The Olympics are on and as a family we cheer and moan with nervous tension and excitement. I am exhausted! Not so much the late hours, which I tend to keep anyway, but more the emotional ride of watching young people strive to excel, nations come together in peaceful competition, and the stress that judging the events puts on the body and mind! What was that judge thinking!? She deserved a much higher score! Yes, we are all now experts on the finer aspects of the parallel bars, vault, and beam…

…it reminds me a bit of energy policy. Have you noticed how many “experts” are weighing in on gasoline prices, carbon sequestration, and electricity markets? Even Paris Hilton is speaking out because, according to her, “she’s hot!”

To be sure, nothing captures the public’s attention like energy price. Opinion polls were against offshore drilling—until the cost per barrel blew past $100! There will be a higher cost to clean power, and it will be interesting to track public response. Along with public awareness comes the predictable flurry of activity (Brownian motion?) in Washington, D.C. Indeed, market forces drive public opinion, which in turn pressures elected officials to “do something.”

Energy is required for a healthy economy, and a healthy economy is the underpinning for significant investment in a clean environment. In terms of energy, a reliable and available supply of fossil fuels provides the bridge to an alternative energy future. Thus, one of those “somethings” the U.S. can do is open up offshore areas currently under drilling moratoria so that we can produce fossil energy, maintain a healthy economy, invest in the environment, and build a stable bridge to an alternate energy future. Some of us have been suggesting this for years; thank goodness Paris Hilton is on board!

It would be great if energy experts could address the energy issues of the nation in a period when gasoline and electricity prices are relatively stable. But, alas, crisis drives action. I for one am glad to see the public get on board the energy train and begin to become educated.

Even the media is now becoming a bit more balanced in its energy reporting. Either/or conflicts—between fossil fuels and alternate energy; between energy and the environment—are red herrings. Energy, environment, the economy, and policy are not mutually exclusive. Quite the opposite. We must continue to build bridges, not dig moats.

As you will read in this midyear report, researchers and staff at the Bureau are building bridges and pressing the edges of energy research (Advanced Energy Consortium), looking hard at ways to reduce carbon emissions (FutureGen and beyond), and educating both the young (GeoFORCE) and the more seasoned (Decision Makers). This steady stream of research prepares us to provide considered input when the “crises” arise.

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**CONTENTS**

- **Advanced Energy Consortium** ........................................... 1
- **FutureGen and Beyond** ................................................. 4
- **Jackson School GeoFORCE Texas** ............................... 6

**Earth Science Week** ......................................................... 8

**In the Field with Decision Makers** ............................. 10
This year, the Bureau of Economic Geology (BEG) has embarked on a program to fund scientific research in the relatively unexplored realm of the infinitesimally small. This “nanorealm” is so small and unexplored that it has never been seriously considered by most geologists, geochemists, geophysicists, or petroleum engineers. But, as one of BEG’s collaborators on this project, John Ullo (Sr. Manager of Schlumberger’s Doll Research Center in Boston, MA), has eloquently pointed out,

1. The petroleum industry has been focused on characterizing and understanding the oil reservoir macro- and micro-worlds over the last century; but, with the depletion of conventional hydrocarbon resources and the need to explore and recover from unconventional sources, the industry now must understand where much of the remaining hydrocarbons are trapped—at the Nano Scale. This could very well be the beginning of a new field of geosciences, “NanoPetroPhysics.”

Increasing world energy demand is the impetus behind this research, and the difficulty in finding and accessing trapped oil is the driving force. In 2006, the U.S. Department of Energy reported that approximately 67 percent of all U.S. oil remains in place, estimating that perhaps one-quarter of this oil can be recovered using conventional recovery techniques. Locating and extracting the remaining petroleum—billions of barrels of potentially available supply—are the research objective of the Advanced Energy Consortium (AEC). That petroleum could serve as a vital hydrocarbon bridge, while renewable energy resources are scaled to meaningful (terawatt) levels.

But this “remaining oil in place” (ROIP) is not easy to find or remove. Despite the use of 3-D and 4-D seismic detection, advanced downhole electrical, sensitive remote electromagnetic, and sophisticated modeling and simulation technologies to improve our understanding of oil and gas reservoirs, these techniques are still lacking in resolution and/or deep penetration into reservoir lithologies. In fact, with the exception of seismic, most sensing technologies penetrate and provide information only inches from the well bore.
Members of the consortium have defined their most significant challenges in improving reservoir characterization as follows:

1. Chemical and physical properties of reservoir fluids and rocks beyond the well bore
2. Three-dimensional distribution of reservoir fluids and rocks
3. Dynamic paths of fluids (including all fracture-generated flow paths)

Nanosensor capabilities must therefore include:

- Accuracy in placement and recovery of sensors into and out of the reservoirs
- Protection against the harsh environment of the reservoirs
- Provision of location information within the reservoirs
- Ability to harvest, generate, and store power for the sensors
- Communication of sensor data, or telemetry
- Effective integration of data (processing and analysis) from millions of sensors

BEG’s platform for this revolutionary research is AEC, which officially opened its doors on January 1, 2008. This consortium, comprising oil industry leaders, is focused specifically on the application of nanoscale technologies to the exploration and production of oil and gas. The primary goal of the research consortium is to develop subsurface micro- and nanosensors that can be injected into oil and gas well bores. By virtue of their very small size, these sensors would migrate out of the well bores and into and through pores of the surrounding geological structure to collect data about the physical characteristics of hydrocarbon reservoirs. The data collected could ultimately enable a more efficient exploitation of hydrocarbon resources.

Developing a consortium of the biggest energy companies in the world was no easy task. The journey started almost 4 years ago, with a series of meetings set up and led by Scott Tinker and Jay Kipper with high-level managers of oil companies from around the world. After a year-long series of workshops, the concept was accepted, common areas of interest were identified, a proposal was developed by BEG, and the process of formalizing the consortium began. Obtaining the required Department of Justice approval for this consortium took 9 months to complete; in the meantime, a parallel challenge was in getting nine different corporations to agree on identical contractual language for membership.

Current consortium membership includes BP America Inc., Baker Hughes Incorporated, ConocoPhillips, Halliburton Energy Services Inc., Marathon Oil Corp., Occidental Oil and Gas, Schlumberger, Shell, and Total. The Smalley Institute for Nanoscale Science and Technology (SINST) at Rice University is collaborating with BEG and will serve as a key technical partner in the consortium.

What is especially challenging about this application is that no one has even really considered using these new nanotechnologies in an operating environment as complex and harsh as might be encountered in an oil reservoir (conventional depths of thousands of feet; operating temperatures exceeding 250°C; pressures to 15,000 pounds per square inch; and an environment of complex mixtures of oily, waxy, acidic, and briny fluids that are corrosive and conductive). Conventional microelectronic sensors could not survive under these conditions, let alone operate and communicate.

AEC and its members have hosted a number of workshops this year, putting experts in electronics, sensor materials, and nanotechnology
together with experts in the oil and gas industries to investigate areas in which the science needs to be understood better and at what point existing technologies and research might be leveraged into the reservoir. A list of promising technologies includes a variety of nanoallomorphs of carbon, magnetic nanoparticles, chemotactic micro- and nanotube structures, and nanoexplosive materials. The consortium is now convinced that building on research that’s ongoing in smart dust, medical imaging, and nanofluidics fields could lead to breakthroughs in “illuminating” the oil or gas reservoir. Consortium members are currently soliciting proposals for applied research projects in functional technologies such as “smart proppants”; nanofluidics-based “nanostraws”; and micro- and nanosensors, nanoseismic, and nanomagnetic contrast agents.

If AEC is successful, all participants think that application of nano- and microscale technologies to oil and gas exploration and production could lead to a revolution in our ability to understand oil and gas reservoirs, and it could ultimately lead to recovery of substantial hydrocarbon energy resources.
Bureau of Economic Geology

Railroad Commissioner Michael Williams turned to the Bureau when he and Governor Rick Perry made the decision 3 years ago to pursue the Department of Energy (DOE) project known as FutureGen.

FutureGen and Beyond

By Ian Duncan

Railroad Commissioner Michael Williams turned to BEG when he and Governor Rick Perry decided 3 years ago to pursue the DOE project known as FutureGen. The project—a way to develop clean-coal technology—was based on a plan for a state-of-the-art coal-fired power plant with “essentially zero emissions.” Clean-coal technologies are such that emissions such as nitrous oxides, sulfur oxides, and CO₂ are cut to near zero.

The FutureGen project set out to build a 275-MW power plant using IGCC (Integrated Gasification and Combined Cycle) technology (IGCC power plants are based on gasification, not coal combustion) that would capture and sequester 95%+ of the produced CO₂. In gasification, coal is heated to high temperatures (typically >2,000°F) and high pressures, along with steam and some pure oxygen (separated from air). Under these conditions coal is converted into a synthetic gas composed of hydrogen (H₂) and CO₂. H₂, perhaps the cleanest energy available, is then burned in a combustion turbine. Excess heat from this turbine powers a second steam turbine (hence, combined cycle). IGCC plants are more energy efficient than traditional pulverized-coal plants (PC) and use less water. So far, only a few IGCC plants have been built worldwide, and FutureGen plants would have been the first to include sequestration of CO₂ in deep-brine reservoirs.

In the long run, building commercial clean-coal plants in Texas can positively impact Texas and its economy. The state is currently the largest user and fifth-largest producer of coal in the U.S., and this coal produces electricity, traditional PC power plants currently being the cheapest way to do so. Plentiful, reliable electricity has played a key role in Texas’ becoming the “Energy Capital of the U.S.”

From the start, Commissioner Williams and BEG Director Scott Tinker agreed that Texas (and BEG) would pursue two parallel tracks—one to develop a winning proposal to site the FutureGen plant in Texas and the other to facilitate the building of “FutureGen-like” power plants in Texas by private industry.

BEG formed the FutureGen Texas Team to pursue winning the FutureGen-siting request for proposal. In addition to
Scott Tinker (Team Leader), the team included Jay Kipper (Management Lead), Chuck McDonald of McDonald Public Relations (Government Relations Lead), independent consultant Jerry Hill (Power Engineering Lead), independent consultant Steve Walden (Environmental Lead), and Ian Duncan (Geology and Sequestration Lead). This team set to work helping local governments in Texas identify suitable sites for IGCC plants and associated sites for CO₂ sequestration. An in-state request for proposals to Texas’ Council of Governments (COG’s) issued by the team resulted in 12 potential sites around the state. Each site was evaluated by the team, both to provide a winning proposal for the FutureGen site competition and to locate a possible “FutureGen-like” commercial power plant.

Two sites were finally chosen by the FutureGen Texas Team—one near Odessa, West Texas, and one near Jewett, East Texas. At each site BEG staff worked with local teams set up by winning COG’s to develop the best site proposals. At both sites BEG led the way in identifying and characterizing a geological sequestration site that met all requirements set out by the FutureGen Alliance (a consortium of power and coal companies empowered by DOE to select the FutureGen site and ultimately build the plant). In the end, after considering site proposals from many states—Ohio, Kentucky, West Virginia, North Dakota, Illinois (four sites proposed), and Texas—the FutureGen Alliance chose both Texas sites and two sites in Illinois for final competition.

After months of grueling work, BEG staff, along with environmental consultants Steve Walden, Russ Baer, and Horizon Environmental, developed a Federal NEPA (National Environmental Policy Act) environmental assessment of both Texas sites. Sadly, these sites ultimately lost to Mattoon, Illinois, in the FutureGen competition, although Illinois’s achievement was a pyrrhic victory because the FutureGen project was terminated by DOE soon thereafter.

Since then, the State of Texas and BEG continue to support companies developing commercially based, clean-coal- and gasification-based projects that will use sequestration in either deep-brine reservoirs or CO₂-based enhanced oil recovery. Several exciting commercial projects are in the engineering-design phase and, if built, they will represent significant breakthroughs in the race to develop environmentally acceptable ways of harnessing the vast energy resources available from coal.
As career opportunities continue to grow in the geosciences, industry and other organizations that hire geoscientists are looking for ways to convince more students to enter this field. Enrollment in universities that offer geosciences as a major has been growing but has not been able to keep up with the demand.

In 2005, the GeoFORCE Texas program was established, under the direction of former Bureau Associate Director and now Director of Outreach for the Jackson School, Doug Ratcliff, and industry partners, to interest high school students in the geosciences. The first group of GeoFORCE students, 40 9th-graders from Southwest Texas, were admitted into the summer program on the basis of their academic and community achievements and their commitment to stay in the summer program throughout their high school careers. The inaugural GeoFORCE Academy included 2 days of classroom instruction and geology field trips in Austin. The students then flew to the Washington, D.C., area to learn the basics of geology by making observations in the field. The program proved to be successful, and another program for 40 more 9th-grade students, called the Young Geoscientists field course, was launched to teach them about geology in their backyard, the Uvalde area.

This year the students, now seniors in high school, are embarking on their final academy to Florida, and these 12th grade Young Geoscientists are traveling to West Texas and New Mexico. Academy 10th-grade students are traveling to Nevada, Utah, and Arizona, and 11th graders are traveling to Washington and Oregon. The Young Geoscientists program includes trips to Mustang Island for 10th-grade students, and 11th graders are traveling to Austin. Each year, a new group of 9th graders take advantage of these opportunities of a lifetime, and Houston-area students joined the program this summer. In 2009, a full complement of 640 students from Houston and Southwest Texas will be attending the Academy or Young Geoscientists field experiences for the summer.
This program, free to students attending targeted schools in the Southwest Texas region and Houston Independent School District, is made possible through the generosity of the GeoFORCE sponsors.

The Bureau has played a significant role in the success of the GeoFORCE program. With the enthusiastic support of the Directorate, Bureau research staff, along with retired Bureau Associate Director Jay Raney, have been responsible for writing each of the four Academy and four Young Geoscientists guidebooks, which serve as their textbooks. The Bureau’s Media Technology team is responsible for producing the guidebooks, including editing, creation of images, design and layout, and printing. Bureau research staff members also serve as instructors for six of the eight field programs.

GeoFORCE Texas would not be possible without the financial and in-kind support of Shell Oil Company, Texas Workforce Commission, Marathon Oil Company, ExxonMobil, BP, ConocoPhillips, Chevron, Halliburton, Texas High School Project Communities Foundation of Texas, Vulcan Materials Foundation, Devon, Valero Energy Corporation, and American Electric Power. In addition, GeoFORCE receives contributions from the GDL Foundation and Bill and Marilee Fisher. Every penny of the financial support from sponsors goes to program activities.

The success of this program will become more apparent as students graduate from high school and establish their future goals. Although not all will major in geosciences in college, GeoFORCE will have provided a solid foundation in geology that will help the students make important decisions in the near future about our critical natural resources and our interaction with the environment.
Earth Science Week

By Sigrid Clift

Earth Science Week (ESW) is a nationwide program designed to promote interest and knowledge of the earth sciences and their contributions to society. The theme for the 2008 event is No Child Left Inside, a nationwide initiative, made up of organizations that believe that young people should receive a strong education about their natural world.

The American Geological Institute (AGI) established the ESW observance in 1998 that is celebrated the second week in October in every state and in countries around the world. Because of AGI’s efforts, more than 1 million students and adults have benefited from thousands of earth science professionals’ volunteering their time to promote their careers and the impact that Earth scientists have on our everyday lives.

Texas communities actively participate in ESW annually. Earth science professionals organize events for thousands of students and adults each year in the following communities:

- El Paso celebrates the event in collaboration with its annual Celebration of Our Mountains program.
- Houston organizers host area field trips and tours at the Houston Museum of Natural Science.
- Midland earth science professionals visit K–12 classrooms. Students tour the Permian Basin Petroleum Museum and get a chance to experience the Bureau of Economic Geology visualization lab.
- San Antonio volunteers have various offerings that include T-shirts for students, radio and TV announcements, earth science experiments, and mineral and rock activities. Earth science professionals are asked to visit K–12 classrooms as well.
Austin earth science professionals have also been active in the ESW effort. To commemorate the first ESW in 1998, a core was taken from an Edwards aquifer monitoring well on the Austin Community College campus to demonstrate local hydrological research. In 1999, the Austin ESW Consortium was established to organize local events. In 2000, the first ESW career fair for 200 middle school students was held at the Bureau of Economic Geology. In the past 8 years, approximately 2,500 students, plus their teachers, have attended this event.

The Austin ESW Consortium is organizing the ninth annual career fair this year for 350 students who will have the chance to learn about careers in petroleum geology, paleontology, hydrology, hydrogeology, meteorology, archeology, planetary science, environmental science, earth science education, and gem faceting. More than 70 volunteers, who include Bureau scientists and support staff, take time away from their jobs to participate in the fair as career presenters, exhibitors, and tour guides.

The Austin ESW Consortium also organizes other events for the community, such as a summer lecture series, Earth science festival, and workshops for teachers. Each year, the consortium raises funds for the Austin ESW book drive to purchase much-needed earth science books for the Austin Public Library. To date, the drive has raised more than $8,000.00.

The U.T. Commons Conference Center, at the J. J. Pickle Research Campus, donates the use of its facilities each year. The Bureau of Economic Geology and the Jackson School, along with other U.T. departments, State and local agencies, nonprofit organizations, and industry, provide support each year to make the Austin area ESW events possible. It is the supporters of Austin ESW that make the event the success that it is today—and 100 percent of all contributions are used toward ESW events.

The Consortium and City of Austin Natural Resources Conservation District collaborated on the 2008 ESW Summer Lecture Series. The theme was Texas Dinosaurs, and guest lecturers included Drs. Louis Jacobs from Southern Methodist University and Pamela Owen from The University of Texas at Austin.

For more information about Texas and Austin ESW, visit the website at www.beg.utexas.edu/esw.
In April of 2004, the Bureau introduced its first Decision Makers Field Trip—one that led decision makers responsible for the management of Texas’ natural resources (State dignitaries, elected officials, leaders in education, and folks from the business community) through the “Geology of Central Texas.” The tour included occurrences, environmental issues, and economic impacts of water resources, fossil-fuel resources, and mineral resources. During the 2-day event, participants traveled by chartered bus to selected sites such as Barton Springs (formed by artesian waters from the Edwards aquifer), Hanson Aggregates’ New Braunfels quarry, Natural Bridge Caverns in New Braunfels, Austin Chalk oil field, and the Alcoa lignite mine.

In September of 2006, the second Decision Makers Field trip broadened its reach to include Houston and the Gulf Coast. That trip, “Hazards and Natural Resources of the Texas Gulf Coast: Building the Bridge between Science and Policy,” brought participants to selected sites to observe firsthand the most significant environmental, technological, and economic issues facing the Texas Coast today. Beginning at the Bureau’s Houston Research Center with tours and talks, the seminar soon made its way to Galveston Island to examine coastal natural hazards and policies concerning hurricanes. The second day of the tour brought the group to the Valero Refinery.

2008 Decision Makers Field Seminar:
Clean Carbon Power for Texas: Science for Sound Policy

The Bureau organized and led the third Decision Makers Field Trip on May 8, 2008—an excursion to Jewett, Texas. Thirty participants from the Texas Legislature, State agencies, and U.S. congressional offices joined trip leaders from the Bureau, Westmoreland Coal Company, and NRG Energy LLC for a day of discussions concerning the future of clean-carbon-power generation in Texas.
The day included tours, talks, and interaction among officials and Bureau staff so that all sides could be enlightened.

A lignite surface mine tour of the Jewett Mine was led by Joe Micheletti of Westmoreland Coal Company. Located between Dallas and Houston, the mine covers 35,000 acres of surface mining, including five currently active coal pits. Jewett Mine is currently partnering with the Jewett NRG Energy Limestone Electric Generating Station and will continue to do so at least through 2015. This particular coal mine produces more than 7 million tons of lignite annually. The field-seminar group saw the mighty excavating machine removing overburden just above a thick lignite seam in the Calvert Bluff Member of the Wilcox Formation. In addition to coal excavation, the group also witnessed the company’s efforts to rejuvenate already used land through reclamation, which consists of filling voids created during removal of coal. Newly replanted flowers, trees, and shrubs are in abundance, encouraging wildlife to begin to return as well. The company’s goal is to leave the area just as it was found.

After the mine tour, participants enjoyed a barbecue lunch at NRG’s 1.8-gigawatt, mine-mouth, coal-fired electrical generation plant. During lunch Bureau Director Scott Tinker and Evan Rowe of the Public Utility Commission of Texas made presentations. Table conversation centered on insight provided by these experts, and a tour of the Jewett NRG Energy Limestone Electric Generating Station followed as conversation continued.

The tour began with a look at the 1.5-mi-long, 1,500-tons-per-hour conveyer belt ferrying coal from the mine to the plant. Next to the conveyer belt, silos can be seen, in which an emergency supply of coal is stored alongside currently usable coal. Later the decision makers toured the control room, which includes a state-of-the-art system that has several checks for emergency shutdown, and next they watched huge drums rotate the coal to break it down. It was an education to most everyone on the tour just how much has to happen to provide energy to Texas! The last stop was the “bird’s nest” of the plant. From a vantage point atop the power-generation facility, participants could see about three dozen drilling rigs in the active Cotton Valley Lime and Travis Peak tight gas sand plays, which surround the NRG plant. From this perspective everyone could see the size of the operation that resulted from the partnership between a coal mine and a power plant.

The town of Jewett was also the site of one of Texas’ two final-four locations in the nationwide competition for the U.S. FutureGen facility.
The Bureau’s Gulf Coast Carbon Center has for several years advocated Texas as an ideal site for a carbon storage industry. Which was to have been a near-zero-emissions power plant and research and development center. The original FutureGen concept has changed significantly from how it was originally conceived, however. Current plans by the U.S. Department of Energy (DOE) call for research on carbon-capture technology to be conducted at several yet-to-be-named power-plant sites.

The Bureau’s Gulf Coast Carbon Center has for several years advocated Texas as an ideal site for a carbon storage industry. Texas has a significant knowledge base in the various aspects of carbon-storage technology, all of which will need to work in concert—power generation, pipelining, enhanced oil-field recovery operations, regulatory framework, and environmental advocacy. That knowledge base, coupled with ideal and well-characterized subsurface storage volumes, such as the Frio Formation in the Gulf Coast, helps to make Texas a leader in the research that will be required to achieve carbon storage on a large scale.

During the day, featured presentations included a talk by Scott Tinker titled “Climate, Carbon, and Electricity: an Rx for Global Energy.” Other speakers were the Bureau’s Jay Kipper—“Power Generation in Texas”; Dan Eden and David Schanbacher, Texas Commission on Environmental Quality—“Clean Power for Texas and Environmental Permits for Generating Units”; David Burton and Bob Osco, NRG—“Limestone Electric Generating Station”; and Evan Rowe, Public Utility Commission of Texas—“Texas Electric Grid and Resources.” Chuck McDonald from the Clean Coal Technology Foundation of Texas also provided overview information.

The trip was organized by Bureau staff: Sigrid Clift, Jennifer Logan, and Katherine Jolly.
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The Visiting Committee at the Bureau of Economic Geology advises the Director and Bureau staff on the Bureau’s mission, both broad and particular; research programs; opportunities and directions; and administrative structure. The Committee acts as a liaison between the Bureau and industry, government, and academe.