University of East Anglia." While I have no information on the results of these inquiries, hacking is illegal. The fact that the person(s) who committed the hacking did not publicly identify themselves demonstrates their lack of moral integrity that might otherwise be a basis for arguing that they had a moral obligation to obtain information that should have been made public (see "Integrity, openness, and exceptions to the general rules," column 87, September 2003).

A second issue involves the issue of whether at least some of the material should have been made public in the first place. In particular, the data used to support the so-called "hockey stick" graph of recent temperature increases is the type of data that should be available to others so that the validity of the conclusion can be assessed. Disclosure of such data is supposed to be part of the normal scientific research process.[2]

A third issue involves the use of the word *trick* in describing a suggested sta-

1. *TPG* publication schedules are such that addressing the issues presented by the "Climategate" issue couldn't be addressed until now. I accessed *http://en.wikipedia.org/wiki/Climatic_Research_Unit_hacking_incident on 1/8/10* for a summary of the incident in preparing this discussion.
2. Because work for employers or clients may involve confidential information, disclosure of such data is usually not appropriate or ethical. This is not the case with publicly supported research data and discoverable through a Freedom of Information Act request. Destruction of such data to prevent disclosure is also illegal.

tistical technique to be used in analysis of the data. There are a wide variety of statistical techniques that can be employed to analyze data, some of which are appropriate for the data in question and some not. In addition, the graphical presentation of analytical results can be used to emphasize or dampen results due to the scales used (see "The ethical use of statistics," column 32, July 1998 and "Lies, statistics, and 'spin': sea level rise," column 104, July 2006).

I bring these issues to your attention not with the intent to debate climate change issues but to reflect on our individual use of data, statistical analysis, and graphics to support the conclusions in our own reports. It is natural to present data and its analysis in a form that supports that conclusions we reach. But in doing so are we fooling ourselves and others intentionally or not? Are we using appropriate analytical and/or statistical techniques? As I pointed out in "Assuring the reliability of your sampling results: the LA abrasion test" (column 121, May 2009), the LA abrasion test is not a reliable test despite having an ASTM standard number. Do our graphics fairly represent the data presented? As I noted in "Honesty in science: acknowledging uncertainty, Feynman" (column 52, March 1999) fooling ourselves is something we must carefully guard against. What uncertainties exist in our approach to a problem. Have we acknowledged these uncertainties?

As previously noted in "Fiddling with the data, [is] the ultimate scientific sin," (columns 47 & 49, October & December 1999). A less clear-cut example of a problem in data analysis was presented in "Case history: changing the contours—what would you do?" (columns 86 & 88, August & November 2003). In my paper, "Are scientific honesty and 'best practices' in conflict?", I present an example of two different contouring algorithms applied to the same data set as examples of the differing results and potential consequences of selecting one method or the other (July 2005, p. 49). In "Whitewashing toxic chemicals and the ethical use of statistics," I noted that some statistically (mathematically) correct results are geologically meaningless (column 117, September 2008). These examples indicate that we must be careful and thoughtful in our data analysis to ensure that we are not using some sort of "trick" to fool ourselves and others in reaching our conclusions.

RISK MANAGEMENT IS GOOD BUSINESS

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Recently I was reviewing the website of Layton Construction, a Utah based company that was founded in 1953. The company history section of their website relates some advice that the retired company founder, Alan W. Layton, passed on to his sons and others at the company. What follows is those various points and a discussion how each of these good business points tie back into risk management.

1. Only contract and work for those that pay.

   This point has both business related and risk management related value. I have touched on this topic in a number of my columns in the past, but these points are worth revisiting. The goal for most, if not all, businesses to make a profit. Some businesses are more successful at attaining this goal than others. If you have clients who don't pay, it is going to be rather difficult to be profitable. The cash flow problems caused by slow pay or no pay clients has far reaching impact on a company. In addition to the obvious issue of employee payroll, there is also the issue of discretionary spending for equipment maintenance and upgrade or employee training. These factors can affect your ability to provide quality services and your ability to meet your client's needs.

2. The company hallmark has been and should always be quality.

   The importance of doing quality work should be obvious. If you are able to do quality work, then the number of professional liability claims should be at a minimum. Quality work enhances a company's reputation and makes it easy to get repeat business from clients. Acquisition cost for repeat business is usually going to be significantly less than the acquisition costs for new business, so quality work should lead to long term profitability. Of course, this assumes that the project was priced properly.

3. We pay our bills on time.

   While there is no direct risk management aspect to this, there is a business aspect. Not paying bills on time subjects your company to fees and interest on those goods or services where payment was delayed. This obviously cuts into your profits. Late payments can also limit your company's ability to borrow money at the most favorable rates. The higher the cost of capital, the lower your profits will be.

4. Employ quality employees and work with skilled subcontractors.

   This one is fairly obvious. Quality, trained employees are the key to your firm providing quality work which enhances your firm's reputation. Working with skilled subcontractors is often overlooked as firms try to use the lowest bid subcontractor on a project to maintain profitability and to win the job. But there are times that the low bid subcontractor creates issues that may result in a professional liability claim or that damages your firm's reputation. Remember that the client hired your firm but in most cases if the subcontractors creates a problem, the client views is as your firm causing the problem.

5. Stay clear from lawyers and legal entanglements. Compromise is better than a courtroom confrontation.

   This one is easier said than done but if you follow the other points laid out by Mr. Layton, then you have a good shot at this one. His statement that "Compromise is better than a courtroom confrontation" has some value in that the costs to litigate matters can be expensive when your lawyer is billing you at $200 or more per hour.

6. Maintain a sound financial base.

   Having sound financials is going to depend on some of the points already discussed on this list such as working for clients who pay and paying bills on time. But the idea of quality work and quality employees is part of that as well because without the quality you will probably not have many clients.

7. Get involved with all employees. Let them know you care about their well-being.

   This one is more touchy-feely than anything but I do think it is important. Your firm really can't exist without the people and it is important that employees feel they are an important part of the firm regardless of what their role is. There is an anecdotal story involving President Lyndon Johnson who when visiting a NASA installation witnessed a janitor who was working particularly hard. President Johnson asked the janitor what he did here and the janitor replied that he was helping put a man on the moon. This janitor was obviously not a rocket scientist (not many of us are) but he knew he was part of something bigger. I don't know how exactly you build a workplace environment where a janitor will answer a question in that manner but I'm certain it starts with how employees are treated.

8. Safety is good business. Insist on a clean, safe workplace.

   Creating a safe workplace is the right thing to do from an ethical standpoint, but beyond that it makes good business sense. Many clients have specific requirements about their vendor's safety records before a vendor's bid can even be considered. Too many job site injuries may eliminate your company from consideration. Poor safety practices can also increase your worker's compensation costs. From a practical standpoint, if an employee is out

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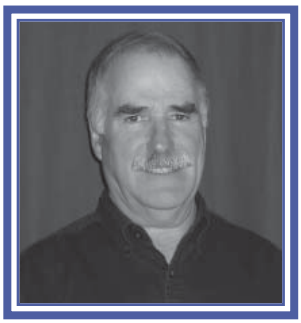

Feel Free to Check My Work

William J. Stone

At some depth everywhere, the ground is saturated. Conceptually, this regional zone of saturation forms a continuum underlying all land forms. The water table is simply higher in elevated areas than in adjacent lowlands.

Ideally, this pattern should apply to basin-and-range settings as well. However, at a mine in basin-and-range country where I once worked, there was an interesting twist to this model. There were springs in the ranges well above the regional water table documented to exist in the basins. Furthermore, the springs were all at approximately the same elevation. Hydrologists modeling the ground-water system of the area interpreted the springs as merely an expression of the elevated water table in the uplands. But modeling showed that there was no permeability (transmissivity) low enough to keep water that high, if it were indeed connected to the regional saturation underlying the adjacent basin.

The alternative explanation is that the water discharging at the springs is associated with a perched zone of saturation. Structural conditions were amenable to such an interpretation. There was a major regional thrust fault in the geologic column of the uplifted range. Ground water could be expected to be perched above the impermeable gouge developed along the sole of this thrust. That simple interpretation stood as a working model until I met one of the exploration geologists who had always wanted to ask a hydrologist why water rose as high as the top of the drill mast when they cored at a site on the flank of the range. When I added the height of his drill mast to the elevation at his drill site, it was the same as the elevation of the various springs. So, not only was the water perched, it was also confined. Listric faults rising from the thrust plate apparently provided both the artesian pressure and pathways to the springs.

None of us had ever heard of perched artesian water before, but that's what everything added up to. However, the concept was so foreign to my boss and one of my colleagues that they decided to test it (behind my back) by drilling a well on the range at a lower elevation than that of the springs. The well flowed with water rising to essentially the level of the springs. Although I never attained god-like status, I came close. TIP: No matter how unusual your interpretation, if it is supported by observations and sound principles, it must be true.

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). Fee free to argue or agree by e-mail: *wstone04@gmail.com*.

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.

ANSWERS TO QUESTIONS ON PAGE 30

Answers:

1. The answer is choice "b" or "topaz" [$Al_2SiO_4(OH,F)_2$], an orthorhombic hydrous fluoro-aluminum silicate, with a hardness of 8 and specific gravity of approximately 3.5.

   Kaolinite is a monoclinic clay mineral and a hydrous aluminum silicate [$Al_4(Si_4O_{10})(OH)_8$] with a specific gravity of around 2.6 and hardness of 1-2.

   Albite or sodium plagioclase feldspar [$NaAlSi_3O_8$] is triclinic with a specific gravity of around 2.7 and hardness of 6.

2 The answer is choice "a"' or the diorite porphyry laccoliths (massive concordant plutons) which form the Henry Mountains of Utah.

   The Vosges Mountains are located in eastern France and illustrate a typical example of fault-block and horst & graben structures.

   Picos Hill in Brazil is a model example of a volcanic neck, volcanic plug or lava neck.

3. The answer is choice "c" or "Fammenian" Stage of the Upper Devonian Period. *Parawocklumeria* is an Upper Devonian ammonoid, a member of the Family "*Clymenidae*."

   The "Rhaetian" and "Tithonian" stages do not apply here, as they respectively represent the uppermost stages of the Triassic and Jurassic periods.

4. The answer is choice "a" or Vn = 4i+4k. The proof follows:
   - If f(0) of $f(x,y,z) = X^2+3Y^2+2Z^2-6=0$, then:
   - grad f = 2Xi+6Yj+4Zk.
   - Then, if grad f = 2Xi+6Yj+4Zk, at point P: (2,0,1):
   - grad f = 4i+0j+4k.
   - Thus, Vn = 4i+4k.

PROFESSIONAL LIABILITY AND RISK MANAGEMENT - Column 30

Continued from page 36

of work due to injury, how is your firm going to fill in the talent gap while that employee is out? How long do you think good employees are going to stay around if their employer has shoddy safety practices? As you can see, safety makes good business sense.

9. Act instead of being forced to react.

   When I working for a consulting firm, I had a manager whose pet phrase was "to be proactive rather than reactive." Looking back at it, it was wise advice. Whether it is addressing job issues/complications with the client when they happen or setting up professional development programs for employees, it is better to address the problems up front rather than waiting.

10. Cultivate good relationships with architects.

    This point is really contractor specific in that they have to deal with architects on a regular basis. However, this advice extends to whatever entities that you are going to have to deal with on a project whether it be a drilling subcontractor or a local regulatory representative. Make sure you have good relationships with those folks who can make your life easier and increase the likelihood that your project goes smoothly.

11. Modern tools and equipment, well maintained, complement a tight schedule and a good job.

    If the equipment breaks down or is simply unavailable it is going to be difficult to stay on schedule and do a good job. You might be able to get the job done well but if you don't meet the schedule then your client not going to think it was a good job.

12. Every project must carry its own weight. Volume means nothing without a fair profit.

    Be careful taking on those projects that might be loss leaders. I've dealt with folks who have underbid a project to help get their foot in the door with a client. Their theory is that it will lead to additional work with that client, but this usually doesn't get the expected result. Because the job was underbid, something has to give. Usually, the job quality suffers or you are asking the client for additional monies to complete a project. This will usually not lead to repeat business from the client.

Send comments to Martin J. Andrejko, 665 Norwood Road, Downingtown, PA 19335, *mjandrejko@gmail.com*, phone (484) 888-6747.

My Old Kentucky Home (with apologies to Stephen Foster)

Stephanie Jarvis, SA-1495

Back in the brachiopod and bryozoan-infested Ordovician limestone of the Bluegrass for winter break, my attention has once again been brought back to the happenings of the world outside of my Wooster bubble. In my first week home, the paper out of Louisville, *The Courier-Journal*, seemed to be on a coal streak—two days in a row it was front-page news. Tom FitzGerald, a lawyer with the Kentucky Resources Council who I had the great pleasure of meeting this past summer, was pictured in an article on December 18th about the suspiciously quick notification of an Alliance Coal lobbyist regarding the firing of Ron Mills, the director of Kentucky Division of Mine Permits, who had refused to issue permits under a policy he deemed illegal. The next day a picture of a subdivision being built on recently reclaimed land in Perry County graced the front page with an article about the different religious perspectives on the issue of surface mining. In the following days, articles dealt with the proposed expansion of the LG&E ash pond right on the Ohio River, the violence surrounding the issue of mountaintop removal, a proposed coal-to-gas plant in Wyoming, the conversion to natural gas or shutting down of two out of four Duke Energy coal-fired units across the river in New Albany, and the never-ending shortfalls of mining safety. Of course, these articles were sprinkled among news on the happenings at the climate-change summit in Copenhagen, health care, the snowstorms, the Cats making 2000 (basketball wins, that is), and general good ol' Kentucky politics (Gatewood Galbraith: "a perennial candidate because Kentucky's got perennial problems"). It's nice to know some things haven't changed.

It was in the Sunday forum section on December 20th that I found words by one of my favorite authors, Wendell Berry. Berry was responding to a piece published the previous week by four Kentucky university/college presidents, in which the presidents address the need to "prepare for a very different energy future" and assert their dedication to focusing higher education and K-12 on STEM (Science, Technology, Engineering and Mathematics) initiatives in order to do so. Nobody will argue with the prospect of a "very different energy future," or the importance of STEM education, but Berry takes issue with the specificity of the presidents' goal. He points out, very correctly, that energy is one of many equally pressing and interrelated problems that need to be addressed. Focusing education on what is seemingly relevant to this single issue excludes many other possible solutions to it and others, contradicting the concept of a liberal arts education that has so much to contribute, even outside of the sciences, to "energy research and development." As Berry puts it, "An unsolvable problem of education is that nobody can foretell what may be relevant." To focus education, from kindergarten through college, on four subjects in order to address one issue is not preparing students to face the challenges of the future, nor is it equipping them with the knowledge and skills they need to be good citizens, good stewards, or good teachers.

On a different note, of the four institutions (University of Kentucky, University of Louisville, Centre College, and Berea College) represented by these presidents so concerned with energy and climate change, only one (UK) offers a geology degree (UK and UL also have geography programs). I'd also like to point out that as a product of the Kentucky public school system, which these presidents hope to and are in a position to influence, I didn't know what "geology" was until I was a senior in high school looking at colleges and a family friend suggested I might be interested in it. I know there is an effort to change this-at the recent GSA meeting I spoke with a woman from Morehead State University who was presenting a poster on a teaching method to train teachers to teach earth science, and she explained the difficulty of finding (and funding) earth science teachers, even though schools are technically required by the state to teach the material. This might be a good starting point for the presidents—how can students be expected to solve energy problems without an understanding of where the energy comes from? With a good background in STEM (including geology) as well as a healthy dose of history, politics, and literature, students should be well equipped to make the necessary connections between science and culture to solve the problems of tomorrow. They might be able, for instance, to take a look at the process of surface mining, and then at the health crises in Eastern Kentucky, and see how the two are related in causes and effects to each other and to other issues like soil loss, water contamination, drug use, or poor education in the area, and how one or more of these related causes and effects might also be at the heart of, say, global warming.

Stephanie Jarvis, SA-1495, is a 2009 AIPG Scholarship Winner. She is junior at The College of Wooster with a double major in geology and biology. Originally from Shelbyville, KY, Stephanie is very interested in water quality issues, especially those pertaining to her region.

An Article Rises from the Ashes, and the Importance of Appearances

Joseph J. Fiore, Jr., SA-01164

After taking a hiatus from my usual article to complete the policy piece from the January/February issue, I return here with a renewed vigor. I was relieved to see in that last issue that Stephanie Jarvis has stepped up to the plate to write the "Student's Voice" column. Now I no longer have to worry about making the ugly choice between squeezing my article into the progressively narrowing box afforded by a graduate's perspective on student life, and trying to convince everyone that being a "student of the profession" is legitimate grounds for writing an article entitled "Student's Voice". As Michael Bersch so accurately put it in his January/February article, "we are all students", so the latter argument didn't fly. Just the thought of continuing a student's article was proving exhausting.

With that being said, this article will henceforth be known as "Young Professionals". The purpose of said article will be to cover topics of interest to budding professionals, many of which were conveniently kicked off for us in the last issue of TPG: all aspects of the job search, early career professionalism, transcribing your book knowledge into technical skill, the ins and outs of work in the various earth-science industries, current events and policy related to our field, as well as sharing some of the career wisdom of our more experienced members. In case anybody is wondering, the official theme song of this new article will be "Young Professionals" sung to David Bowie's "Young Americans".

This new focus is exciting, as I think there are a lot of interesting points to cover here, and it will be energizing to embark on a discussion of the early career developments of competence, integrity, and ethics, which feels actually more relevant for this publication. Additionally, this is a perspective from which I can speak more naturally, as these are the issues I am now exploring myself, as opposed to those on which Stephanie will be able to speak more accurately. As promised last year, I will follow up in discussing the lessons learned from my own job search in the next issue. To Stephanie, best of luck with the "Student's Voice", share with us the honest perspectives of you and your classmates, and enjoy the experience.

On another note, the logo change cat has now been fully let out of the bag. I want to thank first our incredibly talented, creative, and patient graphic artist Chris Ronzio, for the months of hard work he put in to produce page after page of designs. He's a truly solid graphic designer, and has done great work on many different projects. Forthcoming issues of *TPG* will feature ads for his invaluable services, but I would be happy to connect anyone interested in speaking with him in the mean time.

Secondly I'd like to thank all of you for the outpouring of feedback about the proposed logo revisions. I've been totally overwhelmed by the number of people interested in contributing to its design. Most of your comments have been positive, encouraging its development and offering notes on the options Bob has presented. Others have been disappointed that we are considering replacing our tried and tested brand, which is also understandable. To everyone interested, allow me to offer my thoughts on the importance of this project.

While the existing emblems are nice and traditional, at first glance they do appear to be dated. The fonts and colors alone give them away as products of decades past. In many cases with a logo, this isn't an issue. If I go into a hardware store, I know I'm going to find nails, and if I pull into a gas station, I know I'll be able to drive off after filling my tank. The signage out front of those places doesn't make me think twice. In other cases, I can get by at an establishment with an older emblem, but there are limitations involved in my preliminary assessment of what I'm getting into. I'm not deterred from going into a sandwich shop if their sign is basic, because I know that sandwich craft hasn't changed so drastically since the sign was made that I won't be able to get a good turkey club. When I need service on my 1993 Honda Civic, for which "beat up" is a gross understatement, I know that I can probably bring it to a garage regardless of the sign. And up until a couple of years ago, I was likely to prefer a barber shop with an old school sign to a frooffy salon or barber shop with a fancy new one.

But certain assumptions accompany those signs and situations. With a more traditionally signed sandwich shop, I note going in that I'm more than likely not going to see any of the spicy southwest style fare I like on the shop's menu, as it has grown so much in popularity over the past few years. If I drove a new vehicle that wasn't falling apart, I would be unlikely to bring it to a mom and pop garage with older signs, as the sign tells me that they're less likely to keep up on the Technical Service Bulletins (TSBs) necessary to run effective diagnostics, or have comprehensive experience with newer model vehicles as a dealership would. And while an old fashioned barbershop may be able to administer a textbook "boys regular" or straight edge shave, it's unlikely they'll have as much skill, or any, with newer hair styles.

At least for me and many others from my generation, who have been raised witnessing the constant re-branding of corporate leaders, the basic assumptions that follow older visuals boil down to complacency. At some point, the emblem representing a company was determined to be "good enough". It didn't need to be any better, or newer. If that emblem was dull, why was the company OK with it? Did that mentality, then- which would

justify "good enough"- extend to other aspects of the business as well? If they don't care to change the sign and make it better, does the sandwich shop then not care to add any new sandwiches to its menu? Does the garage care enough to have its mechanics stay up with the TSBs for new model vehicles? Does the barber care to improve his craft once he has established his client base and become "set in his ways"? That was the case in my experience, until finally visiting a new barber who prided himself on his professionalism while boasting an image to show it, and I walked away reveling in the glory of my unprecedentedly even hair line.

There are a million anecdotes we can run through here to argue one way or another, we all know what happens to "u" and "me" when we "assume" things, and I'll be the first to admit that there are many exceptions to this rule. But the point is that there is some level of complacency in an organization which chooses not to renovate its image from time to time. Like the outfit we choose to wear to an interview, an organization's emblem is likely the first thing its potential clients or members see, and thus it yields the first impression observers form about that organization.

As we strive to continually provide a higher level of value to our members while attracting new ones, it is imperative for AIPG to demonstrate its commitment to representing the growing and changing identity of professionalism in our field. Yes, professionalism is professionalism, in the strictest sense: competence, integrity, and ethics say it best. But the derivations of those principles, including the ethical disputes we encounter, the standards we set and uphold, and the technical challenges we face, remain dynamic- demanding improvement on all of our parts. So too should the image we choose to represent us to our clients and peers.

Facing the stark reality of tough competition for members geologic organizations and member involvement, it would certainly behoove us to make all reasonable efforts to engage that audience. If a sharp looking new logo catches some eyes, brings them to the table, and allows our organization's values and benefits to speak for themselves, then let's go for it. There is nothing really bad about our logo today, it has served us well for a number of years and will always remain part of the organization's identity. We do, however, stand to benefit from a strong and classy new emblem which says to the observer "AIPG is comprehensively engaged in the pursuit of professionalism, today." I'm committed to seeing that the final product we propose is something we can all be proud of, and I'm looking forward to working more with you all over the next few months to achieve that.

Joey is a recent graduate of Northeastern University, where he served as Student Body President. He is currently job hunting for a position with adventure, responsibility, and ridiculously extreme challenges.

AIPG Student Chapters

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

Central Michigan University
Founded 2003
Chapter Sponsor:
David J. Matty

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

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

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

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Chapter Sponsor:
Cullen Sherwood, CPG-02811

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Founded in 2008
Chapter Sponsor:
Jonathan G. Price, CPG-07814

Ohio State University
Founded in 2004
Chapter Sponsor:
Thomas Berg, CPG-08208

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

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

Earthquake swarm continues in Yellowstone

News Release Jan. 22, 2010 from the Wyoming State Geological Survey A minor earthquake was felt Jan. 21 in Yellowstone National Park. It was a continuation of the earthquake swarm that started Jan. 17. No injuries or damage were reported.

The event brought the total number of earthquakes felt to nine, and the seismic activity was ongoing as of 8 a.m. Jan. 22, according to information received by the Wyoming State Geological Survey (WSGS).

The Jan. 21 earthquake occurred at 9:09 p.m. approximately 10 miles southeast of West Yellowstone, Mont., and 19 miles east-northeast of Island Park, Idaho.

The magnitude 3.0, intensity II earthquake occurred 5.7 miles below the surface, according to the U.S. Geological Survey's National Earthquake Information Center (NEIC) in Golden, Colorado.

The University of Utah Seismograph Stations (UUSS) reports that there have been more than 900 earthquakes in the swarm, ranging from magnitude 0.5 to 3.8. There have been multiple personal reports of ground shaking from observations inside the park and in surrounding areas for some of the larger events.

UUSS reports that the swarm is likely the result of slip on pre-existing faults rather than underground movement of magma.

An earthquake swarm is a collection of small earthquakes that happen in the same general area and time. Earthquake swarms in Yellowstone do not normally indicate that large, damaging earthquakes are imminent. See http://www.quake.utah.edu/index.shtml for more information about the recent activity in Yellowstone.

The strength of an earthquake at its epicenter is called its magnitude, as measured on the Richter scale. Minor earthquakes – those between magnitude 3 and 3.9 – do not cause structural damage.

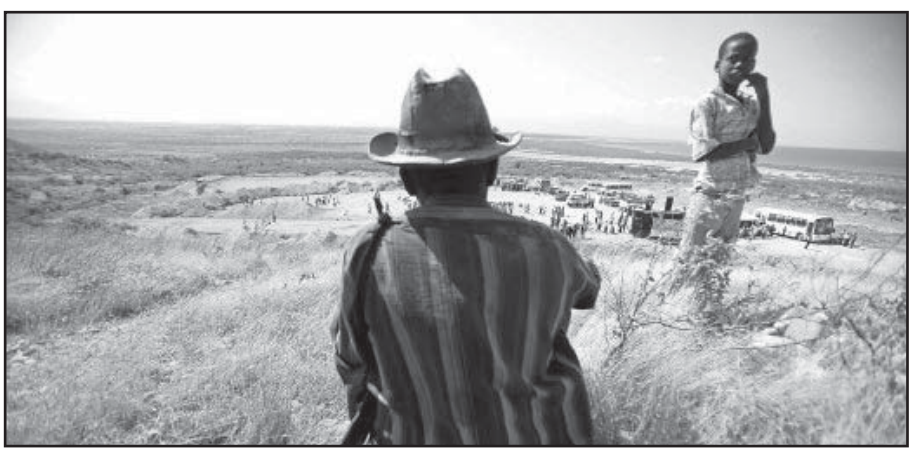
The effect of an earthquake on the surface is called its intensity, as measured on the Modified Mercalli Intensity Scale. Intensities range from I (imperceptible shaking) to XII (catastrophic destruction).

The WSGS has compiled seismological characterizations of all Wyoming counties, which include analyses of historic seismicity. See *http://www.wrds.uwyo.edu/wrds/wsgs/hazards/quakes/seischar/seischar.html* for more information, or contact WSGS surficial geologist Seth Wittke at 307-766-2286, ext. 244, or by e-mail at *wittkesj@uwyo.edu.*

Science in the News *from Sigma Xi, The Scientific Research Society*

Haiti Debates Moving Its Capital

Haiti's official seismologist, who predicted the recent earthquake, has warned that an even stronger one is likely to hit Port-au-Prince within the next 20 years. Now the Haitian government is debating how and if the capital should be rebuilt--or if it should be moved elsewhere.



A memorial ceremony is held at a mass gravesite outside Port-au-Prince: The Haitian government is now debating whether the capital should be moved.

Claude Prépetit had seen it coming in his figures. He had done the calculations, in millimeters and in centuries, he had calculated the pressure that was building up beneath his feet, and he had estimated the energy that would eventually be discharged. And when the earth finally did shake, and falling concrete ceilings, stone walls and wooden beams killed at least 170,000 people within the space of 40 seconds, that was when Prépetit thought to himself: "This is it--this has to be a seven."

He had predicted an earthquake with a magnitude of about 7.2 points on the Richter scale, and the actual quake measured 7.0. For years, he had taken precise measurements and performed careful calculations, and he had done his job exceedingly well. When the earthquake struck, he was sitting at home in front of his computer. For full story go to: *http://snipr.com/u9rif*

Dear Editor:

I'd just like to take a moment to let AIPG and its members now how much I enjoyed my recent "day in the field" at Georgia Southwestern State University, an outing led (and ram-rodded) by one of AIPG's best assets, Ron Wallace (CPG -08153). Ron invited (more like roped) me to help instruct about a dozen students on what they may expect during a "typical day" if employed in the environmental arena. Ron prepared thorough notebooks describing the activities, complete with sample forms, data from actual job sites, as well as a classroom exercise in potentiometric contouring.

Ron finagled Jim Fineis, PG, owner of Atlas Geo-Sampling, to "kindly supply" (at no charge; thank you Jim!) a direct-push / rotary rig (with crew) for a hands-on demonstration of soil sampling and monitoring well installation. Jim pushed down to about 23 feet, set a pre-packed well (finished with a cover), with each student (and their professor, Dr. Sam Peavy) taking their turn at the controls and collecting groundwater samples.

Everyone got to lay their hands on (and turn) a hand auger, operate an OVA, and take a well's top-of-casing reading with surveying equipment. At the end of the day we retired to the department's lab to describe the soil samples collected by Jim.

I think Ron is definitely on the right track in trying to get students excited about geology, as well as AIPG (and yes, he brought plenty of membership forms for the students). With participation in a few follow-up classes like this one, one can only think it can help bolster a student's employment chances when they can say "I've hand augered a bit, installed a monitoring well, described soil samples, collected and bottled waters samples, and surveyed top-of-casings. And by-the-way, I'm active in AIPG".

I personally got a lot out of the trip; maybe somebody benefited a bit from my work experience. And a little time visiting a school makes anyone feel younger, even if just for a day.

Rick Ricci
CPG-11174

Dear Colleagues:

I, Ronald E. Yarbrough, PhD. CPG-6545, PG have decided to retire from my consulting work and rather than geology go into biology—more fishing for the wily trout. I am 71 now and have had a great career—teaching geology—Southern Illinois University-Edwardsville from which I retired in 1993 after 30 years. I was voted by the alumni of the University as their Great Teacher in 1970, which was the first award at our new University. This is the proudest moment in my Teaching career because it came from my former students. During my teaching career I did not teach in the summer but worked in the field and office with the U.S. Bureau of Mines, Twin-Cities Lab, IL State Geological Survey and the U.S. Corps of Engineers, St. Louis District and a series of engineering firms. In 1993, I went back to the Corps full-time (I had worked part time for the St. Louis District from 1972 to 1980). I retired from the Corps in 2000. I went back to the Corps in 2006 as a retired geologist and worked the Katrina disaster in Mississippi for 3 months when we wrapped up our work in Pass Christian. I received two awards while working for the Corps—The Commander's Award for Civilian Service for my environmental work on the Mississippi River and the Hammer Award from Vice-President Gore for again my work with a team program for environmental work on the Mississippi and Illinois Rivers.

In 1979, I was asked to work, with my graduate students, with the Illinois Geological Survey on a program for the State Assembly to establish a Mine Subsidence Insurance Program, the second in the nation, the first being Pennsylvania. We trained insurance adjusters to recognize mine subsidence damage to structures. I was asked to be the expert for the Mine Subsidence Fund and took a leave of absence for the University and created Geo-Technical Associates, Inc. to do the work. I worked for the Fund for 10 years (I taught one to two night classe each quarter during those years) and assisted in establishing Mine Subsidence Funds in Kentucky, Indiana and Ohio. The survey and other data were shared with the IL Geological Survey and Bureau of Mines and we were able to complete several publications from the field experience on ground movements created by coal mine subsidence and movement of structures from this ground movement. During my off hours, I have been involved in about 42 legal cases as an expert witness. Most of these legal cases involved coal mine subsidence.

I was very lucky to have excellent instructors at the University of Tennessee-Knoxville and excellent superiors who were willing to work with me in all of my endeavors. Geology is still written all over me in thought and in pleasure. What interesting work field geology is and to think that I was primed to be a pharmacist and be tied up in a drug store for the rest of my life until a pharmacist, who fished with my father, told me one day in a boat, and again and again that I would not be happy being indoors every day—so I changed my major my Freshman year. This was the smartest thing I have done in my life.

I have served on the Ethics Committee for several years with my friend David Abbott, Jr. He has posed many ethics questions for the Committee and I have learned why ethics is one of the founding principals of AIPG. *The Professional Geologist* magazine is excellent and I hope we can work out something where I can still receive the magazine.

Respectfully submitted
Ron Yarbrough
CPG-6545

IN MEMORY

William H. Dennen
CPG-06533
Member Since 1984-2006
Deceased 2009
Rockport, Massachusetts

Donald L. Garey
CPG-01082
Member Since 1965
Deceased 2009
Hobbs, New Mexico

William P. Grace
CPG-06838
Member Since 1985
August 25, 2009
Aurora, Colorado

Donald A. Parks
CPG-01252
Member Since 1966
Deceased 2009
Carefree, Arizona

Robert R. Roady
CPG-01846
Member Since 1968-1998
January 4, 2010
Houston, Texas

This service is open to AIPG Members as well as non-members. The Professional Services Directory is a one year listing offering experience and expertise in all phases of geology. Prepayment required. Advertising rates are based on a 3 3/8" x 1 3/4" space

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New Member Dues (Membership is activated upon receipt of dues.) **Payment: ☐Enclosed ☐Bill Me**
If you apply Dec-Mar = $100 Apr–Jun = $75 Jul-Sept = $50 Oct-Nov = $25

Last Name: First Name: MI: Suffix:

Employer Name: ☐Mr. ☐Ms. ☐Mrs. ☐Dr.

Preferred Mailing Address: ☐ Home ☐ Business Self-Employed?☐Yes ☐No Birth Year:

Street:

City: State: Zip: Country:

Work Ph: Home Ph: Fax:

Email: Yr Highest Degree Awarded:

Geological Degree: ☐BA ☐BS ☐MA ☐MS ☐PhD University:

ATTESTATION: I attest that I meet the requirements for AIPG Member (30 semester hours/45 quarter hours for Member) and agree to abide by AIPG Bylaws and Code of Ethics.

Applicant Signature: **Date:**

AIPG Mbr Sponsor Signature (Required): ☐CPG ☐MEM ☐RM AIPG #: Date:

HEADQUARTERS USE ONLY Amt: Date Rcvd: Mbr #:

Look What's Coming in the May/June TPG

AIPG National Officers-
Candidate Articles and Biographies

AIPG Annual Meeting Issue-
Sponsorship Opportunites
Exhibitor Opportunities
Registration Form

HAVE YOU SIGNED UP A MEMBER LATELY?

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30 semester or 45 quarter hours in geological sciences*
with a baccalaureate or higher degree

SPONSORS:
1 required from a CPG or Member

SIGN-UP FEE (prorated):
Dec-Mar = $100; Apr-Jun = $75
Jul-Sep = $50 Oct-Nov = $25

ANNUAL DUES: $100 plus Section dues

APPLICATION: Available on website www.aipg.org*

As defined by the American Geological Institute, a geological science is any of the subdisciplinary specialties that are part of the science of geology, e.g., geophysics, geochemistry, paleontology, petrology, etc.

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

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

Applicants for Certified Professional Geologist

AK-John M. Clark
CA-Charles G. Clifton
CT-Jason A. Beach
CT-John Gregory Zbell
MI-Curtis M. Lichy
NC-Cheryl A. Youngblood
NJ-Edward P. Rashak
NY-Bradley Walker
NY-Innocent Taziva
NY-James L. Marolda
NY-Michael R. Sherwood
NY-Thomas V. Larison
VA-Daivd M. Sayre
WA-Roger William Kolvoord

Applicants Upgrading to CPG

AK-Bret L. Berglund MEM-1804
CO-Heather L. Justus MEM-1798
CO-John S. Hazlitt, MEM-1793
CO-Thomas A. Loucks MEM-1792
CT-Glen D. Stefaniak, MEM-1811
FL-Aaron Getchell, MEM-1446
NV-William L. Dam MEM-1791
OR-Joel W. Rotert MEM-0945
TX-Stanley L. Lindsey, Jr. MEM-1805

New Certified Professional Geologists

CO-Anthony A. Kovschak, Jr. CPG-11312
CT-Kenneth D. Taylor CPG-11314
MA-Bruce C. Ross CPG-11306
MI-Uday K. Gollapudi CPG-11308
NM-Annie M. McCoy CPG-11309
NM-Timothy Fred Wawrzyniec CPG-11311
NY-Lee B. Kaplan CPG-11310
SD-Sarah Anne Chadima CPG-11313

New Members

AK-Steven M. Kramar MEM-1794
CA-Eugene L. Blanck MEM-1803
CA-George C. Dunfield MEM-1810
CO-Arthur H. Curtis MEM-1796
CO-Gary D. Witt MEM-1797
CO-Jason Eugene Davidson MEM-1808
CO-John S. Hazlitt MEM-1793
CO-Laura M. Tobin MEM-1801
FL-Kim K. Arnold MEM-1812
IL-Ann M. Walper MEM-1799
KY-Tim W. Blackburn MEM-1815
MI-Ronald L. Friend MEM-1807
MN-Brooke J.A. Roecker MEM-1800
PA-Jay B. Parrish MEM-1809
PA-Kevin W. Frysinger MEM-1813
PA-Tomlinson Fort MEM-1806
TN-Tommy A. Haskins MEM-1814
VA-Joseph G. Aylor, Jr. MEM-1816
VA-Richard C. Doucette MEM-1817
VA-Vincent L. Day MEM-1795
WV-Dennis H. Cumbie MEM-1818
WY-Gordon Marlatt MEM-1802

New Associate Members

FL-John J. Scott AS-0055

AIPG Membership Totals

	As of 2/11/09	As of 2/08/10
CPG / Active	3,641	3,547
CPG/Non-Practicing	428	415
Member	974	1011
Associate Mem.	21	19
Student Adjunct	406	447
Honorary	20	19
Corporate Member	3	3
TOTALS	5,493	5,461

New Student Adjuncts

AK-Anna K. Bellesiles SA-1783
CT-William F. Schnell SA-1733
GA-Crawford White SA-1735
GA-Jason L. Jones SA-1734
GA-Katie Cummings SA-1736
MD-Elisa T. Van Orden SA-1782
MI-Andrew J. Lightfoot SA-1729
MI-Shawn M. McCloskey SA-1730
OH-Brittnee A. Lydy SA-1780
OH-Colleen M. Humphreville SA-1738
OH-Jennifer R. Soehner SA-1737
OH-Katherine M. Gigandet SA-1739
OH-Lance A. Reddoch SA-1781

Uranium Mining Ore Reserve Estimation: Procedures and Pitfalls

George T. FitzGerald, Jr., CPG-06582

Successful uranium mining ventures depend upon five major factors or "keys" to success.

- First: Management's desire to accomplish the successful venture regardless of many trials and tribulations along the way.
- Second: Sufficient venture and working capital to provide for exploration, development and initial operating costs to obtain an adequate return on the investment.
- Third: Estimating a conservatively realistic mining ore reserve to provide for ore production and sale.
- Fourth: A well-designed engineering plan to operate the mine.
- Fifth: Obtaining an effective team of management, miners, and operating support staff who will work together through startup, development and operations to maintain a technically and economically viable venture.

This discussion is focused principally on the third step and most specifically uranium mining reserve estimation including procedures and pitfalls. These pitfalls include considerations of scientific, operations, and economic factors.

During the early years of the 1950s and 1960s, miners often just started driving adits where they found good looking black color and their Geiger counters indicated potential ore grade material. If they could afford some exploration drilling, they developed what could be considered an Inferred Reserve (Figure 1). This was based on surface drilling showing continuity of ore and included an area of influence around ore grade drill holes plus tangential connections between them.

Ore reserve calculation methods varied but basically they involved "connecting the dots" and calculating mean values. This resulted in what could be considered a Mining Reserve for an ore body which would yield a specific volume of ore at a specific grade; e.g., a small mine might include 100,000 tons of 0.15%, (3 pounds per ton) or approximately 300,000 pounds of uranium oxide (U_3O_8 or yellowcake). Table 1 is an example of an "early days" economic evaluation that might have been used to determine the mining feasibility of this small ore body at a rate of about 100 tons per day, 250 days per year, or 25,000 tons per year for four years. The figures are rough estimates and could be refined, but the methodology was utilized for deciding on mine startup. In the 1950s and 1960s, yellowcake could be sold at a price in the neighborhood of $8 per pound; thus, the ore body would potentially be worth $2.4 million (M). The cost of mining and milling was near $20 per ton, so the total costs would be near $2.0 M ($1.84M in Table 1). In this simple example, the miner could make a 15% rate of return on his investment costs after taxes (IROR). Frequently miners would take this information, use a few drills, muckers, and haul trucks, start mining and do well. Many "small" miners did not have the capital to build a mill, and they were compensated by the mill owners for their cost of mining and hauling to the mills.

Some of these ventures failed due to production of grades less than estimated and costs higher than estimated for investment and operations. Due in part to these failures, the federal government (Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey; Geological Survey Bulletin 1450-A, 1976)

ELEMENT	YEAR 1	YEAR 2	YEAR 3	YEAR 4	TOTAL
SALES	600	600	600	600	2400
COSTS	(460)	(460)	(460)	(460)	(1840)
REVENUE	140	140	140	140	560
TAX (50%)	(70)	(70)	(70)	(70)	(280)
INCOME	70	70	70	70	280
% IROR[2] ON COST	15	15	15	15	15

Table 1. Example Mining Economic Evaluation in thousands of dollars ($k) during early mining days (1950s and 1960s).[1]

1. These figures do not include upfront capital investment. Early miners frequently used minimal equipment such as converted tractors, pickup beds, drills, and shovels, and these costs are included in this table.
2. IROR = Rate of Return on Investment.

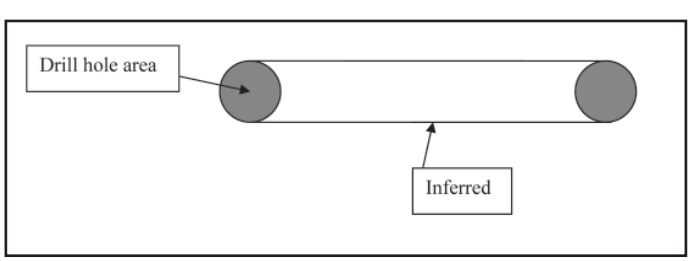


Figure. 1 Inferred Reserve.

advised mining industry geologists, engineers and managers that reserves should be estimated as Measured (Proven), Indicated (Probable) and Inferred (Possible). This resulted in more sophisticated estimates of reserves, and methods to identify ore bodies that could be considered economic for extraction and sale. Figure 2 is a drawing that represents an ore reserve that includes a combination of Measured, Indicated and Inferred Reserves. Measured Reserves were considered accurate within 20%, but Indicated and Inferred Reserves were questionable.

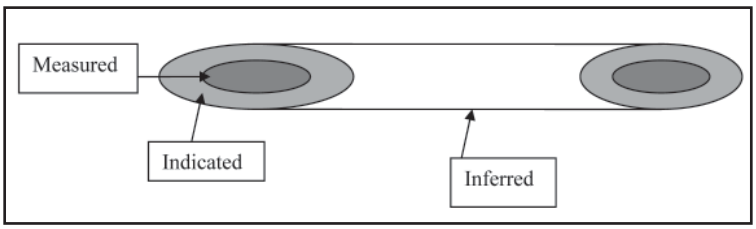


Figure 2. Ore Reserve including Measured, Indicated, and Inferred Ore.

The combination of Measured, Indicated, and Inferred Reserves were considered a geologic resource obtained by surface drilling on spaces that demonstrated continuity in trend direction, ore grade, and thickness. As time went by, and ore bodies were found deeper below the surface, required costs became increasingly greater; therefore, accuracy in estimating Mining Reserves for sales commitments likewise was more important. These costs could include a deep shaft, groundwater pumping stations, subdrifts, development drifts, and deep ventilation holes. Measured reserves took the process another step further with subsurface drilling from subdrifts up through ore zones to detail ore bodies, best define development and extraction patterns, and maximize IROR. Drilling on closer spacing from the surface increased the miners' ability to identify Measured Reserves, but the cost could be 50% to 100% greater than the cost for wider spaced drilling with more reliance on Indicated and Inferred Reserves. On the other hand, this additional cost could result in a greater payoff because it partially offset the significantly greater mine development costs required to define ore bodies 1000 feet below ground. One of the greatest management challenges became estimating uranium mining reserves from surface drilling alone and determining economic feasibility prior to expending significantly additional costs on subsurface development. Expertise in ore reserve estimation by experienced mine geologists was essential to this effort.

Along with closer spaced surface drilling, geologic methods including analysis of cross-sections, structural contours and isopleths have helped estimators determine stratigraphic and structural trends. Geostatistical methods have been developed to take into account the relationship between like values of ore in specific directions, such as along the edges of paleostream channels or structural planes along fractures or faults. These directional trends can show up mathematically in the drill hole data as well as along structural contour maps drawn from analog interpretation. It took years of experience for uranium mining geologists to become skilled in recognizing the best procedures and the biggest pitfalls in determining a "conservatively realistic" Mining Reserve. The rest of this discussion shall focus on pitfalls to successful ore reserve estimation due to scientific error, inattention to quality control during operations and incomplete or inaccurate economic evaluation of mine feasibility.

Pitfalls to Mining Ore Reserves and the Mine Feasibility Study

First, let's consider scientific pitfalls. The principal data point is the drill hole analog. Ore bodies consist of primary and/or secondary ore. Primary ore is mineralization that has accumulated within narrow relatively high-grade bands due to abrupt facies changes such as interbedded sand and shale lenses. Typically, primary ore will consist of bands one to four feet in thickness and greater than 0.50% U_3O_8 (10 pounds per ton); Secondary ore consists of ore that has been redistributed to result in greater thickness and relatively lower grade than primary ore due frequently to accumulation across thick sandstones where faults or other structural features create a mitigating barrier to lateral flow. Secondary ore will consist of ore that is generally uniform over ten to twenty feet in thickness and range in grade between 0.10% to 0.20% U_3O_8 (2 to 4 pounds per ton). Minimum mining thickness ranges from near 4 to 6 feet, so primary ore that is one foot of 0.50% may yield about 5 feet of 0.10% mined ore. If the ore cutoff is 0.10%, this could be considered an ore hole. In developing an ore reserve, it is generally more straightforward to accurately estimate secondary ore simply because it is more uniform in thickness and aerial extent. The biggest pitfall in developing reserves for primary ore is overestimation due to lack of consideration for internal dilution and/or the nugget hole effect.

Internal Dilution

Internal dilution must be considered when estimating a Mining Reserve, This requires subjectivity, but can be based on understanding of the geologic depositional environment and general geostatistics. For instance, general trends may be based on well defined channels such as those found in Utah or interbedded overlapping lenses that have little definition or specific direction such as those found in New Mexico. One thing is clear, and that is one must allow some consideration for internal dilution. Figure 3 demonstrates a cross-section of primary ore from geologic analogs. Inaccurate interconnection of ore data points may result in internal dilution.

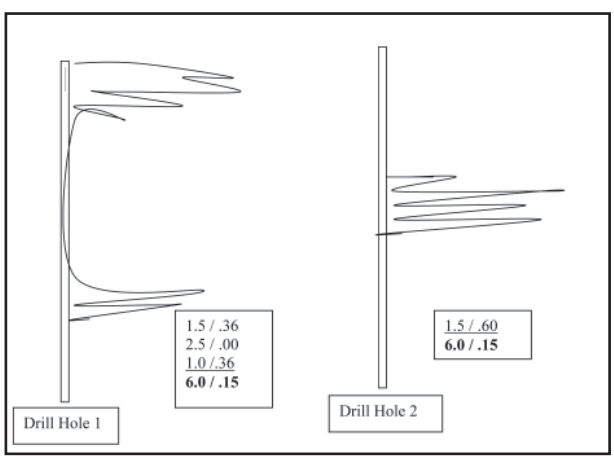


Figure 3. Geologic Analogs indicate that Primary Ore will have internal dilution (Vertically each drill hole represents approximately 6.0 feet and horizontally the variations represent increasing %U_3O_8 to the right.)

These two data points could be interpreted as two interconnecting points averaging 6 feet of 0.15%, but actually are two points that indicate internal dilution of the whole ore reserve area and lack of interconnection between some drill holes. As such, one must ask if Drill Hole 1 can actually be considered 6.0 feet of 0.15 U_3O_8. The answer is "yes" for that one data point; however, when the total reserve is developed including Drill Holes 1, 2 and many more, internal dilution will unquestionably occur and many of the apparently interconnected points will not connect for mining. It is the experience of the writer in analyzing actual mining reserves and final mine production grade that, in these cases, it is wise to use an internal dilution factor of at least 5%. Therefore, due to internal dilution, a geologic reserve averaging 6.0 feet of 0.15% U_3O_8, could actually result in a mining reserve of 6.0 feet of 0.14% U_3O_8, or 2.8 pounds per ton rather than 3 pounds per ton for the whole ore body. If there are a significant number of drill holes like Drill Hole 1 with varying values, one should consider an internal dilution factor greater than 5% but less than 10%.

Nugget Effect

The nugget effect is one of the major concerns in estimating a mining reserve. As the name implies it is derived from the old gold mining days when miners would find a nugget somewhere in the vicinity of an ore body, stake a claim and find the ore. However, many gold miners went broke by not considering the nugget effect, or the fact that "one nugget does not an ore body make." The real value of a nugget hole is evidence that an ore body should exist in the vicinity and the wise estimator can reasonably calculate it using sufficient geologic and arithmetic expertise. Tables 2 and 3 demonstrate why the use of nugget hole values may result in overestimation of an ore reserve.

# Drill Holes (Data Points)	Thickness in feet of ore-grade intersection	Grade (%U_3O_8)	Grade x Thickness (GT)
9	6	0.10	5.40
1	6	0.90	5.40
Mathematical Average	6	0.18	10.80

Table 2. Inappropriate inclusion of the value of a nugget hole may result in overestimation of the grade of the ore body.

Although the mathematical average is 0.18%, logic indicates that this ore body has an average grade less than 0.18%. The experienced ore reserve estimator learned, often the hard way; that, although nugget holes were important to ore reserves, simple calculation of the mean value of drill holes (data points) could result in overestimation of the reserve. It is important to realize that nugget hole values are, in fact, true values and the key to proper calculation revolves around determining adequate aerial extent of the ore associated with them. Various geologic and geostatistical methods have been utilized in calculating the area, but the most important lesson is that nugget values are anomalies and must be treated as such.

One method that takes into account the nugget effect is to limit the aerial extent to a reasonable area or "Measured Reserve" around the nugget hole (See Figure 2), while utilizing the mean value of the other drill holes to calculate the remaining area. This will result in an ore reserve that accurately takes into account values of the vast majority of data points, but recognizes that the nugget hole does represent ore that is truly part of the ore body. Instead of calculating the ore body as demonstrated in Table 2, an experienced mine geologist may use a calculation such as in shown in Table 3, resulting in an average grade of 0.11% U_3O_8.

AREA (%)	THICKNESS (FT)	VOLUME (CF)	GRADE (%U_3O_8)	G x V
99	6	594	0.10	59.4
1	6	6	0.90	5.4
100	6	600	0.11	64.8

Table 3. Reasonably optimistic inclusion of a nugget hole in the calculation of an ore body.

Some estimators eliminate the nugget holes from the calculation in which case this ore body would be estimated to have a thickness and grade of 6 feet of 0.10% U_3O_8. This would be conservatively realistic but would not give any credence to the nugget hole which is a real value.

The two pitfalls of overestimation due to lack of consideration for internal dilution and the nugget hole effect may be exacerbated by external dilution resulting from inadequate quality control during operations.

External Dilution resulting from Inadequate Quality Control during Operations

External dilution of ore during extraction may occur due to overbreak and sometimes subfloor extraction of the developed ore body. Inadequate quality control practices can result in external dilution greater than 10%, lowering the mining grade and negatively affecting the economics of mine feasibility. It must be recognized that some overbreak is common in sandstone mining, and should be taken into account in estimating ore reserves. However, it is imperative that operations personnel including geologists and production staff observe and direct miners on acceptable practices for drilling, blasting, and mucking during the extraction phase. Development miners get paid based on footage produced, and try to keep subdrifts at a minimum height and width to make as much footage as possible. However, extraction miners usually get paid based on tonnage of ore produced, and it is easy to "accidentally" drill a blast hole at a little higher angle into the roof or a little deeper into the floor of the room and pillar extraction area (stope). Also, tram haulers get paid on the number of ore cars produced during their shift, so they, too, have an incentive to "push" extraction miners to produce more tons of ore. Meanwhile, company owners rely upon the best grade being produced for sale. Some mining companies have innovatively paid staff and mining personnel based, not only on tonnage produced, but added bonuses for higher grade; thus, minimizing dilution due to overbreak and undercut. Table 4 and 5 demonstrate the effect of overbreak and/or undercut of a mine stope during extraction.

The experienced estimator will consider using an external dilution factor of 5% to 10% when developing the mining reserve because it is nearly impossible to avoid some overbreak and potentially some undercut. Pitfalls occur in overestimating

Stope Criteria	Thickness (ft)	Grade (% U_3O_8)	GT
Ore	12	0.12	1.44
Overbreak	1.5	0.00	0.00
Undercut	0.5	0.00	0.00
Total	14.0	0.10	1.44
External Dilution (%)	17		

Table 4. External Dilution caused by overbreak and/or undercut.

Stope Criteria	Thickness (ft)	Grade (% U_3O_8)	GT
Ore	12	0.12	1.44
Overbreak	0.5	0.00	0.00
Undercut	0.0	0.00	0.00
Total	12.5	0.115	1.44
External Dilution (%)	4		

Table 5. Minimize External Dilution with good quality control during extraction.

grade of ore reserves caused principally by ignoring internal dilution and the nugget effect during the scientific evaluation and in underestimating the effects of external dilution during operations. There are some ore bodies that have a "halo" of low grade ore around the ore body, and in some instances overbreak will yield economic material. Therefore, in some instances, total dilution has resulted in an increase of over 25% in tonnage but a grade reduction of over 20%. There have been instances when the mine production grade seemed adequate because it was greater than 0.20%; but, upon closer examination, it was determined that inadequate operating procedures were resulting in unnecessary dilution. To rectify this, mining geologists were employed by many companies as grade quality control personnel, resulting in better mine production grades and significantly greater net revenue. Many mine geologists went on to become mine managers following their exposure and consideration of the scientific, operations, and economic factors required for successful mining ventures. The economic feasibility study makes up the third factor for pitfalls in mining ore reserve estimation and provides the required average mining and cutoff grades for profitability.

Economic Feasibility and Mining Ore Reserve Estimation

The two principal guiding criteria necessary for an economically successful mining project are the average mining grade and the mining cutoff grade. Acceptable estimation of these two criteria is required to make an acceptable return on investment after taxes. The first part of this paper discussed initial mining days when miners would take up a drill, a mucker, and a small ore truck, do their drilling, blasting, mucking and milling, sell their ore for production of yellowcake, and start all over again. This may have required little thought in the early days and most miners felt they were always "one foot from a million dollars or a million feet from one dollar."

As time progressed, discoveries of deeper and more complex ore bodies resulted in the need for greater upfront capital investment and increased operating costs. Due to developing and mining on a greater scale, mining companies learned to rely greatly on more complete feasibility studies. Some of the economic pitfalls related to developing a mining ore reserve include underestimation of required capital investment prior to startup, inattention to the effects of working capital, which includes the upfront money required to pay staff prior to receiving sales income and which is considered the greatest cause of business economic failures, underestimation of operating costs such as labor and environmental cleanup, and overestimation of sales price. If we refer back to Table 1, we can see that a miner using some basic economics and operating skills might make a profit and enjoy mining in the early 1950s and 1960s. But what happens if the miner doesn't take into account some of the economic pitfalls that will occur? Table 6 is an example of a mining feasibility study for a successful project. The evaluation demonstrates the effect of capital investment prior to mining, capital investment for equipment needed to access ore, working capital, operating costs during mining and milling, environmental cleanup, and required price to have a feasible project. Assume an ore body of 500,000 tons averaging 0.15% U_3O_8 (3 pounds per ton) produced for sale. Mining and milling rate is 500 tons per day or 125,000 tons per year for four years. This evaluation assumes that the mining company expects to make a 15% rate of return after taxes (IROR). It demonstrates that the company could pay $1,886,000 in year (-1) to purchase the mine property from its current owner and subsequently make the required 15% IROR.

Project Pitfalls May Result in Project Failure

Scientific and operational pitfalls resulting in dilution of the ore body grade, greater upfront capital costs, lesser sales price, and/or greater operating costs, may result in failure of the project outlined as successful in Table 6. In order for the project to succeed, the economic evaluation requires a realistic mining reserve including determination of mine and mill production grades and amount of yellowcake produced for sale. Table 7 enumerates potential scientific, operational and economic pitfalls.

Average Mining Reserve Grade

Based upon the factors in Table 7, the geologic reserve may require a modification to provide a realistic estimate of average produced grade for the project (the mining reserve grade). Using the estimated dilution factors and mill recovery percentage from Table 7, the necessary average geologic reserve grade required to produce a production grade of 0.15% (the mining reserve grade) may be 0.19%. The formula would be:

Formula 1. 0.19% x (.95 x .90 x .90) = 0.15%.

Therefore, the average geologic reserve grade of the ore body prior to considerations for dilution and mill recovery would have to be 0.19%.

Using the same factors, a geologic reserve grade calculated at 0.15% and diluted during mining and milling would result in an average production grade (mining reserve grade) of 0.12%.

Formula 2. 0.15% x (.95 x .90 x .90) = 0.12%.

Table 8 demonstrates that an economic evaluation based on the revised production grade (mining reserve grade) of 0.12% U_3O_8 results in economic failure of the project.

Element	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Exploration Costs	-200						
Equipment Costs	-50	-400					
Development Costs[1]		-2000					
Working Capital (4 mo. operating cost)			-8333				8333
Sales @ $100 / pound (3lb/T)			37,500	37,500	37,500	37,500	
Royalty (10%)			-3750	-3750	-3750	-3750	
Operating Costs @ $200 per Ton[2]			-25,000	-25,000	-25,000	-25,000	
Environmental Costs[3]			-2500	-2500	-2500	-2500	-12,500
Gross profit (Excluding Working Capital)			6250	6250	6250	6250	
-50% Depletion			-3125	-3125	-3125	-3125	
- Equipment Depreciation (450/4 per year)			-113	-113	-112	-112	
- Loss Carried Forward[4].			-2200	00	00	00	
Subtotal			812	3012	3013	3013	
Tax on Subtotal (50%)			-406	-1506	-1507	-1507	
Net Profit (Gross profit less tax)	-250	-2400	-2489[5]	4744	4743	4743	-4167
15% Investment Rate of Return at Year -1	-217	-2032	-3669	-956	1402	3452	1886

Table 6. A Mining Feasibility Study is required to estimate cutoff and average production grade for profit (The Mining Reserve Grade). Dollars are expressed as $k.

1 In this example, assume that development costs represent about 10% of total mine and mill investment, and this mine is 10% of the total project.

2. Assume operating costs include mining and milling.

3. Assume 10% of operating costs; however, 50% of one years operating cost at end of project.

4. Preproduction exploration and development costs included in first revenue producing year.

5. Includes cost of Working Capital which is not tax deductible but is a capital expense in year 1 that will be recouped at the end of the project.

Pitfall	Effect
Internal Dilution	5%, or 95% of reported reserve grade
External Dilution	10%, or 90% of reported reserve grade
Nugget Effect	(may be significant, but will not be included in the following calculations)
Mill Recovery	90% of reported reserve grade
Economics	Inaccurate estimate and/or evaluation of capital costs, working capital, production costs, taxes, and price.

Table 7. Potential Mining, Milling and Economic Pitfalls.

Cutoff Grade

Although the average production grade in the Table 8 example must be something greater than 0.12% U_3O_8, it is important to realize that the cutoff grade may be lower than 0.12%. Cutoff grade is the grade that will support mining and milling costs alone without consideration for capital costs or taxes. Capital costs are considered "sunk" costs when mining commences. Taxes are only charged to net profit, and would only be charged on ore produced above cost. It is necessary to take into account the mill recovery which is near 90%. Calculations for the cutoff grade in the above examples may be:

Mining Costs = $150/ton

Milling Costs: = $50/ton

Subtotal Operating Costs = $200/ton

Mine Cutoff Grade at $100/lb U_3O_8 = ($200/ton) / ($100/lb x 2000 lb/ton x 0.90) = 0.11%, or 2.2 lb/Ton

Mine Cutoff Grade at $75/lb = $200 / (75 x 2000 x 0.90) = 0.15%, or 3 lb/Ton

Mine Cutoff Grade at $50/lb = $200 / (50 x 2000 x 0.90) = 0.22%, or 4.4 lb/Ton

Element	Year -1	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5
Exploration Costs	-200						
Equipment Costs	-50	-400					
Development Costs[1]		-2000					
Working Capital (4 mo. operating cost)			-8333				8333
Sales @ $100 / pound (2.4lb/T)			30,000	30,000	30,000	30,000	
Royalty (10%)			-3000	-3000	-3000	-3000	
Operating Costs @ $200 per Ton[2]			-25,000	-25,000	-25,000	-25,000	
Environmental Costs[3]			-2500	-2500	-2500	-2500	-12,500
Gross profit (Excluding Working Capital)			-500	-500	-500	-500	
- 50% Depletion			0	0	0	0	
Equipment Depreciation (450/4 per year)			-113	-113	-112	-112	
- Loss Carried Forward[4].			-2200	-2700	-3200	-3700	
Subtotal **							
Tax on Subtotal (50%) **							
Net Profit (Gross profit less tax)	-250	-2400	-8833[5]	-500	-500	-500	-4167
15% Investment Rate of Return at Year -1	-217	-2032	-7840	-8126	-8374	-8591	-10,158

Table 8. Economics using a grade of 0.12% U_3O_8. (Dollars expressed as $k). -* See Table 7 for notes.. ** Subtotals not calculated because this number is negative in all cases, and therefore no tax would accrue. Similarly, no depletion allowance can be taken on a negative profit.

Conclusions

Procedures for Uranium Mining Ore Reserve Estimation have resulted from many years of experience in scientific, operations and economic evaluation techniques. In order to successfully plan and implement a uranium mine, the initial step is to prepare an initial economic feasibility study based on an acceptable cost and price structure with estimates of required grade. The next step is to implement an exploration program that will result in a mining ore reserve that "fits" the results of the economic evaluation. This mining ore reserve estimation must take into consideration the effects of internal dilution, the nugget hole effect, external dilution, and mine and mill recoveries. If this can be achieved, the miner may offer a reasonable price to purchase a potential mining property and commence mining. The final step is to utilize quality control in all phases of development and production of the mine.

References:

Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey, Geological Survey Bulletin 1450-A, 1976.

George FitzGerald, CPG-06582, was the first geology graduate from Humboldt State University, Northern California in 1968, focusing on field and analytical studies of stratigraphic and structural geologic features. His career includes 39 years in mining and environmental geology, including completion of mine feasibility studies for nearly 50 uranium mining deposits throughout the United States. He completed technical and economic studies for licensing radioactive and hazardous waste disposal facilities in Illinois and Texas. Currently, he is retired, but consults on mining and economic geology, and is a substitute teacher at Summit Christian Academy in Cedar Park, Texas.

For Immediate Release from NGWA

2010 National Ground Water Awareness Week to be held March 7-13

National Ground Water Awareness Week, March 7-13, is a time to recognize the importance of ground water and water well stewardship to our nation's future, the National Ground Water Association (NGWA) said today.

NGWA emphasizes a four-point stewardship message of:

- Ground water protection
- Proper water well construction
- Regular well maintenance
- Regular water testing and treatment, if necessary.

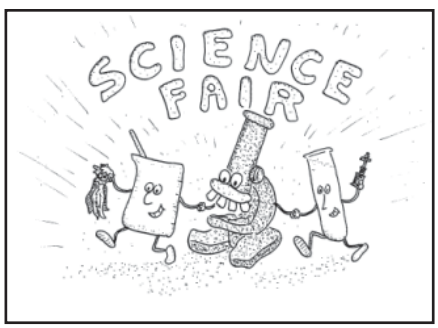
Not only do about 12 million households nationwide rely on private wells for their water supply, many community water systems rely on ground water in whole or part to meet water demands, and ground water supplies much of our nation's water for agricultural irrigation. Ground water makes up about 95 percent of all available fresh water.

Everyone can easily become good stewards by protecting ground water through the proper storage, use, and disposal of hazardous household substances. These include common products such as gasoline and oil, paints and paint thinner, fertilizers, weed killers, pesticides, and cleaning products.

Learn more about how to become a good steward of groundwater and water wells on NGWA's Web site, www.wellowner.org.

California Section

Science Fair Judging-In May 2009, AIPG California Section Vice President David Sadoff performed science fair judging for the California State Science Fair in Los Angeles, California. David has been performing the judging for about a decade and donates a large amount of time to this important effort. Each year, on behalf of the California Section, he gives out two prizes: a $250 award to a senior and junior category exhibit that best shows earth science research. The California Science Fair will occur again at the California Science Center in Los Angeles on May 18, 2010. Please plan on attending and help David judge the geology-related exhibits!



11th Annual 2010 Sacramento Drive-In-The California Council of Geoscience Organizations (CCGO; *www.ccgo.org*), held the 10th annual Sacramento Drive-In for May 28, 2009. AIPG California Section President Jim Jacobs organized this event and the previous drive-ins. He led the delegation to meet with state regulatory authorities as well as legislators and staff. CORE Environmental Foundation (consultants-owners-regulators-envirovendors) joined the delegation to support the BGG and to encourage AB 1188 emergency funding for the California Underground Storage Tank Cleanup Fund (more below). CORE is a new nonprofit organization focused on financing environmental projects, encouraging site closures and educating consultants, legislators and the public about safe resolution of environmental challenges. Since many AIPG California Section geologists work in the environmental field on projects funded by the UST Fund, the information is included in this newsletter. To leverage time, resources and energy, more collaborative efforts with CORE and other groups will be occurring in 2010 as well. The 11th Annual Sacramento Drive-In is planned for March 25, 2010. Please join AIPG California Section on this important lobbying day in Sacramento!

AIPG Student Chapters-The California Section has been working on establishing AIPG student chapters at a few universities. If there are California Section members who are professors or retired professors, you could greatly help in this process. In addition to providing funding for up to two professors to sponsor the AIPG student chapters, the California Section has set aside money for allowing students to join as well as receive *The Professional Geologist* in electronic form. Please let us know if you would like to be a speaker at a career day for the various AIPG student chapters that are being formed. Those wanting to be a Chapter Sponsors, please let Jim Jacobs know. The California Section ordered dozens of the January 2010 Student Issue paper copies to hand out to students and prospective members. Anyone needing more paper copies of *The Professional Geologist*, please contact Jim Jacobs.

Florida Section.

President's Message by James Hirsch.-Is the profession of geology becoming extinct? Although asked tongue-in-cheek, there are many factors seeming to conspire to lead us down a path once traveled by the now-extinct dinosaurs. One of these ominous signs includes the threat College Geology programs across the country face in being phased out or merged with other departments to reduce costs and generate additional funding resources.

As written in the Spring FAPG newsletter, serious consideration was given last spring to dismantling the University of Florida Geology program. Luckily this was avoided, due to the efforts of many people in this organization among others. The Florida State Department of Geological Sciences was not so lucky and is now being "merged" into a new Earth and Atmospheric Sciences Department. Although the undergraduate Geology degree has been suspended, classes will continue to be taught over the next 1-2 years to allow current majors to graduate. Students interested in majoring in Earth Science are encouraged to check out the new Bachelor's Degree in Environmental Sciences (due to be formally announced in Spring 2010).

There is a systematic decrease in the number of earth science classes being taught in our high schools, and (not surprisingly) a corresponding decrease in the number of college students entering the geologic sciences. Many geology graduates are not practicing geology after graduation. Of the 4,000 undergraduate geology majors across the country, it is estimated that only 15% will continue in geology after graduation. The current geosciences workforce is aging, and fewer new geoscientists are entering the profession to make up for those of us who will retire in the next 10-15 years

While painting a bleak picture, extinction is not an inevitable fate for the geology profession. Unlike our dinosaur friends, we have the ability to identify negative trends and to take actions to affect positive change. Positive actions have already begun.

The Florida Association of Professional Geologists (FAPG-AIPG) and the Florida Ground Water Association (FGWA) are working early in this 2010 Legislative Session to continue our efforts to educate our legislators on the importance of protecting Florida's natural resources.

For example, several FAPG-AIPG members and non-members - me, Mr. Jorge Caspary, P.G., Mr. Michael O'Sullivan P.G., Mr. Joe Fuhr, P.G., and Mr. Kevin Warner P.E. - met with Rep. Leonard Bembry on January 11 to discuss Natural Resource Appropriations for the upcoming fiscal year. Continued funding and employment opportunities in natural resource protection and water resources are a key to helping to reverse a shrinking geologic population. However, a good deal more public education and advocacy needs to be conducted to ensure the geology profession remains robust and healthy for decades to come.

For this to happen, we need members of this and other geosciences -related organizations to take action. This includes attending organization meetings, helping to grow membership, volunteering for special committees, writing articles, mentoring students, taking advantage of speaking opportunities, and leading field trips. All of these actions benefit and help forward our cause.

We need to act when presented with an opportunity to educate our peers and the public on the importance of geosciences, and financially support these efforts when able. If we pull together and put in the necessary work, the future looks very promising for us geologists and geoscientists – unlike the dinosaurs.

Georgia Section

Innovative Conference Results- The conference turned out great even though we had a very rocky start because of the flooding rains on Monday September 21, 2009. Our plan was to get everything set up on Tuesday afternoon but the university was closed because of the rain damage. It wasn't until 5:00 PM that we received word that the building would be open for our conference the next day. The folks at Kennesaw State worked tirelessly to keep our conference going even though the rest of the university would be closed. I had dozens of emails and voice mails to answer through out the day. On Wednesday morning we were able to set up and all the exhibitors that arrived on time. The first hour was chaotic but exciting as professionals started to arrive. The conference started about one half hour late but we made up the time throughout the day to get back on schedule. The total attendance was 120 including approximately 12 "walk-ins" that heard about the conference but hadn't registered. We were prepared to accommodate any extras. We had 23 exhibitors with ten coming from out of state. We had two full days of speakers but a few hadn't submitted their presentations early enough to place in the note books, but copies were made available. This year we invited Atlanta Geological Society, Georgia Ground Water Association, Association of Environmental & Engineering Geologists Southeastern Section, and American Society of Civil Engineers Georgia Section to set up displays of their organizations. I've evaluated the questionnaire and almost 100% of the respondents were satisfied or very satisfied with the conference and plan to attend again. We have some improvements to do on the notebook and registration and some people would like the conference in a more central location. Special thanks go to Eric Lowe, Caryl Alfaro, Yo Sumartojo, John Salvino, and Glen Faulkner. We hope to have another conference in early 2011.

A few pictures of the exhibitors at our September 23-24, 2009, conference.

Visit To Georgia Southwestern State University-On October 23, 2009, Rick Ricci, CPG-11174, Ron Wallace, CPG-08153, along with Jim Fineis, president of Atlas Geo-Sampling Company demonstrated installing a monitoring well on campus to the Environmental Geology class. The students watched as the well reached total depth and the screen and riser, sand filter pack, bentonite, well cover, and concrete were completed. Each student got an opportunity to either hand auger or operate the drill rig. We showed them how to screen soil samples and the ASTM method of describing soils. We demonstrated proper groundwater sampling and showed some of the different bottles used in collecting water samples. Some simple surveying was also shown to the students. Back in the class room the soil samples were brought in and the students had a hand in describing the samples. Each student received a notebook with a section on proper soil logging and the classification system. The notebook also had many typical field forms, which I had previously received from members, used by consultants. A homework problem was given to the students on a UST site in Americus where they were to construct a potentiometric surface map and benzene concentration map. We encouraged the students to join AIPG and spoke of the advantages they would receive. We hope to have a chance to do this demonstration again at another university.

Demonstrating drilling to a student.

Rick Ricci demonstrating soil screening.

Jim Fineis discussing water sampling.

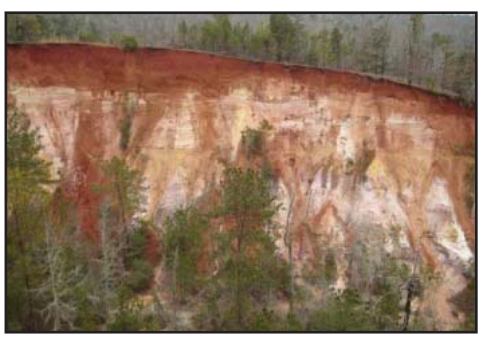
Showing well completion to the students.

Georgia Section Providence Canyon Field Trip-It was a cold and windy day and only the heartiest made the drive. Providence Canyon State Park is south of Columbus, Georgia and

historical accounts indicate that the canyons began forming in the early 1800s as the result of poor farming practices. There are a series of 16 canyons, some as deep as 150 feet. We walked up one of the canyons to look closely at the sequence, stopped and had lively discussions of the stratigraphy. The stratigraphic section visited include the Late Cretaceous to Paleocene and younger.

We then made a short drive along road cuts to look at the marine section from the Providence Formation through the Clayton Formation. There was much discussion on where the contact is between the formations and we also made some comparisons of the Clayton Formation to its type section in Alabama. One of our stops also showed a good example of a stream channel cutting through the section. We would like to thank Carl Froede for leading the field trip.

The hearty crew.



A view of one of the canyons.

Kentucky Section

Presidents Message by Jim Howard, CPG-02536-Well, here I am again. Thanks to all of you who decided that another term as President of the Kentucky Section of AIPG was appropriate (I think!). I have been asked to give some thoughts on what in the coming year, so here I go.

1. The number of practicing geoscientists in the State of Kentucky is relatively low. Of the 1600+ Registered Geologists in the state, less than 500 actually reside in Kentucky. As a result, we have very little actual clout in the political, educational, and regulatory aspects of Kentucky. Since that is the case, I propose to try to maximize what influence we have by developing closer integration of the efforts of the Professional Geoscientists in the state. Hopefully this can be accomplished by increasing the communication and coordination between the various professional groups of which we are members. Toward that end, I intend to more closely interact with the Presidents of the KSPG and the IKGS as well as continue my existing offers of visits and presentations to the Academic Institutions offering Geoscience and Environmental curricula. I hope to include greater cooperation in developing and implementing field trips as well as encouraging greater participation in our professional groups by the professionals in Kentucky.

2. In order to aid our practicing geologists in the state, I hope to initiate a program of teaching/training seminars, short courses and conferences which will enhance and upgrade the professional capabilities and credentials of consultants and state employees in Kentucky. These programs will be based primarily on the expertise of contractors and consultants so that the newest elements of the practice become available to our practicing geoscientists, whether in environmental consulting, fossil fuel exploration and development, mining development and any other area in which geologic expertise is appropriate. I hope to have the first program ready to be offered in August, 2010 with subsequent offerings at a rate of one or two events per year thereafter. A core committee of volunteers to help prepare the events is already active in that regard and we will keep you posted on the results as appropriate. Additional volunteers are welcome at any time since this will, I hope, be an ongoing program and there can never be too much input to keep the offerings and subjects fresh and valuable to our professionals.

3. I hope to expand on the excellent start by Faith and Frank Ettensohn, MEM-1178, with respect to outreach to Science Teachers at the Middle and High School level in Kentucky. This effort will include continuing the scholarship program for teachers to our field trips and, hopefully, making available Speakers/Career advisors/Science Fair Judges, etc. for programs where they are appropriate and desired.

4. Field trip planning is already underway for the Spring Meeting in the Red River Gorge. Additional Field trips in cooperation with KSGP, IKGS, KGS and members of the State University Geoscience Departments are under discussion and dates and subjects will be made available as soon as possible.

5. Our third symposium planning is headed up by Dr. Charles Mason, CPG-07465, of Morehead University. Our two previous events in conjunction with the International Year of the Planet Earth with Dr. Tim Patterson and Dr. Kurt Cuffey (2008) and Dr. Dennis Stanford (2009) were reasonably successful with attendances of around 200 and enhanced our enhanced interaction with other scientific fields. We hope to continue this trend with Dr. Jack Horner, the scheduled speaker at our celebration of the anniversary the Publication of the Darwin's Origin of Species. Tentative date for that event is February, 2011 and we welcome all publicity and help in making it successful. Other projects will emerge during the coming year, hopefully involving more of the membership in all organizations as well as increasing student involvement in our activities. If you have questions at any time or have suggestions that you think should be considered by the AIPG Executive Committee or any combination of the above groups, please feel free to contact me or any member of the organization. My cell phone # is (270) 925-6636 and my e-mail address is *jfhoward89@hotmail.com.* I look forward to working with you all in our various endeavors.

Items of Interest-The KY-AIPG shared a booth with the Kentucky Geological Survey at the Kentucky Science Teachers Association meeting held at Rupp Arena, November 6 & 7. The KY-AIPG let interested teachers fill out a form and we would pick two names to attend our spring field trip. (Photo 1)

Charlie Mason, CPG-07465, professor at Morehead State University, Department of Earth and Space Sciences received the "Outstanding College/

Photo 1. The KY-AIPG shared a booth with the Kentucky Geological Survey at the Kentucky Science Teachers Association meeting held at Rupp Arena, November 6 & 7.

Photo 2. Charlie Mason receives Outstanding College/ Univeristy Teacher Award.

University Teacher" 2009 award at the 95th Annual meeting of the Kentucky Academy of Science, held at Northern Kentucky University. (Photo 2)

Michigan Section

Michigan Section Award Recipients-At the Section Annual Meeting in December, the Michigan Section gives different awards to its members. For 2009, the only awards given were the Longevity Award and Student Poster Award. The following is a listing of those individuals that passed significant longevity milestones:

30 Years: PD (name abbreviated at the individual's specific request).

25 Years: Burrell Shirey

20 Years: Charles Moskowitz

15 Years: Douglas Barber, John Barkach, Mike Belsito, Jim Bradley, Don Conway, Tim Cook, Dan Dyer, Joe Edwards, Phil Emmons, Mark Evans, Greg Foote, Hosam Hassanien, Mike Hebert, Hugh Heuvelhorst, Alfred Jordan, Tim Mayotte, Jeff McCormack, Mike McDuffee, James Mersereau-Kempf, Mark Parrish, Sandy Pelowski-Bresson, Mike Peters, Mark Petrie, Mike Piddington, Ed Radecki, Mike Ripley, Joe Sarnecki, Mark Seaman, Jill Van Dyke, Richard Verstrate, Mike Wilczynski, and Mark Zayatz.

10 Years: Lesa Bagby, Gary Blinkiewicz, Graham Crockford, Loren Curtis, Sara Pearson (who should have been listed last year), Marc Wahrer, and Mark Wollensak.

A $500 student poster award was made at the December meeting to Travis Hayden of Western Michigan University. Congratulations Travis!

The Michigan Section also awarded a $500 educational grant to Plymouth Canton Schools. Science teacher Jennifer Groat applied for and received the 2009 educational award. The grant money will be put toward the school's inquiry-based learning system, and will be used to purchase a variety of items, including glass and streak plates, magnets and iron filings, and other items. The award will benefit three earth science teachers and at least 270 students.

Although normally awarded, the Michigan Section did not receive any nominations for its other awards (Outstanding Geologist, Significant Contribution to the Michigan Section, Outstanding Regulator, or Outstanding Educator). The Michigan Section Executive Committee requests its members to consider providing nominations for these positions. The nomination form and information is available on the Section website under "Awards."

Congratulations to all the Michigan Section awardees!

December Section Meeting Summary-The Michigan Section annual meeting was held on December 3, 2009 at the Fetzer Center on the campus of Western Michigan University, with a premeeting tour of the Michigan Geological Repository for Research and Education facility.

The turnout for the meeting was good, with 69 participants, 24 of whom took the tour of the MGREE facility. The meeting also included a record number of student attendees, with five of them bringing technical posters for review. These posters were judged by the meeting attendees, and Western Michigan University student Travis Hayden's poster titled "The Chesapeake Impact Structure Differentiating Regional Tectonics from Impact Signatures" was judged the winner.

Meeting participants enjoyed dinner and then an educational talk provided by Dr. David Barnes and Dr. David Karowe on "Climate Change: An Interdisciplinary Science Presentation."

Photos from the MGREE tour showing shelves of rock core and the WMU-MGREE CoreKids program display. Photographs courtesy of Sara Pearson.

Members viewing the student posters before dinner at the Fetzer Center. Photograph courtesy of Tim Woodburne, Michigan Section..

Sara Pearson and the student poster authors just before the presentation of the $500 student poster award. Photograph courtesy of Tim Woodburne, Michigan Section.

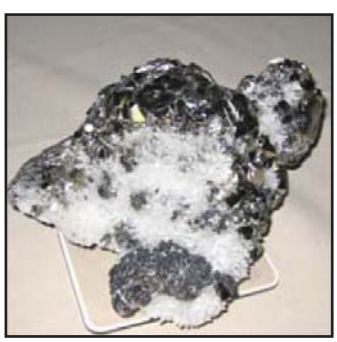
Nevada Section

Nevada Section News-On December 15, 2009, some 100 attendees enjoyed the 20th annual Exploration Round-Up Dinner in Reno. This year's forum featured speakers from nine companies: Barrick Gold, Newmont, Western Uranium, Agnico Eagle, Victoria Resources, Miranda, AUEX, Kinross and Nevada Copper. Each representative briefly described company plans and budgets for 2010, bolstered nicely by gold's recent lofty price.

Nine students from the University of Nevada, Reno AIPG chapter were treated to the prime rib dinner, thanks once again to the generous support of Eklund Drilling/Boart Longyear. In fact, this year marks the 20th year that Marty Dennis and Lance Eklund of Eklund Drilling have hosted the cocktail hour and student dinners. In appreciation of two decades of support, each was presented with an engraved prospector's gold pan.

Also marking a milestone in generous support, Mark Stock of Global Hydrologic Services is in his tenth year of donating beautiful mineral and fossil specimens for raffles supporting the UNR student chapter. This year his two crystals and fish fossil raised over $1,600 for that worthy cause.

Moderator Kel Buchanan presents awards to Lance Eklund and Marty Dennis for 20 years of support.



This spectacular association of crystallized pyrite, quartz, and sphalerite from Peru was one of three specimens donated by Mark Stock for the student raffle.

American Geological Institute
GEOSCIENCE CURRENTS
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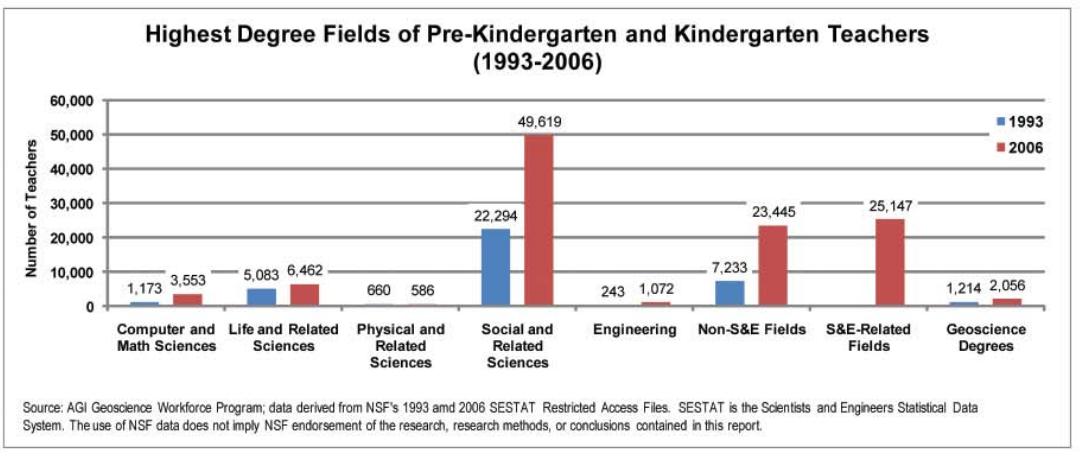
29 January 2010

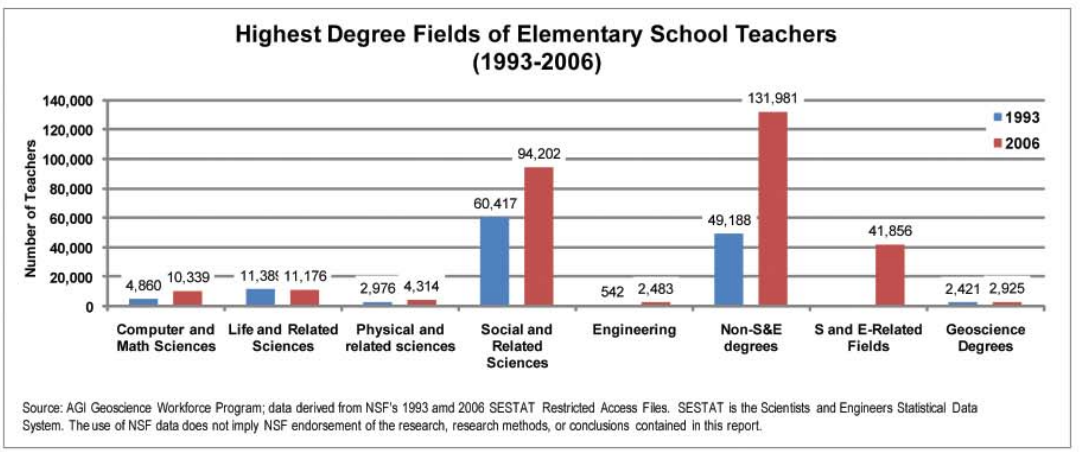
K-12 Teachers and Geoscience Degrees

K-12 education provides an important formative stage in a student's education, and the coursework to which students are exposed during this period (especially during high school) influences choices they make in regards to college majors. Examination of national trends in degrees of K-12 teachers between 1993 and 2006 indicates a low representation of teachers with geoscience degrees. In pre-kindergarten and elementary school, teachers most commonly have their highest degrees in the social sciences or in non-science and engineering disciplines. However, whereas in pre-kindergarten and kindergarten the percentage of teachers with their highest degree in the geosciences is between 2-3 percent, in elementary school it is only 1-2 percent.



Source: AGI Geoscience Workforce Program; data derived from NSF's 1993 amd 2006 SESTAT Restricted Access Files. SESTAT is the Scientists and Engineers Statistical Data System. The use of NSF data does not imply NSF endorsement of the research, research methods, or conclusions contained in this report.

In secondary school, the most common degree fields of computer, math, and science teachers are relatively evenly split between computer and math sciences, life sciences, and non-science and engineering degrees. Approximately 3 percent of these secondary school computer, math, and science teachers have their highest degree in the geosciences. In 2006, 12,679 secondary school computer, math, and science teachers had their highest degree in the geosciences.



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Note: The inclusion of "S&E related fields" as a degree category in 2006 is a primary factor in the decline in the number of degrees from other fields from 1993 to 2006. The "S&E Related fields" category includes Health, Science and Math Teacher Education, Technology and Technology Fields, and Other S&E Related fields.

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- Leila Gonzales

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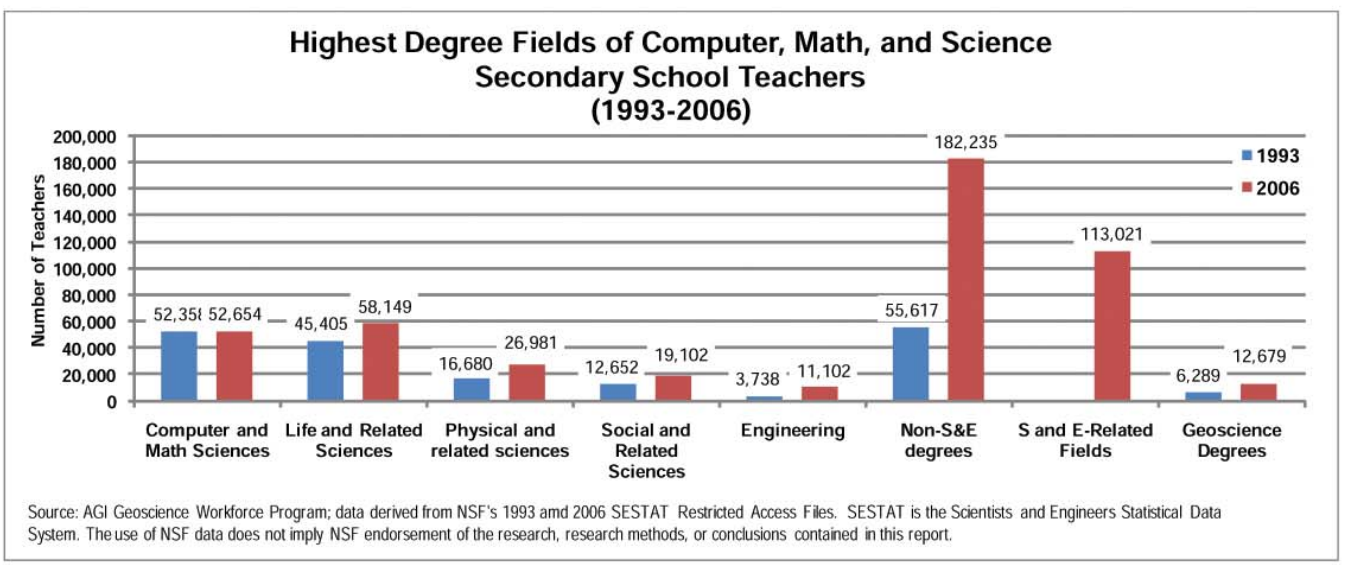
In a related survey, the Council of Chief State School Officers reported a total of 322,907 secondary school math and science teachers for the year 2006. Of that number, only 16,211 were Earth Science Teachers, 74 percent (or 12,320) of which were assigned to the subject in one or more periods and had state certification in the subject.

Considering that earth science education requirements are met by the majority of students in grades 6-8, the low representation of elementary school teachers with geoscience degrees is cause for concern in regards to the preparation of elementary students for mandatory earth science curriculum in the middle grades, and for priming their interest to take earth science courses in the higher grades. In secondary school, earth science is not required for graduation in most states and there are fewer earth science teachers than in other disciplines. As a result, high school students are less likely to take earth science courses in high school. Furthermore, Holbrook's 1997 study[1] indicated that low enrollments in geoscience undergraduate programs are linked to the lack of exposure high school students have to earth science curriculum. Increasing the cadre of well-trained K-12 teachers with geoscience degree backgrounds is important for bolstering the influx of students into geoscience degree programs.



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[1]Holbrook, J. Career Potential in the Sciences, Geology in the High Schools, and Why Anyone Would Major in Geology Anyway. Palaios 1997, 12, 503–504.

- Leila Gonzales

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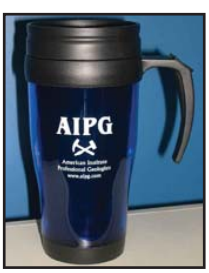

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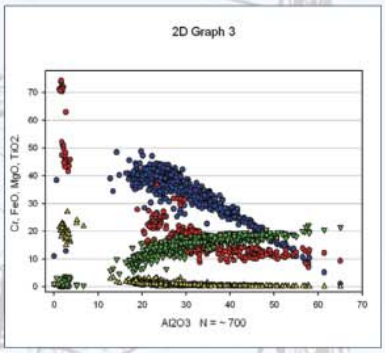

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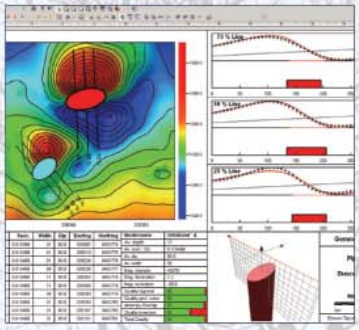

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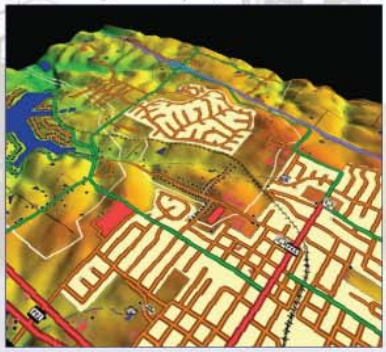

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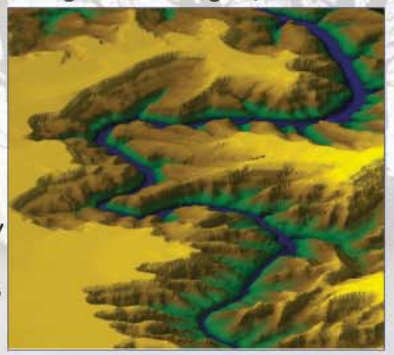

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