

2010

Annual Report

Bureau of Economic Geology



Bureau of Economic Geology
Scott W. Tinker, Director

Director's Message

I have said to my kids many times, to the point that their eyes rolled back in their heads, that the harder I work, the luckier I get....

The Bureau is a soft money organization. Soft money organizations get the vast majority of their support from external grants and contracts with governments and industry. From this, it would follow that the past few years—the so-called Great Recession—would not have been kind to the Bureau. Yet owing to some combination of foresight, talent, hard work, and good fortune, we have managed to remain healthy and even grow.

- ▶ **Foresight** in that we have designed and built programs focused on some of the great challenges facing the world today: carbon sequestration, nanotechnology for advanced oil and gas recovery, water and energy, unconventional gas, and more.
- ▶ **Talent** in that we have managed to attract and retain very high quality scientists, engineers, economists, students, and key staff, doubling in size the past decade.
- ▶ **Hard work** in that we all recognize that the effects of the Great Recession, although nowhere close to the level of difficulty faced by those who lived through the Great Depression of the 1930's, will nonetheless impact the economy for many years to come; we must all do our part, and then more than our part, for the Bureau to succeed
- ▶ **Good fortune** in that during a time when 1 in 10 do not have a job, and many others are employed in areas outside of, or below, their education level, we are extremely privileged to be working at the Bureau in stable jobs, with talented colleagues, in outstanding facilities, and with the flexibility to ply our creativity in areas that matter to the world.

As 2010 draws to a close, we hear from those who believe (or perhaps just wish) that the effects of the Great Recession are coming to an end. Something does not feel quite right, given that we are in the midst of unprecedented federal deficit spending and debt, \$20 billion or more of statewide cuts are being required to balance the budget, federal “stimulus” investments are winding down and have yet to be paid for, and global competition for resources, talent, and leadership is at an all-time high.

My instincts say that now is the time to look even farther into the future, aggressively retain our talented staff, continue to seek new talent, and work harder and more efficiently, taking nothing for granted.

It is hard for me to believe that I am beginning my 12th year at the Bureau. I am privileged to work with such a fine group of people. It promises to be a challenging, but very rewarding, decade ahead.

Scott W. Tinker



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Bureau Highlights

► HRC Upgrade

The Bureau's Houston Research Center (HRC) has completed a series of renovations to maintain its standing as one of the top rock-material repositories in the world. In 2009, a new 25,000-ft² warehouse was constructed to store rock material from Texas, the nation, and from around the world. Then, in early 2010, a state-of-the-art rack system to hold this material was begun. The Bureau anticipates that once racks have been installed throughout the new warehouse, we will be able to accept 200,000+ boxes of additional rock material. The center currently has on hand 800,000+ boxes. The exterior of the warehouse has also been updated.



In addition to a new security fence surrounding the facility, the building now boasts a fresh coat of burnt-orange paint, the school color of The University of Texas at Austin.

► AEC Meetings in Boston, Norman, Houston, and Austin

From June 1st through June 4th the Advanced Energy Consortium (AEC) held its semiannual All Projects Review event at the Schlumberger Doll Research Center in Boston. Over the course of 3 days presenters from the AEC portfolio of 34 funded projects relayed their scientific findings, experimental results, and research plans for the coming months to nearly 160 attendees. Topics included nanomaterial mobility, contrast agents, nanomaterial sensors, and microfabricated sensors. The program comprised not only presentations and panel discussions, but also tours of laboratories at Harvard, Boston, and Northeastern Universities. Member companies and event attendees could visit sites where experiments take place and meet with project investigators, co-project investigators, postdocs, and graduate students at receptions held at each university. There was snow on the ground, but the recep-

tion was welcoming and warm when AEC members and project mentors traveled to Norman, Oklahoma, earlier in the year for a project site visit with Daniel Resasco and his co-principal investigators, Jeffrey Harwell and Ben Shiau. Representatives from ConocoPhillips, Schlumberger, Shell, Total, and the AEC attended in person; additional participants from Baker Hughes, Petrobras, and Halliburton joined by teleconference. This collaborative project requires expertise in catalysis and nanomaterials (Resasco), interfacial chemistry (Harwell), and petroleum engineering (Shiau) and is supported by postdocs, graduate students, and undergrads.

This team is developing novel silica/carbon nanotube hybrids that aim to deliver catalysts directly to stranded oil. Daniel and the students presented on the first year's progress, visitors toured the University of Oklahoma's Sarkeys Energy Center and its research labs, and the visit concluded with lunch at the University Club. Some AEC members then met briefly with OU Professor Dean Oliver and his students, who are just starting a new AEC project this year titled "Data Analysis and Inversion for Mobile Nano Sensors."





The AEC conducted its second in-depth, technology-specific workshop in Houston on July 19 and 20 to explore the utility of nanoparticles as contrast agents in oil and gas reservoirs. Sixty-five technologists and academics attended. Three member-company experts began the workshop, reviewing the state of current geophysical and remote-sensing techniques

contrast agents in fracture jobs, waterflood mapping, and reservoir characterization. AEC held its year-end All Projects Review Meeting December 7 through 9 at the J. J. Pickle Research Campus, UT. Over the course of 2½ days, 34 AEC-funded Principal Investigators and research teams presented the year's summary of exciting results. Participants, numbering 153 and

including engineers and scientists from both academic and oil and gas industry member companies (BakerHughes, BP, ConocoPhillips, Halliburton, Marathon, OXY, Petrobras, Schlumberger, Shell, and TOTAL), networked and



(Paul Rodney, Halliburton), reservoir-production considerations (Usman Ahmed, BakerHughes), and current geophysical surveys using nanoparticle contrast agents (John Ullo, Schlumberger). Principal investigators then reviewed synthesis and characterization of particular nanoparticles, theoretical and experimental limitations of approaches, and integration and data-inversion concerns. "Big-picture" questions were reviewed first, and then focus shifted to research approaches. Subsequent brainstorming sessions focused on electromagnetic and acoustic contrast agents. In addition to identifying key issues and potential show stoppers, these groups helped develop a time line applying nanoparticle

discussed progress in meeting the challenge of using nanosensors in the reservoir. Dr. Scott W. Tinker, AEC director, opened the meeting with a keynote discussing global energy oil demand and supply, future energy options, and AEC's mission in the context of needed solutions. The meeting included presentations, panel discussions, Q&A sessions, and informal receptions with posters. All 34 research projects were reviewed in detail, concluding with a researcher panel discussion for each thrust, which focused on addressing research needs for 2011 through 2015. Extensive discussions sparked new ideas and partnerships for continued AEC innovation and collaboration on subsurface nanosensors.



► The Director Makes a Movie

For the past 3 years, Director Scott Tinker has teamed with award-winning documentarian Harry Lynch to co-produce a feature-length energy documentary with the working title *The Bridge*. The film will educate the public about the long-term transition from fossil fuels to nonfossil energy. The mission of the project is to create a culture of energy education, so that consumers can make wise energy decisions in the ways that they live, the products that they buy, the culture that they shape—to help ensure a secure energy future for us all. Scott and Harry have toured 25 leading facilities and interviewed over 40 CEO's, top-ranking government officials, leading academic experts, and facilities managers in 10 countries on 3 continents.

Scott's role is that of onscreen guide and energy explorer, asking the questions that "his mom" would want to ask. Scott says,

"We know of no other film with this scope, balance, expertise, and quality." Watch for the film in theaters and on televisions near you in the spring of 2011. Visit <http://foundation.aapg.org/thebridgefund.cfm>.



► UT GeoFluids Consortium Meets at Pickle Campus

The first annual UT GeoFluids Consortium Meeting was held Thursday and Friday, February 11 and 12, on the UT Pickle Research Campus in north-central Austin. The meeting was enthusiastically received by more than 50 members from 10 international sponsor corporations and several academic institutions. The consortium is led at UT by Peter Flemings. He and other BEG researchers, including Ruairi Day-Stirrat and Mike Hudec, were among those presenting more than 20 talks during the 2-day event.

► GCCC Wins DOE Contract in Carbon Sequestration

Researchers at the Bureau's Gulf Coast Carbon Center (GCCC) were instrumental in securing a contract recently awarded by the Department of Energy's National Energy Technology Laboratory for carbon sequestration research. DOE selected NRG Energy, one of the nation's largest electric power providers, to receive up to \$167 million of funding to build a postcombustion, CO₂-capture demonstration unit at the company's WA Parish power plant southwest of Houston. Part of the CO₂ emissions will be captured, transported to a nearby oil field, and injected deep underground for enhanced oil recovery and long-term storage. As part of the program, NRG has subcontracted with GCCC to receive up to \$19 million to monitor the CO₂ during and after injection. Principal Investigator Rebecca Smyth explained GCCC's primary role: "Our goal is to demonstrate that the injected CO₂ stays where they put it. We'll be designing and implementing a monitoring system to try to identify where the carbon dioxide goes in the subsurface—both the deep subsurface, which is 5,000 to 6,000 feet below the surface, and the shallow subsurface. The objective is to ensure that the carbon dioxide does not impact drinking water resources."



► Bureau Hosts Start-Up of Mudrock Systems Research Laboratory

On January 12 and 13, attendees representing nearly 20 companies with strong interests in gas-shale exploration participated in the 2-day inaugural meeting of the Mudrock Systems Research Laboratory (MSRL). With the twin goals of unraveling fundamental scientific aspects of the most common sedimentary rock type (shale) and devising applications of this new understanding to the characterization of an important and growing unconventional natural gas resource, the MSRL has invited an interdisciplinary group of Bureau geoscientists to participate. Currently the group is working to integrate stratigraphic and facies analysis, micro- and nanoscale imaging, geochemistry, structural studies, and rock properties analysis. Day 1 featured 18 presentations by Bureau scientists and invited collaborators, including Director Scott Tinker, PI Stephen Ruppel, Fred Wang, Alton Brown, Farzam Javadpour, Uschi Hammes, Scott Hamlin, Nikki Hughes, Bob Loucks, Kitty Milliken, Jiemin Lu, Rob Reed, Ruairi Day-Stirrat, Julia Gale, and Tongwei Zhang. Consortium members helped to make the proceedings lively in a spirited question-and-answer session. Day 2 began at the Bureau's Core Research Center with a core workshop that included materials from the Smithwick, Haynesville, Pearsall, Barnett, and Bone Spring. In the afternoon, consortium participants had the

opportunity to attend a 3-hour class on fundamentals of mudrock petrology presented by Kitty Milliken. With such training rare in university curricula, most attendees chose to participate in all three modules: petrographic techniques for mudrock characterization, grain assemblages in mudrocks, and diagenesis in mudrocks.

► Natural-Gas-Demand Roundtable Discussions

Through a grant made available from the Sloan Foundation, the Bureau held a series of two roundtable discussions. The aim of the series was to closely examine natural gas supply and demand in the U.S. and globally and consider key questions and opportunities regarding the growing role of natural gas in global energy markets.

On May 24–25, Director Scott Tinker hosted a group of international leaders from around the country for the first of two discussions on factors that influence the supply of natural gas in world markets today. The Natural Gas Supply Roundtable comprised participants from industry, government, and academe—William L. Fisher, Professor, Bureau of Economic Geology, UT; Svetlana A. Ikonnikova, Economist, Bureau of Economic Geology, UT; Robert Bryce, Journalist; Jesse H. Ausubel, Vice



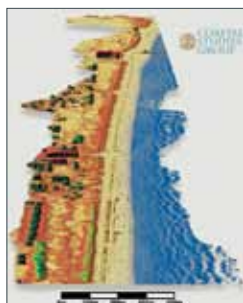
President of Programs, Alfred P. Sloan Foundation; Porter Bennett, President, BENTEK Energy; John R. Browning, Consultant, Retired, ExxonMobil Gas & Power Marketing; John B. Curtis, Director, Potential Gas Committee, and Professor, Colorado School of Mines; Ted Greenwood, Program Director, Alfred P. Sloan Foundation; John A. Harpole, President, Mercator Energy; Ken B. Medlock III, Fellow in Energy and Resources Economics, James A. Baker III Institute for Public Policy, Rice University; Tony Meggs, Senior Member, MIT Energy Initiative (former BP Group Vice President for Technology); Richard Nehring, President, NRG Associates; Tad Patzek, Chairman, Department of Petroleum & Geosystems Engineering, UT; Barry Smitherman, Chairman, Public Utilities Commission; Mark A. Snell, Executive Vice President and Chief Financial Officer, Sempra; and Charles S. Whitmore, Senior Market Analyst, Office of Oil and Gas, U.S. Energy Information Administration. The roundtable had as its aim an examination of factors that impact natural gas supply, infrastructure, economics, and policy.

On August 24 and 25, the second roundtable discussion was held. During this Natural Gas Demand Roundtable, Director Scott Tinker hosted a group of leaders from around the world to discuss the driving forces of demand for natural gas in world markets today. Participants from industry,

government, and academe included Charles S. Whitmore, Anas Alhajji, Ruud Weijermars, John Browning, Richard Jones, Robert Bryce, Brannin McBee, Gürçan Gülen, Ken Medlock, Ben van den Brule, William L. Fisher, Svetlana A. Ikonnikova, Ted Greenwood, Barry Smitherman, Jim Simpson, and Steve Foster.

► Lidar Survey of the Coast

During April, scientists from the Bureau of Economic Geology, the Center for Space Research, and Texas A&M University Corpus Christi completed a light detection and ranging (lidar) survey of the Texas gulf shoreline from Sabine Pass to the Rio Grande. Lidar provides highly accurate and detailed topographic data describing beaches, dunes, and development along the shoreline. The lidar data acquisition is the first stage of a new project titled "Shoreline Change and Beach and Dune Morphodynamics along the Gulf Coast" sponsored by the Texas Coastal Impact Assistance Program and administered by the General Land Office. The project is intended to improve the management,



protection, and restoration of the Texas gulf beach/dune system. This survey—a collaboration among the Bureau and UT's Center

for Space Research (lidar operation), the Harte Research Institute for Gulf of Mexico Studies and Conrad Blucher Institute for Surveying and Science at Texas A&M University Corpus Christi (ground surveying and GPS), and the Texas Department of Transportation Flight Services (aircraft)—is the first by the Bureau since 2000 to cover the entire system. The beach and foredune zone will be surveyed again in 2011 and 2012 to examine annual variability in shoreline and dune position and morphology, intervening storm effects, and recovery from recent storms such as Hurricane Ike, which devastated the upper Texas coast in September 2008. The lidar data are being analyzed in combination with new and historical optical imagery and ground surveys so as to explain the status and trends of the beach/dune system and monitor susceptibility of the coast to storm damage. Status of the beach/dune system will be determined through measurement of volumes, dimensions, and morphology, and a storm susceptibility index will be developed. The overall goal of this project is to improve the management, protection, and restoration of the beach/dune system along the Texas Gulf of Mexico shoreline. Protection of natural foredunes and their enhancement is an excellent way to decrease susceptibility of the shoreline to storm damage while improving the beach/dune environment.

► Madagascar Workshop

Sergey Fomel and his collaborators from the open-source software project organized a PTTC-sponsored workshop and school on reproducible computational geophysics.



The workshop, which took place July 23 and 24 in Houston at the Bureau's Houston Research

Center, attracted more than 50 participants. Program presentations by 8 instructors focused on different aspects of computational technology development and transfer using the Madagascar software package.



► GCCC AAPG Field Trip

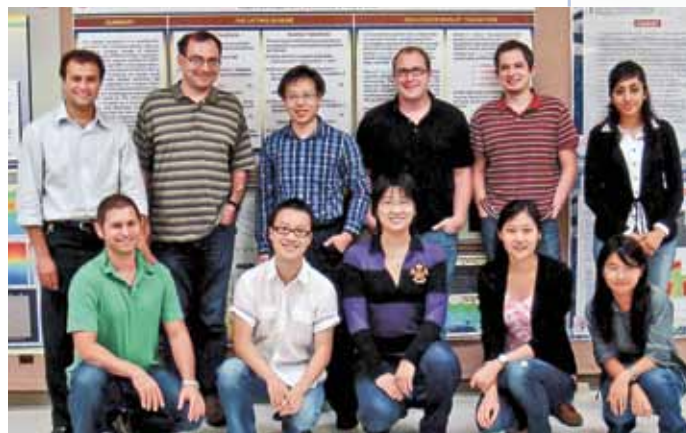
In conjunction with the AAPG annual meeting in New Orleans in April, Tip Meckel, Sue Hovorka, Katherine Romanak, and Stuart Coleman of BEG's Gulf Coast Carbon Center led a premeeting field trip to Natchez, Mississippi, hosted by Denbury Onshore LLC. Hilary Olson and Larry Lake provided educational resources from STORE, and Bob Holt from the University of Mississippi provided information on groundwater monitoring. Fred Walsh, Ken Cameron, and Shane Kelly provided information on Denbury's activities in the region. Twenty-three field-trip participants observed the geologic carbon-storage-monitoring activities taking place at Cranfield field associated with large-volume CO₂-EOR. Highlights of the trip included a tour of Denbury Resources' gas-separation facility, venting of CO₂ from a flow line at an injection well, viewing of core of the injection and confining zone

intervals of the Tuscaloosa Formation, and viewing of the monitoring instrumentation designed and operated with funding from the National Energy Technology Laboratory and collaboration with Sandia Technologies, LBNL, ORNL, USGS and LLNL. Bureau research at Cranfield, part of the Phase 3 SECARB regional partnership program in sequestration managed by the Southern States Energy Board, has effectively monitored the first million-ton brine injection in the U.S. with diverse monitoring methodologies.

► New Bureau IA Program: Texas Consortium for Computational Seismology

TCCS (Texas Consortium for Computational Seismology) is the newest Industrial

Associates program at the Bureau. Directed by Sergey Fomel, TCCS is a joint initiative of the Bureau and the Center for Numerical Analysis at the Institute for Computational Engineering and Science (ICES). ICES draws faculty from 17 participating academic departments at UT. Its mission is to provide the infrastructure and intellectual leadership for developing outstanding interdisciplinary programs in research and gradu-





ate study in computational sciences and engineering and in information technology. Sergey's partners in the program are Professors Björn Engquist and Lexing Ying, renowned applied mathematicians from ICES and UT's Department of Mathematics. In addition, the program involves eight Ph.D. students and two postdocs.

The primary mission of TCCS is to address the most fundamental and challenging problems in the energy industry that can be solved by employing multidisciplinary research that focuses on computational geophysics. The secondary mission is to educate the next generation of research geophysicists and computational scientists. Particular examples of research challenges are:

- ▶ Estimating seismic velocities by using full waveform information.
- ▶ Identifying the most accurate and efficient seismic imaging algorithms while controlling the trade-off between accuracy and efficiency.
- ▶ Assisting the seismic interpreter by automating common interpretation and signal processing tasks.

TCCS plans to take advantage of the multidisciplinary environments at the Bureau and ICES and the unique supercomputing facilities hosted by the Texas Advanced Computing Center (TACC), such as Ranger, a 63,000-core, 580-teraflop cluster, which is the largest open-research computing system in the world.

Companies are welcome to join TCCS through two forms of membership. Gold sponsors are companies that support focused research projects of defined scope and provide funding in excess of the sponsor fee. Regular sponsors are companies that support the program by the sponsor fee of \$45,000 per year. A promotional 1-year membership is given to a number of companies that have supported our work in the past.

▶ Bureau Folks in the News



The Advanced Energy Consortium (AEC) and nanoscale technologies were the featured cover story of the July 2010 *American Oil and Gas Reporter*. Formed in

2008 and managed by the Bureau, AEC has 10 industry partners. In 2010 the consortium funded more than 25 different research entities working to develop micro- and nanoscale sensors for enhanced reservoir illumination.

Sergey Fomel was featured in an article that appeared in the January issue of the *CSEG Recorder*, "'Geophysics Is a Hugely Rewarding Profession': an Interview with Sergey Fomel."



On May 19, CEE's Dr. Michot Foss provided comments on the oil spill in the Gulf of Mexico to the NPR/

KUT Monday morning newspod. Link: <http://kut.org/items/show/20874>.

Bureau scientist Martin Jackson was the subject of an article that appeared in the *AAPG Explorer* in August. He is quoted as saying that salt tectonics "provides



complexity of structure, the mystery of what makes them move, the wonder that mountains of salt lie beneath the ground, a vast array of beautiful organic

shapes and a dominant importance in many sedimentary basins that inspires companies to spend good money trying to understand them for exploration and seismic processing." The whole story can be found at <http://www.aapg.org/explorer/2010/08aug/martinj0810.cfm>.

A story about the Bureau's new carbon sequestration contract with the federal



government appeared in the *Austin American Statesman* on Tuesday,

June 29. The Bureau will receive as much as \$19 million in a CO₂-capture project at a power plant southwest of Houston.



"Industry icon" is the acknowledgment recently bestowed upon Director Scott Tinker by *Oil and Gas Investor* magazine in its January issue. The energy

journal's feature story traces Tinker's history from early educational mentors to his leadership roles at the Bureau, AAPG, and AASG. It also discusses his recent worldwide lecture tour and his role in an upcoming feature-length documentary on global energy. To read the full article, go to http://www.beg.utexas.edu/publications/pdf/G&GI_0110_lcons.pdf



Wanda LaPlante, Executive Assistant to Director Scott Tinker, was featured in an April 15 *Daily Texan* article titled "Time-Honored UT Employee Plans to Retire: Assistant Eager for Free

Time." In it, Wanda's 30+ years of service at the Bureau is lauded, particularly the last 10 years, during which she worked for the Director. "I'm a people-person," Wanda is quoted as saying, "and that's what I love about my job." Scott Tinker is quoted as well: "She had to train me on how to be a director"! For more, see <http://www.dailytexanonline.com/content/time-honored-ut-employee-plans-retire>. Also see story in Bureau Transitions section, p. 30.

Environmental Systems Division in 2010

► Ian Duncan Transitions back to Research



In August, after 6 years of leading the Environmental Systems Division, Dr. Ian Duncan returned to full-time research at the Bureau. Ian's research

will focus on risks associated with CO₂ sequestration (funded by a 4-year, \$2 million grant from DOE), offshore CO₂ sequestration, the role of CO₂-enhanced oil recovery (CO₂-EOR) in sequestration, environmental impacts of shale-gas exploitation, and water issues associated with the production of energy (including geothermal energy and life-cycle analysis of water-energy systems).

► Coastal, Mapping, and Geohazards Group

Researchers in the coastal, mapping, and geohazards group (Jeff Paine, Eddie Collins, Sojan Mathew, Tom Tremblay, Tiffany Caudle, and John Andrews) combine techniques in remote sensing, field investigations, airborne-lidar surveying, and surface, borehole, and airborne geophysics to address several important issues in coastal evolution and hazards, groundwater protection, wetlands change, urban-corridor geologic mapping, and radioactive-waste-disposal site characterization. A few of these activities for 2010 are highlighted herein.

Geophysical Hydrostratigraphy at a Radioactive Waste Repository

Jeff Paine

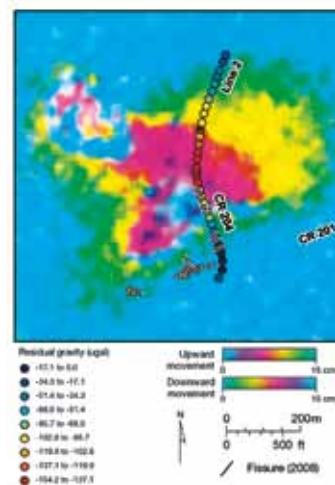
At the recently licensed low-level radioactive waste repository near Andrews, Texas, Bureau researchers have applied surface electromagnetic induction methods and

borehole geophysical logging to better understand hydrostratigraphic issues, including delineating areas where water infiltration into soils is most likely, defining the extent of shallow groundwater, and examining variations in thickness and lithology of low-permeability host strata. Despite the hundreds of boreholes and monitoring wells installed during nearly 2 decades of site-characterization activities, conductivity-depth sections, EM soundings, and borehole measurements, the research group provided intraborehole continuity and high-resolution information on key vertical and lateral hydrostratigraphic parameters, such as moisture and clay content. Results from these studies are being used to guide placement and construction of new monitoring wells adjacent to the repository cells.

Sinkholes, Subsidence, and Risk Assessment Using Radar Interferometry and Gravimetry

Jeff Paine and Eddie Collins

Bureau researchers are continuing their research on assessing potential sinkhole development. Research at two sites, near the communities of Wink in the Permian Basin and Daisetta on the Gulf coastal plain, culminated in an invited paper and related presentations on geophysics applied to geohazard assessment at the International Conference on Environmental and Engineering Geophysics held in Wuhan and Chengdu, China. Satellite radar interferometry studies conducted by collaborators at UT's Center for Space Research,



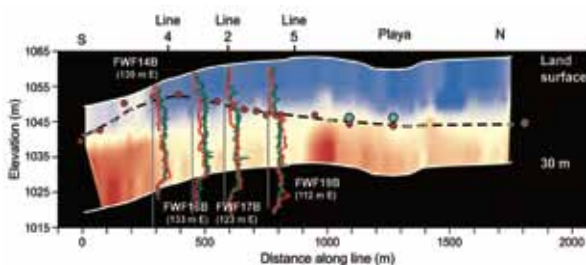
combined with microgravity surveys conducted by Bureau and JSG staff, were used to identify areas undergoing rapid subsidence (as much as 30 cm/yr), and to identify shallow mass deficits in these areas that are likely sites of future subsidence or collapse. The conference included a field excursion to examine the geologic effects and human impact of the 2008 Great Sichuan earthquake.

Quantifying Long-Term Shoreline Changes, Texas Gulf Coast

Jeff Paine and Sojan Mathew

Reinforcing the Bureau's advisory role as provider of long-term shoreline-change rates for the Texas Gulf shoreline, Bureau researchers began a new study sponsored by the Texas General Land Office to update these rates from the year 2000 to the latest pre-Hurricane Ike shoreline position. Research includes aerial photographic interpretation of shoreline position, comparisons of airborne-lidar- and imagery-derived shoreline positions, and a narrative summary of results and factors affecting shoreline change. Researchers will use the new information to update

the website (<http://www.beg.utexas.edu/coastal/imsindexNew.php>), which makes these data available to the public for a variety of uses, including establish-





ing construction setbacks, assessing storm impact and recovery potential, predicting future shoreline position, and quantifying coastal land loss as a result of changes in sediment supply, storm frequency, engineering activities, and relative sea-level rise.

Wetlands Change Analysis, Matagorda Bay Area

Tom Tremblay

The NOAA-funded Status and Trends of Inland Wetland and Aquatic Habitats, Matagorda Bay Area, report was completed this year and delivered to the Texas General Land Office. The study involved wetland status mapping and analysis of wetland change between the mid-1950's and the present. Changes were quantified, located, and investigated as to probable causes. Status and Trends of Inland Wetland and Aquatic Habitats, Freeport and San Antonio Bay Areas, was begun and mostly completed. Preliminary results were presented at a San Antonio Bay Partnership science

conference. A synthesis of multiple wetland-trend studies compared the effects of climate change and land use on wetland habitats at

various locations along the Texas Gulf Coast. Findings were presented at the Restore America's Estuaries Conference 2010. Wetland status and trend reports are used by planners, resource managers, and environmental scientists. Data created for these studies provide base information for environmental models, including the sea level affecting marshes model (SLAMM) and ecosystem services and valuation studies, among others.

Shoreline Change and Beach/Dune Morphodynamics along the Gulf Coast

Tiffany Caudle, Sojan Mathew, John Andrews, Jeff Paine, and collaborators

The Coastal Studies Group has begun a newly funded study to provide detailed data on the position, volume, vegetative cover, and dynamics of the beach/dune system along the Texas Gulf Coast. The beach and dune system is an important and dynamic natural environment that fulfills multiple natural and human activities and protects landward environments and structures from storm damage. Maps showing parameters such as volume, width, and elevation of this environment will show where it has deteriorated and will help focus restoration plans. Data on the dynamics, morphology, and horizontal and vertical positions of foredunes and beaches are needed to determine the design, viability, and lifespan of restoration projects. This project is providing fundamental data needed to protect and enhance not only the beach/dune environment but also the landward environments that the beach/dune system protects.

Researchers will accomplish several objectives over the next 4 years. The first is to update long-term and calculate short-term shoreline change rates for the Gulf of Mexico. They are also developing protocols for mapping the line of vegetation, including developing and documenting methods of integrating topographic data (airborne lidar) and aerial photographs for assessing the potential vegetation-line position. The project will annually map the morphology, sediment volume, and vegetative cover and determine the storm-protection status of the beach/dune system and determine cumulative changes in beach/dune volume. Deliverables will be made available to the public through a website and an ArcGIS server. Resulting data can be used to formulate policy regarding the beach/dune system and designing shoreline projects. Further, the study

will help explain the storm-, annual-, and decadal-scale dynamics of beach/dune system and coastal processes.

The multiyear project is funded by the Texas Coastal Impact Assistance Program (CIAP) and administered by the Texas General Land Office. The goal of CIAP is to conserve, restore, enhance, and protect the diversity, quality, quantity, functions, and values of the state's coastal natural resources. Collaborators include the



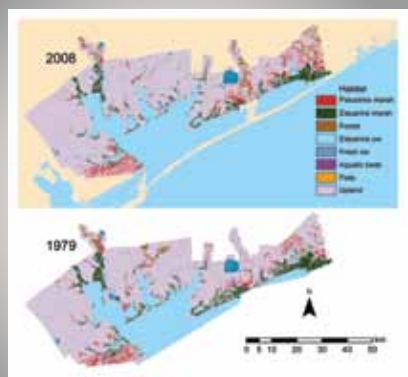
Coastal and Marine Geospatial Sciences Laboratory at Harte Research Institute for Gulf of Mexico Studies and Conrad Blucher Institute for Surveying and Science at Texas A&M University Corpus Christi, as well as the Center for Space Research at UT.

Geologic Mapping for the STATEMAP Program

Eddie Collins

The goal of the Texas STATEMAP projects, part of the National Cooperative Geologic Mapping Program administered by the U.S. Geological Survey, is to produce geologic maps of areas of Texas where knowledge of the geologic framework is of vital importance. Study areas for the Texas program typically include areas having specific environmental and natural resource concerns, urban and rural corridors undergoing population growth, and critical aquifers and their recharge areas.

Researchers are currently mapping a part of North-Central Texas within the Interstate 35W transportation corridor within the Cleburne 30 x 60 minute quadrangle (south of Fort Worth) and within the Texas Gulf Coast Corridor along the Colorado River Delta. Basic geologic knowledge



gained from new geologic maps of the North-Central Texas transportation corridor will address the need for an accurate geologic data set for managing water and Earth resources and responsible land use. New geologic maps for the Texas Gulf Coast Corridor are intended to address needs for evaluating historical changes of coastal depositional environments, focusing on erosion issues, permitting activities related to resource development, educating the public, and managing land use. Miscellaneous Maps 48 and 49 were published this year, *Geologic Map of Mariscal Mountain, Big Bend National Park, Texas*, by Patricia W. Dickerson, William R. Muehlberger, and Edward W. Collins, and *Geologic Map of Southern Franklin Mountains, El Paso, Texas, with Focus on Collapse Breccia*, by F. Jerry Lucia, respectively (see p. 33–34).

Surface Casing Estimator Website

Eddie Collins

The objective of this project with the Texas Commission on Environmental Quality (TCEQ) Surface Casing Team is to construct a website that estimates depths of fresh (generally a salinity of <1,000 mg/L), usable quality (generally a salinity of <3,000 mg/L), and the base of an underground source of drinking water (generally a salinity of <10,000 mg/L) for Texas counties. Project work also involves scanning of the TCEQ Surface Casing Team's extensive geophysical log library. The website offers viewing of selected geophysical logs. Researchers are currently working on data for seven counties: Anderson, Cherokee, Rusk, Harrison, Panola, Winkler, and Ward. The surface casing estimator website, <http://www.beg.utexas.edu/tceq/index.html>, currently provides information for 27 counties. The website is intended to provide quick estimates of casing depths for the drilling of oil and gas. The TCEQ Surface Casing Team is responsible for making final recommendations for casing depths to operators.

► Gulf Coast Carbon Center

The Bureau's Gulf Coast Carbon Center (GCCC) is a premier facility for technical and educational resources that advance implementation of geologic storage (GS) of anthropogenic carbon dioxide. GCCC (Sue Hovorka, Ian Duncan, Tip Meckel, Rebecca Smyth, J.-P. Nicot, Jiemin Lu, Katherine Romanak, Ramón Treviño, Changbing Yang, Carey King, David Carr, Seyyed Hosseini, and Sigrid Clift) has received more funding to answer questions about GS than any other institution in the country. These resources are currently targeted in four major areas: characterization, monitoring, modeling and risk, and education and outreach.

Characterization

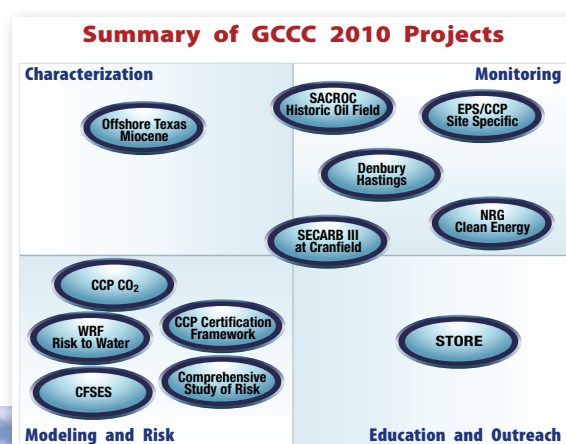
GCCC's 5-year Offshore Texas Miocene Project is investigating the regional geologic potential of Miocene-age rocks of Texas State Submerged Lands to store CO₂ for geologically significant periods of time. Such geologic storage provides current and future emitting industries with a viable environmental alternative to the current practice of atmospheric release. Results of this study take the next

step in making permanent geologic storage of CO₂ a commercial reality. This project will also identify at least one prospective site capable of accepting 30 million metric tons of CO₂.

Monitoring and Characterization

GCCC is involved in two DOE-funded regional carbon sequestration partnerships (RCSP), which are focused on monitoring strategies but that involve characterization. As part of the Southeast Carbon Partnership (SECARB), researchers have conducted a \$34-million, multi-year injection on the oil rim of Cranfield field near Natchez, Mississippi. The first of the RCSP large-scale carbon-sequestration demonstration sites, the project has injected 1 million tons of CO₂ since April 2009, which is the magnitude required for industrial operations. We are now conducting time-lapsed crosswell seismic, vertical seismic profiling, and surface seismic measurements to evaluate monitoring strategies. GCCC's second RCSP project is part of the Southwest Regional Partnership (SWP). We evaluated impacts on drinking water in the SACROC historic oil field in the Texas Panhandle, where millions of

tons of CO₂ has been injected since 1972 for enhanced oil recovery (EOR). Despite intensive analyses, we were unable to detect any degradation of shallow drinking-water resources.



Monitoring

A major goal of GCCC is to optimize monitoring strategies to ensure safe and secure geologic sequestration of CO₂. EPA and the CO₂ Capture Project (CCP) have provided funding to develop site-specific guidance for project developers and regulators to select appropriate tools to monitor geologic storage of CO₂. We are currently collecting input from expert panelists to develop an approach that allows transparent comparison of tools from different disciplines.

As part of its long-term commitment to assessing the value of EOR to geologic sequestration, GCCC will be working with Denbury Onshore LLC to develop and then deploy a project monitoring plan. During the project, anthropogenic CO₂ will be captured from industrial sources and brought to Hastings field. This CO₂, which will supplement Denbury's current natural source from Jackson Dome, is one of the first to use anthropogenic CO₂ for GS. GCCC also has a contract pending to develop a monitoring program for NRG Energy's new project to use CO₂ captured from industrial sources and inject it into Frio Formation oil fields for EOR.

Modeling and Risk

Most noteworthy, GCCC is evaluating risk associated with geologic storage to ensure that it is safe and secure. We are currently involved in five projects that focus on modeling geologic sequestration and risk evaluation.

Currently no information is available on impacts of CO₂ introduced into potable groundwater under controlled field conditions. To fill this gap, GCCC is conducting a project funded by the Water Research Foundation to measure impacts of CO₂ injection on water quality. We will perform push-pull tests in which CO₂ is injected



into an aquifer and, after a prespecified time, groundwater is extracted for analyses of major and trace elements and isotopes. This study represents one of the first field tests of CO₂ injection impacts on groundwater quality. Data from field, laboratory, and modeling analyses will be used to identify key geochemical processes related to groundwater quality impacts of CO₂ injection, such as pH reduction and trace-metal mobilization.

The CCP Certification Framework project is modeling to develop a simple, transparent, accepted approach to analyzing leakage risks at CO₂ storage sites. Dr. J.-P. Nicot is collaborating with UT's Petroleum and Geosystems Engineering Department and Lawrence Berkeley National Laboratory on this work. The certification framework approach has already been applied at five sites, its modular nature allowing for constant improvements and additions.

CFSES (Center for Frontiers of Subsurface Energy Security) is developing a scientific understanding of subsurface physical, chemical, and biological processes from the small scale to the large scale. CFSES, funded by DOE Basic Energy Sciences, is a cooperative of UT's Petroleum Engineering Department, JSG, GCCC, and Sandia National Laboratory. Dr. Katherine Romanak is working with collaborators to couple data from lab experiments using a state-

of-the-art high-pressure-temperature apparatus with pore-scale modeling, molecular modeling, microbial studies, and imaging of the behavior of supercritical CO₂. We are also developing case studies from SECARB work at Cranfield that will be used to develop code optimized for multiscale, multiphysics processes. Cranfield is one of the few locations where dense data have been acquired to support such code development.

The CCP3 CO₂ Impurities project is investigating the impact of impurities in the CO₂ stream on CO₂ storage. Different technologies at coal-fired power plants generate impurities such as N₂, O₂, H₂, CO, Ar, and NO_x/SO_x. Removing these impurities is expensive and must be balanced against their potential impact on storage. The project includes high-pressure-temperature experiments to collect data, gather modeling parameters, and perform preliminary modeling runs.

Drs. Ian Duncan, J.-P. Nicot, and Changbing Yang, together with Eric Bickell (Mechanical Engineering) and Marc Hesse (Department of Geological Sciences), are initiating a comprehensive study of risks associated with geologic CO₂ sequestration. The study will focus on various components of risk that a company could face in engaging in a CO₂ sequestration project, bounding consequences from the worst-case scenario for specific proposed sequestration project sites and the perception of risk by experts, lawyers, project developers, and nongovernmental organizations.





Outreach

GCCC has long taken an aggressive approach toward outreach. In 2009, UT was awarded a grant to establish the Alliance for Sequestration Training, Outreach, Research, and Education, or STORE (www.storeCO2now.com), which is GCCC's major outreach program. STORE has hosted several field trips to the SECARB injection site at Cranfield, a number of training courses for professionals, and a multiday course aimed at high school and middle school girls. This fall, several members of STORE and GCCC, including Drs. Sue Hovorka and J.-P. Nicot, taught a new course on carbon sequestration at UT, increasing the exposure of undergraduate and graduate students to the technology.

Focus on Collaboration

Carbon sequestration fundamentally involves a variety of disciplines, and GCCC actively seeks out collaborations with many different groups at the Bureau. Groundwater protection is a key issue under U.S. federal law for any type of subsurface injection and is an important consideration for geologic storage as part of carbon capture and storage (CCS). GCCC works closely with Dr. Bridget Scanlon of the Bureau's Center for Sustainable Water Resources, who will collaborate on the push-pull test to assess in situ rock-water reactions in fresh-water systems when CO₂ is introduced. GCCC also works with soil-gas experimentation and modeling, thus complementing and extending capabilities of the Bureau's groundwater group.

Another important area of collaboration is with near-surface geophysics groups, led by Dr. Jeff Paine. GCCC projects have helped purchase logging tools, which have been used in developing the geologic framework to study groundwater protection and the effectiveness of monitoring.

Modeling the movement of immiscible nonwetting fluid is a key issue in GS and

is built on our understanding of subsurface behaviors of oil and gas. GCCC strongly benefits from frequent information exchange with the Bureau's groups focused on hydrocarbon energy, in particular STARR (Uschi Hammes and Bill Ambrose) and RCRL (Steve Ruppel, Seay Nance, and Jerry Lucia). Hongliu Zeng and Bob Hardage (and others of the EGL group) have been supportive in lending expertise to the interpretation of geophysics data.

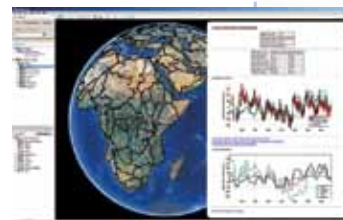
Center for Sustainable Groundwater Resources

Sustainability of water resources is a critical issue that needs to be understood within the context of global change. The Center for Sustainable Water Resources (CSWR) (Bridget R. Scanlon, Laurent Longuevergne, Robert Reedy, Nathan Sheffer, and Yun Huang) focuses on many aspects of sustainability using a variety of approaches from global satellite-based studies to detailed ground-based studies. Water resources and food production are strongly linked because 90 percent of global fresh-water resources were used for irrigated agriculture during the last century. Rising global population from about 6 billion now to 9 billion in 2050 will increase water demands in the future. Although climate predictions mostly focus on mean values with considerable uncertainty in precipitation predictions, there is much more agreement in predictions of extremes, with longer term droughts interspersed with more intense floods. This increased variability in climate will reduce reliability of precipitation, soil moisture, and surface-water availability and should increase reliance on groundwater to buffer against these extremes.

The primary goal of the CSWR is to assess spatiotemporal variability of groundwater resources, including water quantity and quality aspects, at local scales using field studies, at regional scales using remote sensing, and at annual scales to millennial time scales. Impacts of land use change

and climate variability/change are critical drivers considered in these studies. Results have serious implications for development of sustainable water resource programs in different regions.

In one such study, Gravity Recovery and Climate Experiment (GRACE) satellites are used to monitor changes in terrestrial water storage at global spatial scales and at weekly to monthly time scales. Laurent Longuevergne has developed information on water storage changes for 218 river



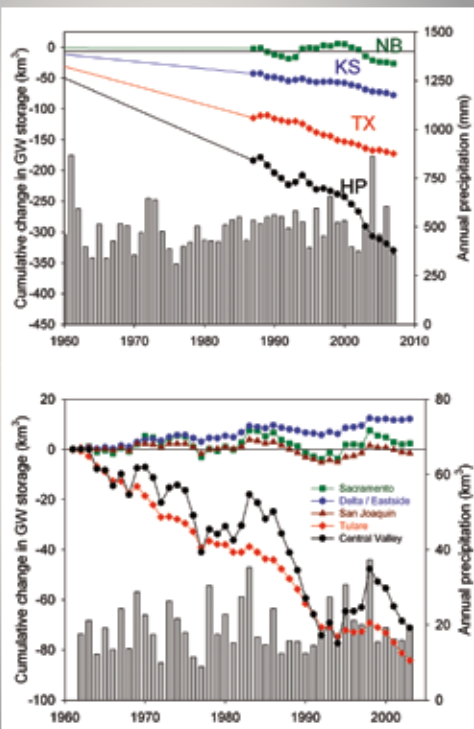
basins globally using Google Earth to increase application of GRACE data for water-resource studies. In addition, GRACE has been applied to quantifying groundwater depletion in the U.S. High Plains, California Central Valley, North China Plain, and Niger. Much of the focus has been on developing detailed information for ground referencing satellite data. These studies indicate that GRACE is an invaluable tool for tracking changes in groundwater storage in these basins.

We are collaborating with Dr. Prasanna Gowda of the U.S. Department of Agriculture in using MODIS satellite data for monitoring temporal variability in evapotranspiration (ET) in the High Plains. ET estimates provide critical information on ground-water

consumption for irrigation in this region. Various approaches are being used

to ground reference the satellite-based estimates, including lysimetry, large-aperture scintillometry, and use of eddy covariance stations. We have





also deployed large-aperture scintillometers in the North China Plain and in Niger to monitor ET in collaboration with researchers in these regions.

The strongest component of our program is field-based studies that measure and monitor spatial and temporal variability in water fluxes in response to changes in land use and climate. Many of these studies have focused on the High Plains and compare recharge rates beneath natural ecosystems and rain-fed and irrigated agroecosystems. By developing accurate estimates of groundwater recharge, we can evaluate what level of irrigation could be sustainable in a region. Studies in the Texas High Plains show increases in groundwater storage in rain-fed areas and large-scale groundwater depletion in irrigated areas, over 10 m within a 10,000-km² area. Groundwater depletion in this region exceeds recharge by as much as a factor of 10. Groundwater conservation districts use managed aquifer depletion, allowing groundwater storage to be reduced by 50 percent in 50 years. In contrast, much higher recharge in the Nebraska area of the

High Plains and irrigation from stream water have resulted in minimal groundwater depletion, although we note that stream flows have been reduced by as much as 50 percent, causing problems for several endangered species near the Platte River.

Water resources in the High Plains contrast sharply with resources in the intensively cultivated Central Valley of California, which has much more surface water. We are collaborating with Claudia Faunt and others at the USGS on a large-scale comparison of High Plains and Central Valley water resource issues. Large-scale diversions of surface water from more humid regions in the north to more arid regions in the south since the 1950's and 1960's have alleviated water stress in the south. The extremely dynamic hydrologic system responds rapidly to droughts but only partly recovers after droughts. Approaches toward more sustainable groundwater management in this region include conjunctive use of surface water and groundwater and groundwater banking.

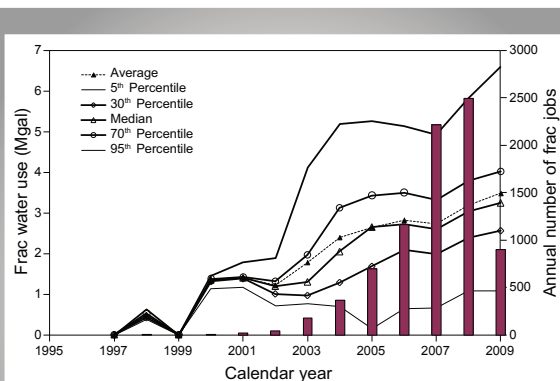
Groundwater quality is also critical to water availability. We have conducted several studies on natural and anthropogenic contamination in aquifers in Texas, including arsenic, chloride, total dissolved solids, and nitrate. More recent studies are focusing on characterizing vertical zonation of contaminants using a stratified aquifer sampler. Nathan Sheffer, a postdoctoral fellow in CSWR, is also evaluating different approaches toward in situ treatment of arsenic contamination.

► Energy and Water: Gas Shales in Texas

The past decade has seen tremendous growth of a gas resource that the geological community always knew existed, but a lack of appropriate technology prevented the industry from developing the resource. After more than a century of producing from conventional oil and gas reservoirs, improvement of hydraulic fracturing toward the end of the 1990's now allows operators to pursue massive reserves of the source rock, including the successful combination of horizontal drilling and use of so-called *slick-water fracs*. In this combination, horizontal wells considerably increase the contact between well bore and formation. Then water and additives are pumped under intense pressure into low-permeability formations, cracking open the rocks and building the fracture network needed to transport the gas/oil to the well bore. Slick-water fracs rely on fast (turbulent) flow to carry proppant (usually fine sand) to where fractures need to remain open after the pressure subsides. In older fracs, viscosity of the carrier fluid transported the proppant. Another aspect of targeting the source rock is that dry wells are essentially a thing of the past; these resource plays can produce gas over widespread areas. This ability, combined with the limited drainage area covered by each well, results in a well coverage more dense than that of conventional drilling.

The fracture process can use large amounts of water, typically between 3 and

6 million gallons per job, in a couple of days or less. Supported by funding from the Texas Water Development Board (TWDB), the Bureau, in a study led by J.-P. Nicot, has been investigating the amount of water used in different Texas plays and has found that more than





100,000 acre-feet (or about 33 million gallons) of water has been used since the beginning of the Barnett play in North Texas. The current rate is about 20,000 to 25,000 acre-feet per year. Newer plays have come online in the past few years, including Haynesville in East Texas and Eagle Ford in South Texas; these plays used about 1,000 to 4,000 acre-feet per year in 2010. Water use in the Barnett is likely to stay at current levels, whereas other plays are likely to see a sharp increase in water use. We found that water use is comparable to that in both coal mining and aggregate industries in Texas and represents a small fraction of overall water use in Texas. Gas operators are finding ways to use less water (i.e., recycling) as the industry becomes more efficient, although flowback water (coming back with the gas) is still disposed in deep injection wells, rather than being put to beneficial use.

Working in concert with the Gas Technology Institute (GTI) and funded by an RPSEA grant, the Bureau is also investigating alternate water sources in the Barnett play, particularly as operators move west of the Fort Worth core area into regions that are already water scarce. Options include brackish aquifers and municipal and industrial wastewater-plant outfalls. This program is likely to expand in the coming years as society at large takes an interest in shale-gas-related issues.

► Center for Energy Economics

The Center for Energy Economics (CEE)



(Michelle Michot
Foss, Gürcan Gülen,
Miranda Ferrell

Wainberg, Ruzanna Makaryan, and Dmitry Volkov) focuses on the role of economics and open competitive markets in the efficient allocation of investment flows and supply, delivery and use of scarce energy, and nonfuel resources. Policies and best practices that foster competitive development and access, along with price discov-

ery and transparency, are also those that reduce market distortions. The problems we take on range from practical considerations in developing and using frontier resources, such as U.S. shale gas, to how governments can best reduce energy poverty and balance economic and environmental priorities. Our applied research always incorporates public service components through outreach and communication, including a commitment to human-resource-capacity building through our international energy-sector development projects and partnerships. CEE team members interact with people and programs throughout the Bureau.

Key themes across current project areas include

- What are the factors impacting energy prices in the U.S. and internationally?
- How do national oil companies (NOC's) perform within their country's frameworks? What is their role?
- What is needed for a small country's development of newly discovered hydrocarbon resources?
- What is the future of natural gas as a clean energy source in the United States and elsewhere? How does international trading of liquefied natural gas (LNG) support global natural gas development and use, and how are trade patterns evolving?
- CO₂ capture, enhanced oil recovery (EOR), and sequestration: where do we go from here?

Why Energy Prices are Important

Energy prices convey critical information about supply-demand balances and, thus, serve as crucial signals for both investment in new production and careful use. On behalf of the U.S. Energy Information Administration, the CEE team is preparing an expert review of factors driving crude oil prices and their interactions and impact with respect to market outcomes,

including changes in price levels and price volatility. Our broad-ranging review incorporates "fundamentals," including how supply-demand balances change and market operations, such as drilling and associated costs, inventories, and refining operations that affect these balances, and how to better integrate fundamentals with financial markets (the huge day-to-day and long-term trading in crude oil, natural gas, and other commodities). Our findings thus far highlight the importance of understanding how producers, including NOC's and their governments, respond to price signals and the intrinsic link between full funding and development cost and oil price; refining operations and regulations that affect refinery output and inventories of refined products; and government policies that create distortions by subsidizing petroleum products. This last arena is now a focus for the G-20 Group of Nations. Reducing or eliminating energy-sector subsidies not only benefits government fiscal budgets but also removes distortions that block critical capital flows for modern, clean infrastructure and petroleum fuels, while encouraging more "rational" use.

Role of NOC's and Their Performance

NOC's are the "gatekeepers" to many of the best hydrocarbon accumulations worldwide. They are also the main implementers of government policies that affect availability and use of modern, clean fossil fuels in large parts of the world. CEE has undertaken research on NOC's since 1998, including collaboration with the World Bank since 2008. Whether NOC's can build modern, effective, commercial organizations with strong management and institutional capabilities will influence heavily the delivery of new oil and natural gas supplies to meet future demand. For Phase I of the World Bank research initiative, CEE helped

create an online dataset of 49 NOC's in 47 different countries. CEE completed a second phase of work in 2010, targeting value-creation metrics, including case studies of 12 companies. Throughout our research, we consistently find that the best-performing NOC's operate in more competitive environments, including the ability to partner with international oil companies (IOC's), and with transparent and reasonable fiscal regimes provided by their governments.

Ghana's Emerging Offshore Oil and Gas Industry

With the discovery of Jubilee field in 2007, Ghana has been facing the prospect of a new status as net exporter of oil and the possibility of abundant domestic natural gas resources to fuel the country's economy. Jubilee, as well as additional new and potential discoveries, has raised many issues and concerns: sector governance issues, such as managing expectations; questions about preparedness, such as capacity of technocrats at various government agencies to implement laws, rules, and regulations for safe and environmentally responsible oil and gas resource exploitation; workforce and other local content concerns; and revenue-management challenges. These concerns spurred the Government of Ghana (GOG) to request an independent assessment of key energy-sector issues. In November 2009, CEE was tasked by the U.S. Agency for International Development (USAID) with conducting a needs-assessment survey, including coordination with other international

development partners and U.S. Government offices. CEE's final report identified crucial gaps and provided program recommendations for workforce adequacy and related training and educational needs; institutional capacity building and best practices for oil- and gas-sector development and oversight, including health, safety, and environment practices for offshore operations and production revenue management; and stakeholder engagement and local content and community mitigation strategies. USAID is in the process of renewing CEE's "Smart Development in Energy Sector Governance" cooperative agreement, or CA, which will include implementing our recommendations.

Natural Gas in the U.S. and Trends in LNG International Trade

Worldwide, natural gas is considered a clean fuel that can meet base-load demand, as well as a bridge to future energy sources and technologies. The CEE team has significant experience in the natural gas arena, more than any other energy commodity or technology. Our research began in the early 1990's, with decades



of individual professional expertise. Our current focus began in fall 2009 with the launch of *The Critical Role of Natural Gas in the U.S. Energy Mix*, including updates to seminal papers and publications, new research, public outreach, and education. Education includes presentations by team members to a wide variety of audiences both in the U.S. and overseas, participation in industry research such as National Petroleum Council studies, support of Bureau research, and training and international capacity building through short courses and other activities. Much of our work centers on shale-gas production in the U.S., which has increased significantly

in recent years as conventional production in many mature fields continues to decline. Attention has focused on ongoing substitution of natural gas for coal in power generation to reduce both greenhouse-gas emissions and water requirements for electricity generation. Questions about possible growth in industrial consumption of natural gas dovetail with myriad economic and policy considerations





surrounding U.S. manufacturing. Distinct efficiency and environmental benefits are derived when natural gas is used directly in homes and businesses. Our underlying research also tackles assumptions about the U.S. shale-gas resource base and cost structure and environmental concerns, especially regarding how policy and regulatory frameworks might evolve.

Along with new frontiers in domestic natural gas resources, significant new LNG import-capacity additions have been made, creating extraordinary advantages for U.S. natural gas customers and consumers. Since 2002, CEE has been a leader in developing and hosting a public-domain LNG database that has been widely accessed and used with translations in multiple languages. Currently the team is completing work on a grant from the Association of International Petroleum Negotiators (AIPN) to examine long-term trends in international LNG trade. Research questions pertain to commercial practices in LNG contracting, including new strategies for flexibility in an industry that historically has been dominated by long-term contracts linked to crude-oil prices and fixed destinations. The AIPN grant work, coupled with our existing U.S. natural gas and LNG research portfolio, will expand information that CEE is gleaned on several inquiries related to global natural gas supply, demand, and pricing underlying long-term outlooks.

Economics of Integrated CO₂ Capture, EOR, and Sequestration

CEE continues to participate in research at the Gulf Coast Carbon Center (GCCC). Our past research on CO₂-EOR economics was refined in 2010 by focusing on a single coal power plant and a single EOR-ready oil field with saline formations suitable for sequestering more CO₂ than that needed for EOR. CEE researchers collaborated with Dr. Carey King, Stuart Cohen (Ph.D. student in Mechanical Engineering) and Stuart Coleman (a student in JSG's Energy and Earth Resources or EER program) to produce a paper presented at the Greenhouse Gas Control Technologies (GHGT)-10 Conference in September. Results will also be presented at the upcoming AAPG Annual Convention in Houston in April 2011. Carbon capture and sequestration are neither cheap nor simple. Significant uncertainties related to cost, financing, risk, and liability persist in a dynamic policy and regulatory environment. Many options and alternatives exist for emissions management. Our research helps to inform choices on whether CO₂ emissions reductions should remain a priority for governments and societies.

Capacity Building and Public Service

Research at CEE translates into action through our capacity-building programs and initiatives, as well as other public service commitments. Since 2001, CEE has conducted the New Era in Oil, Gas & Power Value Creation program, an outgrowth of our international energy-sector development-assistance expertise gained since our first USAID-funded projects in Central Asia in 1997. USAID remains a strong partner in the New Era sessions, along with other industry and government organizations, sponsoring delegates from countries of interest through our cooperative agreement and

supporting deployment of New Era content as part of in-country work assignments. More than 40 countries have been represented in the New Era rosters over the past 10 years. CEE also leverages the New Era platform in separate training programs, such as the oil and gas upstream session conducted with Mexico's Secretaría de Energía in August. Apart from its New Era initiatives, CEE collaborates with McCombs School of Business for energy content through the Houston Professional MBA, the ExxonMobil Commercial Overview program, and the UT-Petrobras management program (a joint venture between McCombs and JSG). Our capacity building feeds into strong public service commitments that reflect our core mission and objectives. Over the years, CEE has engaged in grant-supported partnerships to help build energy economics content and understanding in a variety of international locations. Our association with Mexico's Instituto Tecnológico Autónomo (ITAM), including four Higher Education for Development (HED)/USAID graduate student scholarships for JSG's EER degree program, concluded in the fall. We maintain our relationships well beyond grant and contract termination, for example our participation in a successful MacArthur Foundation grant proposal by University of Ibadan in Nigeria to establish an energy economics center and program. We gladly host visiting scholars and delegations who want to better understand the economic development and environmental benefits associated with energy markets. Imad Al Deen, a Fulbright Scholar to Columbia University from Iraq and visitor during the summer, is our most recent alumnus. Our gifts and other discretionary funding are invaluable to sustaining these public service commitments.



The Bureau Welcomes

Michael Young



In August, Dr. Michael Young joined the Bureau as the new Associate Director for Environmental Systems, replacing Ian Duncan,

who had served for 6 years and is returning as a full-time researcher. Dr. Young came to UT-Austin by way of the Desert Research Institute (DRI), where he served as Acting Executive Director of the Division of Hydrologic Sciences (he was also Deputy Director for 5 years). He left DRI with the academic rank of Research Professor. At DRI, Dr. Young administered one of the largest academic research groups in the United States focusing on hydrologic sciences. He has 25 years' experience in research, consulting, and government. He has B.A. and M.S. degrees in Geological Sciences from Hartwick

College (Oneonta, NY, 1983) and Ohio University (Athens, OH, 1986), respectively, with a specialty in Hydrogeology at Ohio. He earned his Ph.D. in Soil and Water Science (specializing in soil physics and hydrology) from the University of Arizona, Tucson, in 1995. While at Arizona, Dr. Young was named Research Specialist of the Year in the College of Agriculture. He held assistant and senior research scientist positions at the University of Arizona and Georgia Institute of Technology, respectively, between 1995 and 2000. Dr. Young has authored or co-authored more than 40 peer-reviewed journal articles, several book chapters, more than 100 presentations at scholarly meetings, and many other technical reports. He currently serves as co-editor of the *Vadose Zone Journal* and serves on numerous other committees in scholarly organizations. His research interests and experience are on movement of water and solutes in arid and semiarid vadose zones, soil–water–plant interactions,

groundwater recharge and the connection between water resources, landscape development, and human interactions.

While in Nevada, Dr. Young served on the graduate faculty in the Hydrologic Sciences Program at the University of Nevada, Reno, and he was a graduate faculty associate in the Department of Geosciences at the University of Nevada, Las Vegas. He was recently lead investigator on a Nevada statewide project titled “Scaling Environmental Processes in Heterogeneous Arid Soils” (SEPHAS—an NSF-funded infrastructure project that included construction and operation of large weighing lysimeters), a nationally unique facility in Boulder City, Nevada, designed to measure arid soil processes in semicontrolled conditions. When not thinking about science questions, Dr. Young has time for a few hobbies, including spending time with his wife Kathy and their three dogs, listening to music, and being outdoors. An avid road cyclist, he averages more than 7,000 miles per year.



The Environmental Systems Division: Where It's Headed

In his recently published book *Collapse: How Societies Choose to Fail or Succeed*, Jared Diamond documented civilizations ranging from Easter Island and the Anasazis to more modern societies, like Haiti and Rwanda, that have subsequently either ceased to exist or are otherwise significantly reduced in size and vibrancy. In many of these cases (cf. Easter Island and Haiti), Diamond posited that significant reductions in trees and other vegetation (often used for agriculture, fuel, and homebuilding) led to soil erosion and subsequent collapse of local ecosystems. These changes to the landscape altered water balance, fertility, and soil quality—essentially, the ability of the land as an agricultural pathway to sustain human advancement. We see the same activity in regions of Africa and elsewhere, where deforestation has led to loss of soil, alteration of water recharge to aquifers, and reduced land productivity. Many of the cases that Diamond discussed are complex and interconnected; many

factors may have contributed to loss of economic output, in addition to land use.

Considering just the connection between water and energy, one study recently completed for Congress by the U.S. Department of Energy and the Sandia National Laboratories links water use and energy generation. The report concluded that “trends in energy use, water availability, and water demand suggest that the U.S. will continue to face issues related to the development, utilization, and management of the critical resources of water and energy.”¹ With the intense interest now being focused on alternative (solar, wind, biofuels, etc.) and nonconventional (shale gas) sources of energy, the connections among land, water, and energy are even more important to both State and National interests.

The point is that understanding environmental systems, connecting their relationships to other aspects of energy and economic systems, and examining how they react to change are vital goals in

research that can contribute to and shape public policy and decision making. The Environmental Systems Division already pursues a wide range of environmental research that highlights these relationships, including programs in geologic sequestration of carbon, water resource assessment and quality, coastal and wetland processes, advanced numerical simulation of subsurface processes, economic analyses of energy systems, and geological mapping. This intellectual horsepower is supplemented by significant physical infrastructure, such as an airborne lidar system for high-resolution land mapping, a suite of geophysical tools that detect shallow subsurface features, computational resources for high-level simulation modeling, and a recently awarded 3-D seismic surveying and imaging system that will be one of the most advanced in the U.S. With wet laboratories for water-quality analyses and experiments to examine carbon interactions with rock samples and in-house drilling equipment to interrogate the subsurface soil



¹ U.S. Department of Energy. December 2006. Energy Demands on Water Resources. Report to Congress on the Interdependency of Energy and Water.



and rock layers, the Environmental Systems Division has the tools and talent to approach diverse research ideas and projects. We aim to further leverage these resources in the future.

In my recent role as Acting Executive Director (and, previously, as Deputy Director) of Hydrologic Sciences at the Desert Research Institute (DRI), I was charged with running a division of scientists and engineers who studied all manner of hydrologic sciences in a variety of settings, from arid warm deserts, to semiarid highlands, to the polar regions. My focus was on (1) reducing barriers (often administrative) that impeded progress, (2) empowering researchers by giving them the responsibility (and funding) to identify and pursue interesting and compelling research projects, and (3) assisting them wherever possible as a sounding board and mentor. My current role at the Bureau is similar. Namely, key aspects of my role are to implement efficient administrative processes to improve success rates and to make the workplace more enjoyable. My role is not to insert myself between the researchers and their hard-won research programs; rather, it is to help where necessary to ensure that they can implement their research efficiently and effectively. This role also extends to identifying and encouraging connections between program areas and research groups inside and outside the Bureau. Although these opportunities for collaboration may not be as obvious to those who work every day to make deadlines and maintain viable programs, I will be advocating on behalf of researchers and the Bureau to potential sponsors. Basically my role includes everything from assisting in recruiting, to mentoring, to budgeting, to long-range planning, and everything in between.

Time is clearly needed for me to gain an in-depth understanding of this scientifically diverse group and to determine and implement suggestions to improve

what we do. Short-term, I will continue to meet—and engage with—research staff to learn about their existing and proposed research programs, understand Bureau processes and suggest ideas to improve efficiency and effectiveness wherever possible, meet with existing and potential sponsors to get to know their needs, and help initiate new collaborations and projects. Thus far, I have had the pleasure of meeting with many State leaders in water and environment, members of the Jackson School, and the Bureau research team. Many intersections exist between what we have (at the Bureau) and what sponsors need (at the State level). My goal is to link these pieces of the puzzle into a final picture of a robust and integrated science team that addresses the overall needs of the State of Texas and, by extension, the needs of stakeholders and colleagues outside of Texas.

So what are some specific medium-term goals for the Environmental Systems Division?

- ▶ Strengthen connections among environmental, energy, and economic programs, while focusing on hypothesis-driven research whenever possible.
- ▶ Provide high-level advocacy for the Bureau within State, National, and International circles, especially with respect to environmental programs.
- ▶ Maintain upward visibility of the Bureau's research activities through peer-reviewed publications and Reports of Investigation.
- ▶ Foster the local, National, and International reputation of the Bureau as a critical facility for explaining the role and value of environmental systems.
- ▶ Attract, recruit, and retain top-level talented researchers for the Bureau.
- ▶ Build new programs that focus on quantitatively connecting available natural resources to how these resources are used in a way that allows us to “see” connections in natural and human

systems. For example, in Texas alone, these connections can be helpful in

- ◆ Expanding the use of reservoir characterization techniques to explain and quantify groundwater volumes in aquifer systems across conservation districts (addressing new TWDB/State programs that limit impacts to groundwater resources).
 - ◆ Assessing potential for brackish water as a usable water supply, especially in desalinization plants or for other industrial/municipal purposes (addressing potential water shortages in Texas during periodic droughts, as outlined in the *Texas State Water Plan 2007*).
 - ◆ Expanding the coastal processes research portfolio.
- ▶ Oversee carbon studies judiciously. As many who follow the Bureau know, the Gulf Coast Carbon Center (GCCC) has received several awards from the U.S. Department of Energy (DOE) and other private entities engaged in deep geological sequestration of carbon. Its enormous success has personnel and project management challenges that must be addressed to ensure success of the program for the research team, as well as the National and International notoriety that accompanies success.
 - ▶ Expand the Bureau's research footprint into hydrologic characterization of potential geothermal energy sources (leveraging new research programs funded by DOE).
 - ▶ Create a multidisciplinary international research, training, and outreach program that provides strategies for optimizing specific water resources for potable and agriculture uses, thus expanding Bureau and Jackson School visibility in international programs.

In summary, my leadership goals are to keep the Bureau a place where researchers can pursue their passion for science and engineering in a supportive and enjoyable environment and to help maintain a work environment that draws and keeps top talent.

—Michael Young
Associate Director, Environmental Systems

International Exposure

► Bureau Carbon Team Spans the Globe

— In January 2010, GCCC's Tip Meckel attended a joint China-Australia Geological Storage of CO₂ (CAGS) meeting in Canberra, Australia. The meeting was hosted by Geoscience Australia as part of the Asia-Pacific Partnership on Clean Development

Investment Corp. For more, see <http://www.cagsinfo.net/Sessions.html>. In September, Tip participated in the biannual international meeting of the Greenhouse Gas Control Technologies held in Amsterdam, Netherlands. This meeting attracts thousands of delegates from around the globe. The next meeting is being held in Japan in 2012, and Austin is being considered to host the meeting in 2014. On December 9, Tip was the invited keynote speaker for the annual review meeting of CCS research for the Japanese Research Institute of Innovative Technology for the Earth (RITE). The meeting was held in Kyoto, Japan, with 200 invited national researchers and industry representatives present. Tip presented a summary of current CCS research in the U.S., focusing on accomplishments of the GCCC in field tests monitoring CO₂ injection at Cranfield, MS. In the coming year, Tip and colleague Sue Hovorka will host a field experiment conducted by RITE at the Cranfield site using passive microseismic techniques. Collaborations have also been initiated between GCCC and RITE in monitoring offshore CCS projects, in concert with an ongoing DOE-funded project at the Bureau (Tip and Ramón Treviño are the PI's) to evaluate storage opportunities in the Texas offshore Gulf of Mexico.

— From March 25 through 31, Sue Hovorka visited Beijing, China, to talk about GCCC research as part of a Bureau delegation that included Eric Potter and Hongliu Zeng. Sue visited Dr. He Dengfa and Xiao



Jianxin at China University of Geosciences in Beijing, gave a lecture at BGP (China National

Petroleum Company and geophysical unit of PetroChina) in Zhuozhou City, Hebei Province, and visited RIPED (the research arm of PetroChina) and Peking University. Eric Potter made presentations at BGP, RIPED, and China Petroleum University (CUP) on consortium research progress and opportunities at the Bureau, emphasizing unconventional gas research, and a deep carbonate karst play in western China. In these sessions, Hongliu Zeng also presented on the theory and practice of thin-bed seismic resolution for seismic sedimentology. At BGP, President Wang Tiejun and Vice President Xia Yiping hosted. At CUP, Vice President Wu Xiaolin; Prof. Zhu Xiaomin, Dean of the Geoscience Faculty; and Prof. Sun Xudong, Director of the International Office served as hosts. And at RIPED Dr. Wang Daofu, President of RIPED and Chief Geologist of PetroChina hosted. Their hosts from BGP, RIPED, and CUP provided wonderful dinners and guided them on weekend trips to the Forbidden City, the Summer Palace, the Ming Tombs, and the Great Wall.

— Changbing Yang also visited China in December for the Third U.S.-China Symposium. He presented a talk on early and anthropogenic tests and met with the deputy chief engineer of the Shenhua Group to discuss improving their CO₂ injection monitoring plan.

— In August, GCCC's Katherine Romanak attended the 30th meeting of the Water Rock Interaction Group of the International Association of Geochemistry and Cosmochemistry in Guanajuato, Mexico. Katherine spoke on "The Role



and Climate. Meeting attendees included delegations from the Chinese Academy of Sciences, China University of Petroleum, Australian government, British Geological Survey, and industry. Tip presented on technical accomplishments of the GCCC field projects at Frio Pilot and Cranfield and also provided an overview of the U.S. DOE Regional Carbon Sequestration Partnership Program. In early February, Australian mining company Resourcehouse Ltd. announced a record \$60 billion agreement to supply 30 million tons of coal annually over 20 years to China Power International Development Ltd., part of major power producer China Power





of Dedolomitization in the Detection of Anthropogenic CO₂ in Freshwater Aquifers.”

Early in November, Katherine traveled to Maria Laach, Germany, and presented “Soil-Gas Behavior and Measurement in a Carbon-Reactive Natural Analog: Implications for Near-Surface Monitoring.” She also chaired a session, “Monitoring Challenges in Light of Natural Systems” and served on the steering committee for the meeting. Later that same month, Katherine traveled to Switzerland, presenting “Pilot Studies of CO₂ Injection into Geologic Reservoirs as a Prelude to Large-Scale Carbon Sequestration” at the Séminaire du Département de Géologie et Paléontologie in Geneva and “Monitoring CO₂ Storage in Deep Geological Formations” at the University of Bern.

— Jiemin Lu traveled to Edinburgh, Scotland, in July to attend the UK Geological Storage and Monitoring of CO₂ Conference in St. Leonard’s Hall, Edinburgh University. The aim of the



meeting was to develop CO₂ geological storage and monitoring research capacity in the UK for upcoming demonstration storage projects being funded by the Department of Energy and Climate Change CCS competition. Researchers involved in CO₂ storage projects around the world presented their latest results, helped define gaps in knowledge, and identified priority research needs for UK carbon geologic storage. Jiemin’s talk, “Monitoring CO₂ Injection at Cranfield Field, Mississippi, USA,” presented updated geophysical and geochemical data and discussed lessons learned from SECARB’s Cranfield carbon sequestration project.

— Ramón Treviño represented the GCCC (Gulf Coast Carbon Center) at the CSLF (Carbon Sequestration Leadership Forum), October 6 and 7, in Warsaw, Poland. Ramón presented an overview of the ongoing research of the Department of Energy’s Southeast Carbon Sequestration Partnership (SECARB) CO₂ injection field experiment at Cranfield field, Mississippi. He presented the



overview to the CSLF Projects Interaction and Review Team (PIRT), which reported the SECARB Cranfield experiment with a positive recommendation to the CSLF Technical Committee. Ramón’s presentation to the Technical Committee likewise resulted in a positive recommendation to the CSLF Policy Committee. After consideration, the Policy Committee accepted SECARB/Cranfield as one of its “Recognized Projects.” SECARB is the second GCCC study to be a “CSLF Recognized Project,” following the now-completed Frio Project.

► On Tour with QCL

— The Quantitative Clastics Laboratory (QCL) folks did some globe-trotting themselves this year. Lesli Wood visited Veracruz, Mexico, as a guest of AAPG to attend the GTW Subsalt Technology Conference held in November and to present a keynote lecture titled



“What Lies beneath: Exploring and Exploiting beneath the Worldwide Tertiary Blanket.” In April Lesli Wood traveled to Beijing, China, as a guest of the China University of Petroleum, where she met with students, taught a 1-week credit course in sequence stratigraphy for the university, and enjoyed learning how to make killer dumplings from her hostess, Dr. Yanlei Dong. From China, Lesli flew to Perth, Australia, to visit Woodside Energy’s Perth Office and conduct a core viewing as the guest of Simon Lang and other Woodside geoscientists. There she gave an invited lecture to the Perth Geological Society titled “On beyond Zebra: Moving from Depositional Models to Successful Integrated Modeling of Deposits.” In August Lesli traveled to the capital city of Suriname, Paramaribo, as a guest of the major hydrocarbon company there, Staatsolie. She taught a short course in sequence stratigraphy and exploration and spent a day in the offices there looking at their deep offshore exploration area and the onshore development areas.

— In the fall, Lorena Moscardelli visited member company YPF in Buenos Aires, Argentina, where she presented a series of technical talks showcasing the most recent work performed by QCL researchers and students. The rest of the visit



was spent discussing potential areas of research interest for future collaboration between YPF and QCL. Lorena also attended the 18th International

Sedimentological Congress in Mendoza, Argentina, where she co-chaired a technical session entitled “Mass Wasting Events and Related Sediments.” Nine oral presentations and five posters were part of the well-attended session.

→ Dr. Peter Flaig, QCL Postdoctoral Researcher, spent about 2.5 months in Antarctica working in collaboration with Dr. Steven Hasiotis of the University of Kansas on an NSF-funded study of the Triassic and Jurassic stratigraphy and



sedimentology of the Trans-Antarctic Mountains. Prior to heading out to base camp, Pete spent time in McMurdo Station preparing the Research Group's gear and supplies, as well as receiving training in Mountaineering, Snow Machine, and Antarctic Survival. Pete spent some alone time on the ridge overlooking McMurdo Station with Mount Erebus, the southernmost active volcano on the planet, in the background. Follow Pete's adventures on his blog at <http://peterflaig.blogspot.com/>. Some stunning photos of Captain Scott's camp can be found there as well. Pete is a professional photographer.

➤ RCRL— from Indonesia to Rio

→ In November, Xavier Janson and Takashi Shimazu, a visiting scientist from JAPEX to the RCRL, traveled to Indonesia to visit



Kangean Energy Indonesia Ltd. in Jakarta. They then headed to Kangean

Island east of Java, first by plane for 1 hour, then by car for 4 hours, and finally by boat for 3.5 hours. The two spent 10 days on the island field mapping Miocene carbonate strata and measuring fractures in a large, exposed anticline structure. The field data will be used as an analog for a nearby oil and gas field operated by KEI. The field party comprised these two scientists, another geologist, a safety officer from KEI, local military and police escorts, and several local officials from forestry and agriculture offices, who helped navigate through the maze of dirt roads, bike trails, jungle, and rice fields. Fieldwork transportation included a small pickup truck and motor bike for inland excursions, as well as a traditional Indonesian fishing boat for visiting the coastal outcrop.

→ A long-standing relationship between Petrobras in Brazil and the Bureau has led to several new initiatives, including a training and research collaboration on integrated fractured reservoir characterization. RCRL's Chris Zahm has been leading a project to construct a 3-D model of a fractured carbonate reservoir in the Campos Basin using an integrated



workflow that highlights the importance of stratigraphy in the fracture reservoir

modeling process. Important collaborators on this project include Charlie Kerans (DGS), Jerry Lucia and Xavier Janson (BEG), and external collaborators Reinaldo Michelena, Patricia Rodrigues, and Jim Gilman of iReservoir in Denver, Colorado.

➤ CEE Abroad

→ From January 30 through February 7, meetings to finalize the oil and gas industry needs assessment report, conducted by CEE at the request of USAID on behalf of the Government of Ghana, were held in Accra. The meetings, conducted by Dr. Michelle Michot Foss and Dr. Gürcan Gülen, focused on key recommendations from CEE's report, which included



(1) workforce training, (2) oil and gas sector development and oversight, and (3) stakeholder engagement and local content and community mitigation strategies. On the 5th through the 7th of March, as part of the ongoing collaboration between CEE-UT and Oxford Institute for Energy Studies (OIES), Dr. Foss gave a presentation on global natural gas developments and issues at the OIES seminar on U.S. natural gas. Dr. Foss also presented on U.S. natural gas issues and participated in the Windsor Energy Group Annual 2010 Consultation at Windsor Castle. She reports that the Queen was there! Dr. Foss was a panelist in Mexico City at the International Conference on Exploration and Production of Oil and Gas in Mexico: the New Regime, which was held April 15–16. The Conference was sponsored by the IEL (Institute for Energy Law) and ANADE (National Association of Business Lawyers). From May 31 through June 2, Michelle attended the 10th Doha Forum on Democracy, Development, and Free Trade in Qatar. She had been selected by the Qatar Foundation as a delegate to the forum. She also visited RasGas, Ras Laffan City, which is the largest LNG facility in the world.



► Director and Scientists Visit Iceland

Early in March, Bureau Director Scott Tinker and scientists Bruce Cutright and Bill Ambrose visited Reykjavik, Iceland—specifically the Iceland National Energy Authority (NEA), United Nations University—Geothermal Training Programme (UNU-GTP), and the Iceland GeoSurvey (ISOR). The three also met with members of NEA, UNUA-GTP, and ISOR to discuss common interests in geothermal energy and oil and gas exploration. Highlights of the visit included a tour of Hellisheidi and Svartsengi geothermal power plants and the world-famous Blue Lagoon. Scott's presentation at Reykjavik University about global energy capped the visit.

► Paine Tours China

In June, Jeff Paine traveled to China to attend a geophysics and geohazards conference and workshop held in Wuhan



and Chengdu, China, where he gave invited presentations on geophysics applied to sinkholes. These events, hosted by the China University of Geosciences and the Chengdu University of Technology, were part of the 4th International Conference on Environmental and Engineering Geophysics chaired by Runqiu Huang, Xuben Wang, Jianghai Xia, Yaoguo Li, Shen Yu, and Yixian Xu. Highlights of the trip were a 1-day workshop in Wuhan, a visit to laboratories at the China University of Geosciences, 2 days of geohazard-focused presentations at the conference, and a 2-day field trip to areas affected by the Great Sichuan Earthquake (magnitude 8) of May 12, 2008. Photo depicts the village of Beichuan, a former community of about 20,000 that was abandoned after the quake and left largely untouched in memory of the residents who lost their lives. More than 70,000 perished; more than 4,000,000 were left homeless.

► Gale in Amsterdam

Julia Gale was an invited speaker at the Global Unconventional Gas 2010 Conference, which was held June 15–17. The event, organized by GTI, was conducted in the 17th-century Koepelkerk in the heart of Amsterdam. Presentations focused on the potential for development of unconventional gas beyond the U.S., along with the challenges.



► Ruppel Down Under

Steve Ruppel traveled to Sydney, New South Wales, Australia, in March to present a short course on mudrock systems to the staff of Pangaea Resources, a sponsor of the Bureau's Mudrock Systems Research Laboratory. Pangaea is active in exploration and development of a spectrum of oil and gas systems in Australia. The short course comprised four parts, including (1) a survey of depositional environments, models, and distribution of modern and ancient mudrocks; (2) techniques for characterizing mudrock systems and caveats for their application; (3) a case history of a mudrock reservoir system—the Barnett Shale; and (4) an overview of other mudrock systems in the world.

► Geological Society of London Meetings

Several GSL meetings were held during the course of the year, with many Bureau scientists attending and presenting. In January, Tim Dooley and Mike Hudec attended the conference titled Salt Tectonics, Sediments, and Prospectivity, which was held at Burlington House in London. The meeting was organized jointly by The Geological Society's Petroleum Group and by SEPM. AGL contributed the following papers:

Carruthers*, D., Cartwright, J., Jackson, M. P. A., and Kristensen, M., Using polygonal fault systems to reconstruct the state of stress of salt diapirs.

Dooley*, T. P., Jackson, M. P. A., and Hudec, M. R., Roof breakup and extrusion of shallow salt stocks during lateral shortening. Poster.



Graham*, R., Jackson, M. P. A., Kilsdonk, B., and Pilcher, R., Allochthonous salt in the sub-Alpine fold and thrust belt of Haute Provence.

Hudec*, M. R., and Peel, F. J., Influence of deep Louann structure on evolution of the deepwater Gulf of Mexico. Keynote Talk.

Tomasso*, M., Wright, W. R., Costa, F. O., Araujo, A. D., Sant'Anna, M. V., Machado, E. C. V., Hudec, M. R., Jackson, M. P. A., and Kerans, C., Linking halokinetic structure to the Pre-Evaporitic Structural Regime, Evaporite Facies and the Albian Carbonate Platform Succession, Campos Basin, Brazil.

In his capacity as co-opted member of the Petroleum Group Committee of the Geological Society, Steve Laubach, after collecting samples near Ullapool, Scotland, convened two more meetings in October and November. The October meeting occurred October 5–6 and was titled The Geology of Unconventional Gas Plays. On October 5, Uschi Hammes presented “Paleogeomorphology and Sea-Level-Fluctuation Controls on Development of Shale-Gas Deposits: An Example from the Upper Jurassic Haynesville and Bossier Shales, East Texas, USA,” and “Review



and Preliminary Classification of Matrix Pores in Mudrocks.” Later, Julia Gale presented “Natural Fractures in Shales: Timing, Sealing, Mechanisms of Formation, and Relevance for Shale-Gas Reservoirs.” On October 6, Peter Eichhubl presented “Timing and Stratigraphic Distribution of Natural Fractures in Tight Gas Reservoirs

in the Piceance Creek Field, Colorado, USA, Based on Fluid Inclusion and Fracture Scaling Analyses” and “Characterization and Modeling of Pore-Scale Flow Pathways in Tight Gas Sandstone, Piceance Basin, Colorado.” Steve Laubach presented “Contrasts in Fracture Array Intensity, Connectivity, and Porosity Associated with Faults in Tight Fluvial and Marine Sandstones: Evidence from Outcrop Analogs and Core.” The November meeting, titled Advances in Carbonate Exploration and Reservoir Analysis, was held November 4–5. RCRL’s Charlie Kerans and Xavier Janson also traveled to London and, despite a tube strike and student protests, joined 200+ carbonate experts from around the world in attending the Advances in Carbonate Exploration and Reservoir Analysis Conference. The meeting focused on topics ranging from emerging plays and concepts to porosity and geomodeling. Charlie Kerans gave a keynote lecture titled “Reservoir Compartmentalization and Distribution of Matrix and Super-Permeability Zones in Paleokarst Reservoirs: What Can Be Predicted from Sequence Framework and Unconformity Rank.” Xavier Janson chaired the Geomodeling Session and gave a presentation on carbonate mound modeling using two-point and multipoint statistics, as well as presenting a poster on ultra-deep karst in the Tarim Basin of western China. John Hooker presented “The Relationship between Fracture Cement Patterns and Fracture-Set Size Distributions in Carbonate Rocks.”

► Young and Duncan also in London

Unrelated to Geological Society meetings, Associate Director Michael Young and former Associate Director Ian Duncan traveled to London for a meeting with researchers from the University of Illinois; University of California—Berkeley; Stanford University; the Universities of London, Cambridge, and Oxford; Massachusetts Institute of Technology; and others to focus on a project funded by BP to study the nexus between water and energy. The meeting was held at Richmond Hill Hotel in outer London just a few doors down from where Rolling Stones’ Sir Mick Jagger once lived. Ian gave a presentation on water usage for fossil energy production, using gas-shale exploitation as an example.



Public Outreach and Education

► GCCC Partners with UTIG, PGE to Create STORE

The Bureau's Gulf Coast Carbon Center (GCCC), the Institute for Geophysics, and the Center for Petroleum and Geosystems Engineering have formed an alliance for Sequestration Training, Outreach, Research, and Education (STORE) to "promote better under-



standing of CO₂ sequestration science and engineering technology...[by] helping to create a skilled workforce for the carbon capture and sequestration (CCS) industry and fostering the public understanding required to advance the United States in its energy security and its leadership position with regard to climate change mitigation technology." Recently STORE sponsored sequestration training at both the GCAGS meeting and SPE International CO₂ Conference; outreach events with the theme of "Energy, Climate, and Water in the 21st Century"; research and technology transfer through field trips for AAPG and IEA meetings to the Cranfield field test site in Mississippi; and education of undergraduates via a new Jackson School course on "Advances in CO₂ Injection and Storage in Geologic Formations."

See more at the STORE website, <http://www.storeco2now.com/>

► STORE Goes to Dallas

On October 1 GCCC participated in Energy, Climate, and Water in the 21st Century at Ursuline Academy in Dallas—



an event organized by Hilary Olson, PI of the STORE program and a member of GCCC. Sue Hovorka, Becky Smyth, and Katherine Romanak met with middle and high school girls, and during a day-long workshop gave presentations titled "What to Do with CO₂," "What is in the Water You Drink?" and "CO₂: Too Much of a Good Thing." Sue explained properties of CO₂ during activities on carbon sequestration, and Katherine visited with middle and high school girls over breakfast. Bureau Director Scott Tinker gave a keynote lecture titled "Time, Technology, and Transition."

► Scientific Software Day at the Jackson School



Center, in association with the Jackson School of Geosciences at The University of Texas at Austin, presented the 4th annual Scientific Software Day. The purpose of the event is to increase awareness of new scientific software and to inform users of relevant and timely issues. The day included a number of short presentations related to the developments in scientific software. Bureau scientist Sergey Fomel has been an organizer of the event since its inception.

► Earth Science Week

Each year, a group of earth science professionals from the Austin area meet to plan activities for the annual Earth Science Week (ESW) to educate students, teachers, and the general public about the earth sciences and to encourage stewardship of the Earth. The 11th annual Austin ESW career fair, held on October 1 at the Commons Learning Center, was organized by Sigrid Clift, and a host of Bureau researchers and staff participated in the event. Approximately 300 middle school students and their teachers from the Austin



area attended the event to learn about exciting careers in the earth sciences.



More than 70 earth science professionals volunteered their time to participate as presenters, exhibitors, and tour guides. Thanks to the Bureau, Texas Space Grant Consortium, Lower Colorado River Authority, Austin Geological Society, Anvil Energy, Subsurface Library, Commons Learning Center, American Geological Institute, the Jackson School, and volunteers for their financial and in-kind support, which make the career fair possible each year.

► Explore UT

On March 6 the Bureau participated in Explore UT, in which 50,000 students, teachers, parents, and the general public from around the state of Texas are welcomed to The University of Texas at Austin to see a 100-ring circus featuring



► GeoFORCE

GeoFORCE is a summer program administered by the Jackson School that rewards outstanding high school students from select South Texas independent school districts and Houston area schools. Students who are admitted to the program



what UT does. The Bureau participated in four events. It is a hands-on introduction to university life in classrooms and laboratories, studios and performance halls, and



museum and library collections. Sue Hovorka was the Bureau coordinator for the event, and Sue and her daughters organized the "Find Gold" activity that teaches children about density,



Reuben Reyes and Dallas Dunlap were on hand with virtual-reality demonstrations ("Potpourri of 3-D Earth"), Rebecca Smyth and Texas Memorial Museum's Ann Molineux were guides for the Rock Garden tour featuring large rock samples collected by UT geologists from across Texas and the world, and the STORE-sponsored "What to Do with CO₂ for the Feverish Earth," was organized by Ramón Treviño and Institute for Geophysics researcher Hilary Olson.

travel each summer to many exciting areas of the U.S. to learn about career opportunities in the geosciences. The Bureau plays a significant role in this program as instructors and writers of the guidebooks for eight different field trips. Bureau researchers who participated as instructors in 2010 were Tiffany Caudle, Jeff Paine, and Laura Zahm.

► 5th-Grade Field Trip

Fifth-grade students from Valley West Elementary in Houston came to Austin for their annual geology field trip on March 12. Topics for the day included (1) erosion, deposition, sediment, lithification, rock types, and the law of superposition at McKinney Falls State park; (2) earthquakes, faults, and displacement at Mount Bonnell; and (3) Deep Time in Texas Tour and Fabulous Fossils activity at the UT Texas Natural Science Center. Sigrid Clift was field-trip leader, and Dr. Pamela Owen led the tour and the fossil activity at the Texas Natural Science Center.



► Field Trip to KBDJ Quarry

On November 24 the Bureau participated in an "outdoor classroom" organized by the KBDJ limestone quarry in Hays County, which is also a certified wildlife habitat conservation site. About 140 students and their teachers from Bridgepoint Elementary in Eanes ISD participated. They drank hot chocolate from Starbucks on this chilly morning before activities began. Then they toured the quarry and pit, examined native habitat, planted wildflowers, and visited a cave on the quarry site. Sigrid Clift, public information geologist for the Bureau, provided activities and discussion about the importance of natural resources found in the Earth's crust. The students enjoyed their morning at the quarry, which included packets containing T-shirts and educational materials. KBDJ provided pizza and drinks for lunch.



► Texas High School Coastal Monitoring Program

THSCMP is currently in its thirteenth year of operation. Participating schools are Ball High School on Galveston Island (13 years in the program), Port Isabel High School in South Texas (12 years), Port Aransas High School on Mustang Island (12 years), Van Vleck High School





(6 years), Palacios High School (5 years), the Innovation Academy at Cunningham Middle School in Corpus Christi (3 years), and students participating in the Spanish Science Club at Tidehaven Middle School (6 years). Tiffany Caudle is the lead scientist at the Bureau for this program.

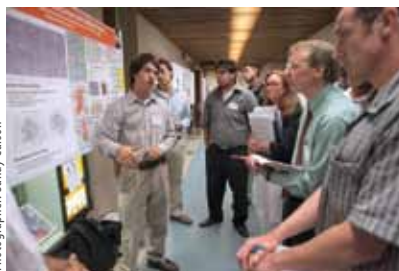
THSCMP has not only expanded the number of schools we work with, but we have also expanded the number of students within each school. Cunningham Middle School has its entire 8th grade class participate in THSCMP by sending approximately 25 students on each of the three field trips. Elective laboratory-based science courses (i.e., aquatic science, environmental systems, etc.) are seeing greater numbers of students owing to implementation of the new 4 × 4 graduation requirement. To graduate, students must now take 4 years of core classes from these four areas: language arts, mathematics, science, and social studies. As a result, teachers involved in THSCMP are seeing an increase in the number of students in their classes. For example, Ball High School now has two sections (approximately 35 students) of Advanced Placement Environmental Systems, and Port Aransas High School has two sections of Aquatic Science (27 students). In order to accommodate all of the students, as well as keep field trips manageable, the students are allowed to rotate which field trips they



attend so that they all have an opportunity to be active participants. In addition, during the first field trip of the 2010–2011 academic year, Ball High students were joined by eight students from Crenshaw Middle School from Bolivar Peninsula. One of the goals of THSCMP is to increase public awareness and understanding of coastal processes and hazards. And the greater the number of students actively involved in this program, the wider the message is spread about caring for our Texas coast.

► Teachable Moment: Gulf of Mexico Lease Sale

On Tuesday, April 27, students of the GEO 330K Energy Exploration class taught by Ron Steel and Bureau Scientists Peter Flemings and Xavier Janson participated in a first-ever Gulf of Mexico annual lease sale. The 120 students worked for 6 weeks developing bids on an exploration block in an offshore Louisiana dataset provided by Chevron. Their final geological and risk analyses and their bids, which were included on their posters, were evaluated by their teacher, as well as Ellen Clark, Dr. Younis Altobi, and Berik Zhakiyanov from Chevron.



Photographer: Sandy Carson



Photographer: Sandy Carson

Awards and Honors

► GCCC Wins CCS Award

The Gulf Coast Carbon Center (GCCC)



Frio Project received a Carbon Sequestration Leadership Forum (CSLF) Recognition Award for

being one of the



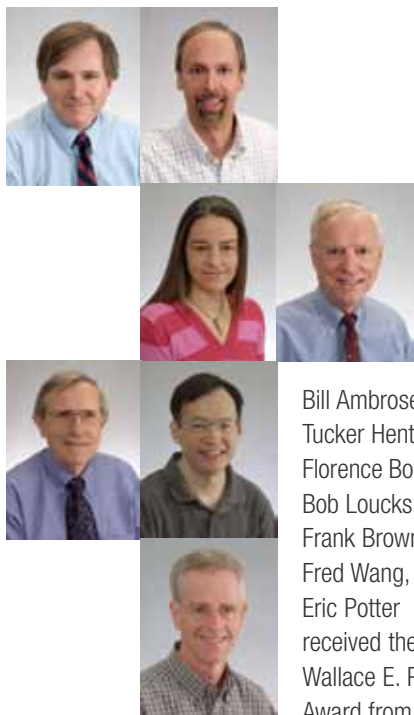
most important projects (globally) in the effort toward commercial implementation of carbon capture and sequestration. Ramón Treviño received the award on behalf of the Frio Project and GCCC Team Leader, Dr. Susan Hovorka. The award was presented by Polish Deputy Prime Minister, Waldemar Pawlak.



Program Director Dr. Ian Duncan has received the Bureau of Economic Geology Outstanding Service Award for his work as Associate Director for

Environmental systems from 2004 through 2010. The award, which was presented by Director Scott Tinker, reflects Ian's singular role in the development of many of the Bureau's major research programs, including carbon sequestration, geothermal energy, and resource management. In the future Ian will focus on research and program management, primarily in geothermal energy, carbon sequestration, and enhanced-energy-recovery technologies.

► Pratt Award Recipients

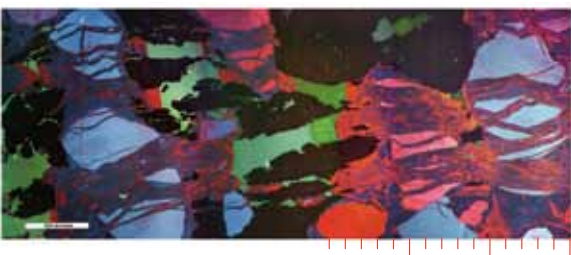


Bill Ambrose, Tucker Hentz, Florence Bonnaffé, Bob Loucks, Frank Brown, Fred Wang, and Eric Potter received the Wallace E. Pratt Award from

AAPG for the best *AAPG Bulletin* article published in calendar year 2009. Their paper "Sequence Stratigraphic Controls on Complex Reservoir Architecture of Highstand Fluvial-Dominated Deltaic and Lowstand Valley-Fill Deposits in the Upper Cretaceous (Cenomanian) Woodbine Group, East Texas Field: Regional and Local Perspectives" will be formally recognized at the 2011 AAPG Convention in Houston in April.

► JSG Photo of the Month

In June Rob Reed shot the *Journal of Structural Geology's* Photo of the Month—fracture with crack-seal texture and porosity, depth 6,274 m, Wyoming. The photo and its extended-abstract-length caption appear in the December issue of the journal.



► SPE Honors Javadpour



Dr. Farzam Javadpour was selected by the SPE *Journal of Canadian Petroleum Technology* to write the technology summary for its

August 2010 issue. The summary covers eight papers, with topics ranging from carbon capture and storage to methods of estimating hydrocarbon-production distribution in various naturally fractured reservoirs. For the full summary, see http://www.beg.utexas.edu/nwsimg_10/pdf/Farzam_Tech_summ_0810.pdf.

► Bureau Awards

Lorena Moscardelli and Lesli Wood were Bureau 2010 Publication Award winners.



Their publication, "New Classification System for Mass Transport Complexes in Offshore Trinidad," published in *Basin Research*, has already been cited 11 times in the ISI recorded citation index. This is a prestigious honor, selected from amongst a growing list of important Bureau contributions. Those receiving plaques for being lead authors of articles in peer-reviewed journals are: Bill Ambrose, Frank Brown, Tim Dooley, Peter Eichhubl, Andras Fall, Sergey Fomel, Qilong Fu, Scott Hamlin, John Hooker, Mike Hudec, Farzam Javadpour, Steve Laubach, Yang Liu, Bob Loucks, Jiemin Lu, Gang Luo, Lorena Moscardelli, J.-P. Nicot, Chris Ogiesoba, Jeff Paine, Bridget Scanlon, Dmitry Volkov, Lesli Wood, Changbing Yang, and Chris Zahm. At a dinner on April 19 celebrating all Bureau scientists

who published in recognized journals in 2009, Director Scott Tinker also recognized 2 publications by Frank Brown, who has been working since 1955; 5 publications each by Steve Laubach and Bridget Scanlon; and 10 publications by Sergey Fomel. "This kind of leadership from our senior research scientists is remarkable and something for us all to emulate," Scott said.

This year Bureau Technical Award recipients included Steve Laubach for his service as Senior Technical Advisor from 2006 through 2008; Ian Duncan for his term of service as Associate Director for Environmental Systems, 2004 through 2010; and Bob Loucks for his service as Senior Technical Advisor from 2008 through 2010.



► Fomel Recognized



A recent paper by Sergey Fomel, "Adaptive Multiple Subtraction Using Regularized Nonstationary

Regression," was selected by the Society for Exploration Geophysics (SEG) for inclusion in its upcoming volume *Geophysics Today*, a book celebrating 75 years of *Geophysics*. The 2009 paper is remarkable in its being accepted by the editors and reviewers "as is," without reviews or corrections.

► Bureau Scientists Receive AAPG Awards



The Bureau was well represented at the American Association of Petroleum Geologists 2010 National Convention in New Orleans April 12–14, coming home with three awards. Frank Brown received AAPG's most distinguished honor, the Sidney Powers Memorial Award. This

award is a gold medal given in recognition of distinguished and outstanding contributions to, or achievements in, petroleum geology. Martin Jackson received the Robert R. Berg for Outstanding Research Award, which is given in recognition of a singular achievement in petroleum geoscience research. And Bob Hardage received an AAPG Distinguished Service Award for singular and long-term service to AAPG.



Laura Zahm received the AAPG House of Delegates House Recognition of Service Award.

► STARR Team Wins

On December 6, Co-PI's William Ambrose and Ursula Hammes accepted the JSG Outstanding Research Program Award on behalf of the STARR team from Dean Sharon Mosher. The Bureau's STARR (State of Texas Advanced Oil



and Gas Resource Recovery) project is a unique alliance between academe, government, and industry designed to improve energy resource recovery while increasing State education funding through enhanced tax revenues. In the 2008–2010 biennium, STARR researchers published 45 peer- and non-peer-reviewed articles and received six Excellence in Geoscience awards, including the Wallace E. Pratt best paper award, published in the world's premier petroleum geology journal, the *AAPG Bulletin*. In the same period, the team generated total severance tax revenues for the State of Texas in the amount of \$16,568,217. In addition to Ambrose and Hammes, STARR team members at the Bureau include Tucker Hentz, Maryam Mousavi, Jeff Sprowl, Hongliu Zeng, Gregory Frébourg, Chris Ogiesoba, Bob Loucks, Seay Nance, Scott Hamlin, Bruce Cutright, Laura Zahm, Qilong Fu, Tongwei Zhang, and Robert Baumgardner.

► Hardage President-Elect of SEG



Bob Hardage assumed his new status this year as President-Elect of the Society of Exploration Geophysicists (SEG). An SEG member for

44 years, Bob previously served on the Executive Committee as Editor and First Vice President. He became internationally known in the 1980's for being an early proponent of vertical seismic profiling, now a standard geophysical technique. Bob has received several awards, including Honorary Membership, the SEG's second-highest award. He will serve on the incoming Executive Committee as President-Elect and will ascend to the presidency at the

conclusion of SEG's Annual International Meeting in September 2011. For more, see <http://view.exacttarget.com/?j=fe5615737d600178731d&m=fef51c7274630c&ls=fe901270766c017574&l=ff651c7174&s=ff001771706707&jb=ffcf14&ju=fe301576766d077c731472&r=0>.

and Gas Resource Recovery) project is a unique alliance between academe, govern-

► Honors for Laubach



The Structural Geology & Tectonics Division of the Geological Society of America has created the Stephen E. Laubach Structural Diagenesis

Research Award Fund to promote research that combines structural geology and diagenesis, as well as curriculum development in structural diagenesis. The grant is intended to encourage multidisciplinary approaches that may reveal new insights into long-standing problems and reveal new avenues for inquiry. In creating the new award, GSA states "This award highlights the growing need to break down disciplinary boundaries between structural geology and sedimentary petrology, exemplified by the work of Dr. Stephen Laubach and colleagues." This year the National Research Council also appointed Steve to the DUSEL (Deep Underground Science and Engineering Laboratory, located at the Homestake Mine in Lead, South Dakota) Committee. Formed in 2008, the DUSEL Committee coordinates the activities of the laboratory's scientific community.

► QCL Students Receive Awards



In February, Damian Markez was informed that he had won an endowed graduate fellowship from the Jackson School, a package valued at \$47,000, for the 2010–2011 academic year. Stefan Punnette received a BG Fellowship, a 2-year

award for his M.S. work, and Darrin Burton received a \$1,500 Off-Campus Research



grant from the Jackson School. Tricia Alvarez was given third place in the AAPG Student Poster Competition, and Anmar Davila was awarded the Chevron Scholarship during the summer semester.



On March 26, the GCAGS Imperial Barrel Award Competition winners were announced, and the UT team came in second, winning \$2,000. That team included QCL students Vishal Maharaj and Sarika Ramnarine, and Chris Zahm and Scott Tinker were their faculty advisors. In April, Kadira Singh and Lesli Wood's was one of the Top 10 Posters presented at the AAPG Annual Convention in New Orleans.



It was titled "The Impact of Astroblems on Earth's History and Its Implications for Hydrocarbon Production." On November 8, the Houston Geological Society presented Graduate Research Assistant Dolores van

der Kolk its award for UT's Outstanding Geoscience Student. Presented annually, the award includes a \$500 cash prize and biographical feature in the *HGS Bulletin*. Finally, Vishal Maharaj was named the ConocoPhillips SPIRIT Scholar again this year, as was Jessica Morgan, who also continued to receive the ConocoPhillips Graduate Fellowship. Vishal also received the 2010 AAPG Grants-in-Aid



William Dow Hamm Memorial Grant, an ExxonMobil Geoscience Grant of \$7,500, a JSG/GSC Chevron Fellowship, and he was awarded 3rd place for this year's GCAGS Thomas A. Philpot Excellence of Presentation. Jessica also was a finalist for the AAPG Oral Award Competition.

► Jackson School Award Winners



On April 1, the Jackson School of Geosciences recognized professional excellence at the Walter Awards Banquet at the UT Alumni Center.

The event, hosted by Dean Sharon Mosher, honored four Bureau folks for their outstanding contributions. Senior Research Scientist Shirley Dutton received the School's Research Award. The Dean remarked on how deserving Shirley was of the award: "In 33 years at the BEG, Shirley has delivered a constant and exceptional level of research quality and productivity.... Principles from her research have been applied to tight gas sandstones worldwide. As one of her nominators wrote, '[Shirley] takes a well-organized approach to her research projects, concentrating on collecting the correct data through to establishing strong databases. She is excellent at working with multiple hypotheses and establishing the dominant hypothesis by using convincing underlying data. She is proactive in testing her concepts on others and listens to alternative ideas—essence of an excellent research scientist.'"



The Jackson School Staff Excellence Award went to contracts and grants specialist Julie Duiker. Said the Dean, "Julie Duiker leads the contracts and grants organization at the Bureau—a critical position in an essentially soft money

organization. She demonstrates extraordinary leadership: since 2005 the volume of work going through her office has doubled with virtually the same number of staff, and she started after a time without a grant person for 3 months—her organizational skills and attention to detail are second to none. I know she is well respected by the Dean's staff and the UT Office of Sponsored Projects. In sum: Julie is an outstanding performer in her position as Contracts Manager."



Bureau alum and former Associate Director Doug Ratcliff was presented the Joseph C. Walter Jr. Excellence Award for his work as Director of JSG's

GeoFORCE earth sciences educational program. Along with program associates Eleanour Snow, Naiva Morales, Edgar Garza, Lindsay Stephens, and nearly 100 counselors, Doug administers the college preparatory summer outreach program for more than 700 Texas 8th- to 12th-grade students. This is the second time that Doug has received the award created by the Joseph C. Walter family.



Last year's Staff Excellence Award winner, Wanda LaPlante, also received special recognition for her career contributions to the Jackson

School. Dean Mosher got it right when she said of Wanda, "During her career at the Bureau, Wanda has received high praise from all who come in contact with her. She has always been a consummate professional and, I can say from my time as Department Chair and now Dean, she is a joy to work with."



Bureau Transitions

► Moving up in the Bureau

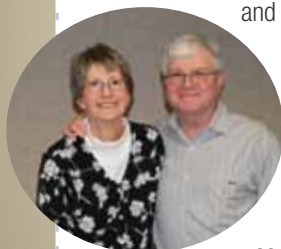


Congratulations to the Bureau scientists who were promoted in 2010! Xavier Janson was promoted to Research Scientist, and Seay Nance is now a Research Associate.



► So Long, Sharon

Sharon Bierschenk retired from the Bureau of Economic Geology on January 31 after 16 years of dedicated service to UT, 15 years at the Bureau, and 1 year at the office of the Vice President for Research. Sharon was hired by Lisa Orr, former IT supervisor, on January 16, 1989, as an Accounting



Clerk I. In December of the same year she was promoted to Computer Programmer/Services Assistant, followed by a promotion in 1993 to Information Specialist. Sharon's numerous duties included user training; maintaining manuals and fact sheets; technical support; maintaining, analyzing, and designing databases; designing menus and reports; managing the VAX cluster; system administration and LAN troubleshooting; purchase and installation of MAC software; chargeback distribution for MAC computers; quality assurance; and computer inventory. In February 1995 Sharon went off to pursue other personal interests, but she returned in 2000 as an Administrative Associate until she retired. This time she worked in the accounting section, mainly processing payment and credit card vouchers.

When questions would come up regarding payment options, Sharon was the go-to person. She was diligent about keeping up with appropriate UT procedures for processing all types of payments and would give her "Are you crazy?" look if asked an irrelevant question. Sharon seems to be enjoying her retirement. She's been gardening, spoiling her grandchildren, and traveling with husband Fred all over the country.

—Contributed by Wanda LaPlante,
former Executive Assistant to the Director

► Ciao, Wanda!

Wanda LaPlante—the friendly voice welcoming callers and visitors to the Bureau director's office for the last decade—retired from the Bureau at the end of April after 33 years of service.

The Bureau was a small but prolific organization housed on the fifth floor of the geology building when Wanda joined the administrative staff as a secretary in 1974. Correspondence was typed with carbon paper between sheets of stationery and blank pages to preserve a file copy. Spreadsheets were large ledger books meticulously recording debits and credits and manually balanced. Computers filled a whole room, and punchcards were fed into a slot to coax a program to run. Voicemail was a secretary reading a message aloud that was jotted on a pink notepad. Back then, Wanda's fingertips were flying at the keyboard of a typewriter or grasping a freshly sharpened pencil or picking up the phone to take a message for someone. Today the tools are different, and many cell phones are "near-computers" themselves. But then and now, the tools alone don't provide the warmth of a cheerful voice or the positive attitude that perseveres when the work piles up and the budget is lean. The technology evolves, and patches are created to bridge gaps. The valued traditions of professionalism, however, take a human touch. Wanda provided continuity of service and that unique brand of professionalism for more than 3 decades.

Wanda learned the administrative functions of the Bureau and quickly grew fluent in University policies and procedures. She emerged as a leader of the administrative staff, taking on more responsibility through the years and supervising a team of support personnel.

When Scott W. Tinker became the Bureau's eighth director in January 2000, he arrived with extensive practical and research experience, professional society ties, and buoyant enthusiasm. But he was new to the Bureau and the University of Texas and found Wanda's expertise the perfect complement to make the director's office run smoothly. It was in this last decade of her Bureau career that Wanda truly came into her own. A natural "people person," Wanda had a knack for meeting and remembering friends of the Bureau—inside and outside its walls, inside and outside Texas borders, and across the globe. She traveled to professional society meetings and deepened the Bureau's presence in the geological community. She became the go-to person for communication with the state geologist and the gold standard for what it means to be an exemplary University employee. Her contributions were recognized in 2008 with the Jackson School's Staff Excellence Award.

It's fitting that Wanda, after her 1/3-century of service, helped organize the Bureau's centennial celebration in 2009, for few could match the breadth of her knowledge of Bureau history or her personal friendships with Bureau alumni both near and far. Although



Wanda retired, you may still run into her at occasional venues important to the Bureau. Wanda regards her Bureau family the same way she regards her own family and friends: she will always be there for them. As Bureau Director Scott Tinker aptly summed up



Wanda's role: "We are fortunate that Wanda has agreed to help out with some of the upcoming large Bureau-hosted events, filling the role she perfected over the last 10 years—ambassador of Bureau hospitality and professionalism!"

—Contributed by Susie Doenges,
former Bureau Editor in Chief

► Bye-Bye, Bugs!

Ross (Bugs) Graham retired this year after 14 years with the Bureau. Bugs started his Bureau career pulling core out of storage racks and laying it out in the viewing room for patrons of the Core Research Center. For the next 13 years, Bugs did everything from the mail run to campus twice a day to schlepping heavy boxes of books to Media for checking, to doing whatever was called for by George Bush, Facilities Maintenance Manager. In his free time Bugs made rock kits for Publication Sales, which is how George came to dub him "Rockit Scientist." George says that Bugs (who lives in Wimberley) eventually drove 350,000+ miles to and from work, wearing out five different vehicles in the process because he always bought used vehicles with 100,000+ miles on the odometer. Bugs' staff page says that he had 2 years' study at St. Bernard's College in Alabama. It also says that he managed a Quick Lube automotive center for 6 years and was a trim and framing carpenter for 12 years in Cullman, Alabama. Bureau folks will remember Bugs as a joke teller, tale spinner, and friend with an unmistakable chortle. We'll miss hearing that laugh in the halls!

—Contributed by George Bush,
Facilities Maintenance Manager



► In Memoriam

The Bureau bid a final farewell to Scientist Jerry Mullican, who passed away in



Lubbock on April 29. Jerry had had a long and varied career before he came to the Bureau in October of 1995 as a Research Fellow in groundwater-resource

protection, State and Federal environmental laws and regulations governing oil and gas exploration and producer operations, and examination and investigation of cost-effective regulatory opportunities, approaches, and solutions. In 1963, Jerry received a B.S. from West Texas State University, and in 1975, he was awarded an M.S. by Texas Tech University. From Parks Superintendent in the Texas Parks and Wildlife Department at Palo Duro State Park and Chief of Geological Services for the Texas Water Quality Board to Director of Underground Injection Control for the Texas Railroad Commission to Assistant Division Director for Environmental Programs and Director of Field Operations at RRC, Jerry pretty much saw and did it all. In 1988, he received the Outstanding Service Award from RRC, and in 1995 he was recognized by the U.S. Environmental Protection Agency with the Regional Administrators Award for Outstanding Service. Director Scott Tinker said "Jerry was a very good man. He will be missed, and the Bureau mourns his loss."

► New Research Staff



Robert I. McNeill has signed on as a Research Chemist for AEC, and is based in Houston. His fortes are unconventional hydrocarbons, oil chemistry, drilling fluids and completions/simulations, petrophysics, and radiation chemistry. After receiving a B.S. in Chemistry at the New Mexico Institute of Mining and Technology and an M.S. in Physical Organic Chemistry at the University of Illinois, Robert went on to receive his Ph.D. in Physical Chemistry (Radiation Chemistry) at the University of Tennessee and Postdocs from

the Radiation Lab/Chemistry Department at Notre Dame and the Chemistry Department at Vanderbilt. Robert also holds patents for a lubricant for silicate drilling muds and a microfluidics device for measuring chemistry of drilling, completion, stimulation, and production fluids.



Research Associate Gregory Frébourg, who splits his time between STARR and the Mudrock Consortium, has expertise in carbonate and clastic sedimentology, from continental to abyssal realm; sedimentological processes in eolian and subaqueous environments; petrography and diagenesis; micropaleontology; and sequence stratigraphy. Gregory earned a License (B.S.) in Earth Sciences at the University of Geneva, Switzerland, where he later received an M.S. and Ph.D. in Sedimentology. Gregory later worked as an intern for TOTAL in Pau, France.



Seyyed A. Hosseini is a new Research Associate with GCCC, who counts upscaling and upgridding of geological models, reservoir fluid flow simulation, history matching, streamline simulation, and environmental and industrial applications of biotechnology among his interests. After receiving a B.S. in Chemical Engineering at the University of Isfahan, Iran, and an M.S. in Biotechnology at Sharif University of Technology in Tehran, Iran, Seyyed received his Ph.D. in Petroleum Engineering at the University of Tulsa.



Joseph El-Azzi is an RCRL Research Engineering Scientist Associate II, whose interests include integrated field mapping and remote sensing, along with carbonate depositional systems. Joseph received both his B.A. and M.S. in Geological Sciences at The University of Texas at Austin. He was a Research Assistant here at the Bureau 2007–2009, and was employed by Occidental Petroleum (Permian) as well.



Mohammad Moravvej Farshi is a new Research Scientist Associate working in the NanoGeosciences Lab, whose research inter-

ests include underground flow modeling, atomic force microscopy, optimization, CO₂ injection in fractured reservoirs, and energy economics. Having received a B.S. in both Petroleum and Electrical Engineering at Sharif University of Technology in Tehran, Iran, Mohammad went on to receive an M.S. in Petroleum Engineering at Stanford University, California.



Vanessa Nuñez is back, this time working as a Research Scientist Associate with the GCCC group. Vanessa graduated with honors in Petroleum Engineering at Universidad Central de Venezuela before receiving her M.S. in Petroleum Engineering, as well as her M.A. in Energy and Mineral Resources, at UT. Vanessa lists CO₂ EOR/sequestration, reservoir characterization and performance, resource evaluation, and risk analysis as her main research interests.



A new STARR Research Engineering/Scientist Associate from China, Xiaohu Tang received both his B.S. and M.S. in Materials Science from Beijing University of Aeronautics and Astronautics. He received his Ph.D. in Materials Science from The University of Tennessee at Knoxville. Xiaohu lists application of electron-microscopy-related techniques to materials characterization and analysis among his research interests.



Rongsheng Yang, new Research Fellow in the Mudrock Consortium, has B.S. and B.L. degrees in Geology and Management Science, respectively, from Lanzhou University, China; an M.S. degree in Geochemistry from the Chinese Academy of Sciences; and a Ph.D. in Mineralogy and Petrology from Peking University in Beijing. Rongsheng works in isotope geochemistry; gas composition; mineralogy, petrology, and mineral-deposit geology; fluid inclusion; scanning electron and optical microscopes; petroleum-resource assessment; and plate tectonics evolution of the Tethyan domain.

Postdoctoral Fellow Peter Flaig of the QCL Group received his B.S. and M.S. in



Geology from the University of Wisconsin—Milwaukee and his Ph.D. in Geology from The University of Alaska—Fairbanks. His research interests are fluvial sedimentology; paleoenvironmental reconstruction of continental, deltaic, shoreface, and shallow marine clastic systems; dinosaur-bearing clastic successions; sedimentology/stratigraphy across extinction events; high-latitude clastic depositional sequences; and high-resolution imaging of clastic systems.



Yun Huang, who joined Bridget Scanlon's Center for Sustainable Water Resources this year, is a Postdoctoral Fellow. Yun received a Ph.D. in Hydrologic Sciences from Texas A&M University in 2006. He worked as a hydrologist at LBG-Guyton Associates from 2006 through 2010. His research interests include ecohydrology—land use land cover change and the hydrologic cycle, hydrological modeling—numerical modeling of flow and contaminant transport in both saturated and unsaturated zones, and regional hydrology—groundwater—surface water interactions, extreme events, and stochastic structure of the hydrologic processes.



Postdoctoral Fellow S. Hesam Kazemeini, working with Sergey Fomel's group, Texas Consortium for Computational Seismology, is interested in seismic wavelet and spectral analysis for processing and interpretation, amplitude preserving seismic data processing, quantitative seismic interpretation using prestack and poststack attributes, and time-lapse and multicomponent seismic studies. Hesam has degrees in Geology, specializing in Groundwater Hydrology from Shiraz University, Iran (B.S.), and Geophysics, specializing in Exploration Seismology, from the Institute of Geophysics—Tehran University, Iran (M.S.), and specializing in Controlled Source Seismology from Uppsala University, Sweden (Ph.D.).



A Postdoctoral Fellow with STARR, Maryam Mousavi, hails from Iran, where she received B.S. and M.S. degrees in Geology and Petroleum Geology, respectively, from

Tehran University. She received her Ph.D. in Petroleum Engineering from The University of Texas at Austin. Maryam is interested in 3D stratigraphic modeling of reservoirs, carbonate reservoir characterization modeling, pore-scale modeling of sandstone (tight gas), petrophysical modeling of both carbonates and clastics, reservoir modeling using well logs, and petrography of sandstone.



Marisa Sheffer, new Postdoctoral Fellow in Bridget Scanlon's Center for Sustainable Water Resources has B.S., M.S., and Ph.D. degrees in Chemistry from The Hebrew University of Jerusalem, Israel. Her research interests include environmental chemistry, surface modification and analysis, development of analytical methods for geochemical purposes, and electrochemistry.



Marc-Olivier Titeux is a Postdoctoral Fellow with the RCRL Group, who includes modeling complex structures, the finite element method, and numerical analysis among his research interests. Marc-Olivier graduated with a B.Sc. in Flow Simulation, Mechanical Modeling, and Numerical Analysis, as well as an M.Sc. in Mechanical Behavior Laws, Acoustic Simulation, and Experimentation, from the University of Bordeaux, France, and a Ph.D. in Geosciences, Modeling, and Structural Geology from the Institut National Polytechnique de Lorraine, Nancy, France.



The Bureau's FRAC research group has added Postdoctoral Fellow Tobias Weisenberger to its roster. Tobias holds Ph.D. and M.Sc. degrees from Albert-Ludwigs University, Freiburg, Germany. Among his interests, Tobias includes low-temperature geochemistry and petrology, water-rock interaction, zeolite geochemistry and mineralogy, and aqueous geochemistry.



Khandaker Zahid is a new Postdoctoral Fellow in the GCCC group. Khandaker received a B.S. in Geophysics from the University of Dhaka in Bangladesh, an M.S. in Geology from Auburn University in Alabama, and a Ph.D. in Geosciences from the University

of South Carolina in Columbia. His research interests include sediment provenance via mineralogy and geochemistry, clastic reservoir characterization using logs and composition data, and stratigraphy and basin analysis.

► New Support Staff



Tessa Green is the new Projects Director in the Geofluids Consortium. Tessa has over 10 years' experience as a project manager in various fields, including

education, event management, television/film, and theatre. She has extensive experience planning, marketing, and executing large-scale live events, as well as a wealth of experience in client management, academic administration, and policy development. After moving to Austin, Tessa started working in education and has enjoyed working at The University of Texas at Austin. She is now responsible for project management and marketing activities of the UT GeoFluids Consortium. She works to develop and implement standards in attaining consortium goals and objectives. Tessa is responsible for client relationships, website development, running logistics of the annual UT GeoFluids meeting, and overseeing financial management of the consortium.



Emily Hooks is the Director's new Executive Assistant, after Wanda LaPlante retired this year. An expert in contracts and grants, budgets, and accounting, Emily earned a

Bachelor of Science degree in Geosciences from Tarleton State University in Stephenville, Texas. She began working in administration shortly after graduation and has continued on that path. Emily has been with The University of Texas at Austin for 6 years, working as a research administrator for sponsored projects within the College of Natural Sciences before coming to the Bureau.



Lisa Nault has signed on as Accounting Associate in charge of accounts payable. Lisa comes to the Bureau by way of the UT Office of

Accounting, having 19 years of professional accounting and administration experience with the State, as well as corporate and small business sectors. Originally from

Kansas City, Lisa has been in Austin since 1995. She and her husband own a residential remodeling and restoration business.



Jeremy Ortuño, son of Daniel Ortuño (Bureau guru of the Log Library), began at the Bureau as a UTemp in 2009, but he became a full-

fledged Bureau employee as a Lab Research Assistant II this year. He splits his time between the Bureau main building and the Core Research Center.

Jeremy's higher education is currently on

hold, although eventually he will return to school to pursue a career in geology.



Kyleen Piejko, a new accounting technician working in Beth Ellison's group, has a B.B.A. in Business from UT. Earlier in her career, Kyleen was

an internal auditor for the Harris County Auditor's Office in Houston, an internal auditor for the Travis County Auditor's Office in Austin, and an auditor for the Texas State Auditor's Office in Austin.

Bureau Publications

The Bureau produced four new publications in 2010. A Report of Investigations,

Sequence Stratigraphy, Depositional Facies, and Reservoir Attributes of the Upper Cretaceous Woodbine Group, East Texas Field, edited by Tucker F. Hentz, with contributions by William Ambrose, Florence Bonnaffé, Tucker F. Hentz, Robert Loucks, and Fred Wang. Perfect bound, 114 pages. *RI0274*, \$40.



Comprehensive results of the STARR-funded project on the Woodbine Group reservoirs of East Texas field have been published in the most

recent Report of Investigations, a collection of four separate articles. The collective objective of the four papers is to detail primary attributes and controls on the field's reservoir framework—chronostratigraphy, depositional facies, and character and quality of Woodbine reservoir sandstones—and their influence on fluid flow, incompletely swept reservoir zones, potential bypassed pay, and deeper pay zones. East Texas field, discovered in 1930, has been the most productive oil field in the U.S. Lower 48 states and the second-most-productive field in the country. The report, therefore, presents not only a

modern approach to characterizing the geology of the still-productive field, but also considers development of the field from a historical perspective.

Two Miscellaneous Maps,

Geologic Map of Mariscal Mountain, Big Bend National Park, by Patricia W. Dickerson, William R. Muehlberger, and Edward W. Collins, scale 1:24,000, 36½ × 37¾ inches. *MM0048*, \$12.

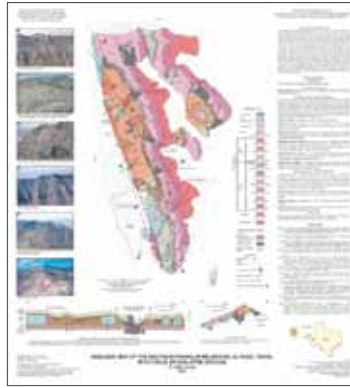
Portrayed on this geologic map (scale 1:24,000), as well as in four cross sections and selected field photos, are the results of at least eight tectonic and magmatic events. Principal observations: (1) Post-K rhyolite and basalt are thrust faulted in the nose of the Mariscal anticline. (2) A range-parallel thrust fault in



central Mariscal Canyon is cut by north- and west-striking normal faults. (3) A major left-lateral strike-slip fault and probable flower structure are exposed in the east-central Canyon. (4) Previously unmapped rhyolite ignimbrite and Del Carmen Formation (oldest Cretaceous rocks in the park) are now documented. (5) Solution-collapse features are common in folded, faulted, and fractured Lower Cretaceous carbonate rocks—Boquillas Formation and rhyolite sills have foundered into one approximately 0.3-km sinkhole on the eastern mountain flank. This is the first geologic map of the area to be constructed on a topographic base.

Geologic Map of Southern Franklin Mountains, El Paso, Texas, with Focus on Collapse Breccia, by F. Jerry Lucia, scale 1:24,000, 19½ × 21¼ inches. *MM0049*, \$12.

Portrayed on this geologic map, as well as in two cross sections and selected field photos, are the stratigraphy and structure of the Southern Franklin Mountains and locations of major



collapse breccias. One of the principal geologic features found in the Southern Franklin Mountains is collapse breccias. The breccias range in size from tens of feet to major collapses that have vertical and lateral dimensions of over 1,000 ft. The largest breccias are found in the Lower Ordovician El Paso Group and extend through the overlying Upper Ordovician Montoya Group. Field evidence shows that these are not fault breccias but instead were formed by collapse into a major cave system. The timing of the cave system is arguable but has been postulated to be Lower to Middle Ordovician with cave collapse extending through Silurian time.

The collapse breccias and surrounding limestones are selectively dolomitized.

And one page-size map,

Ecoregions of Texas Map, page-sized color map and text, scale: 1 inch = 100 miles, *SM0013*, \$.25.



Newest in the Bureau's popular series of page-sized maps, the *Ecoregions of Texas Map* (2010) depicts areas of Texas that are similar in their environment

and natural resources. Data depicted in color on this map were condensed from a poster issued by the U.S. Environmental Protection Agency (EPA) as part of a nationwide ecoregions research project designed to facilitate resource management and planning by Federal, State, and nongovernmental agencies. A poster-sized version of this map (SM0013P) is also available for \$6.50 from the Bureau, or it may be downloaded from the EPA's website. A 15-percent discount is available on orders of 100 or more copies.

Peer-Reviewed Publications by Bureau Researchers

► Articles in Peer-Reviewed International Journals

Acharya, K., Schulman, C., and Young, M. H., 2010, Physiological response of *Daphnia magna* to linear anionic polyacrylamide: ecological implications for receiving waters: Water, Air, Soil, & Pollution, v. 212, no. 1–4, p. 309–317.

Alkhalifah, T., and Fomel, S. B., 2010, An eikonal-based formulation for traveltimes perturbation with respect to the source location: Geophysics, v. 75, no. 6, p. T175–T183.

Baghzouz, M., Devitt, D. A., Fenstermaker, L. F., and Young, M. H., 2010, Monitoring vegetation phenological cycles in two different semi-arid environmental settings using a ground-based NDVI system: a potential approach to improve satellite data interpretation: Remote Sensing, v. 2, no. 4, p. 990–1013, doi:10.3390/rs2040990.

Barbeau, D. L., Davis, J., Murray, K. E., Valencia, V., Gehrels, G., Zahid, K. M., and Gombosi, D. J., 2010, Detrital-zircon geochronology of the metasedimentary rocks of north-western Graham Land: Antarctic Science, v. 22, p. 65–78.

Barker, D. S., and Reed, R. M., 2010, Proterozoic granites of the Llano Uplift, Texas: a collision-related suite containing rapakivi and topaz granites: Geological Society of America Bulletin, v. 122, no. 1/2, p. 253–264.

Becker, S. P., Eichhubl, P., Laubach, S. E., Reed, R. M., Lander, R. H., and Bodnar, R. J., 2010, A 48 m.y. history of fracture opening, temperature, and fluid pressure: Cretaceous Travis Peak Formation, East Texas Basin: Geological Society of America Bulletin, v. 122, no. 7/8, p. 1081–1093, doi: 10.1130/B30067.1.

Burton, D., and Wood, L. J., 2010, Seismic geomorphology and tectonostratigraphic fill of half grabens, West Natuna Basin, Indonesia: AAPG

Bulletin, v. 94, no. 11, p. 1695–1712, DOI: 10.1306/06301010003.

Chen, J. L., Wilson, C. R., Tapley, B. D., Longuevergne, L., Yang, Z. L., and Scanlon, B. R., 2010, Recent La Plata basin drought conditions observed by satellite gravimetry: Journal of Geophysical Research, v. 115, D22108, doi:10.1029/2010JD014689, 12 p.

Day-Stirrat, R. J., Dutton, S. P., Milliken, K. L., Loucks, R. G., Aplin, A. C., Hillier, S., and van der Pluijm, B. E., 2010, Fabric anisotropy induced by primary depositional variations in the silt: clay ratio in two fine-grained slope fan complexes: Texas Gulf Coast and northern North Sea: Sedimentary Geology, v. 226, p. 42–53.

DeAngelo, M. V., Sava, D. C., Hardage, B. A., and Murray, P. E., 2010, Integrated 2D 4-C OBC analysis for estimating hydrate concentrations, Green Canyon, Gulf of Mexico: Journal of Seismic Exploration, v. 19, p. 263–278.



- Dunlap, D. B., Wood, L. J., Weisenburger, C., and Jabour, H., 2010, Seismic geomorphology of offshore Morocco's east margin, Safi Haut Mer area: *AAPG Bulletin*, v. 94, no. 5, p. 615–642.
- Dutton, S. P., and Loucks, R. G., 2010, Diagenetic controls on evolution of porosity and permeability in lower Tertiary Wilcox sandstones from shallow to ultradeep (200–6700 m) burial, Gulf of Mexico Basin, U.S.A.: *Marine and Petroleum Geology*, v. 27, p. 69–81. *Reprinted in Marine and Petroleum Geology*, v. 27, no. 8, p. 1775–1787.
- Eichhubl, P., Hooker, J. N., and Laubach, S. E., 2010, Pure and shear-enhanced compaction bands in Aztec Sandstone: *Journal of Structural Geology*, v. 32, p. 1873–1886.
- Fiorillo, A. R., McCarthy, P. J., and Flaig, P. P., 2010, Taphonomic and sedimentologic interpretations of the dinosaur-bearing Upper Cretaceous strata of the Prince Creek Formation, northern Alaska: insights from an ancient high-latitude terrestrial ecosystem: *Palaeogeography, Palaeoclimatology, Palaeoecology*, v. 295, p. 376–388.
- Fomel, S. B., 2010, Predictive painting of 3D seismic volumes: *Geophysics* v. 75, no. 4, p. A25–A30.
- Fomel, S. B., and Liu, Y., 2010, Seislet transform and seislet frame: *Geophysics*, v. 57, p. V25–V38.
- Fomel, S. B., and Stovas, A. M., 2010, Generalized nonhyperbolic moveout approximation: *Geophysics*, v. 75, no. 2, p. U9–U18.
- Frébourg, G., Hasler, C.-A., and Davaud, E., 2010, Catastrophic event recorded among Holocene eolianites (Sidi Salem Formation, SE Tunisia): *Sedimentary Geology*, v. 224, p. 38–48.
- Frébourg, G., Davaud, E., and Virgone, A., 2010, Discovery of an eolianite in the Upper Dalan Member, South Pars field, Iran: *Journal of Petroleum Geology*, v. 33, p. 141–154.
- Gale, Julia F. W., Lander, R., Reed, R. M., and Laubach, S. E., 2010, Modeling fracture porosity evolution in dolostone: *Journal of Structural Geology*, v. 32, p. 1201–1211. doi:10.1016/j.jsg.2009.04.018.
- Hosseini, S. A., Kang, S., and Datta-Gupta, A., 2010, Qualitative well placement and drainage volume calculations based on diffusive time of flight: *Journal of Petroleum Science and Engineering*, v. 75, p. 178–188.
- Hosseini, S. A., and Kelkar, M., 2010, Analytical upgridding method to preserve dynamic flow behavior: *SPE Reservoir Evaluation & Engineering*, v. 13, no. 3, p. 473–484. doi: 10.2118/116113-PA.
- Houser, C., and Mathew, S., 2010, Alongshore variation in foredune height in response to transport potential sediment supply: South Padre Island, Texas: *Geomorphology*, v. 125, p. 62–72.
- Huuse, M., Jackson, C. A.-L., Van Rensbergen, P., Davies, R. J., Flemings, P. B., and Dixon, R. J., 2010, Subsurface sediment remobilization and fluid flow in sedimentary basins: an overview: *Basin Research*, v. 22, p. 342–360. doi:10.1111/j.1365-2117.2010488.x.
- Kazemine, S. H., Juhlin, C., and Fomel, S. B., 2010, Monitoring CO₂ response on surface seismic data; a rock physics and seismic modeling feasibility study at the CO₂ sequestration site, Ketzin, Germany: *Journal of Applied Geophysics*, v. 71, p. 109–124.
- Kazemine, S. H., Yang, C., Juhlin, C., Fomel, S. B., and Cosma, C., 2010, Enhancing seismic data using the prestack blueing technique: an example from the Ketzin CO₂ injection site, Germany: *Geophysics*, v. 75, no. 6, p. V101–V110.
- Laubach, S. E., Eichhubl, P., Hilgers, C., and Lander, R. H., 2010, Structural diagenesis: *Journal of Structural Geology*, v. 32, p. 1866–1872.
- Lin, W., Doan, M.-L., Moore, C., McNeill, L., Byrne, T. B., Ito, T., Saffer, D. M., Conin, M., Kinoshita, M., Sanada, Y., Moe, K. T., Araki, E., Tobin, H., Boutt, D., Kano, Y., Hayman, N. W., Flemings, P. B., Huftile, G. J., Cukur, D., Buret, C., Schleicher, A. M., Efimenko, N., Kawabata, K., Buchs, D. M., Jiang, S., Kameo, K., Horiguchi, K., Wiersberg, T., Kopf, A., Kitada, K., Eguchi, N., Toczko, S., Takahashi, K., and Kido, Y., 2010, Present-day principal horizontal stress orientations in the Kumano forearc basin of the southwest Japan subduction zone determined from IODP NanTroSEIZE drilling Site C0009: *Geophysical Research Letters*, v. 37, L13303, doi:10.1029/2010GL043158, 6 p.
- Liu, Y., and Fomel, S. B., 2010, OC-seislet: seislet transform construction with differential offset continuation: *Geophysics*, v. 75, no. 6, p. WB235–WB245.
- Longuevergne, L., Scanlon, B. R., and Wilson, C. R., 2010, GRACE hydrological estimates for small basins: evaluating processing approaches on the High Plains aquifer, USA: *Water Resources Research*, v. 46, W11517, doi:10.29/2009WR008564, 15 p.
- Lu, J., Partin, J. W., Hovorka, S. D., and Wong, C., 2010, Potential risks to freshwater resources as a result of leakage from CO₂ geological storage: a batch-reaction experiment: *Environmental Earth Sciences*, v. 60, no. 2, p. 335–348. DOI: 10.1007/s12665-009-0382-0.
- Luo, G. and Liu, M., 2010, Stress evolution and fault interactions before and after the 2008 great Wenchuan earthquake: *Tectonophysics*, v. 491, p. 127–140, doi:10.1016/j.tecto.2009.12.019.
- Makowitz, A., Lander, R. H., and Milliken, K. L., 2010, Chemical diagenetic constraints on the timing of cataclasis in deformed sandstone along the Pine Mountain overthrust, eastern Kentucky: *Journal of Structural Geology*, v. 32, p. 1923.
- Mathew, S., Davidson-Arnott, R. G. D., and Ollerhead, J., 2010, Evolution of a beach-dune system following a catastrophic storm overwash event: Greenwich Dunes, Prince Edward Island, 1936–2005: *Canadian Journal of Earth Science*, v. 47, no. 3, p. 273–290.
- McDonnell, Angela, Jackson, M. P. A., and Hudc, M. R., 2010, Origin of transverse folds in an extensional growth-fault setting: evidence from an extensive seismic volume in the western Gulf of Mexico: *Marine and Petroleum Geology*, v. 27, p. 1494–1507.
- Milliken, K. L., and Reed, R. M., 2010, Multiple causes of diagenetic fabric anisotropy in weakly consolidated mud, Nankai accretionary prism, IODP Expedition 316: *Journal of Structural Geology*, v. 32, p. 1887–1898.
- Ng, G. C., McLaughlin, D., Entekhabi, D., and Scanlon, B. R., 2010, Probabilistic analysis of the effects of climate change on groundwater recharge: *Water Resources Research*, v. 46, W07502, doi:10.1029/2009WR007904.
- Ogiesoba, O. C., 2010, Porosity prediction from seismic attributes of the Ordovician Trenton–Black River groups, Rochester field, southern Ontario: *AAPG Bulletin*, v. 94, no. 11, p. 1673–1693.
- Ortega, O. J., Gale, J. F. W., and Marrett, R. A., 2010, Quantifying diagenetic and stratigraphic controls on fracture intensity in platform carbonates: *Journal of Structural Geology*, v. 32, p. 1943–1959.
- Paine, J. G., and Collins, E. W., 2010, Characterizing oil field salinization using airborne, surface, and borehole geophysics: an example from the upper Colorado River Basin, Texas: *Environmental Geosciences*, v. 17, no. 4, p. 193–207.
- Reilly, M. J., and Flemings, P. B., 2010, Deep pore pressures and seafloor venting in the Auger Basin, Gulf of Mexico: *Basin Research*, v. 22, p. 380–397.
- Salazar, M., Moscardelli, L., Fisher, W. L., and Lorente, M. A., 2010, Tectonostratigraphic evolution of the Morichito piggyback basin, Eastern Venezuelan Basin: *Marine and Petroleum Geology*, v. 28, p. 109–125, doi:10.1016/j.marpetgeo.2009.07.0004.
- Sava, D., and Hardage, B. A., 2010, Evaluating marine gas-hydrate systems. Part I: Stochastic rock-physics models for electrical resistivity and seismic velocities of hydrate-bearing sediments: *Journal of Seismic Exploration*, v. 19, no. 4, p. 371–386.
- Scanlon, B. R., Gates, John, Reedy, R. C., Jackson, W. A., and Bordovsky, J. P., 2010, Effects of irrigated agroecosystems: 2. Quality of soil water and groundwater in the southern High Plains, Texas: *Water Resources Research*, v. 46, W09538, doi:10.1029/2009WR008428.
- Scanlon, B. R., Mukherjee, A., Gates, J., Reedy, R. C., and Sinha, A. K., 2010, Groundwater recharge in natural dune systems and agricultural ecosystems in the Thar Desert Region, Rajasthan, India: *Hydrogeology Journal*, v. 18, no. 1, p. 959–972. DOI 10.1007/s10040-009-0555-7.
- Scanlon, B. R., Reedy, R. C., and Gates, J. B., 2010, Effects of irrigated agroecosystems: 1. Quantity of soil water and groundwater in the southern High Plains, Texas: *Water Resources Research*, v. 46, W09537, doi:10.1029/2009WR008427.
- Scanlon, B. R., Reedy, R. C., Gates, J. B., Gowda, P. H., and Marek, T. H., 2010, Impact of agroecosystems on groundwater resources in the central High Plains, USA: *Agriculture, Ecosystems, & Environment*, v. 139, p. 700–713.
- Shabro, V., Javadpour, F., and Verdin, C. T., 2010, A generalized finite difference diffusive-advective (FDDA) model for gas flow in micro- and nano-porous media:

World Journal of Engineering,
v. 6, no. 3, p. 7–15.

Weisenberger, T., and Bucher, K., 2010, Zeolites in fissures of granites and gneisses of the Central Alps: *Journal of Metamorphic Geology*, v. 28, p. 825–847.

Wilcox, B., and Huang, Y., 2010, Woody plant encroachment paradox: Rivers rebound as degraded grasslands convert to woodlands: *Geophysical Research Letters*, v. 37, L07402, doi:10.1029/2009GL041929

Wu, J. E., McClay, K. R., Whitehouse, P., and Dooley, T., 2009, 4D analogue modelling of transtensional pull-apart basins: *Marine and Petroleum Geology*, v. 26, p. 1608–1623.

Young, M., Robinson, David, and Ryel, R. J., 2010, Introduction to coupling soil science and hydrology with ecology: toward integrating landscape processes: *Vadose Zone Journal*, v. 9, p. 515–516.

Zahid, K. M., and Barbeau, D. L., 2010, Provenance of eastern Magallanes foreland basin sediments: heavy mineral analysis reveals Paleogene tectonic unroofing of the Fuegian Andes hinterland: *Sedimentary Geology*, v. 229, p. 64–74.

Zahm, C., Zahm, L., and Bellian, J. A., 2010, Integrated fracture prediction using sequence stratigraphy within a carbonate fault damage zone, Texas, USA, *Journal of Structural Geology*, v. 32, p. 1363–1374. doi:10.1016/j.jsg.2009.05.012.

Zeng, H., 2010, Geologic significance of anomalous instantaneous frequency: *Geophysics*, v. 75, no. 3, p. P23–P30.

► Other Peer-Reviewed Publications

Ambrose, W. A., and Hentz, T. F., 2010, Depositional systems and facies variability in highstand fluvial-dominated deltaic and lowstand valley-fill systems in the Lower Cretaceous (Cenomanian) Woodbine Group, East Texas field, in Hentz, T. F., ed., *Sequence stratigraphy, depositional facies, and reservoir attributes of the Upper Cretaceous Woodbine Group, East Texas field: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 274*, p. 17–81.

Bergman, K. L., Whetsthal, H., Janson, X., Poiriez, A., and Eberli, G. P., 2010, Chapter 2. Controlling parameters on facies geometries of the Bahamas, an isolated carbonate platform environment, in Whetsthal, H., Eberli, G. P., and Reigl, B., eds., *Factors controlling modern carbonate deposition*: Springer-Verlag, ISBN:978-90-481-9363-9, p. 5–80.

Day-Stirrat, R. J., McDonnell, A., and Wood, L. J., 2010, Diagenetic and seismic concerns associated with interpretation of deeply buried 'mobile shales,' in Wood, L., ed., *Shale tectonics*: AAPG Memoir 93, p. 5–27.

Gale, J. F. W., and Holder, J., 2010, Natural fractures in some U.S. shales and their

importance for gas production: *The Geological Society, London, Petroleum Geology Conference Series*, v. 7, p. 1131–1140. doi: 10.1144/0070899

Gómez-Cabrera, P. T., and Jackson, M. P. A., 2009, Chapter 1. Regional Neogene salt tectonics in the offshore Salina del Istmo Basin, southeastern Mexico, in Bartolini, C., and Román Ramos, J. R., eds., *Petroleum systems in the southern Gulf of Mexico*: AAPG Memoir 90, p. 1–28.

Gómez-Cabrera, P. T., and Jackson, M. P. A., 2009, Chapter 11. Neogene stratigraphy and salt tectonics of the Santa Ana area, offshore Salina del Istmo Basin, southeastern Mexico, in Bartolini, C., and Román Ramos, J. R., eds., *Petroleum systems in the southern Gulf of Mexico*: AAPG Memoir 90, p. 237–255.

Hardage, B. A., 2010, Elastic wavefield seismic stratigraphy and reservoir characterization, in Chapter 6. The road ahead, in Johnston, D. H., ed., *Methods and applications in reservoir geophysics*: Society of Exploration Geophysicists, *Investigations in Geophysics Series No. 15*, 513–530.

Hentz, T. F., and Bonnaffe, Florence, 2010, Sequence stratigraphy of the Upper Cretaceous (Cenomanian) Woodbine Group: chronostratigraphic integration of the East Texas Basin and East Texas field, in Hentz, T. F., ed., *Sequence stratigraphy, depositional facies, and reservoir attributes of the Upper Cretaceous Woodbine Group, East Texas field: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 274*, p. 1–16.

Jackson, M. P. A., Hudec, M. R., and Dooley, T. P., 2010, Some emerging concepts in salt tectonics in the deepwater Gulf of Mexico: intrusive plumes, canopy-margin thrusts, minibasin triggers and allochthonous fragments: *The Geological Society, London, Petroleum Geology Conference Series*, v. 7, p. 899–912. doi: 10.1144/0070899

Janson, X., Van Buchem, F., Dromart, G., Eichenseer, H. T., Boichard, R., Dellamonica, X., Bonnaffe, F., and Eberli, G., 2010, Architecture and facies differentiation within a middle Miocene platform, Ermenek, Mut Basin, southern Turkey, in Van Buchem, F. S. P., Gerdes, K., and Esteban, M., eds., *Mesozoic and Cenozoic carbonate systems of the Mediterranean and the Middle East: stratigraphic and diagenetic reference models*: Geological Society, London, *Special Publications*, 329, p. 265–290.

Loucks, R. G., 2010, Petrographic controls on reservoir quality of the Upper Cretaceous Woodbine Group, East Texas field, in Hentz, T. F., ed., *Sequence stratigraphy, depositional facies, and reservoir attributes of the Upper Cretaceous Woodbine Group, East Texas field: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 274*, p. 83–93.

McNeill, D. F., Janson, X., Bergman, K. L., and Eberli, G., 2010, Chapter 3. Belize: a modern example of a mixed carbonate-siliciclastic shelf, in Whetsthal, H., Eberli, G. P., and Reigl, B., eds., *Factors controlling modern carbonate deposition*: Springer-Verlag, ISBN: 978-90-481-9363-9, p. 81–144.

Meckel, T., 2010, Chapter 7. Capillary seals for trapping carbon dioxide (CO₂) in underground reservoirs, in Maroto-Valer, M. M. (ed.),

Developments and innovation in carbon dioxide (CO₂) capture and storage technology: Woodhead Publishing Series in Energy: Number 16, Volume 2: Carbon dioxide (CO₂) storage and utilisation, p. 185–202.

Mosccardelli, L., Hornbach, M., and Wood, L. J., 2010, Tsunamigenic risk associated with mass transport complexes in offshore Trinidad and Venezuela, in Mosher, D. C., Shipp, R. C., Moscardelli, L., Chaytor, J. D., Baxter, C. D. P., Lee, H. J., and Urgeles, R., eds., *Submarine mass movements and their consequences: 4th International Symposium*: Springer, v. 28, p. 733–744.

Mosher, D. C., Moscardelli, L., Shipp, C., Chaytor, J. D., Baxter, C. D. P., Lee, H. J., and Urgeles, R., 2010, Submarine mass movements and their consequences, in Mosher, D. C., Shipp, R. C., Moscardelli, L., Chaytor, J. D., Baxter, C. D. P., Lee, H. J. and Urgeles, R., eds., *Submarine mass movements and their consequences: 4th International Symposium*: Springer, v. 28, p. 1–8.

Nicot, J. -P., and Hovorka, S. D., 2009, Chapter 17. Leakage pathways from potential CO₂ storage sites and importance of open traps: case of the Texas Gulf Coast, in Grobe, M., Pashin, J. C., and Dodge, R. L., eds., *Carbon dioxide sequestration in geological media—state of the science*: AAPG Studies in Geology, 59, p. 321–334.

Oldenburg, C. M., Bryant, S. L., Nicot, J. -P., Kumar, N., Zhang, Y., Jordan, P. D., Pan, L., Granvold, P., and Chow, F. K., 2009, Chapter 21. Model components of the certification framework for geologic carbon sequestration risk assessment, in Eide, L. I., ed., *Carbon dioxide capture for storage in deep geologic formations—results from the CO₂ capture project, volume 3: Advances in CO₂ capture and storage technology results (2004–2009)*: UK, cplpress, p. 289–316.

Riegl, B., Poiriez, A., Janson, X., and Bergman, K. L., 2010, Chapter 4. The Gulf: facies belts, physical, chemical, and biological parameters of sedimentation on a carbonate ramp, in Whetsthal, H., Eberli, G. P., and Reigl, B., eds., *Factors controlling modern carbonate deposition*: Springer-Verlag, ISBN: 978-90-481-9363-9, p. 145–215.

Scanlon, B. R., 2010, Chapter 7. Chemical tracer methods, in Healy, R. W., *Estimating groundwater recharge*: Cambridge University Press, p. 136–165.

Volkov, Dmitry, Gülen, Gürçan, and Foss, Michelle Michot, 2010, Section III: changing the rules for the EU natural gas markets—from state to market and plan to contract, Chapter 1: The new EU energy policy and implications for former Soviet Union natural gas suppliers, in EU Russia energy relations, legal and political issues: Oil, Gas, & Energy Law, www.euroconfidential.org, 205–244.

Wang, F. P., 2010, Engineering characterization of East Texas oil field: north and south pilot studies, in Hentz, T. F., ed., *Sequence stratigraphy, depositional facies, and reservoir attributes of the Upper Cretaceous Woodbine Group, East Texas field: The University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 274*, p. 95–114.

Wood, L. J., 2010, Shale tectonics: a preface, in Wood, L. J., ed., *Shale tectonics*: AAPG Memoir 93, p. 1–4.

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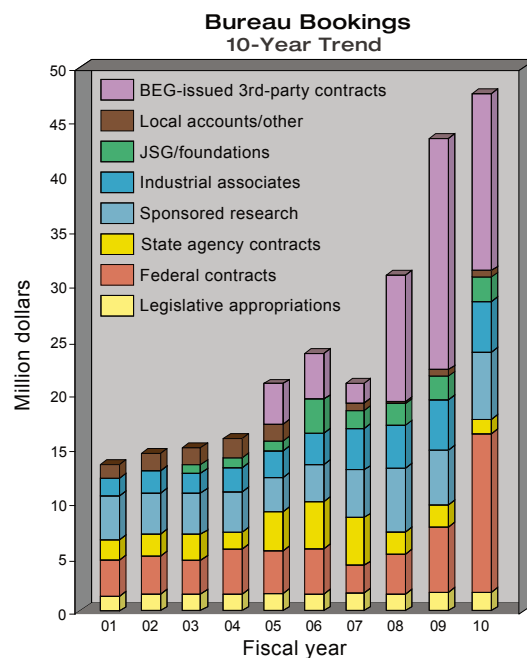
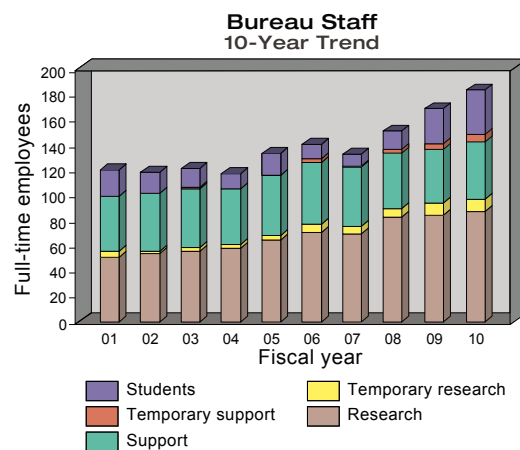
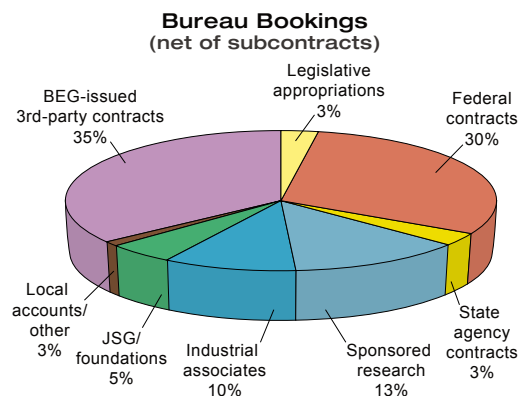
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