FOREWORD

The Bureau of Economic Geology, established in 1909 as the successor to the Texas Geological Survey and the Texas Mineral Survey, is a research unit of The University of Texas at Austin. It also functions as the State Geological Survey, the Bureau Director representing Texas in the Association of American State Geologists.

Extensive advisory, technical, and informational services relating to the resources and geology of Texas are provided by the Bureau. In addition, the Bureau conducts basic and applied research projects in energy resources, mineral resources and statistics, coastal and environmental studies, land resources, geologic mapping, and a variety of other research programs in areas such as hydrogeology, basin analysis, and geochemistry. Some projects are conducted jointly with other units of the University, as well as with industry and with State, Federal, and local agencies.

The Bureau provides ongoing services to governmental agencies, including reviews of (1) environmental impact statements that are submitted to the Office of the Governor of Texas and (2) permit applications that are submitted to the Surface Mining and Reclamation Division of the Railroad Commission of Texas.

Major reports of the Bureau are published in The University of Texas Publication series; its own series include Reports of Investigations, Geologic Quadrangle Maps, Geologic Atlas Sheets, Environmental Geologic Atlases, Guidebooks, Handbooks, Geological Circulars, Mineral Resource Circulars, and other publications. Publications are sold for a nominal price to recover printing costs. A complete list of publications is available on request.

The Comprehensive Report of the Bureau of Economic Geology outlines the scope and status of current research projects, publications, personnel activities, and services in the area of Texas resources and geology that are available to governmental agencies, industry, and the public.

ON THE WEB

A wealth of information regarding the Bureau of Economic Geology can be found at our Website, http://www.beg.utexas.edu. Here you can learn about every aspect of the Bureau’s mission, its research, public services, and staff. Download what you need.

When you visit our Website, you can check upcoming events, read about recent research awards and honors, learn about the Bureau’s large collection of rock cores and well cuttings, and contact any Bureau researcher or staff member by using his or her office e-mail address or telephone or fax number. You can review titles and authors of past and present Bureau publications—and then place an order.

Teachers and students can view earth science projects, print directions and then follow them in a Do-It-Yourself Aquifer Demonstration, determine whether Dirt Is Just Dirt, or study the Texas Rock Cycle. The Bureau’s Website also contains links to State, Federal, and industry organizations, as well as geologic and earth science resources. Visit us at www.beg.utexas.edu.
The Comprehensive Report is a record of Bureau research projects and professional activities of Bureau staff during the calendar year. Additional information about Bureau research and researchers, news items, funding, and awards can be found in the Bureau's Annual Report and Midyear Report. The List of Publications contains titles of all Bureau publications, brief descriptions of new publications, and information regarding placing orders. These reports are available on request.
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**RESEARCH AT THE BUREAU**

**ENERGY**

**BASIC ENERGY RESEARCH**

Applied Geodynamics Laboratory (AGL)

Martin P. A. Jackson and Michael R. Hudec, co-principal investigators; Bruno C. Vendeville and Timothy P. Dooley, laboratory managers; Daniel D. Schultz-Ela and David C. Jennette; assisted by Xuejiao Liu and Nanda Sukhavasi

AGL research on salt tectonics during 2003 included further work on new modules of a digital atlas, fundamental geologic research on another large 3-D seismic volume, and ongoing tectonic modeling.

*The Salt Mine*, a browser-based, interactive atlas of salt tectonics, features a comprehensive collection of salt structure images and the best models produced during the lab’s 16-year history. Five new atlas modules are under construction for the topic of allochthonous salt tectonics. The atlas is available only to AGL sponsors at present. Four new animations illustrating fundamental interactions of salt tectonics and sedimentation were also produced.

Integrated structural-stratigraphic research was carried out on prestack, depth-migrated, 3-D seismic data from the deep-water Gulf of Mexico. AGL researchers investigated (1) mechanisms of advance for a salt canopy along the abyssal Sigsbee Scarp and (2) origin and evolution of minibasins above the salt canopy. In addition, researchers worked on salt tectonics in the Zechstein Basin (Germany), Kwanza Basin (Angola), the Pyrenees, and associated orogenic belts.

Modeling research continued into salt tectonics associated with hydrocarbon traps. Numerical modeling focused on mechanical parameters affecting salt-sheet advance, folding of evaporite-clastic interlayers, and formation of diapir flanges. Using computer-controlled deformation rigs, overhead photographs, serial sections, and time-lapse videos, physical modeling focused on colliding minibasins and synsedimentary thrusting.

**Gulf Coast Carbon Center (GCCC)**

Susan D. Hovorka, principal investigator; Eugene M. Kim, Mark H. Holtz, Paul R. Knox, and Joseph S. Yeh

Burning fossil fuel (gas, oil, and coal) has measurably increased the total load of carbon dioxide in the atmosphere. Although the long-term consequences of these changes are hotly debated, one likely outcome is the alteration of global climate as greenhouse gases trap heat at the Earth’s surface. One possible response is to capture gasses after combustion and reinject them into subsurface settings where they will be retained for geological periods of time.

The Gulf Coast Carbon Center (GCCC) seeks to apply its technical and educational resources to implement geologic storage of anthropogenic carbon dioxide on an aggressive time scale, focusing on a region where large-scale reduction of atmospheric releases is needed and short-term action is possible.

Deep-Marine Depositional Margins

Industrial Alliance (DM2)

Lesli J. Wood and Paul Mann (The University of Texas at Austin, Institute for Geophysics [UTIG]), co-principal investigators

Deep-marine margin frontiers are some of the highest-potential, most active hydrocarbon exploration and production provinces in the world. They are, however, also some of the most complex, dangerous, and least understood regions in today’s oceans. For several years, our researchers have been engaged in the study of these regions throughout northern South America and the Gulf of Mexico through the use of comprehensive, megaseismic surveys (several thousands of kilometers of contiguous data coverage) integrated with selective core- and log-data analyses. These data allow quantitative seismic geomorphologic analyses of the myriad deposits making up basin fills in these settings, as well as study of the effect that subseafloor structure, gas hydrates, fluids, substrate character, sea-level change, and climate variability have on the evolution of these complex geologic areas.

The primary goal of the project is to characterize upper Pleistocene and Holocene stratigraphy, structure, and depositional processes in this tectonically active and passive basin. Data are interpreted using Landmark Seisworks, Earthvision, and Geoprobe and are exported to GIS packages, such as ArcMap and Ermapper, for quantitative data collection of fill morphometrics. These data form the basis for statistical evaluation of risk and uncertainty in facies and the generation of rich data sets for stochastic modeling. In addition, larger hydrocarbon systems models, as well as structural and sequence frameworks, are developed to provide the regional and basinwide context within which to assess uncertainty for both E and P, as well as facilities design and emplacement, in these deep-marine margin frontiers.

Fracture Research and Application Consortium (FRAC)

Stephen E. Laubach, Randall A. Marriott (Department of Geological Sciences, The University of Texas at Austin), Jon E. Olson (Department of Petroleum and Geosystems Engineering, The University of Texas at Austin), co-principal investigators; Julia F. W. Gale, Jon Holder (Department of Petroleum and Geosystems Engineering), Kitty L. Milliken (Department of Geological Sciences, The University of Texas at Austin), Edgar Pinzon, and Robert M. Reed, assisted by John Hooker, Leonel Gomez, and Meghan Ward, in collaboration with Robert H. Lander and Linda M. Bonnell (Research Fellows, The University of Texas at Austin, and Geocosmos).

The FRAC group conducts research to better characterize and predict fracture and fault attributes. Selecting the best exploration or development strategy for rocks that contain fractures can have a huge impact on economic success or failure. FRAC research leads to new concepts and methods for accurate characterization and reliable prediction of fracture attributes, which in turn provide insights that are essential for our making well-informed exploration and development decisions. Many fractures are difficult or impossible to characterize adequately using currently available technology. Consequently, fractured reservoirs have been difficult to describe.
and interpret, posing serious challenges to successful exploration or development. The practical methods under development by FRAC can be used for evaluating individual wells or, using data from many wells, identifying field- or regional-scale fracture patterns and drilling fairways.

FRAC applications are based on advances in fundamental understanding of how structures develop in the subsurface. Specifically, FRAC is investigating the interactions of chemical and mechanical processes. Recent results include linked geomechanical and structural-diagenetic models that make accurate predictions of fracture architecture that can be verified using limited subsurface samples. Predictions of interwell fracture patterns from these models have been used for designing drilling and stimulation programs and for input in fluid-flow simulators. Another effort is under way to use new fracture characterization methods, which overcome the sampling limitations that plague conventional methods, to calibrate seismic fracture detection methods. Currently the project is conducting studies in deep sandstone targets in Texas, the Rocky Mountain region, and Venezuela and is analyzing fractures in carbonate rocks in Texas, the eastern United States, and Mexico.

Environmental Quality Research (EQR)

Bridget R. Scanlon, principal investigator

The EQR group provides research to support decision-making concerning petroleum-related contaminants; evaluates the latest technology for characterizing contaminated sites (direct and remote-sensing measurements); leverages existing contracts funded by the U.S. Department of Energy, the U.S. Environmental Protection Agency, and other agencies to address petroleum issues; and interfaces with regulators to ensure that regulations are based on technically reliable data. Applications for EQR research are wide ranging and include unsaturated-zone hydrologic studies, including monitoring and modeling approaches to evaluate aquifer vulnerability to contamination, guiding environmental regulation, and remediating and closing contaminated sites; airborne geophysical studies to locate contamination resulting from oil wells; and studies identifying suitable subsurface sites for carbon dioxide sequestration.

Exploration Geophysics Laboratory (EGL)

Bob A. Hardage, principal investigator; Milo M. Backus, Michael V. DeAngelo, Sergey B. Fomel, Robert J. Graebner, and Paul E. Murray

Joint studies with industry sponsors give EGL access to onshore multicomponent seismic surveys and to multicomponent marine data. The EGL develops multicomponent seismic field-recording techniques and data-processing and data-interpretation procedures that allow reservoirs to be imaged using all components of the seismic wavefield. The goal is to determine the value of independent compressional (P) wave and shear (S) wave images of subsurface stratigraphy. When P and S images are transformed into a depth-equivalent data space, researchers gain insight into petrophysical properties, pore structure, pore-fluid properties, sequence stratigraphic relationships, and spatial distributions of lithologies, fractures, and anisotropic properties of complex reservoirs.

In 2003, EGL concentrated on developing robust methodologies that define depth-equivalent data windows in P wave and S wave images. Precise warping of the image time of all modes of an elastic wavefield to depth-equivalent image spaces is fundamental to most applications of multicomponent seismic data.

Reservoir Characterization Research Laboratory (RCRL)

Charles Kerans and F. Jerry Lucia, co-principal investigators; James W. Jennings, Jr., Xavier Janson, Jerome A. Bellian, Hongliu Zeng, and Fred P. Wang; assisted by Ted E. Playton, Edmund Frost III, Craig Calkins, and Elizabeth A. Roller

Carbonate outcrop studies during 2003 included greenhouse lower Albian rudist buildups from south Texas and the classic shelf to shelf-margin icehouse upper Carboniferous of the Dry Canyon area of the Sacramento Mountains in New Mexico. The south Texas greenhouse rudist model involved integration of outcrop laser imaging and detailed surface mapping using photographic and GPS tools, ground-penetrating radar data, and 17 shallow-subsurface cores, all combined in a 3-D Gocad model. Outcrop-constrained geometries of reef-core, reef-flank, and grainstone shoal dimensions were used to guide a 3-D reservoir model and fluid-flow simulation experiments that illustrated the complex nature of water breakthrough in secondary recovery projects.

A full 3-D depositional facies and petrophysical model of the Permian Victorio Canyon slope-to-basin setting, including velocity and seismic forward modeling, was completed. The work flow using ILRIS/LIDAR-generated digital outcrop models that were developed for this project will serve as a guide for all future RCRL outcrop analog studies.

Work on a 3-D laser model of Dry Canyon was begun with the collection of a 3-D grid of lidar data in Yuca, Dry, and Beeman Canyons, 24 measured sections in Yucca and Dry Canyons, photomosaic mapping and bed tracing, and collection of approximately 500 samples for petrographic and petrophysical analysis. The complex stratigraphy of this high-amplitude, high-frequency icehouse eustatic setting, combined with the active tectonic setting, is uniquely captured in the 3-D laser data, with juxtaposition of carbonate slope, reef-margin, shelf, and subaerial caliche facies, as well as fluvial and deltaic clastic facies all occurring within a 2- x 3-mile window along the west margin of the Pedernal uplift. Buildup geometries and related shelf cycles provide an excellent match for ongoing work in the reservoirs of the Horseshoe Atoll trend. Completion of the 3-D model, including the remainder of the lidar and geologic mapping of Beeman Canyon, as well as integration of core descriptions from the three ExxonMobil research core holes in the area, will serve as a basis for reservoir simulation and for generation of facies dimension data.

Extensive work was carried out on the Cogdell Unit of the Horseshoe Atoll Upper Carboniferous icehouse, isolated platform trend. The Fullerton Clear Fork reservoir study, co-funded by DOE, University Lands, and ExxonMobil and led by Steve Ruppel, was also presented in 2003. The RCRL continues to look for subsurface data sets of carbonate fields with recent-vintage 3-D seismic, complete logging suites, and good core control, in order to further develop the core-log-seismic integrated approach to reservoir characterization in carbonates.

Petrophysical analysis and modeling focused on interpretation of diagenetically modified pore systems in oolitic grainstones from the icehouse Pennsylvanian data sets. The
porosity-permeability relationships developed were used to more accurately model permeability in Cogdell field, as well as to provide a general model for a range of oolitic reservoir settings. Integrated petrophysical characterization of the Fullerton Clear Fork model using log and detailed petrographic analysis also illustrated a work flow for improved permeability mapping.

New research on the use of CAT-scan data for describing the 3-D porosity systems of both interparticle and vuggy pore systems was carried out in 2003 and is continuing. Understanding the contribution that vuggy pore systems make to the permeability structure of carbonate reservoirs is one of the fundamental research goals of carbonate reservoir characterization that remains today and is a continuing focus for the RCRL.

**Predicting Fracture Porosity Evolution in Sandstone**
Stephen E. Laubach, Robert H. Lander and Linda M. Bennell
(Research Fellows, The University of Texas at Austin), Jon E. Olson (Department of Petroleum and Geosystems Engineering, The University of Texas at Austin), Julia F. W. Gale, Randall A. Marrett (Department of Geological Sciences, The University of Texas at Austin), co-principal investigators; Jon Bolder (Department of Petroleum and Geosystems Engineering) and Robert M. Reed; assisted by John Hooker, Leonel Gomez, and Meghan Ward

This research is a cooperative effort between Rob Lander and Linda Bonnell (Geocosm and Research Fellows at the Bureau), Steve Laubach, Julia Gale, and Rob Reed (Bureau of Economic Geology), Randy Marrett (Department of Geological Sciences), and Jon Olson and Jon Holder (Department of Petroleum and Geosystems Engineering) at The University of Texas at Austin.

The 3-year effort will involve detailed sandstone/fracture petrography (including, among other things, high-resolution cathodoluminescence and fluid-inclusion analysis), Touchstone modeling of the unfractured parts of the sandstone, and analysis of the ability of Geocosm’s new Prism model to accurately predict the extent, morphology, and timing of quartz cementation in fractures. In addition, Dick Larese will create synthetically quartz-cemented samples for subcritical crack-index measurements (the subcritical crack index is a fundamental rock property that influences fracture mechanics). We hope that this project will take us a major step forward in our quest to develop a modeling approach that can accurately predict the flow properties of fracture systems in sandstones. Funded by the Office of Basic Energy Sciences, U.S. Department of Energy, under Grant No. DE-FG02-03ER15430.

**Advanced Technology for Predicting the Fluid-Flow Attributes of Naturally Fractured Reservoirs from Quantitative Geologic Data and Modeling**
Jon E. Olson, Larry W. Lake (Department of Petroleum and Geosystems Engineering, The University of Texas at Austin), and Stephen E. Laubach, principal investigators; assisted by Myeong Hwan Noh

This project was successfully completed this year. Microstructural analysis of fractures established key processes that led to fracture sealing. These results are being compared with those of a mathematical model that has been developed to simulate hydrodynamics and fluid-mineral reactions in permeable media. Fluid convection, diffusion, and precipitation/dissolution (PD) reaction inside a finite space are solved as a simplified representation of natural fracture mineralization. The problem involves mass transfer within the fluid, accompanied by chemical reaction at the fracture surface. Mass-conservation equations for components in fluid are solved in this problem, and these are coupled with chemical reaction at the fracture surface. The model shows time evolution of fracture aperture shrinkage patterns from PD reactions. Partly cemented fractures are created if cementation fails to fill the fracture completely or if subsequent dissolution leaches out some of the mineral. Certain sets of boundary conditions show how the fractures are completely filled by precipitation.

The success of efforts to extract hydrocarbons from many remaining domestic exploration and development targets depends on creation of new approaches to predicting natural fracture attributes. This research, supported by the U.S. Department of Energy, is to develop new understanding and new technology for prediction of fracture-pattern attributes related to subsurface fluid flow. In recent years interest has increased considerably on flow and transport in low-permeability fractured rock. Groundwater flow frequently induces dissolution and cementation processes. It is the latter with which we are concerned, inasmuch as the mechanisms for fracture closure are not well defined. The basic dilemma is that fractures are closed by fluid flow even when there are no flow paths apparent in the surrounding medium. In many reservoir engineering applications and field performance studies, characterization of fractures is an important issue and a useful parameter for the studies of well productivity and breakthrough behavior. The focus of the study is predicting connectivity, clustering, and aperture—fracture-pattern attributes that are exceedingly difficult to measure but that can be controlling fractures for fluid movement. The diagenetic process of dissolution and partial cementation is a key control on the creation and distribution of natural fractures in hydrocarbon reservoirs. Even with extensive data collection, fracture permeability still creates uncertainty in reservoir description and prediction of well performance. Data on the timing and stages of diagenetic events can provide an explanation as to why, when, and where natural fractures will be open and permeable. Funded by the U.S. Department of Energy under Cooperative Agreement No. DE-FC26-00BC15308.

**Combining a New 3-D Seismic S-Wave Propagation Analysis for Remote Fracture Detection with a Robust Subsurface Microfracture-Based Verification Technique**
Bob A. Hardage and Stephen E. Laubach, principal investigators; Milo M. Backus, Julia F. W. Gale, Robert J. Graebner, Randall A. Marrett (Department of Geological Sciences, The University of Texas at Austin), Paul E. Murray, and Jon E. Olson (Department of Petroleum and Geosystems Engineering, The University of Texas at Austin)

Three-component 3-D (3C3D) seismic data were analyzed in this study to determine whether P or C wavefields exhibit azimuthal variations that allow the principal axis of anisotropy to be determined across a fractured interval of McElroy field, West Texas. Preliminary data interpretation implies any azimuth-dependent seismic properties will be modest, but additional analyses will be done before the study period ends. An extensive subsurface database was compiled to support the seismic interpretation.
The study is conducted over that portion of McElroy field in West Texas that is operated by Chevron/Texaco, using data and co-funding provided by the operator. This study is funded by the U.S. Department of Energy.

Devine Test Site
Bob A. Hardage, principal investigator; Milo M. Backus, Robert J. Graebner, and Paul E. Murray
James A. Doss, Jr., and George T. Bush, site managers

The Devine Test Site, managed by the Bureau’s Exploration Geophysics Laboratory, continues to gain recognition within the geophysical community. The low level of cultural noise at the site and the efficient seismic transmission properties of the strata beneath the 100-acre property provide ideal conditions for seismic demonstrations. Information about the Devine Test Site, including an inventory of publicly available data acquired by its previous owner, British Petroleum, and conditions for use by nonuniversity individuals, can be found on the Bureau’s Website at www.beg.utexas.edu/indassocc/egl.

Multicomponent and Multifrequency Seismic for Assessment of Fluid-Gas Expulsion Geology and Gas Hydrate Deposits: Gulf of Mexico
Bob A. Hardage, principal investigator; Milo M. Backus, Sergey B. Fomel, Robert J. Graebner, and Paul E. Murray

A wide range of fluid-gas expulsion processes is observed in seafloor strata across the northern Gulf of Mexico. These geological features can be segregated into rapid-flux processes (mud volcanoes, flows, and vents), moderate-flux processes (gas-hydrate mounds and chemosynthetic communities), and slow-flux processes (carbonate mounds, hardgrounds, and mineral-prone features). The objective of this study is to analyze shallow seafloor strata across selected deep-water expulsion sites with a range of seismic imaging options: 4-component ocean-bottom-cable (4-C OBC) data, conventional 3-D P-wave data, and deep-towed P-wave sources/receivers that produce 2- and 10-kHz profiles of shallow strata in deep water. Emphasis will be placed on improving the seismic imaging of moderate-flux expulsion sites where gas hydrates exist. Improved geologic understanding of these sites is expected to be provided by high-frequency P-wave profiles that will detail structure and stratigraphy immediately below the seafloor and by converted-shear images extracted from 4-C OBC data, which will image inside P-wave wipeout zones.

Elastic-Wavefield Seismic Stratigraphy: A New Seismic Imaging Technology
Bob A. Hardage, principal investigator; Milo M. Backus, Sergey B. Fomel, Michael V. DeAngelo, Robert J. Graebner, Paul E. Murray, Lesli J. Wood, and Glenn Winters (Fasken Oil and Ranch, Ltd.)

EGL is partnering with Fasken Oil and Ranch Ltd. and Vecta Technology to develop a new seismic imaging technology—Elastic-Wavefield Seismic Stratigraphy. This technology is based on the physics that each mode of an elastic wavefield can, and often does, image a suite of stratigraphic layers differently than do the other elastic modes. Shear (S) modes can image seismic sequences and facies not observed in the compressional (P) mode, which is the only elastic-wave mode used in conventional seismic stratigraphy. In a homogeneous Earth, a full-elastic (9-component) seismic wavefield yields three S-wave modes: SH (horizontal shear), SV (vertical shear), and C (converted shear). In an anisotropic Earth, each of these S modes splits into S1 (fast-S) and S2 (slow-S) modes controlled by the principal axes of anisotropy. A rich source of stratigraphic information thus exists in a full-elastic wavefield that is not being utilized in conventional P-wave seismic stratigraphy studies. The objectives of this research are to create compelling examples that prove that different stratal surfaces are imaged by different elastic wave modes, to develop systematic relationships between petrophysical properties and combinations of elastic-mode sequences and facies, and to demonstrate how this new seismic imaging technology should be applied to improve geologic understanding of oil and gas systems.

Shear Wave Seismic Study: Comparing 9C3D SV and SH Images with 3C3D C-Wave Images
Bob A. Hardage, principal investigator; Paul E. Murray, Milo M. Backus, and Sergey B. Fomel

In a simple homogeneous Earth, three shear-wave (S-wave) images can be made from 9C3D seismic data. One image can be made from the SV mode, a second image can be made from the SH mode, and a third, called the C-wave, can be made from the “converted” SV mode created by P-to-SV mode conversion at subsurface interfaces. Only one S-wave image can be created from 3C3D data, that being a C-wave image. Independents who are interested in S-wave seismic technology need to be informed about the differences, similarities, advantages, and disadvantages of these three S-wave imaging options.

The objective of this study is to create all three S-wave data volumes (SV, SH, C) across the same prospect(s) and to document the relative merits of each S-wave seismic mode.

Exploring for Subtle Mission Canyon Stratigraphic Traps with Elastic-Wavefield Seismic Technology
Bob A. Hardage, principal investigator; Milo M. Backus, Michael V. DeAngelo, Sergey B. Fomel, Robert J. Graebner, and Paul E. Murray

Vecta Exploration, Inc., is working with the Exploration Geophysics Laboratory (EGL) at the Bureau of Economic Geology to develop a new seismic technology to explore for subtle Mission Canyon oolitic limestone reservoirs in the Williston Basin. This technology will be based on acquisition and application of full-elastic (9-component) seismic data. Mission Canyon reservoirs are elusive targets when exploration is based on conventional compressional (P) wave seismic data. The attraction of 9-component (9-C) seismic data is that three shear (S) wave modes can also be used for target imaging, these being the SH (horizontal shear), SV (vertical shear), and C (converted shear) modes. Work at EGL has shown that each mode of an elastic wavefield can, and often does, image stratal surfaces across a target interval differently than do the other elastic modes. Any of the S modes can thus depict seismic sequences and seismic facies that are not observed using P waves. This rich, expanded source of stratigraphic and lithofacies information in full-elastic seismic wavefields needs to be utilized in Mission Canyon exploration. The objectives of this study are to acquire, process, and interpret 9C3D seismic data across Mission Canyon plays, develop relationships...
between drilling objectives and elastic-wavefield attributes, drill confirmation wells, and then share the research findings so that full-elastic seismic technology can be applied to improve oil exploration across the greater Rocky Mountain Frontier area. This study is funded by the U.S. Department of Energy and Vector Exploration.

BASIN AND FIELD STUDIES

Play Analysis and Digital Portfolio of Major Oil Reservoirs in the Permian Basin: Application and Transfer of Advanced Geological and Engineering Technologies for Incremental Production Opportunities

This project is focused on play analysis and preferred management practices of oil reservoirs in the Permian Basin, the largest onshore petroleum-producing basin in the United States. A total of 32 oil plays were defined for the Permian Basin. Approximately 1,500 major oil reservoirs (reservoirs having cumulative production greater than 1 MMbbl of oil through December 31, 2000) were identified in the Permian Basin; 1,000 of these reservoirs are in Texas and 300 in New Mexico. Each reservoir was assigned to a play and mapped in Geographic Information Systems (GIS) format this year.

Researchers at the Bureau of Economic Geology and the New Mexico Bureau of Geology and Mineral Resources have teamed up to conduct this project, which has been designed to increase reserves and improve recovery of oil from existing reservoirs in the basin. The Permian Basin of West Texas and southeast New Mexico contains 29 percent of estimated U.S. future oil reserve growth and has the biggest potential for additional oil production in the country. The project is part of the Department of Energy Identification and Demonstration of Preferred Upstream Management Practices (PUMP II) for the Oil Industry program. Workers on the project are (1) developing an up-to-date portfolio of oil plays in the Permian Basin of west Texas and southeast New Mexico and (2) studying key reservoirs from some of the largest or most active plays to incorporate information on improved practices in reservoir development in the portfolio. At the end of the project a CD-ROM containing the database of reservoirs within each play, maps in GIS format showing play outlines and reservoir locations, and summary play descriptions will be made available to the public.

Linking the Mexico and U.S. Gulf Coast: Geologic Framework and Play Definition Research in the Laguna Madre-Tuxpan Area

William A. Ambrose, principal investigator; Khaled Fouad, Shinichi Sakurai, L. Frank Brown, Jr., Edgar H. Guevara, Daniel D. Schultz-Ela, Timothy F. Wawrzyniec, Suhas C. Talukdar, Dallas B. Dunlap, Luis Sánchez-Barreda, and Alfredo Guzmán, Mario Aranda, Ulises Hernández, Ramon Cárdenas, Héctor Ruiz, Juan Alvarado, Santiago Sarmiento, and Eduardo Macías (PEMEX Exploración y Producción)

The Bureau of Economic Geology and PEMEX Exploración y Producción jointly conducted an 18-month evaluation of basin-scale, Neogene oil and gas plays in the Laguna Madre-Tuxpan area, located between the Veracruz and Burgos Basins. The study defined and mapped 32 Neogene plays in basin-floor, slope, canyon, and shelf depositional settings in offshore areas out to the present-day 500-m isobath. The study, conducted by Bureau and PEMEX teams in Poza Rica and Tampico, used an extensive database consisting of seven 3-D seismic surveys comprising >8,100 km², more than 140 2-D seismic lines representing approximately 10,000 linear kilometers of data, approximately 45 wells, and a variety of production test data, as well as gas shows and gas-seep data. The 32 plays were characterized and ranked with a variety of play elements, including reservoir presence and quality, trap, seal, source, migration, and timing. This study provided a comprehensive structural, stratigraphic, and play-element framework for existing prospects and for future exploration activities, especially in untested fairways.

Plays in the Laguna Madre-Tuxpan study were defined from mappable geologic attributes. The study used a threefold definition for plays based on (1) geologic age, (2) paleogeographic setting and facies association, and (3) trap. Many plays were completely untested by the end of the study, especially the deep-water, basin-floor plays, where regionally extensive fans occur with numerous 3-way and 4-way closures.

Laguna Madre-Tuxpan plays are structurally and stratigraphically complex, affording a unique opportunity to examine a complete coast-to-basin succession from valley fill to basin floor over a distance of less than 25 km, especially north of the Veracruz Basin. A dynamic, tectonically active setting, coupled with an abundant sediment supply, resulted in a greatly telescoped system. Narrow shelf margins in the Laguna Madre-Tuxpan area represent an end member in the spectrum of shelf-margin types and promise to be of significant worldwide interest.

Integrated Reservoir Characterization of the Poza Rica Field within a Sequence Stratigraphic Framework: Phase 1—Data, Sequence Framework, and Petrophysics

This two-phase project for PEMEX Exploración y Producción (PEP) will provide a state-of-the-art 3-D static reservoir characterization model for giant Poza Rica field in the onshore Gulf of Mexico. Phase 1, begun in 2002, included data preparation, stratigraphic framework analysis, and initial petrophysical analysis. Phase 2, which was finished in February 2004, includes infield stratigraphic and structural analysis. Giant Poza Rica Field produces from carbonate turbidites and debris flows shed from the adjacent Tuxpan Platform (Golden Lane field). To date, extensive sedimentological and petrophysical studies have been carried out on the field, but an integrated study comprising detailed sedimentologic descriptions of core material through core-, log-, and seismic-based sequence stratigraphic analysis through 3-D property modeling and upsampling has not been undertaken. This project incorporates the special talents of the Bureau in carbonate sequence stratigraphy, reservoir characterization, and 3-D modeling, which allow such a complete study to be undertaken by a single, integrated group. The researchers applied the latest sequence stratigraphic and seismic facies techniques to define the distribution of flow units within this giant, complex reservoir.
Definition of the Geological Framework and Exploration Plays of the Miocene of the Burgos Basin, Northern Mexico


The Burgos Miocene project, which started in mid-December 2002 and is funded by PEMEX Exploración y Producción, was completed in February 2004. The study is a continuation of collaborative Bureau-PEMEX investigations of the geologic framework, petroleum systems, and hydrocarbon plays of Neogene strata in southeastern, eastern, and northern Mexico (Veracruz and Macuspana Basins and Laguna Madre-Tuxpan area), conducted from 2000 through the present time. This study extends analysis to the Miocene strata of the onshore and offshore Burgos Basin of northeastern Mexico. The primary objectives of the project are to define the sequence-stratigraphic, structural, petrophysical, geochemical, and petroleum-engineering characteristics of the Miocene succession in the Burgos Basin. The emphasis of the project is to develop a play framework to help guide PEMEX exploration efforts in the virtually unexplored offshore part of the basin. The study uses an extensive database comprising ~40,000 km of 2D seismic lines, log suites from 122 wells, and a variety of production-test, gas-seep, and gas-show data.

The 15-month Burgos project will define and map 20 regional Miocene plays in 39,700 km2 of the central (onshore) and eastern (offshore) Burgos Basin. These plays are defined on the basis of age (four Miocene chronostratigraphic zones) and five mappable areas (unexpanded shelf, expanded shelf, slope, basin-floor, and diapiric onlap) extending offshore to the 500-m isobath. Ranking of the plays involves a qualitative procedure based on a systematic evaluation of five key play elements: reservoir presence and quality, trap, seal, source, and migration. The study also provides a structural, stratigraphic, and play framework for existing PEMEX prospects and future exploration areas in the basin.

The Miocene plays are structurally complex and are characterized by local and regional detachment systems, growth faults and an associated regionwide pattern of downright extensional rollover folds, pervasive secondary faults, and salt and shale diapiric masses that dominate the east part of the basin. The Burgos Basin appears to be a transitional zone between gravitational collapse in offshore Mexican basins to the south and salt-related raft tectonics of the South Texas Gulf Coast. The basin thus offers high promise for gas reservoirs containing a variety of trap styles.

Multidisciplinary Imaging Rock Properties in Carbonate Reservoirs for Flow Unit Targeting

Stephen C. Ruppel, principal investigator; James W. Jennings, Jr., Rebecca H. Jones, Jeffrey A. Kane, Charles Kerans, F. Jerry Lucia, Fred P. Wang, Hongliu Zeng, Dallas B. Dunlap, and Joseph S. Yeh; assisted by Shawn Fullmer, Yanping Sun, and Lijing Xu.

The ultimate goal of this project is to find new, more cost-effective ways to locate and recover oil remaining in existing carbonate reservoirs in the United States. Specific objectives of the project, which is funded by the Department of Energy, are to develop and test new methodologies for improving imaging, measuring, modeling, and predicting reservoir properties in carbonate oil and gas reservoirs. Focus of the project is the Fullerton Clear Fork (Permian) reservoir in the Permian Basin, which, like many carbonate reservoirs in the United States, exhibits low recovery efficiency despite more than 50 years of production activity.

In 2003, research continued to concentrate on (1) interpretation and modeling of 3-D seismic attributes, (2) characterization and modeling of reservoir attributes, and (3) 3-D reservoir flow simulation. Early successes in these areas include (1) construction of a seismic impedance inversion model and calculation of porosity and permeability from integrated 3-D seismic and wireline porosity data, (2) development of permeability and saturation models from new core data, and (3) successful construction of 3-D reservoir model and simulation of fluid flow.

One of the goals of the project has already been partly achieved. Preliminary results of 3-D seismic reservoir attribute studies were used to define porosity distribution in areas of poor wireline-log control and to select optimal candidates for infill drilling.

Future activities include development of geostatistically based models of porosity distribution for more accurate depiction of reservoir attributes and construction of virtual reality models for improved reservoir imaging and interpretation.

STARR: Technology Center for Oil and Gas Recovery Optimization on Texas State Lands

Robert G. Loucks, principal investigator; L. Frank Brown, Jr., Shinichi Sakurai, Randy L. Remington, Ramón H. Treviño, and Eugene M. Kim

During the past 7 years, the State of Texas Advanced Resource Recovery (STARR) project researchers have been applying the latest geological concepts and geophysical techniques to mature fields on State Lands. The goal of the project is to enhance ultimate hydrocarbon recovery on State leases by working jointly with oil and gas operators who are producing from or exploring these leases. This goal is accomplished through reservoir characterization studies and extended development, including drilling new wells, recompleting old wells, developing enhanced recovery programs, and defining deeper targets.

Project STARR has been involved in 16 oil and gas fields over a 7-year period. We are now concentrating on several south Texas Frio sandstone areas to delineate new compartments for gas production. Lowstand basin-floor fans and slope fans are also being investigated as deeper production targets. Landmark Graphics Corporation software is used extensively to analyze 3-D seismic data and model seismic attributes and to correlate wireline logs.

STARR is a State of Texas program designed to increase royalty payments—a result of drilling or recompleting oil and gas wells—for the benefit of the Permanent School Fund. Texas State Lands operators are invited to participate in STARR, which provides free, expert, technical advice on developing their fields.
ULARE: Integrated Geological and Engineering Characterization of the Fullerton Clear Fork Field in Andrews County, Texas

Stephen C. Ruppel, principal investigator; James W. Jennings, Jr., Rebecca H. Jones, Jeffrey A. Kane, Charles Kerans, F. Jerry Lucia, Fred P. Wang, Hongliu Zeng, Dallas B. Dunlap, and Joseph S. Yeh; assisted by Shawn Fullmer, Yanping Sun, and Lijing Xu.

The Fullerton field study is a collaborative research effort between the Bureau, ExxonMobil, and Oxy Permian funded by the University of Texas System, ExxonMobil, and the U.S. Department of Energy. The primary goal of the study is to define the causes of low recovery efficiency in this field and other Leonardian restricted-platform carbonate reservoirs in the Permian Basin and to develop better ways to recover the remaining oil resource. Fullerton Clear Fork field, with original oil in place of about 1.5 billion barrels and cumulative production of more than 300 million barrels, is the largest Leonardian reservoir in West Texas and one of the largest on University System Lands.

Critical issues being addressed include (1) stratigraphic architecture and flow-unit continuity, (2) rock-fabric character and its effect on the distribution of porosity and permeability, (3) volume and distribution of original and remaining oil, (4) value of 3-D seismic in defining stratigraphic architecture and porosity distribution, and (5) construction and simulation of geologically realistic flow models to define fluid flow and the distribution of remaining oil.

In 2003, the second year of the project, the Bureau’s multi-disciplinary team of geologists, petrophysicists, geophysicists, and petroleum engineers focused on (1) extending the previously established cycle-based stratigraphic architecture throughout the entire field, (2) improving oil-saturation models for the reservoir on the basis of new special core analysis data, and (3) completing and interpreting results of reservoir flow simulation.

Preliminary results of the study have been used to help the operator define and optimally select infill drilling locations; 15 new wells will be drilled in 2004.

RESOURCE ASSESSMENT

Pennsylvanian Bituminous Coal, North-Central Texas: Potential for Coalbed Methane Resource Development

Eugene M. Kim, principal investigator

The objective of this cooperative project between the Bureau of Economic Geology and the U.S. Geological Survey (USGS) is to provide digital data and information for use in USGS’s National Coal Resources Data System (NCRDS) and a preliminary assessment of the coalbed methane potential of the coal-bearing seams of the Pennsylvanian bituminous coals of North-Central Texas. As a multiyear assessment, major accomplishments for FY03 included digital compilation of major background regional data for Pennsylvanian depositional systems and major coal resources, such as the Strawn (Thurber) coals, as well as a comparison with current coalbed methane production from Olmos bituminous coals in the Maverick Basin. Detailed and updated information on the coal resource in this region, utilizing digital spreadsheets of available data, as well as digitized maps compiled for Geographic Information System (GIS) usage and a comprehensive report in pdf document format was included in the FY03 Annual Report. FY04 tasks to be completed include analysis of other coal resources, such as the Canyon (Bridgeport) and Cisco (Newcastle) coals and subsequent data, as well as an overall future assessment of the coalbed methane potential of North-Central Pennsylvanian bituminous coals.

EARTH SYSTEMS

WATER RESOURCES

Groundwater-Availability Modeling: An Example from the Central Part of the Carrizo-Wilcox Aquifer, Texas

Alan R. Dutton, principal investigator; Jean-Philippe Nicot, Bridget R. Scanlon, and Robert C. Beedy; assisted by Katherine S. Kier and Thandar Phyu

A quasi-three-dimensional, numerical model of the occurrence and movement of groundwater in the central part of the Carrizo-Wilcox aquifer, a major Texas aquifer, was developed to help estimate groundwater availability and water levels in response to potential droughts and future pumping. This six-layer model includes data on the geological structure and depositional setting of the aquifer, hydrological properties, water-use survey estimates of historical groundwater withdrawals, and base flow of rivers and streams. The central model overlaps with models for north and south parts of the aquifer in Texas and was prepared as part of the GAM (Groundwater Availability Modeling) program being administered by the Texas Water Development Board.

Groundwater Analysis and Modeling

Alan R. Dutton, principal investigator; Bridget R. Scanlon, Jean-Philippe Nicot, Sunil Mehta, and Robert C. Beedy

Bureau researchers, as subcontractors to Freese and Nichols, Inc., are helping to develop the 2005 Panhandle (Region A) Regional Water Plan for the Panhandle Planning Area (PWPA). The scope of work centers around updating information included in the 2001 Regional Water Plan and includes (1) improving calibration of a regional groundwater model and updating estimates of water availability in the Ogallala aquifer for 2005 through 2060, (2) developing and implementing a new cross-sectional model to evaluate the potential for change in water quality that might be attributed to future groundwater pumping in the Roberts County area, (3) reviewing aquifer recharge and storage estimates for the Seymour and minor aquifers, and (4) updating information on current groundwater quality and water-quality standards for the PWPA area.


Susan D. Hovorka, principal investigator; Alan R. Dutton, Joseph S. Yeh, and John R. Andrews; assisted by Thandar Phyu

This study develops the aquifer database for an improved computer model of groundwater flow in the San Antonio segment of the Edwards aquifer. The Edwards aquifer is the
major source of water for more than 1.5 million people in the San Antonio area and provides nearly all of the water used in the region for industrial, military, irrigation, and public supplies. Furthermore, accelerating withdrawals of groundwater are a threat to spring flow at Comal and San Marcos Springs. Both springs supply water to meet downstream needs, sustain Federally listed endangered species, and support local economies through tourism. The U.S. Geological Survey and the Bureau are collaborating to develop the database and computer model on behalf of the Edwards Aquifer Authority. The study, which began late in 2000, was completed in 2003. The model being developed will enable water managers to test the effects of alternative, potentially costly management scenarios before enactment. Input simplifications and output enhancements will make the model user-friendly for trained personnel, as well as ensure that the graphics-rich output is understandable to nonscientists.

Field Validation of Geologic Assessment of Features Sensitive to Pollution in Karst and Development of Best Management Practices

Susan D. Hovorka, principle investigator; Adrien L. Lindley, Bridget R. Scanlon, Mike Barrett, and Robert C. Reedy

In this multiyear study, the current geomorphic method for assessment of sensitive features is quantitatively evaluated using hydrologic methods. Typical upland karst features in the Edwards aquifer recharge zone, specifically sinkholes, are studied to determine their connectedness to the subsurface. Sinkholes may allow water or contaminants to be transported rapidly to the subsurface via fractures or conduits and therefore have the potential of being highly sensitive features. Constant-head ponding tests are conducted using a 12-foot-diameter ring infiltrimeter to determine infiltration rates of sinkholes and the surrounding area. Comparing results of these infiltration experiments, features with higher infiltration rates are determined to be more sensitive than the surrounding background area. Several sites have been identified in northern San Antonio, New Braunfels, Kyle, and south Austin, and candidate sinkholes identified at sites in Kyle and south Austin. Shallow trenching, dye tracing, and surface geophysical methods will also be used to image the subsurface below selected features.

Edwards Aquifer Fracture/Conduit Study

Susan D. Hovorka, principal investigator; Bridget R. Scanlon and Robert C. Reedy; assisted by Adrien L. Lindley and Thandar Phyu

The Edwards aquifer of south Texas has a complex and highly heterogeneous flow system. Integration of multiple data sets has the best chance of providing an adequate view of the nature of the heterogeneities and impact on aquifer performance. Karst has developed in this carbonate aquifer in response to the interaction of structure and gradient. Karst capture, favored by fractures of the Balcones Fault Zone, has diverted surface-water flow from toward the Gulf of Mexico into the subsurface eastward and discharge at Comal and San Marcos Springs. Large troughs in the potentiometric surface were mapped by grouping the large volume of historic water-level data according to aquifer stage. Cave orientations confirm a history of karst capture at a smaller scale.

We examined additional evidence of this conduit flow by interpreting natural chemistry and introduced contaminant distribution, as well as high-frequency water-level records and mapped cave systems.

Environmental Quality

Optimal Geological Environments for Carbon Dioxide Disposal in Brine-Bearing Formations in the United States—Phase III Pilot Sequestration in Brine in the Frio Formation

Susan D. Hovorka, principal investigator; Paul R. Knox, Mark H. Holtz, Khaled Fouad, Shinichi Sakurai, Jeffrey G. Paine, and Joseph S. Yeh; assisted by Thet Naing

Brine formations below and separated from potable water provide a large volume of widely available resource for storage of carbon dioxide (CO2) as an alternative to releasing byproducts of combustion to the atmosphere. We are conducting a short-term, small-scale injection into a small compartment of a brine aquifer to collect data that will demonstrate the validity of conceptual models of this sequestration method. We have completed characterization and numerical modeling of the pilot site and are preparing to conduct the experimental injection. The project goal is to create an early success for the U.S. geologic sequestration effort in high-permeability, high-volume sandstone representative of a broad area that is an ultimate target for large-volume sequestration.

The project monitoring and modeling is designed to demonstrate that CO2 can be injected into a brine formation without adverse health, safety, or environmental effects; determine the subsurface distribution of injected CO2; demonstrate validity of conceptual models; and develop experience necessary for success of future large-scale CO2 injection projects.

The upper Texas Gulf Coast is both an area of high need for CO2 sequestration, because of the large volumes of CO2 produced from diverse sources, and an area of high potential for sequestration, because of large volumes of well-characterized, high-porosity, high-permeability sandstone and abundant reservoir seals. Injection into a reservoir compartment away from the complications resulting from concentration of oil and gas phases in the pore system and without the pressure perturbation resulting from production history will better characterize this environment and provide basic data about performance of CO2 in the subsurface.

CO2 Sequestration in Saline Formations

Susan D. Hovorka, principal investigator; Paul R. Knox and Mark H. Holtz

If significant volumes of carbon dioxide (CO2) derived from combustion of fossil fuels were injected into the subsurface below and isolated from potable water in order to avoid impact on the atmosphere, how long would they be retained and sequestered? Two mechanisms appear to have the potential to retain a high percent of the injected CO2: (1) residual saturation and (2) structural trapping. Residual saturation will trap CO2 on a pore scale as it migrates updip. Statistical assessment of flow-path length in regionally dipping, compartmentalized Gulf Coast formations with formation specific Sgr measurements of 20 to 40 percent demonstrates that large volumes of CO2 will be retained. This dispersed CO2 has the potential to interact with pore water and be dissolved. Volumes of CO2 retained in structural closure are greatly
increased by considering stratigraphic complexity, which will result in more rock being contacted by CO₂.

This collaborative project with Lawrence Berkeley National Laboratory supports the Frio Brine Pilot by providing an experimental field site at which monitoring and modeling techniques may be applied to validate conceptual and numerical models.

**Ecological Resource Assessment of the Rio Grande Riparian Corridor**

Jay A. Raney, co-principal investigator; William A. White and Thomas A. Tremblay; Melba M. Crawford, co-principal investigator, and Amy Neuenschwander (Center for Space Research, The University of Texas at Austin); Frank Judd, co-principal investigator, and Robert Lonard (The University of Texas–Pan American); Gene Paull co-principal investigator (The University of Texas at Brownsville)

In 2003, researchers completed work on this project, which included (1) collecting and analyzing high-resolution, remotely sensed data from multiple sensors; (2) integrating existing and new field data and remotely sensed data into a GIS; (3) determining whether native vegetation communities are maintaining themselves and identifying the factors that perpetuate these communities; (4) interpreting spatial and temporal variations in riparian habitats; and (5) developing a foundation for future analysis of riparian floodplain communities by linking local and remotely sensed regional data using GIS. This assessment of southwestern U.S. riparian ecosystems along the Lower Rio Grande Valley of Texas and Mexico is supported by a grant from the U.S. Environmental Protection Agency’s Science to Achieve Results program. Riparian ecosystems of the southwestern United States are among the most productive ecosystems of North America, but these ecosystems are generally in decline.

Among our findings, which are based on field transects of vegetation, we found that dominant trees and shrubs appear to be replacing themselves. Only small, isolated, woodland areas, however, characterize the Rio Grande valley today. To make comparisons between the remaining riparian vegetation in Texas and Mexico, we created a 20-km-wide buffer zone along the Rio Grande, with 10 km on the U.S. side and 10 km on the Mexico side, a total area of approximately 526,936 ha.

According to Landsat analysis of woodland areas within the corridor, 74 percent of the woodlands are in the U.S. and 26 percent in Mexico. Compared with other land cover, however, only small percentages of woodlands remain along the Rio Grande in the U.S. (6 percent) and Mexico (2 percent). If we assume that in the past, most of the area was vegetated with riparian woodlands and brushlands, as has been suggested by some authors, then almost 94 percent of these wooded areas have been cleared in the U.S. and 98 percent in Mexico. On the U.S. side, this estimate is in agreement with estimates by Jahrsdoerfer and Leslie (1988), who stated that since the early 1900’s, 95 percent of native brushland has been cleared for agriculture, urban development, and recreation, and in riparian areas they estimated that 99 percent of native brush has been destroyed. These percentages are in relatively close agreement, with the 91-percent loss of woodlands in Cameron County quantified during our study for the period from the 1930’s through the mid-1980’s.

To counter some of the losses that have occurred in these valuable riparian resources, the USFWS, as part of its LRGV National Wildlife Refuge program, is in the process of acquiring thousands of hectares of land along the Rio Grande in order to preserve and establish riparian habitats. GIS data layers and the relationship of various parameters, such as soils, topography, hydrology, and land use that have been compiled and analyzed along the Rio Grande during our study, should help provide a foundation for future analysis of riparian floodplain communities by linking local and remotely sensed regional data using GIS. This information is valuable in analyzing riparian vegetation with respect to historical trends, anthropogenic effects, and optimal sites for reestablishment of riparian tracts.

**Ecological Controls on Water Cycle Response to Climate Change in Desert Regions**

Bridget R. Scanlon, principal investigator; Robert C. Reedy, Kelley E. Keese, and Dan Levitt (Science & Engineering Associates, Inc., Albuquerque, New Mexico)

This study was conducted to evaluate the role of vegetation in controlling the water-cycle response to climate variability in semiarid/arid settings. Vegetation dynamics in desert regions play a critical role in the water cycle and regulate water-cycle response to climate variability at both interannual to millennial time scales and point-to-regional spatial scales. Data derived from the Mojave Desert show that plant transpiration in these dry desert regions can reduce water storage to half of that in a nonvegetated system. Vegetative control on the water cycle can be extended to interdrainage basins throughout the southwestern U.S., where long-term (5–12 yr) water-potential measurements indicate that vegetation removes all infiltrated water. Xeric vegetation in these settings has been drying out the subsurface and precluding groundwater recharge for the past 10,000 to 15,000 yr, as shown by measured and modeled upward water potential and chloride concentration profiles.

The results of this study sponsored by the U.S. Department of Energy have important implications for understanding the natural water cycle in these systems and for assessing potential performance of evapotranspirative covers for waste containment in these regions.

**Evaluation of Aquifer Vulnerability to Contamination**

Bridget R. Scanlon, principal investigator; Robert C. Reedy and Kelley E. Keese

Because most contaminants originate at the land surface, recharge is the primary mechanism for transporting contaminants to underlying aquifers. Aquifers with higher recharge rates are more vulnerable to contamination than those with low recharge rates. The purpose of this study was to estimate recharge rates for major aquifers characterized by porous media in Texas. Recharge was estimated using one-dimensional unsaturated flow modeling for the major aquifers and using limited field studies in the Southern High Plains and Seymour aquifers. Field studies included measurement of soil physics (water content, matric potential head) and environmental tracers (chloride) in soil samples from boreholes installed in different land use settings, including natural, dryland farming, and irrigated farming.

Numerical modeling of unsaturated flow was used to estimate recharge using long-term (30-yr) climatic forcing, soil data from STATSGO and SSURGO, and vegetation data. Hydraulic properties were estimated using pedotransfer...
functions. Simulated recharge using bare sand ranged from 54 mm/yr in west Texas to 720 mm/yr in east Texas and was positively correlated with precipitation. These high recharge rates indicate that climate is not the limiting factor for recharge and that soil texture and vegetation are important in reducing recharge. Unsaturated flow modeling proved to be a useful tool in estimating recharge for major porous media aquifers in the state. The modeling analysis allowed evaluation of different factors controlling recharge, including climate, vegetation, and soils, and indicate that long-term average precipitation can be used as a predictor of recharge. The results of this study have important implications for assessing aquifer vulnerability to contamination and indicate that vegetation, soil texture, and land use are important factors in controlling recharge and aquifer susceptibility to contamination.

**Variations in Flow and Transport in Thick Desert Vadose Zones in Response to Paleoclimatic Forcing (0–90 kyr): Field Measurements, Modeling, and Uncertainties**

Bridget R. Scanlon, principal investigator; Robert C. Reedy, Kelley E. Reese, Jirka Simunek, and Brian J. Andraski

An understanding of unsaturated flow and potential recharge in interdrainage semiarid and arid regions is critical for quantification of water resources and contaminant transport. For this project, we evaluated system response to paleoclimatic forcing using water-potential and chloride (Cl) profiles and modeling of nonisothermal liquid and vapor flow and Cl transport at semiarid (High Plains, Texas) and arid (Chihuahuan Desert, Texas; Amargosa Desert, Nevada) sites. Infiltration in response to current climatic forcing is restricted to the shallow (~0.3–3 m) subsurface. Subsurface Cl accumulations correspond to time periods of 9 to 90 kyr. Bulge-shaped Cl profiles generally represent accumulation during the Holocene (9–16 kyr). Lower Cl concentrations at depth reflect higher water fluxes (0.04–8.4 mm/yr) during Pleistocene and earlier times. Low water potentials and upward gradients indicate current drying conditions. Nonisothermal liquid and vapor flow simulations indicate that upward flow for at least 1 to 2 kyr in the High Plains and for 12 to 16 kyr at Chihuahuan and Amargosa Desert sites is required to reproduce measured upward water potential gradients and that recharge is negligible (<0.1 mm/yr) in these interdrainage areas. This research was sponsored by the U.S. Department of Energy.

**Evaluation of Evapotranspirative Covers for Waste Containment in Arid/Semiarid Regions**

Bridget R. Scanlon, principal investigator; Robert C. Reedy and Kelley Keese

Evaluation of performance and assessment of flow processes in evapotranspirative (ET) covers are critical issues for waste containment. The purpose of this study sponsored by the U.S. Environmental Protection Agency was to evaluate ET covers in arid/semi-arid regions in Texas and New Mexico by monitoring components of the water balance over long periods (4–5 yr) and simulating water balance in response to short-term (1–5 yr) and long-term (25-yr) climate forcing. Strong relationships between large reductions in soil-water storage and planting of vegetation at the Texas site and enhanced vegetation productivity at both sites underscore the importance of vegetation in controlling water balance in these systems. ET covers work extremely well in these regions because of the dominance of summer precipitation (~80 percent) that corresponds to periods of high ET. The data from this study indicate that a 1-m ET cover underlain by a capillary barrier should be adequate to minimize drainage in these arid/semi-arid regions.

**Soil Water Content Monitoring Using Electromagnetic Induction**

Bridget R. Scanlon, principal investigator; Robert C. Reedy

The purpose of this study, sponsored by the U.S. Environmental Protection Agency, was to evaluate the use of EM induction to monitor changes in water content in the upper 1.5 m of an engineered soil cover, including detailed evaluation of spatial and temporal variability in water content. Engineered covers are widely used to minimize water movement into underlying waste, including municipal-solid, industrial, and hazardous waste. The study area is located approximately 145 km southeast of El Paso, Texas, in the Chihuahuan Desert. Ten locations were monitored monthly over a 3-year period. Water content was monitored using a neutron probe, and bulk soil electrical conductivity was monitored using a Geonics EM38 ground-conductivity meter. EM induction has several advantages over traditional water-content monitoring techniques, including nonradioactivity, speed, and ease of use over larger areas, as well as noninvasive character.

Results of this site-specific study indicate that a simple linear model based on EM induction and neutron-probe water-content measurements can estimate volumetric water content over the 0- to 1.50-m-depth interval to within ±0.009 at any location. The spatially averaged volumetric water content could be predicted for the 0- to 1.50-m-depth interval to within ±0.003.

**Inclusion of Queen City & Sparta Aquifers into Existing Carrizo-Wilcox Groundwater Availability Models**

Jean-Philippe Nicot, principal investigator; Alan R. Dutton, H. Seay Nance, Bridget R. Scanlon, and Robert C. Reedy; assisted by Katherine S. Kier and Thandar Phy.

The Queen City and Sparta aquifers are locally important water resources in Texas and are classified as minor aquifers. They are part of several large depositional systems of Paleocene–Eocene age prograding on the Gulf coast. The Queen City and Sparta Formations overlie the Carrizo Formation, separated by a leaky aquitard. The Carrizo Formation represents the upper part of a major Texas aquifer system, the Carrizo-Wilcox aquifer. Three overlapping, quasi-three-dimensional numerical models of the Carrizo-Wilcox aquifer have previously been constructed and calibrated. The current project involves adding three layers over the five main layers already represented in the three Carrizo-Wilcox GAM’s—the Queen City and Sparta Formations, as well as the intermediate aquitard.

The main activities of 2003 consisted of determining the structure of the added layers, mainly the top and bottom of the formations, collecting data to infer hydrologic properties, obtaining insight into recharge to the aquifers, and describing water quality of the aquifers. Structure work was done by correlating stratigraphic boundaries throughout the study area at approximately 220 well locations. Collecting more than
1,000 specific-capacity data helped in determining hydrologic properties. A reasonable range of recharge was estimated by relating chloride concentrations in precipitation water to those of shallow reaches of the aquifers. Water-quality analysis confirmed the current conceptual model of the aquifers.

The groundwater model is now ready to be calibrated. After calibration, it will be used as an evaluative and predictive tool, and simulations will be made to help us understand future water-level changes with assumed periods of normal and drought-of-record precipitation. The project is funded by the Texas Water Development Board as part of its Groundwater Availability Modeling (GAM) program and the Bureau is a subcontractor to Intera.

Analysis of Soil Remediation Requirements of Abandoned Centralized and Commercial Drilling-Fluid Disposal Sites

Alan R. Dutton, principal investigator;
Jerry W. Mullican, H. Seay Nance, and Rebecca C. Smyth

Researchers concluded a summary project for abandoned, offsite, drilling-fluid disposal facilities in Louisiana, New Mexico, Oklahoma, and Texas. Data on the number, acreage, and volume of centralized and commercial drilling-fluid disposal pits and levels of constituents in the drilling waste and adjacent soil and groundwater were compiled and evaluated. Information for more than 265 active and inactive sites, with more than 690 pits in a total area of more than 8 km², was placed in a database designed to provide a basis for improving cost effectiveness of assessment and remediation of abandoned sites in these and other states. The study was sponsored by the U.S. Department of Energy, National Energy Technology Laboratory, with a matching grant from the American Petroleum Institute.

Evaluation and Validation of EO-1 and Landsat 7 Imagery through an Analysis of Land Cover/Land Use and Rates of Deforestation in Belize, Central America

William A. White, principal investigator; Jay A. Raney, co-principal investigator, and Thomas A. Tremblay; Melba M. Crawford, co-principal investigator, Sinan Erzurumlu, and Amy Neuenschwander (Center for Space Research, The University of Texas at Austin)

The Bureau of Economic Geology and Center for Space Research completed their evaluation of NASA’s advanced imaging system that was on board the Earth-Observing 1 (EO-1) satellite launched on November 21, 2000, at Vandenberg Air Force Base. EO-1 is the first satellite in NASA’s New Millennium Program Earth Observing series, the mission of which is to develop and validate instruments and technologies for space-based Earth observations using unique spatial, spectral, and temporal characteristics not previously available. Scientists at the Bureau and Center for Space Research evaluated the new imaging technology in Belize, Central America, where the researchers have previously conducted remote sensing studies in cooperation with the Government of Belize.

Among the objectives of the study were to (1) evaluate the Advanced Land Imager (ALI) sensors relative to Landsat TM data in terms of accurate classification of specific types of land cover and land use in central and southern Belize, (2) analyze the capability of ALI sensors to determine extent and rate of deforestation through GIS-assisted spatial and temporal analyses of classified imagery, and (3) classify spectral data using both existing statistical methods and new contextual and multisensor algorithms currently developed at The University of Texas at Austin for multispectral and hyperspectral data. Researchers concluded that overall classification results of land cover/land use are similar, but ALI is superior to Landsat-7 for discriminating several difficult class pairs in test data. For example, areas classified as regrowth were sometimes confused with cropland in Landsat data, and the confusion was reduced in ALI. In addition, areas of regrowth and broadleaf forest were more frequently confused in Landsat data, and mangrove communities were generally more accurately classified with ALI than Landsat.

Analyses of the extent and rates of deforestation as a result of human activities in central Belize and hurricane landfall in southern Belize illustrated that ALI data can be used effectively to determine the impacts of human activities and destructive natural events such as hurricanes on forest cover. For example, analysis of ALI data in central Belize showed that only a small portion (17 percent) of deforestation from human activities occurred in protected areas such as forest reserves, although forest reserves and other protected areas made up almost 40 percent of the study area. Changes in spectral signatures and texture related to deforestation were clearly delineated by ALI data. Classification accuracies obtained using new statistical classifiers developed for analysis of ALI are usually higher than those obtained by traditional methods.

COASTAL PROCESSES

Mapping of Padre Island National Seashore and NPS Mapping Support in Texas

James C. Gibeaut, principal investigator; William A. White

In 1980, the Bureau published a map titled Geology and Natural Environments of Padre Island National Seashore based on aerial photographs taken in 1975. The geology and the natural environments have changed significantly over the past 28 years, and now the National Park Service is funding a 2-year program to remap this dynamic environment. Bureau researchers will remap Padre Island National Seashore using the 1980 map as a template for the new map. The mapping will be based on color infrared digital orthophotos acquired in 2003, and field studies will verify the mapping. All of the mapping will be in ESRI ArcView format. Photo interpretation and mapping of geoenvironmental units will be conducted at a scale of 1:8,000 or larger. The final map will be at least as accurate as 1:24,000-scale U.S. Geological Survey Topographic Quadrangle maps.

The new map will provide data for evaluation of the many changes in both geology and natural environments that have occurred since 1975. This information is valuable for park management and helps meet the objectives of the National Inventory and Monitoring Program. This work will also benefit from ongoing studies in the Laguna Madre area funded by other sources.

Packery Channel Lidar Survey

James C. Gibeaut, principal investigator

Coastal researchers at the Bureau have conducted lidar surveys of coastal Texas since 1997, including surveys in the Mustang Island area. With funding from the Galveston District
of the U.S. Army Corps of Engineers and in conjunction with an experimental survey on Mustang Island in September and October 2003, Bureau researchers acquired additional data in the Packery Channel area and along the Gulf shoreline. These data will serve as a topographic baseline for determining the effects of opening Packery Channel on the coastal environment.

An approximately 6-km² area was mapped from the Gulf shoreline to the bay shoreline in the area where Packery Channel will be dredged. Kinematic geodetic GPS surveys of roads in the area allowed precise calibration of lidar instrumentation and provided a check on quality of data. The final product is a Digital Elevation Model with a 1- × 1-m grid in UTM zone 14 coordinate system, NAD83 horizontal datum, and NAVD88 vertical datum.

**Texas Shoreline Change Project**

James C. Gibeaut, principal investigator; Roberto Gutierrez, Rachel L. Waldinger, William A. White, Tiffany L. Hepner, Rebecca C. Smyth, John R. Andrews, and Melba M. Crawford

(Center for Space Research, The University of Texas at Austin)

Texas has a variety of shoreline types along its coastal bays and open Gulf of Mexico coast that are constantly shifting and mostly retreating landward. This retreat results in loss of private and public property and important natural habitats such as beaches, dunes, and marshes. To address this problem the Texas Legislature passed the Coastal Erosion Planning and Response Act in 1999. This act authorized the General Land Office to conduct a coastal-erosion response program. In support of the program, Bureau coastal researchers are identifying and studying eroding areas along the Gulf of Mexico and coastal bay shorelines of Texas, quantifying data gleaned from research, and creating a comprehensive, digital database of historical shoreline positions and average annual rates of shoreline change that are being made available to the public through the Internet. Funding is provided by the Texas General Land Office, Texas Coastal Management Program, and the National Aeronautics and Space Administration (NASA).

The goal of the Texas Shoreline Change Project is to develop a modern shoreline-monitoring and shoreline-change analysis program that will help guide coastal-erosion and storm-hazard-mitigation projects along bay and Gulf shorelines. This goal is being accomplished through digital rectification of historical photographs to extract past shoreline positions, airborne topographic lidar surveys for acquiring new and future shoreline data, select ground topographic transects, and establishment of Global Positioning System (GPS) reference points to support the monitoring.

Funding from NASA has enabled the Bureau to develop the application of lidar and geodetic GPS surveys for tracking coastal change. The Bureau owns and operates an Optech Inc. lidar instrument and is continually developing new and improved coastal survey techniques. We have developed processing techniques for extracting shoreline positions from the lidar data, as well as mapping sediment volumes along-shore. Spatial variation in the sand volume and elevation and shape of the beach/dune system are primary controls on the amount of damage to landward structures that can occur during storms. This work involves mapping these variations and developing new parameters to describe them for use in hazard mitigation efforts.

Selected shoreline-change data collected from various sources are now posted on a newly developed Website (using new Arc/Info Internet Map Server software) at www.beg.utexas.edu/coastal/intro.htm.

**GIS for Sand Resources of the Upper and Central Texas Coast**

James C. Gibeaut, principal investigator; Thomas A. Tremblay, Rachel L. Waldinger, and Haiyan E. Yang

Shoreline retreat along the Texas southeast coast has prompted interest in finding sources of sand for beach nourishment projects. In 2001 and 2002 and continuing in 2003, the Bureau renewed investigation of sand resources in Federal waters of the Texas continental shelf in cooperation with the Division of International Activities and Marine Minerals (INTERMAR) of the U.S. Department of Interior’s Minerals Management Service (MMS). MMS and the Bureau cooperated from 1993 through 1995 to collect and analyze data pertaining to Sabine and Heald Banks. During 2001, the earlier data were incorporated into a geographic information system (GIS). During 2003, extensive core data from the central Texas coast belonging to Rice University were added to the Web-based GIS site using ArcIMS software. Data and documentation may be viewed and downloaded from the Website at http://www.beg.utexas.edu/coastal/sand.htm. In addition to the geological data, GIS layers of obstructions to potential sand-mining operations, such as oil platforms, pipelines, shipwrecks, and navigation channels are available. Shoreline data acquired by the Bureau’s lidar system in 2000, 2001, and 2002 were also analyzed during 2003 and integrated with historical shoreline data sets that the Bureau maintains to compute short- and long-term shoreline-change rates.

**Monitoring and Evaluation of Geotubes**

James C. Gibeaut, principal investigator; Tiffany L. Hepner, Rachel L. Waldinger, Rebecca C. Smyth, John R. Andrews, and Haiyan E. Yang

Long-term shoreline retreat is occurring throughout the southeastern Texas coast. This retreat has recently received increased attention after Tropical Storms Josephine in 1996 and Frances in 1998 caused episodic erosion and the destruction and endangerment of houses and infrastructure. The erosion has prompted residents and government officials to take stopgap measures, such as geotubes, to mitigate the erosion. Geotubes are tubes with an oval cross section made of geotextile fabric. When filled with sand they have a cross section of about 12 ft. They are placed parallel to the shoreline to protect property from storm surge and erosion.

Since 1998, nine separate projects have been installed, and in March 2003 they covered a total of 7.34 mi of the Gulf shoreline from Follets Island to High Island. An additional 709 ft of tubes has been destroyed. There is concern that the tubes may eventually cause the fronting beach to narrow unnaturally and steepen and adjacent shorelines to retreat at a rate higher than they would without the geotubes in place. Even if the geotubes do not cause changes in the dynamics of the environment, they may eventually form an unacceptable landward boundary to the public beach. This study was begun in 2001 and was funded by the Texas Coastal Management Program. During 2003, a March ground survey was conducted. Analysis of 2001–2003 data was also performed and a report completed.
The report and data are available on the Bureau’s Web page at http://www.beg.utexas.edu/coastal/geotube.htm. Results will be used to develop coastal management policy concerning use of geotubes and will also aid the design of future erosion-control projects, such as beach nourishment and other geotube projects in the area.

**Texas Tidal Inlets Project: Depositional Environments and Morphodynamics of San Luis Pass**

James C. Gibeaut, principal investigator; Tiffany L. Hepner, Rachel L. Waldinger, William A. White, Rebecca C. Smyth, Roberto Gutierrez, and John R. Andrews; assisted by D. Shane Valentine

During 2002, topographic and bathymetric surveys were completed in the San Luis Pass area, a natural tidal inlet on the southeast Texas coast. During 2003, the detailed survey data acquired by lidar, ground, and echo sounder systems using geodetic GPS positioning were combined to create a seamless digital elevation model (DEM). The DEM is serving as the base for a geoenvironmental map describing various depositional environments and associated habitats of the tidal inlet system. Numerous historical aerial photographs were scanned and georeferenced to examine how the inlets, shoals, channels, and adjacent shorelines have changed through time. Preliminary analyses were presented at the Texas General Land Office’s Coastal Erosion Technical Conference.

The Texas General Land Office is funding this study because tidal inlets play a variety of critical roles. They serve as passageways for commercial and recreational vessels, as well as marine life and nutrients. Tidal inlets affect water quality in the coastal bays, and deposition of sediment near inlets forms foundations for intertidal habitats. Inlet processes are also fundamental controls on the littoral sediment budget and, hence, affect shoreline change. Full understanding of coastal-erosion problems along the Texas coast must include examination of processes occurring at 13 open inlets and several more that are periodically open.

**Patterns of Shoreline Change and Hurricane Washover on Barrier Islands**

James C. Gibeaut, principal investigator; Roberto Gutierrez; Tiffany L. Hepner, Rebecca C. Smyth, John R. Andrews, and Melba M. Crawford (Center for Space Research, The University of Texas at Austin)

This multiyear project is funded by the National Aeronautics and Space Administration’s (NASA’s) Solid Earth and Natural Hazards Program. The goal is to apply advanced terrain mapping technology to improve our understanding of storm hazards and erosion along sandy barrier-island coasts. The Bureau is using its airborne topographic lidar instrument to acquire detailed terrain models of beaches and dunes along the southeast Texas coast. With these models we can accurately track change in position of the shoreline and develop sediment volume budgets for the beach/dune system. Spatial variation in sand volume and elevation and shape of the beach/dune system is a primary control on amount of damage to landward structures during storms. This project is mapping these variations and developing new parameters to describe them.

**Characterization of the Beach Zone via Airborne Lidar and Hyperspectral Remotely Sensed Data**

James C. Gibeaut and Melba M. Crawford (Center for Space Research, The University of Texas at Austin), co-principal investigators; Roberto Gutierrez, Tiffany L. Hepner, Amy Neuschwander, William A. White, Rebecca C. Smyth, John R. Andrews, and Thomas A. Tremblay

In 2002, a highly detailed and accurate airborne topographic lidar survey was conducted over a low-lying, barrier-island test site on the southwest end of Matagorda Island, Texas. The survey was conducted over 3 days and included five separate flights. A GPS ground-reference station within the study area, data acquisition only during optimal GPS satellite conditions, survey of a calibration target on each flight, overlapping flight lines, and careful postprocessing of the raw data resulted in vertical accuracy of 5 cm and an average data-point spacing of less than 1 m. The 20-km² area is undeveloped and includes an open-ocean sandy beach, multiple dune lines, ridge-and-swale topography, stabilized back barrier and active dune fields, relict recurved spits and tidal channels, and a large relict washover/flood tidal delta fan. During 2003, a manual classification of depositional subenvironments using color infrared photography and field visits was compared with the lidar DEM. Results show that the lidar DEM significantly enhances environmental mapping of barrier islands and will provide a means of projecting how environments will change during future sea-level-rise scenarios.

Also in 2003, two highly detailed topographic lidar transects were acquired across Mustang Island. These data are being combined with ground-based vegetation and conductivity surveys to explore ways to better map wetland environments.

This project is funded by a grant from the Army and Navy through the Center for Space Research of The University of Texas at Austin. The goal of the work is to develop applications of new remote-sensing technology for the mapping of sandy barrier-island coasts. The lidar program at The University of Texas at Austin is a leader in coastal applications of airborne topographic lidar.

**Status and Trends of Wetlands on Barrier Islands, Upper Texas Coast**

William A. White, principal investigator; Thomas A. Tremblay, Rachel L. Waldinger, and Thomas R. Calnan (Texas General Land Office)

Wetlands and aquatic habitats on upper Texas Gulf coast barrier islands (Galveston Island, Bolivar Peninsula, and Follies Island) are dominated by estuarine emergent wetlands (salt and brackish marshes). Preliminary analysis of status and trends indicates that substantial salt marsh loss has occurred since the mid-1950’s. For example, preliminary analysis of wetlands on Galveston Island shows an approximately 30-percent net loss of estuarine marsh from the mid-1950’s through 2002. In the mid-1950’s, estuarine marshes on Galveston Island encompassed 5,540 acres, and in 2002 approximately 3,875 acres. Among other mapped classes, wind-tidal flats decreased in total area, whereas seagrass beds had a net loss from the 1950’s through 1979 and a net gain from 1979 through 2002. Losses in tidal flats appear to be ex-
plained partly by a rise in relative sea level, causing the flats to be replaced by other habitats, such as open water and marshes.

Historically losses and gains in habitats have occurred throughout the study area. Preliminary analysis of causes of change indicates that subsidence, local faulting, and development have contributed. Preliminary analysis of habitat distribution by geographic subarea reveals local differences in historical trends. There were systematic net losses of estuarine marshes on Galveston Island as relative sea-level rise submerged topographically low marshes from the mid-1950’s through 1979. Losses continued from 1979 through 2002 but at a slower pace. Marshes expanded into wind-tidal flats as these areas became more frequently flooded owing to subsidence and rising sea level. On Bolivar Peninsula, some estuarine marsh losses from the mid-1950’s through 1979 were due to active surface faults, along which marshes were submerged on their downthrown sides. Movement along active faults has apparently accelerated rates of relative sea-level rise, which have exceeded rates of marsh vertical accretion. As a result, several hundred acres of marsh has been submerged and replaced by open water on the downthrown side of faults. Losses along faults in this area were previously reported by Bureau researchers.

The objective of this research, funded by the National Oceanic and Atmospheric Administration through the Coastal Management Program, and Coastal Coordination Council, and with funding administered by the General Land Office of Texas, is to determine wetland status and trends and probable causes of trends along the upper Texas coast using recent and historical aerial photographs supported by field surveys. Current wetland distribution (status) was determined by interpreting and digitizing wetlands on color infrared (CIR) photographs taken in 2002. Historical distribution was based on photographs taken in the 1950’s and 1979 and on historical GIS maps obtained from the U.S. Fish and Wildlife Service (USFWS).

Coastal Hazards Atlas of Texas: A Tool for Hurricane Preparedness and Coastal Management
James C. Gibeaut, principal investigator; Thomas A. Tremblay and William A. White; assisted by Haiyan E. Yang

The Texas Coastal Management Program has funded this project to develop a Coastal Hazards Atlas. During 2002, data on coastal hazards were compiled for the south Texas coast, and the atlas and report (all digital) were completed in 2003. The rest of the Texas coast had been covered in earlier years. Information provided by the atlas is needed by local governments, State agencies, the general public, and others concerned about responsible development, environmental protection, and emergency preparedness. An atlas published by the Bureau in 1974 titled Natural Hazards of the Texas Coastal Zone inspired the current work. We completely revised and updated the earlier atlas to include current transportation routes (needed for evacuation planning), hurricane flooding areas, the best available data on subsidence and faulting, and new information on shoreline change. Geographic data for the atlas are available on the Bureau’s Website in a Web-based geographic information system (GIS) using ArcIMS software (http://www.beg.utexas.edu/coastal/coastal01.htm). Users can make custom maps and data queries online. All GIS data may also be downloaded.

Near-Surface Geophysics
Evaluating the Integrity of the Ogallala Fine-Grained Zone Using Airborne Geophysics
Jeffrey G. Paine, principal investigator

At the U.S. Department of Energy’s Pantex Plant near Amarillo, Texas, recharging groundwater encounters a permeating fine-grained zone (FGZ) above the main Ogallala (High Plains) aquifer, which is a critical source of agricultural, municipal, and industrial water. In March, airborne geophysical surveys were conducted to measure the magnitude and variation of apparent electrical conductivity of the subsurface to help assess the extent and integrity of the FGZ. We obtained time-domain electromagnetic induction data along flight lines totaling 1,243 km in length within four survey blocks located north, east, south, and west of the main Pantex Plant. Preliminary results include the observation that the conductivity structure beneath surveyed playa basins differs from that outside the basins. In particular, playas have high higher apparent electrical conductivities than do interplaya areas at shallow depths and lower apparent conductivities at equivalent deeper depths. This observation is consistent with the dissolution-induced subsidence model of playa formation, where the shallow, more conductive material represents lacustrine basin fill with high clay content and deeper, less conductive material may represent deposits disturbed by subsidence. These data will be integrated with available geological and hydrological data from survey area wells and borings to establish the relationship between stratigraphic and hydrologic characteristics and measured apparent conductivity.

Ground-Based Geophysical Investigations in the Seco Creek Area, Medina County, Texas
Jeffrey G. Paine, principal investigator

In 2002, the U.S. Geological Survey (USGS) conducted an airborne geophysical survey of the Seco Creek area in Medina and Uvalde Counties, Texas, to better understand geological and hydrological issues relating to this important recharge area for the Edwards aquifer. We began working with USGS in 2003 to conduct ground-based electromagnetic induction measurements in support of the airborne geophysical effort and to examine the influence of rock type and geological structure on geophysical measurements.

We collected ground-conductivity measurements along nine lines on and near Seco Creek, Medina County, Texas. These ground-based measurements demonstrate that (1) mapped geologic units consisting of Cretaceous limestones and dolomitized limestones, marls, mudstones, and shales and Quaternary alluvial deposits have mappable differences in apparent conductivity; (2) geologic features such as faults and karst can have detectable apparent conductivity signatures; and (3) conductivity measurements can be combined with geologic maps and outcrop studies to identify hidden contacts, covered strata, and unmapped structural features. Limited comparisons of measurements from ground and airborne instruments confirm that the instruments produce similar apparent conductivities at the same primary frequency and coil orientation. Ground instruments can be used to capture small-scale lateral conductivity change, complementing smoothed but spatially dense airborne measurements over
large areas that are inaccessible or impractical to survey using ground-based instruments.

**A New Look at Mustang Island Wetlands**
Jeffrey G. Paine, principal investigator

This project examines whether two innovative technologies—lidar (light detection and ranging) and EM (electromagnetic induction)—can be used to improve the accuracy of wetlands mapping that has historically been based chiefly on analysis of aerial photographs. Recognition of the importance of monitoring the status and trends of coastal wetlands has increased in recent decades because of our new awareness of the critical role wetlands play in the transitional aquatic-terrestrial environment and our increasing alarm at the rapid change in wetlands resulting from the rise in relative sea level. In this pilot study on Mustang Island, we will demonstrate a rapid and accurate wetland-mapping approach that will complement existing efforts in traditional photographic analysis. This project will be exploiting (1) the known strong relationship between elevation and marsh type by comparing a lidar-derived digital elevation model of Mustang Island with existing wetlands maps and detailed vegetation transects and (2) another known strong relationship between soil and water salinity and marsh type by collecting and comparing EM-derived conductivity data with elevation and vegetation type along the same detailed island transects.

**GEOLOGICAL AND TERRAIN MAPPING**

**Powder River Basin: Hydrogeology of Coalbed Natural Gas Production and Airborne Lidar Terrain Mapping**
Roberto Gutierrez, principal investigator; John R. Andrews, Alan R. Dutton, Tiffany L. Hepner, and Rebecca C. Smyth, Amy Neuenschwander and John Schutz (The University of Texas at Austin, Center for Space Research)

Production of natural gas from coal beds (CBNG) has proved to be a significant addition to U.S. natural gas resources, accounting for about 8 percent of the 2002 production of dry gas. A large percentage of this production comes from the Powder River Basin in Wyoming and Montana. Bureau researchers are now working with one of the basin’s technology leaders, Marathon Oil Company, to apply its skills in lidar high-resolution topographic mapping and hydrogeology to achieve the greatest production having the least surface and environmental impact on the basin.

In May 2002, the Bureau transported its ALTM 1225 lidar mapping system to the Powder River Basin and conducted hundreds of miles of airborne lidar and ground Global Positioning System (GPS) surveys. Data generated from the surveys were used to construct high-resolution, detailed 3-D maps called digital elevation models (DEM’s) that are currently being used to evaluate and plan a multitude of CBNG operations. Project hydrologists are using the DEM’s to delineate surface drainage features, design reservoirs and containment ponds, and model water retention and ground recharge to manage produced groundwater. These DEM’s have become an excellent tool for project engineers as they plan drill locations and design roads, surface facilities, and pipelines with minimal environmental impact. The planning results and maps are also used by landmen to communicate with landowners and by surface hydrologists to communicate with government permitting agencies. The value and wide usability of lidar-generated DEM’s have made them an indispensable tool for the development of CBNG reserves.

Bureau researchers are also providing expertise on the subsurface flow of water for the Powder River Basin. During the production of CBNG, large volumes of groundwater are produced from the coal seams to lower reservoir pressure and enable production of the adsorbed gas within the coal. Produced water in the Powder River Basin typically has low salinity and is disposed of through surface discharge in drainages and containment ponds. Marathon is working with both lidar and groundwater hydrology to provide mutually beneficial residential, agricultural, and wildlife uses for the surface water.

Critical subsurface hydrologic issues being investigated are the volume of produced water and its relation to drawdown. The Bureau is providing numerical modeling, the standard method for hydrogeologic analysis of groundwater flow in sedimentary basins, of the Powder River Basin aquifers. The regional aquifer flow model is being used to investigate hydrogeologic controls on the production of CBNG, estimate boundary conditions for local-scale reservoir models, predict pressure changes that affect production, and project the volume of produced water for disposal. This research is funded by Marathon Oil Company.

**Lidar Research and Commercial Applications Collaboration between UT Austin and Airborne 1**
Roberto Gutierrez, principal investigator

This collaboration seeks to increase the utility and usage of airborne lidar systems in scientific, environmental, and engineering applications. This agreement allows Airborne 1, a commercial lidar firm, and the Bureau to interact to develop techniques and methods that benefit both research and commercial lidar applications. The partners can investigate how efficiencies in commercial practice can be adapted to enhance the lidar research program at UT. Likewise, research applications can be examined to see whether they hold commercial potential.

**Airborne Lidar Survey for the Southern California Beach Processes Study: Point La Jolla to Dana Point**
Roberto Gutierrez, principal investigator; James C. Gilbeaut, Tiffany L. Hepner, Rebecca C. Smyth, and Amy Neuenschwander (The University of Texas at Austin, Center for Space Research)

The goal of this joint program between the University of California, Scripps Institution of Oceanography, and the Bureau is to understand beach processes in Southern California, especially the relationship between seasonal storm patterns, ocean waves, and changes in beach sand level. The specific objective of the Bureau is to collect topographic data along the coast from Point La Jolla to Dana Point and develop new methods of shoreline mapping using airborne lidar technology. Lidar surveys were conducted in May, September, and December of 2002 during periods of low tide. Additional surveys were conducted in March and October 2003. Besides mapping the shoreline and beach, lidar passes were flown offshore to map sea-surface topography for comparison with computer-model estimates of wave and swell heights. All these data are being analyzed at Scripps and at UT.
During 2003, work focused on new geologic mapping within two project areas: (1) Hill Country Trinity aquifer near Kerrville and Bandera, Central Texas, and (2) Christmas Point quadrangle—San Luis Pass area, Texas Gulf of Mexico coast. Maps of the Hill Country Trinity aquifer area will be used to make decisions regarding aquifer management and modeling, land use, and environmental protection for Central Texas, a region where population growth is causing greater demands for use of water and Earth resources. The area straddles the east edge of the Edwards Plateau, the boundary between the Edwards–Trinity aquifer of the plateau and the Hill Country Trinity aquifer. The map of the Christmas Point quadrangle includes Holocene and Pleistocene environmental geologic units associated with coastal depositional environments within this important tidal-inlet area of the Texas Gulf Coast. It will support crucial activities, such as evaluating historic changes of coastal depositional environments, addressing erosion issues, educating the public, and establishing a framework for conducting studies and presenting data for management of other Texas inlets. This mapping is supported by the STATEMAP program, part of the National Cooperative Geologic Mapping program administered by the U.S. Geological Survey for the production of geologic maps to augment the Texas and national geologic database, and includes collaboration with the Texas Water Development Board and the Texas General Land Office.

Airborne Lidar Survey of Resaca Restoration Area, Brownsville, Texas

Roberto Gutierrez, principal investigator; Tiffany L. Hepner, Rebecca C. Smyth, and Amy Neuenschwander
(Center for Space Research, The University of Texas at Austin)

The Bureau of Economic Geology and the Center for Space Research, at The University of Texas at Austin (UT), are using airborne lidar to provide elevation data over the Brownsville Resaca Restoration project area. This research stems from collaboration between UT, the City of Brownsville, NASA, and the U.S. Army Corps of Engineers to understand the effects of lidar data resolution and data collection on generation of accurate elevation data. The research contributes to technical advice provided by NASA to FEMA in requirements for map modernization in flood-risk assessment. In January 2003 the Bureau began the project with a lidar survey over Brownsville, the Rio Grande, and adjacent portions of Matamoros, Mexico.

The objectives of this project include development of accurate topographic data to assist in restoration of the Brownsville resaca system and its associated habitats. Another objective is to determine the optimal postspacing of lidar-derived DEM’s required for different levels of accuracy in the prediction of flood risk from hydrologic models. A third objective is to investigate the utility of lidar in mapping land cover and assess the effect of varying land-cover resolutions on hydrologic model results and predicted flood risk.

Geomorphic Studies of Archeological Sites
Jeffrey G. Paine, principal investigator

The Bureau is performing geomorphic studies for the Texas Department of Transportation as needed for archeological investigations. Activities include field investigations and drilling programs for selected locales, analysis of soils data, and short reports of geological observations and conclusions. The geomorphic studies are conducted to determine geomorphologic character of the locales, influences on past human activities, and effects of natural processes on cultural deposits.

PUBLIC OUTREACH

WEB-BASED EDUCATIONAL MODULES
Scott D. Rodgers, principal investigator; Robert G. Loucks, F. Jerry Lucia, Charles Kerans, Scott W. Tinker, and Xavier Janson

In 2003, the Bureau continued work on the next generation of educational, Web-based, reservoir characterization modules in collaboration with the American Geological Institute (AGI) and the American Association of Petroleum Geologists (AAPG). The new series, distributed by AAPG through the Interactive Online Learning program, focuses on carbonate reservoir characterization with content from Bureau researchers. The new modules are structured around real data sets and work-flow processes and complement the first series, already online, which illustrates the principles of reservoir characterization for fluvial depositional environments. These interactive, game-theory-based modules allow students to interact with geological, geophysical, and engineering data in the form of text, illustrations, and programmed animations; make data interpretations; and then test their answers against the instructor’s through comprehensive interactive exercises.

AUSTIN EARTH SCIENCE WEEK
Sigrid J. Clift

Earth Science Week (ESW) was observed nationwide October 12–18, 2003, and the Bureau, a member of the Austin
ESW Consortium, celebrated by sponsoring its 4th Career Day Fair. The Austin ESW Career Day Fair, organized by Bureau researcher and Austin ESW Chairperson Sigrid J. Clift and members of the Austin area ESW Consortium, treated 350 Austin-area middle school students to a day of learning about careers from earth science professionals. The following Bureau staff gave presentations: Dallas Dunlap and Scott Rodgers, who staged a 3-D view of the Earth using the Bureau’s virtual reality theater; Randy Remington, who gave a hands-on demonstration of soil properties; Becky Smyth, who made a geohazards presentation; Pat Alfano, who presented an art-in-science poster session and gave hands-on demonstrations; and Dr. Ursula Hammes, who talked about life as an exploration geologist. Other Bureau staff members served as tour guides and organizers. The Texas Earth Science Week 2003 proclamation was issued by Governor Rick Perry and Texas, State Geologist, Scott W. Tinker, wrote a message promoting the importance of earth sciences. To find out more about ESW in Austin and other cities throughout Texas, visit the Texas ESW Website at www.beg.utexas.edu/esw.

CATACLYSMS AND CATASTROPHES—THE ROLE OF SCIENCE
Roberto Gutierrez, principal investigator; Tiffany L. Hepner and Rebecca C. Smyth

This project seeks to create an innovative program of professional development for secondary science teachers centered on teachers interacting with scientists that use technology in science learning. The proposal is a collaborative effort involving The University of Texas Institute for Geophysics (UTIG), the Bureau of Economic Geology (BEG), and 4empowerment, an Austin-based private education company. We are developing and will field-test curricular materials on the basis of the role of science in causing and/or understanding catastrophes to help high school teachers incorporate the geosciences into the teaching of physics, mathematics, chemistry, and biology. Events such as the devastation caused by Hurricane Mitch in Honduras, the Chixculub asteroid impact event, and the Oklahoma City bombing will serve as the basis for inquiry-based, hands-on learning activities using data collected by UTIG and Bureau scientists. Activities will be designed to expand familiarity with technologies such as lidar (light detection and ranging), drilling, seismic reflection and refraction, geophysical logging, and the Internet.

PETROLEUM TECHNOLOGY
TRANSFER COUNCIL (PTTC)
Scott W. Tinker, Sigrid J. Clift, Sylvia J. Jennette, and Eric C. Potter; Jessica Blackshear (Student Assistant); Bob Kiker (PTTC Permian Basin Program Manager); A. Scott Anderson (Texas Independent Producers and Royalty Owners Association)

The PTTC Texas Region, for which the Bureau serves as Regional Lead Organization, sponsored a variety of workshops for Texas independent producers during 2003: Coalbed

Methane Potential in Texas, Louisiana, and Mexico; Rapid Cross-Section Generation Utilizing Riley Electric Log’s Raster Log Images and Divesto’s CrossLog Suite™ Software; New Methods for Locating and Recovering Remaining Hydrocarbons in the Permian Basin; Produced Water and Associated Issues; Reservoir Fluids 2003—PVT and Beyond; Understanding Paraffin and Asphaltene Problems in Oil and Gas Wells; and Well Cuttings. Members receive updates and technology transfer news through the PTTC quarterly newsletter, ProducerNews, which is distributed by mail to more than 1,200 independent oil and gas producers. You can visit the PTTC Texas Region Website at www.energyconnect.com/pttc/ for more information.

TEXAS HIGH SCHOOL COASTAL MONITORING PROGRAM: A PROJECT IN EDUCATION, PUBLIC AWARENESS, AND COASTAL MANAGEMENT
James C. Gibeaut, principal investigator; Tiffany L. Hepner and Rachel L. Waldinger

The Texas Coastal Monitoring Program (TCMP) is designed to help coastal residents develop a better understanding of dune and beach dynamics on the Texas coast. Bureau researchers work with high school students and teachers, teaching them to measure the topography, map the vegetation line and shoreline, and observe weather and wave conditions. As participants in an actual research project, students enhance their science education and provide coastal communities with valuable data on the changing shoreline. The TCMP, in its seventh year of operation, receives funding from the Texas Coastal Management Program, Conoco, the Exxon Foundation, and the Wray Family Trust. Participating schools are Ball (7 years in the program), Port Isabel, and Port Aransas (5 years in the program) High Schools. During the 2002–2003 school year, Bureau researchers and students made three field trips to survey sites in the nearby coastal regions. The Bureau envisions a network of coastal high schools conducting scientific beach studies and then using the Internet to share their observations with other students, schools, and the public. For more information, visit the program’s Website at inet1.beg.utexas.edu/thscmp/.
The Bureau maintains formal and informal cooperative arrangements with several governmental entities. Parts of the Bureau's research program are conducted under The University of Texas at Austin contracts and grants with Federal, State, and private organizations.

Contract-management personnel prepare proposals and budgets, negotiate contracts, and monitor expenditures. During the contract period, technical and financial reports are distributed at monthly, quarterly, and annual intervals. In 2003, the following 111 contracts, each of which had reporting requirements, were active at the Bureau:

**FEDERAL**

“Advanced Technology for Predicting the Fluid Flow Attributes of Naturally Fractured Reservoirs from Quantitative Geologic Data and Modeling”: supported by the U.S. Department of Energy (joint project with the Center for Petroleum and Geosystems Engineering).

“Analysis of Soil Remediation Requirements of Abandoned Centralized and Commercial Drilling-Fluid Disposal Sites”: supported by the U.S. Department of Energy.

“Cataclysms and Catastrophes—The Role of Science”: supported by the National Science Foundation through the Institute for Geophysics.

“Characterization of the Beach Zone via Airborne Lidar and Hyperspectral Remotely Sensed Data”: supported by the Army Research Office through the Center for Space Research.

“Combining a New 3-D Seismic S-Wave Propagation Analysis for Remote Fracture Detection with a Robust Subsurface Microfracture-Based Verification Technique”: supported by the U.S. Department of Energy.

“Committee to Evaluate a Hydrologic Observatory”: supported by the National Science Foundation through the Consortium of Universities for the Advancement of Hydrologic Science, Inc.


“Evaluation and Validation of EO-1 and Landsat 7 Imagery through an Analysis of Land Cover/Land Use and Rates of Deforestation in Belize, Central America”: supported by the National Aeronautics and Space Administration.

“Evaluation of Design, Monitoring, and Modeling Issues Related to Engineered Covers of Waste Containment”: supported by the U.S. Environmental Protection Agency.

“Exploring for Subtle Mission Canyon Stratigraphic Traps with Elastic-Wavefield Seismic Technology”: supported by the U.S. Department of Energy through Vecta Technology, L.P.

“Feasibility Study for the Establishment of a National Geoscience Data System” supported by the U.S. Department of Energy through the American Geological Institute. Additional support under this contract also funded the following tasks: “Web-Based Educational Modules Describing Reservoir Characterization Technology,” “GeoTrek Integration Project,” and “Energy Posters for High School Earth Science Curricula.”


“Integrating P-Wave and S-Wave Seismic Data to Improve Characterization of Oil Reservoirs”: supported by the U.S. Department of Energy through Prairie View A&M University.


“Managing Karst Aquifers, Applications of Laser Terrain Mapping and Other Remotely Sensed Data in Central Texas”: supported by National Aeronautics and Space Administration through the California Institute of Technology, Jet Propulsion Laboratory.
“Mapping of Padre Island National Seashore and NPS Mapping Support in Texas”: supported by the National Park Service, U.S. Department of the Interior.

“Multidisciplinary Imaging Rock Properties in Carbonate Reservoirs for Flow Unit Targeting”: supported by the U.S. Department of Energy.

“New Geologic Mapping of the Seymour Aquifer of the Vernon, Texas, 30 x 60 Quadrangle (1:100,000)”: supported by the U.S. Geological Survey, U.S. Department of the Interior.


“Patterns of Shoreline Change and Hurricane Washover on Barrier Islands”: supported by National Aeronautics and Space Administration.


“Please Pass the Salt: Finding Solutions for Subsurface Disposal of Concentrate from Desalination Plants”: supported by the Bureau of Reclamation, U.S. Department of the Interior through the Texas Water Development Board.

“Predicting Fracture Porosity Evolution in Sandstone”: supported by the U.S. Department of Energy.


“Reviving Abandoned Reservoirs with High Pressure Air Injection: Application in a Fractured and Karsted Dolomite Reservoir”: supported by the U.S. Department of Energy.


“Sequestration in Saline Formations”: supported by the Lawrence Berkeley National Laboratory.

“Shear Wave Seismic Study: Comparing 9C3D SV and SH Images with 3C3D C-Wave Images”: supported by the U.S. Department of Energy through Vecta Technology, L.P.

“Startup of a Public Geological Core and Sample Repository in Houston, Texas”: supported by the U.S. Department of Energy.

“Support for the Curation of Academic Research Cores, Samples, and Collections in the Geosciences”: supported by the National Science Foundation.

“A Technology Transfer Program, Texas Region of the Petroleum Technology Transfer Council”: supported by the Petroleum Technology Transfer Council.

“TDEM Survey and Report w/TX Bureau of Economic Geology”: supported by the U.S. Department of Energy through BWXT Pantex.


“Archeological Projects—Assistance to the Texas Department of Transportation”: supported by the Texas Department of Transportation.

“Evaluation of Beach Nourishment Sand Resources along the Central Texas Coast: Follets Island North Padre Island”: supported by the Texas General Land Office.

“Evaluation of Nitrate Contamination in Selected Aquifers in Texas”: supported by the Texas Commission on Environmental Quality.

“Fate and Transport Short Course FY03 and FY04”: supported by the Texas Commission on Environmental Quality (two contracts).

“Field Validation of Geologic Assessment of Features Sensitive to Pollution in Karst and Development of Best Management Practices”: supported by the Texas Commission on Environmental Quality.

“Groundwater Availability Model of Central Part of the Carrizo-Wilcox Aquifer in Texas”: supported by the Texas Water Development Board.

“Gulf Coast Carbon Center”: supported by the John A. and Katherine G. Jackson School of Geosciences, The University of Texas at Austin.

“Insufficient of Conceptual Model of Fracture/Conduit Flow in the Recharge Zone of the Edwards Aquifer”: supported by Edwards Aquifer Authority.

“Inclusion of Queen City and Sparta Aquifers into Existing Carrizo-Wilcox Aquifers”: supported by the Texas Water Development Board through Intera, Inc.

“Monitoring and Evaluation of Geotubes during 2002/2003”: supported by the Texas General Land Office.

“A New Look at the Mustang Island Wetlands”: supported by the Texas General Land Office.

“Ogallala GAM Model”: supported by the Texas Water Development Board through Daniel B. Stephens & Associates, Inc.
“Phase III, Playa Lakes Study”: supported by the Texas Water Development Board.

“Quantification of Recharge for Evaluation of Groundwater Availability and Vulnerability to Contamination and Short Course on Groundwater and Surface Water Interactions”: supported by the Texas Commission on Environmental Quality.

“Sierra Blanca Ranch Project FY02-FY04”: supported by the Texas General Land Office.

“Status and Trends of Wetlands on Texas Barrier Islands, Upper Coast”: supported by the Texas General Land Office.

“Status and Trends of Wetlands, Upper Coast from East Matagorda Bay to Christmas Bay”: supported by the Texas General Land Office.

“Status and Trends of Wetlands on Texas Barrier Islands—South Padre Island”: supported by the Texas General Land Office.

“Technical Editing for the TWDB FY03 and FY04”: supported by the Texas Water Development Board (two contracts).

“Technology Center for Oil and Gas Recovery Optimization on Texas State Lands”: supported by the State of Texas.

“Texas High School Coastal Monitoring Program: Ball High School, Galveston, Years 5 and 6”: supported by the Texas General Land Office through Galveston Independent School District (two contracts).

“Texas High School Coastal Monitoring Program: Port Aransas High School, Years 3 and 4”: supported by the Texas General Land Office through the Port Aransas Independent School District (two contracts).

“Texas High School Coastal Monitoring Program: Port Isabel High School, Years 3 and 4”: supported by the Texas General Land Office through the Point Isabel Independent School District (two contracts).

“The Texas Shoreline Change Project: Coastal Mapping of West and East Bays in the Galveston Bay System Using Airborne Lidar”: supported by the Texas General Land Office.

“The Texas Shoreline Change Project—Gulf of Mexico Shoreline from Sabine Pass to the Brazos River, Pass Cavallo to Aransas Pass and the Padre Island National Seashore”: supported by the Texas General Land Office.

“The Texas Shoreline Change Project—Gulf of Mexico Shoreline from Mansfield Channel to Rio Grande and Shorelines in Matagorda, Copano/Aranas, and Corpus Christi Bays”: supported by the Texas General Land Office.

“Texas Tidal Inlets Project: Depositional Environments and Morphodynamics of San Luis Pass”: supported by the Texas General Land Office.

“University Lands Advanced Recovery Initiative”: supported by the University of Texas System.

“Vadose Zone Hydrogeology FY2003”: supported by the Texas Commission on Environmental Quality.

PRIVATE

“Airborne Lidar Survey for the Southern California Beach Processes Study: Point La Jolla to Dana Point”: supported by the University of California, San Diego.

“Airborne Lidar Survey near Sheridan, Wyoming”: supported by Marathon Oil Company.

“Airborne Lidar Survey of Resaca Restoration Area, Brownsville, Texas”: supported by the Brownsville Public Utilities Board.

“Analysis of Regional Hydrogeological Data and Flow Models for Support of Coalbed Natural Gas Reservoir Management”: supported by Marathon Oil Company.


“BP Azerbaijan Outcrop Study”: supported by the Azerbaijan International Operating Company.

“Customization of the Virtual Reality 3-D Model of the Edwards Aquifer”: supported by the Witte Museum.

“Definition of the Geologic Framework of the Neogene in the Southern Laguna Madre-Tuxpan Continental Shelf of Eastern Mexico”: supported by PEMEX. Additional support under this contract also funded the project entitled “Definition of the Geological Framework and Exploration Plays of the Miocene of the Burgos Basin, Northern Mexico.”

“Detailed Architectural Analysis of Late Cretaceous Channel Complexes in the Magallanes Basin, Chile”: supported by Shell International Exploration and Production Inc.

“Development of the 2005 Panhandle (Region A) Regional Water Plan”: supported by Freese and Nichols, Inc.

“Differential Azimuth Moveout”: supported by Total E&P Services.


“Groundwater Analysis and Modeling”: supported by the Panhandle Groundwater Conservation District.

“Groundwater Analysis for Panhandle Groundwater Conservation District”: supported by the Panhandle Groundwater Conservation District.

“ILRIS Survey of Syncrude Open Pit Mine”: supported by Imperial Oil Resources.
"Integrated Geological and Engineering Characterization of the Fullerton Clear Fork Field in Andrews County, Texas": supported by ExxonMobil Production Company.

"Integrated Reservoir Characterization of the Tamabra Reservoir of the Poza Rica Field in a Sequence Stratigraphic Framework, Phase II": supported by PEMEX.

"Lidar Research and Commercial Applications Collaboration between UT Austin and Airborne 1": supported by Airborne 1 Corporation.

"Multicomponent and Multifrequency Seismic for Assessment of Fluid-Gas Expulsion Geology and Gas Hydrate Deposits: Gulf of Mexico": supported by Louisiana State University.

"Packery Channel Lidar Survey": supported by G.E.C., Inc.

"Plume Research Group: Integrated Regional, Site-Specific, and Theoretical Studies of Ground-Water Contaminant Plumes": supported by the ExxonMobil Foundation.

"Preparation of Baku Lidar Data for HIVE": supported by the Azerbaijan International Operating Company.

"Rangely Colorado Fluvial Workshop": supported by ExxonMobil Upstream Research Company.

"Recent Shoreline Change along the Southeast Texas Coast": supported by Galveston County.


"Reservoir Characterization of the Ghawar Field": supported by Aramco Services Company.


"Seismic Vector-Wavefield Imaging": supported by Vecta Technology, L.P.

"Support of EarthView Texas by the Shell Foundation.”

"Support of the Texas High School Coastal Monitoring Program": supported by the Margaret Cullinan Wray Trust.

"Updated Benefit/Cost Analysis of Gas Technology Institute’s Initiative for a Program of Research and Development of Ultra-Deepwater and Unconventional Resource Exploration and Production Technologies": supported by Gas Technology Institute through New Mexico Institute of Mining and Technology.

"Workshop on Detailed Architectural Analysis of a Jurassic Fluvial Channel Complex, Southern Colorado": supported by ExxonMobil Upstream Research Company.

"Workshop on Detailed Architectural Analysis of a Miocene Channel Complex, Tabernas Basin, Spain": supported by Shell International Exploration and Production, Inc.

"Workshop on Exposures of Cretaceous Fluvial Deposits": supported by the University of Wyoming.

"Workshop on Exposures of Ross Sandstone, Western Ireland": supported by the University of Colorado, Energy and Minerals Applied Research Center.

"Workshop on the Green River Fluvial Outcrops": supported by Utah State University.

"Workshop on Petrophysical Characterization of Carbonate Reservoirs": supported by Aramco Services Company.
Lectures and Public Addresses

William A. Ambrose
“Defining hydrocarbon plays in Mexico”: presented at Meeting of the Texas PTTC Producers Advisory Group and State of Texas Policy Makers, Austin, Texas.

Renaud Bouroullec
“An overview on the kinematics of syndepositional faults using multidisciplinary approaches: Gulf of Mexico, Niger delta, Congo margin, and French Alps case studies”: presented to Department of Geological Sciences, The University of Texas at Austin.

“Mississippi Canyon/Atwater Valley area, northern Gulf of Mexico: tectonics, stratigraphy and petroleum system modeling”: presented to ENI-AGIP, Houston, Texas.

“Regional structural setting, Mississippi Canyon/Atwater Valley area, northern Gulf of Mexico”: presented to Emarc Industrial Consortium, Petroleum Systems of the Mississippi Canyon/Atwater Valley Area, Northern Gulf of Mexico, Annual Meeting, Boulder, Colorado.

“Salt tectonics of the Mississippi Canyon/Atwater Valley area, Northern Gulf of Mexico”: presented to BP, Houston, Texas.

“Structural/tectonic/stratigraphic setting of the greater Thunder Horse/Mensa area, Mississippi Canyon, northeastern Gulf of Mexico: overview for 3-D study”: presented to Emarc Industrial Consortium, Petroleum Systems of the Mississippi Canyon/Atwater Valley Area, Northern Gulf of Mexico, Annual Meeting, Boulder, Colorado.

“Tectono-stratigraphic framework of the Mississippi Canyon/Atwater Valley area, northern Gulf of Mexico”: presented to Devon Energy Corporation, ENI-AGIP, ConocoPhillips, ExxonMobil, Norsk Hydro, and NewField Exploration Company, Houston, Texas.

Sigrid J. Clift
“Visualizing Texas natural resources in 3-D—promoting public awareness”: presented at Meeting of the Texas PTTC Producers Advisory Group and State of Texas Policy Makers, Austin, Texas.

Edward W. Collins
“Time, land, and Barton Creek—an excursion to Shield Ranch, Travis and Hays Counties, Texas”: field trip for the Austin Geological Society, Austin, Texas.

Shirley P. Dutton
“Calcite cement distribution in Permian turbidite sandstones, West Texas”: presented to SEPM Sandstone Diagenesis Research Group, Salt Lake City, Utah.

“Diagenesis and reservoir quality”: presented at Energy, Engineering, and the Environment Workshop for PEMEX at The University of Texas at Austin, Austin, Texas.

“Increasing reserves and improving oil recovery—play analysis of the Permian Basin”: presented at Meeting of the Texas PTTC Producers Advisory Group and State of Texas Policy Makers, Austin, Texas.


William L. Fisher
“Moving to a methane economy and its implications”: presented to SIPES, Austin Chapter, Austin, Texas.

“Oil and gas industry: a global perspective”: presented to Internal Revenue Service, Petroleum Industry Conference, Houston, Texas.

Sergey Fomel
“Anelliptic approximations in VTI media”: presented at Exploration Geophysics Research Seminar, Jackson School, The University of Texas at Austin, Austin, Texas.

“Angle-domain seismic imaging and the oriented wave equation”: presented at GXT and BP seminars, Houston, Texas.

“Angle-domain seismic imaging and the oriented wave equation”: presented to PGS, Houston, Texas.

“Angle-domain seismic imaging and the oriented wave equation”: presented at 73rd Annual International Meeting, Society of Exploration Geophysicists, Dallas, Texas.


“Multicomponent data registration and the oriented wave equation”: presented at Exploration Geophysics Seminar, The University of Texas at Austin, Austin, Texas.

“Multicomponent data registration and the oriented wave equation”: presented at Conference on Interpreting Reservoir Architecture Using Scale-Frequency Phenomena, Oklahoma City, Oklahoma.

“Multicomponent seismic data registration by least squares”: presented at EGL Sponsor Meeting, Dallas, Texas.

“Multicomponent seismic data registration by least squares”: presented...
at Exploration Geophysics Laboratory Sponsor Meeting, Bureau of Economic Geology, Austin, Texas.

“Multicomponent seismic data registration by least squares”: presented at 73rd Annual International Meeting, Society of Exploration Geophysicists, Dallas, Texas.

“Multicomponent seismic data registration for subsurface characterization in the shallow Gulf of Mexico”: presented at Offshore Technology Conference, Houston, Texas.

“Plane wave destruction: a tool for seismic data analysis and attribute extraction”: presented at EDGER Technical Symposium, Department of Geosciences, The University of Texas at Austin, Austin, Texas.

“Rays, fronts, and waves: traveltimes in seismic imaging”: presented at SIAM Conference on Mathematical and Computational Issues in the Geosciences, Austin, Texas.

“Seismic elastic modeling”: presented at Exploration Geophysics Laboratory Sponsor Meeting, Bureau of Economic Geology, Austin, Texas.

“Seismic fracture detection”: presented at AAPG Fractured Reservoir Characterization and Modeling School, Austin, Texas.

“Wave-equation imaging: problems and solutions”: presented at TRIP seminar, Rice University, Houston, Texas.

Julia F. (Stowell) Gale

“Fractures in Central Texas”: field trip for Oil & Gas Consultants International, Inc., Austin, Texas.

“Predicting and characterizing fractures in hydrocarbon reservoirs: using the link between diagenesis and fracturing”: presented at Houston Structural Geology Group Meeting, Bureau of Economic Geology Houston Core Facility.

James C. Gibeaut

“Coastal geological studies in support of coastal management”: presented to Coastal Geography Graduate Class, Texas State University, San Marcos, Texas.

“Geotubes for temporary erosion control and storm surge protection along the Gulf of Mexico shoreline of Texas”: poster presentation at Coastal Zone 03: Coastal Zone Management through Time, Baltimore, Maryland.

Bob A. Hardage

“Applications of time-warped P and S seismic data”: presented at Oklahoma Geologic Survey Conference, Oklahoma City, Oklahoma.

“Integrating multicomponent VSP with surface-recorded multicomponent seismic data”: workshop presented at Baker Atlas Workshop, Houston, Texas.

“Integration of VSP and multicomponent seismic data”: presented at VSFusion Seminar, Calgary, Canada.

“Integration of VSP and multicomponent seismic data”: presented at VSFusion Seminar, Houston, Texas.

“Integration of borehole and surface multicomponent seismic data”: presented at VSFusion Seminar, Stavanger, Norway.

“Multicomponent seismic applications to rock physics—think vectors”: keynote presentation to European Association of Geoscientists and Engineers, Stavanger, Norway.

“Multicomponent seismic data—an emerging technology that will affect small independents”: presented to Society of Independent Professional Geologists and Scientists, Austin, Texas.

“Multicomponent seismic research”: presented to ExxonMobil management team, Austin, Texas.

“Multicomponent seismic technology”: workshop presented jointly with WesternGeco, Houston, Texas.

“Multicomponent seismic technology for small independents”: presented at Texas Independent Producers and Royalty Owners Annual Convention, San Antonio, Texas.

“Status report and overview of Exploration Geophysics Laboratory research program”: presented to EGL sponsors, Dallas, Texas.

“Vertical profiling and multicomponent imaging—two important seismic technologies in reservoir management”: presented to Society of Professional Economic Engineers, Houston, Texas.

VSP Short Course: presented to industry, Buenos Aires, Argentina.

Mark H. Holtz


Susan D. Hovorka


Michael R. Hudec

“AGL technology transfer: the Salt Mine and the AGL Website”: Petrobras Corporate University, Rio de Janeiro, Brazil.

“A new look at Angolan salt tectonics, tectonostratigraphy, and differential uplift in the Kwanza Basin”: presented to ExxonMobil.

“Deepwater deformation in the lower Congo Basin, Gabon”: presented to Woodside Petroleum, Ltd., Australia.

“Effects of basement uplift on passive-margin salt basins: new insights from the Kwanza Basin, Angola”: Petrobras Corporate University, Rio de Janeiro, Brazil.

“Effects of basement uplift on passive-margin salt basins: new insights from the Kwanza Basin, Angola”: Petrobras Corporate University, Rio de Janeiro, Brazil.

“Effects of rift segmentation on salt tectonics, Kwanza Basin, Angola”: Petrobras Exploration and Production, Rio de Janeiro, Brazil.

“Effects of rift segmentation on salt tectonics, Kwanza Basin, Angola”: Petrobras Corporate University, Rio de Janeiro, Brazil.

“Estranged neighbors: independent tectonic evolution of the onshore and offshore Kwanza salt basins, Angola”: Petrobras Corporate University, Rio de Janeiro, Brazil.
“Influence of precursor salt structures on thrust faulting, deepwater Gabon”: presented to ExxonMobil.

“Overview of salt modeling: the Applied Geodynamics Laboratory”: presented to Anne Rieckmann and managers from ExxonMobil.

“Principles and applications of salt tectonics”: 8th International Congress of the Brazilian Geophysical Society, Rio de Janeiro, Brazil.

“Principles and applications of salt tectonics”: presented to Woodside Petroleum, Ltd., Australia.

“Salt and extensional tectonics in the Paradox Basin”: field trip for AAPG Field Seminar, Moab, Utah.


Martin P. A. Jackson


“Latest thoughts on salt”: presented to BP, Austin, Texas.


“Structural restoration of minibasins translating down a ramp, deep-water Kwanza Basin, Angolan passive margin”: presented to Woodside Petroleum, Ltd., Australia.

“3-D Geometry, tectonostratigraphy, and kinematics of a gravity-driven linked system in deepwater Lower Congo Basin, Gabon”: presented to ExxonMobil, Houston, Texas.

“The great escape: pressurized extrusion of allochthonous salt sheets in orogenic belts”: presented to Applied Geodynamics Laboratory Industrial Associates, Austin, Texas.

“3-D Geometry, tectonostratigraphy, and kinematics of a gravity-driven linked system in deepwater Lower Congo Basin, Gabon”: presented to ExxonMobil, Houston, Texas.

James W. Jennings, Jr.
“Introduction to geostatistics for reservoir characterization and modeling”: presented to GEO 383, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

“Modeling caprinid mounds in the Pipe Creek Reef, Glen Rose Formation, Central Texas”: presented at RCRL Annual Meeting, Austin, Texas.

“Predicting permeability from well logs in carbonates with a link to geology for interwell permeability mapping”: presented to Dutch Petrophysical Society, Delft, The Netherlands.

“Principles of carbonate reservoir flow model construction”: presented at RCRL Annual Meeting, Austin, Texas.

“Spatial statistics of carbonate permeability and the resulting scale effects in data analysis and modeling”: presented to Sarawak Shell, Lutong, Malaysia.

“Statistical analysis, spatial statistics, scaleup, and model construction in carbonate reservoirs”: Short Course Section: Carbonate Reservoir Characterization and Modeling, Carlsbad, New Mexico.


“3-D modeling of stratigraphically controlled petrophysical variability in the South Wasson Clear Fork reservoir”: presented to Sarawak Shell, Lutong, Malaysia.


“3-D modeling of stratigraphically controlled petrophysical variability in the South Wasson Clear Fork reservoir”: presented to the Society of Petroleum Engineers Reservoir Studies Group, Midland, Texas.

“What was it like to be a visiting
Charles Kerans
"Bringing outcrops to life as animated 3D models: application to Wolfcamp deepwater carbonate play": presented at PBS-SEPM luncheon meeting, Midland, Texas.
"Cretaceous rudist reefs of Pipe Creek area": field trip for AAPG Student Chapter, Lake Medina, South Texas.
"Industrial research consortiums—developing new methods to better understand hydrocarbon reservoirs": presented at Meeting of the Texas PTTC Producers Advisory Group (PAG) and State of Texas Policy Makers, Austin, Texas.
"Integrated analysis of the Cogdell field—stratigraphic framework from core, logs, and 3D seismic data": presented at Reservoir Characterization Research Laboratory Annual Review, Austin, Texas.
"Review of icehouse characteristics and reservoirs—new generalizations": presented at Reservoir Characterization Research Laboratory Annual Review, Austin, Texas.
"Stratigraphic patterns and controls on reservoir quality of the giant Poza Rica field, Albian, Cretaceous, Mexico": presented at Reservoir Characterization Research Laboratory, Austin, Texas.
STGS Pipe Creek Field Trip: South Texas Geological Society and Gulf Coast Section SEPM, Lake Medina, South Texas, April 2003.
STGS Pipe Creek Field Trip: South Texas Geological Society and Gulf Coast Section SEPM, Lake Medina, South Texas, November 2003.
"3D modeling of carbonate outcrops and application to deep-water systems, Victorio Canyon": presented to ExxonMobil Upstream Research Company, Houston, Texas.
"3D modeling of deep-water carbonate outcrops, Victorio Canyon": presented to Reservoir Characterization Division, ExxonMobil Upstream Research Company, Houston, Texas.

Stephen E. Laubach
"Advanced technology for predicting the fluid flow attributes of naturally fractured reservoirs from quantitative geologic data and modeling": presented to U.S. Department of Energy, Tulsa, Oklahoma.
"Fracture characterization" (invited keynote lecture): presented at Université de Liège, Liège, Belgium.
"Fractures in reservoirs: prediction, characterization, and incorporation in fluid-flow simulations": SPE Distinguished Lecture: presented to Society of Petroleum Engineers, Dongying, China.
"Future research opportunities for structural geologists in the petroleum industry": presented at Student Seminar, Department of Geology, University of Idaho, Moscow, Idaho.
"Linked mechanical and chemical processes in the development of fracture patterns": presented at Departmental Speaker Series, Department of Geology, University of Idaho, Moscow, Idaho.
"Recent trends in fractured reservoir analysis": presented to Society of Petroleum Engineers, Dongying, China.
"Surrogate analysis and microstructure imaging": presented at Fracture Research and Application Consortium Workshop, Jackson, Wyoming.

Robert G. Loucks
"Ellenburger palecave reservoirs: origins, burial-depth modifications, spatial complexity, and reservoir implications": half-day seminar presented to the Roswell Geological Society, Roswell, New Mexico.
"Origin of growth-faulted subbasins in South Texas and sequence stratigraphic analysis of associated sediment fill": presented at University of Oklahoma’s Shell Oil Colloquium series, Norman, Oklahoma.
"Origin of Lower Ordovician Ellenburger Group brecciated and fractured reservoirs in West Texas: Paleocave, thermobaric, tectonic, or all the above?": invited lecture: presented at the University of Mississippi, Oxford, Mississippi.
"Overview of breccia- and fracture-forming processes in Ordovician carbonates": presented at University of Oklahoma’s Shell Oil Colloquium series, Norman, Oklahoma.
"Paleocave reservoirs": invited lecture: presented at the University of Mississippi, Oxford, Mississippi.
"Underexplored deep-gas potential in the Gulf of Mexico": presented at Meeting of the Texas PTTC Producers Advisory Group and State of Texas Policy Makers, Austin, Texas.

F. Jerry Lucia
"Petrophysics of Pipe Creek rudist bioherm": presented at Reservoir Characterization Research Laboratory Annual Review Meeting, Austin.
"Rock fabric and pore types; Cogdell Pennsylvanian Reservoir": presented at Reservoir Characterization Research Laboratory Annual Review Meeting, Austin, Texas.
"Sequence stratigraphy and rock fabrics, the keys to constructing realistic petrophysical models of carbonate reservoirs": presented to ChevronTexaco, Houston, Texas.

Paul Murray
"Using multicomponent seismic data for shallow sedimentary properties in the Gulf of Mexico": presented at
Geophysical Seminar Series, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

Jean-Philippe Nicot
“Fate and transport”: presented to Texas Commission on Environmental Quality, Austin, Texas (May).

“Fate and transport”: presented to Texas Commission on Environmental Quality, Austin, Texas (June).

Jeffrey G. Paine
“Airborne geophysics: applications and advances in environmental and engineering investigations”: presented at Symposium on the Application of Geophysics to Engineering and Environmental Problems, Environmental and Engineering Geophysical Society, San Antonio, Texas.

“Applying airborne electromagnetic induction in groundwater salinization and resource studies, West Texas”: presented at the Ninth European Meeting of Environmental and Engineering Geophysics, Prague, Czech Republic.

“Applying airborne electromagnetic induction in groundwater salinization and resource studies, West Texas”: presented at the Symposium on the Application of Geophysics to Engineering and Environmental Problems, San Antonio, Texas.

“Assessing vibration susceptibility over shallow and deep bedrock using accelerometers and walkaway surveys”: presented at the Symposium on the Application of Geophysics to Engineering and Environmental Problems, San Antonio, Texas.

“Evaluating the integrity of the Ogallala FGZ using airborne geophysics”: presented to U.S. Department of Energy and BWXT Pantex, Amarillo, Texas.


“GPR investigation of the UT Charter School site, Travis County, Texas”: presented to the University of Texas System and The University of Texas at Austin Environmental Health and Safety Office, Austin, Texas.

“Near-surface geophysics: instruments, platforms, and applications”: presented to Daniel B. Stephens & Associates, Austin, Texas.


Eric Potter
“Geologists and geographers making a difference”: presented at Texas Community College Teachers Association Annual Convention, Austin, Texas.

“Texas Bureau of Economic Geology’s research collaboration with Pemex: what do the Mexican gas basins look like?”: presented to Texas Trade Mission to Mexico, Mexico City, Mexico.

Robert M. Reed

Bridget R. Scanlon
“Assessment of groundwater surface water interactions”: presented to EPA Region 6, Dallas, Texas.

“Atmospheric and land surface measurements in a prototype hydrologic observatory”: presented to American Geophysical Union (with W. Krajewski, J. Famiglietti, and C. J. Duffy).

“Defining the need for augmented recharge—techniques for quantifying recharge”: presented to California Groundwater Resources Association, San Jose, California.


“Estimating groundwater recharge to Texas aquifers using unsaturated zone modeling”: poster presented to Austin Geological Society, Austin, Texas (with K. Keese and R. C. Reedy).

“Fate and transport”: presented to Texas Commission on Environmental Quality, Austin, Texas (with J. P. Nicot).

“Groundwater surface water interactions”: presented to Texas Commission on Environmental Quality, Austin, Texas.

“Interactions of groundwater and surface water”: presented at Regional EPA Meeting at Texas Commission on Environmental Quality, Austin, Texas.


“Modeling Barton Springs aquifer”: presented to Barton Springs Edwards Aquifer Authority, Austin, Texas.


“Role of vegetation in controlling water balance at the land-atmosphere interface in water limited ecosystems”: presented to American Geophysical Union (with D. Levitt, M. J. Sully, K. Keese, R. C. Reedy, J. Simunek, L. Desotell, and C. Lohstrofer).


Scott W. Tinker
“Bureau introduction and overview”: presented at meeting of the Texas PTTC Producers Advisory Group and State of Texas Policy Makers, Austin, Texas.

“Carbonate sequence stratigraphy: outcrop and subsurface seminar”: presented at American Association of Petroleum Geologists Field Seminar, New Mexico and Texas.


“The coming natural gas economy”: presented to the Michigan Oil & Gas Association (invited), Mt. Pleasant, Michigan.


“Decarbonization—the coming natural gas economy”: presented to COGA, Rocky Mountain Natural Gas Conference, Denver, Colorado.
From rocks to lasers: today’s Bureau of Economic Geology and how it impacts Texas”: presented to Northwest Austin Rotary Club, Balcones Country Club, Austin, Texas.

“Geologic curation, the BEG, and the Houston Research Center”: presented at National Science Foundation Workshop, Preservation of Scientific Research Cores and Collections, Bloomington, Indiana.

“Lasers light the way: 3-D outcrops will revolutionize subsurface modeling”: keynote speaker: presented to the Rocky Mountain Association of Geologists, Denver, Colorado.

“Natural gas demand and opportunities in Texas and Mexico”: invited speaker: presented to the CWC Group of Companies, Seminar on Opportunities for the Mexican Gas Market: Powering the Future, Houston, Texas.


“Summary of a Workshop on U.S. Natural Gas Demand, Supply, and Technology: Looking to the Future”: presented to Kathie Olsen and staff, Office of Science and Technology Policy, Executive Office of the President, National Research Council of the National Academies, Washington, D.C.

“Upstream technology for the coming gas economy”: presented as 2002–03 Society of Petroleum Engineers Distinguished Lecture Program (five lectures in the United States and two in Canada; N. Africa, Middle East, and Far East trips cancelled owing to war in Iraq).

“Upstream technology for the coming gas economy”: presented at 65th EAGE Conference and Exhibition, Stavanger, Norway.

“Upstream technology for the coming gas economy”: presented to Society of Petroleum Engineers, Austin Section, Austin, Texas.


Fred P. Wang
“3-D reservoir modeling using Petrel”: presented to El Paso Production, Inc., Houston, Texas.

Laura Zahm
“Database management using SAS”: seminar presented to Amerada Hess Corporation, Austin, Texas.

Hongliu Zeng
“Log properties from seismic attributes—a frequency decomposing approach”: presented at Forum for Exploration and Development Geophysics Education and Research, The University of Texas at Austin, Austin, Texas.

“Seismic applied to lithology: facies imaging, attribute analysis, and inversion”: presented to Pemex, Villahermosa, Mexico.

“Seismic frequency control on seismic stratigraphy”: presented at the Petroleum University of China, Beijing, China.

William A. Ambrose
“Definition of the geological framework of the Neogene in the southern Laguna Madre-Tuxpan continental shelf of eastern Mexico”

Renaud Bouroullec
“An overview on the kinematics of syndepositional faults using multidisciplinary approaches”

L. Frank Brown, Jr.
“Sequences, depositional systems, and synsedimentary tectonics, Oligocene rocks, Corpus Christi region, South Texas: revisiting mature fields with new prospecting tactics”

Bob A. Hardage
“Multicomponent seismic technology: principles and applications”

Martin P. A. Jackson
“Salt glaciers: a geological wonder of the world”

Robert G. Loucks
“Origin of Ordovician brecciated and fractured reservoirs: paleocave, thermobaric, tectonic, or all the above?”

Robert M. Reed
“Introduction to the Bureau’s scanning electron microscope”

Bridget R. Scanlon
“Relationship between climate and vegetation dynamics in water limited systems, monitoring and modeling analysis”

Rebecca C. Smyth
“Forensic hydrogeology applied to a half-century-old crude-oil seep, Colorado River, Wharton County, Texas, U.S.A.”

Lesli J. Wood
“Mud volcanoes, shale diapirs, and fluid systems: making mud pies on a grand scale”

COMMITTEE SERVICES, OFFICES, AND OTHER PROFESSIONAL RESPONSIBILITIES

Caroline Breton
Member, Austin Earth Science Week Consortium

Renaud Bouroullec
Member, M.S. Thesis Committee, Aaron van den Berg, University of Colorado at Boulder
Member, M.S. Thesis Committee, John Martin, University of Colorado at Boulder, Boulder, Colorado.
Member, M.S. Thesis Committee, Ryan Sincavage, University of Colorado at Boulder

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Chair, Austin Earth Science Week, Austin, Texas
Coordinator, Austin Earth Science Week Career Fair
Chair, Decision Makers Field-Trip Committee, Bureau of Economic Geology

Member, Bureau Informational Data Services Task Force Committee, Bureau of Economic Geology

Member, Bureau Log Scanning Task Force Committee, Bureau of Economic Geology

Member, Bureau Support Staff Promotions Committee, Bureau of Economic Geology

Member, Jackson School Outreach Committee, Jackson School of Geosciences, The University of Texas at Austin

Member, Media Production Manager Task Force Committee, Bureau of Economic Geology

Dallas B. Dunlap
Member, Bureau Log Scanning Task Force Committee, Bureau of Economic Geology

Shirley P. Dutton
Invited participant, NSF Workshop on Preservation of Geoscience Research Cores and Collections: the View from Academic Researchers

Member, Committee on Graduate Student Admission and Support Policies in the Jackson School, Jackson School of Geosciences, The University of Texas at Austin

Member, Graduate Admissions and Support Committee, Department of Geological Sciences, The University of Texas at Austin

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Director, John A. and Katherine G. Jackson School of Geosciences, The University of Texas at Austin

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Member, Energy and Mineral Resources Graduate Studies Committee, The University of Texas at Austin

Director, Geology Foundation, The University of Texas at Austin

Chair, Executive Committee, Geology Foundation, The University of Texas at Austin

Trustee and Secretary, American Geological Institute Foundation

Trustee, Southwest Research Institute

Trustee, American Association of Petroleum Geologists Foundation

Member, Hedberg Award Committee, Institute for the Study of Earth and Man

Member, Advisory Board, World Energy Update

Member, Committee on Resources, American Association of Petroleum Geologists

Member, Steering Committee, National Geoscience Data Repository System, American Geological Institute

Member, National Petroleum Council

Member, National Academy of Engineering

Member, U.S. National Committee for World Petroleum Congress

Member, Energy Resources, Research, and Technology Committee, Interstate Oil and Gas Compact Commission

Member of the Corporation, American Association of Petroleum Geologists Foundation

Member, Past President’s Council, American Geological Institute

Member, Honorary Membership Committee, Association of American State Geologists

Member, United States Energy Association

Member, National Academies Workshop on Novel Approaches to the Management of Greenhouse Gases from Energy Systems

Member, Natural Gas Committee, National Petroleum Council

Sergey B. Fomel
Co-organizer, minisymposium, Seismic Velocity Analysis, Society for Industrial and Applied Mathematics (SIAM) Conference on Mathematical and Computational Issues in the Geosciences

Co-organizer, Workshop, Synthetic Seismograms for Processed Seismic Data and for Seismic Field Data, Society of Economic Geologists SEG Annual International Meeting

Organizer, minisymposium, Geoscience Applications of Dijkstra-Like Methods for Solving Hamilton-Jacobi Equations, Society for Industrial and Applied Mathematics (SIAM) Conference on Mathematical and Computational Issues in the Geosciences

Session Chair, Oklahoma Geological Survey Conference on Interpreting Reservoir Architecture Using Scale-Frequency Phenomena, co-sponsored by U.S. Department of Energy and National Energy Technology Laboratory, Oklahoma City, Oklahoma

Julia R. W. (Stowell) Gale
Member, Ph.D. Dissertation Committee, Leonel Gomez, The University of Texas at Austin, Austin, Texas

Bob A. Hardage, B. A.
Chairman, Distinguished Lecture Committee, Society of Exploration Geophysicists

Member, Editorial Board, Journal of Seismic Exploration

Member, Evaluation Panel, Hart’s E&P 2003 Meritorious Engineering Awards

Member, Geophysics License Exam Committee, Texas Board of Professional Geoscientists

Susan D. Hovorka
Chair, Geoscience Alliance, Jackson School K-12 and Public Outreach Committee, John A. and Katherine G. Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas

Member, Texas Education Commission Task Force of Geoscience Education in High School

Michael R. Hudec
Chair, Associate Director for Environmental Research Search Committee, Bureau of Economic Geology, Austin, Texas

Leader, Salt and Extensional Tectonics in the Paradox Basin, Field Seminar, American Association of Petroleum Geologists, Moab, Utah

Member, Information Distribution System Task Force, Bureau of Economic Geology, Austin, Texas

Member, Program Advisory Committee, Gulf Coast Section—SEPM 24th Annual GCSSEPM Foundation Bob F. Perkins Research Conference, Houston, Texas
Martin P. A. Jackson  
Co-Supervisor, Ph.D. Dissertation Committee, Pedro Gomez-Cabrerol, Stratigraphic and structural analysis of the Neogene sediments of the offshore portion of the Salina del Istmo Basin, southeastern Mexico: The University of Texas at Austin, Austin, Texas  
Member, Ph.D. Dissertation Committee, Nedra Alexander, The University of Texas at Austin, Austin, Texas  
Member, Ph.D. Dissertation Committee, Xinxia Wu, The University of Texas at Austin, Austin, Texas  
Member, Steering Committee, John A. and Katherine G. Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas

Sylvia Jennette  
Editor, ProducerNews, PTTC Quarterly Newsletter

James W. Jennings, Jr.  
Co-Chairman, Ph.D. Dissertation Committee, Zeno Philip, Incorporating subcritical crack growth mechanics into natural fracture characterization for improved reservoir simulation: The University of Texas at Austin, Austin, Texas

Jeffrey A. Kane  
Chair, Bureau Log Scanning Task Force Committee, Bureau of Economic Geology

Charles Kerans  
Presenter, ChevronTexaco Technology Conference  
Session Chair, Porosity Development within a Sequence Stratigraphic Framework in Carbonates, American Association of Petroleum Geologists Annual Convention, Salt Lake City, Utah  
Session Chair (with Mitch Harris and A. S. Al Sharhan), New Approaches in Carbonate Reservoir Modeling, American Association of Petroleum Geologists International Convention, Cancun, Mexico

Supervisor of Ted Playton, Jerome Bellian, Craig Calkins, Jesse Kimball

Stephen E. Laubach  
Convener, Hedberg Research Conference, American Association of Petroleum Geologists  
Member, various dissertation and thesis committees (DCS and P&GSE)  
Session Chair and Abstracts Review, American Association of Petroleum Geologists Annual Meeting

Robert G. Loucks  
President-Elect, Gulf Coast Section, SEPM

Jeffrey G. Paine  
Session Chair, Mining and Landfill Site Investigations, Symposium on the Application of Geophysics to Engineering and Environmental Problems, Environmental and Engineering Geophysical Society, San Antonio, Texas

Eric Potter  
Member, Grants-In-Aid Committee, American Association of Petroleum Geologists

Stephen C. Ruppel  
Chairman, Committee on Conferences, Bureau of Economic Geology, Austin, Texas

Bridget R. Scanlon  
Associate Editor, Hydrogeology Journal

Scott W. Tinker  
Chairman, Energy and Mineral Policy Committee, Association of American State Geologists  
Field Seminar Subcommittee Chairman, Education Committee, American Association of Petroleum Geologists  
Member, Advisory Committee, Service to Society Committee of the Commission of 125, The University of Texas at Austin, Austin, Texas  
Member, Association of American State Geologists  
Member, Board on Energy and Environmental Systems, The National Academies, National Research Council  
Member, Continental Margins Committee, Association of American State Geologists  
Member, Coastal Processes Committee, Association of American State Geologists  
Member, Education Committee, American Association of Petroleum Geologists  
Member, Energy and Mineral Policy Committee, Association of American State Geologists  
Member, Geological Society of America  
Member, Liaison Committee, Association of American State Geologists  
Member, U.S. Potential Gas Committee, Association of American State Geologists  
President, Austin Geological Society  
Vice Chair for SEPM, American Association of Petroleum Geologists Annual Meeting

Thomas A. Tremblay  
Member, Critical Infrastructure Workgroup, Texas Geographic Information Council

Bruno C. Vendeville  
Convener, Comparative Salt Tectonics: Similarities and Differences between Salt Basins session (oral), American Association of Petroleum Geologists Annual Convention, Salt Lake City, Utah  
Convener, Global Salt Tectonics Session (oral), American Association of Petroleum Geologists Annual Convention, Salt Lake City, Utah  
Member, Best Paper Award Committee, Geological Society of America, Structural Geology and Tectonics

William A. White  
BEG Point of Contact for Laguna Madre, GEMS Managers, Gulf Ecological Management Sites (GEMS) Program, and the NOAA Community-based Restoration Program (CRP)  
Member, Science Validation Team for New Millennium Program Earth Observing series (EO-1), National Aeronautics and Space Administration

Lesli J. Wood  
Delegate, House of Delegates, American Association of Petroleum Geologists  
Session Convener, Shale Diapirs and Mud Volcanoes Worldwide, American Association of Petroleum Geologists
CONGRESSIONAL, LEGISLATIVE, AND SPECIAL COMMITTEE TESTIMONY

Eric Potter
Texas House Committee on Energy Resources, Buddy West, HB 183, East Texas Field Study, State Capitol, Austin, Texas

Texas House Committee on Natural Resources (briefing; not a formal hearing), Rep. Tommie Merritt, East Texas Oil Field and Energy Briefing, House Bill 183—Kilgore, Texas

Stephen Laubach
“New methods for fracture prediction and evaluation”: presented to U.T. Reservoir Geology class (Tinker/Fisher), Austin, Texas

“Diagenetic processes in fractures”: presented to U.T. Structural Geology class (Marrett), Monterrey, Mexico

Jerry F. Lucia
“Introduction to carbonate tidal flats and beaches”: presented to GEO 383, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

K-12 AND PUBLIC OUTREACH

Sigrid J. Clift
“Geoscience as a Career”: presented to Webb Middle School

“Is Dirt Just Dirt Classroom Activity”: presented to Laurel Mountain Elementary

Judge, Barton Springs/Edwards Aquifer Conservation District Scholarship Essay

Organizer and Leader, Botanical Institute of Texas Teacher Workshop

Organizer and Leader, Lake Travis 4th grade class Bureau tour

Tour Guide, Jackson School prospective graduate students

Julia F. W. (Stowell) Gale
Core demonstration for teachers, Bureau of Economic Geology

Michael R. Hudec
5th grade Science Fair judge: Hill Country Christian School, Austin, Texas

Amanda R. Masterson
Greeter, Bureau field trip, Texas Community College Teachers

Tour Guide, Earth Science Week’s Career Fair

Lisa E. Remington
Judge, Poster Session, 2003 Gulf Coast Association of Geological Societies Convention

Judge, 2003 Science Fair, Bryker Woods Elementary

“Rocks”: presented to kindergartners and 1st graders, U.T. Child and Family Lab

Tour guide, Kealing Jr. High 8th graders, 2003 Earth Science Week Career Fair

Ramon H. Treviño
Judge, Poster Session, 2003 Gulf Coast Association of Geological Societies Convention

Judge, 2003 Science Fair, Bryker Woods Elementary

“Rocks”: presented to kindergartners and 1st graders, U.T. Child and Family Lab

Tour guide, Kealing Jr. High 8th graders, 2003 Earth Science Week Career Fair

UNIVERSITY TEACHING/CONTINUING EDUCATION

Shirley P. Dutton
“Advanced reservoir geology: clastics”: presented to GEO 391, co-instructor, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

Sergey B. Fomel
“Geometrical theory of seismic imaging”: presented to Department of Geological Sciences (Geology 391), The University of Texas at Austin, Austin, Texas.

“Seismic imaging as an inverse problem”: presented to Department of Petroleum and Geosystems Engineering (PGE 383), The University of Texas at Austin, Austin, Texas.

Martin P. A. Jackson
“Salt tectonics”: presented to Tectonics II (GEO 391) graduate class, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas.

Charles Kerans
“Carbonate and Evaporite Petrography” (GEO 383M), five lectures and one lab, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas

“Sequence Stratigraphy” (GEO 380N, W. L. Fisher), four lectures, Department of Geological Sciences, The University of Texas at Austin, Austin, Texas

Organizer and Leader, Lake Travis 4th grade class Bureau tour

Tour Guide, Jackson School prospective graduate students
PAPERS AND ABSTRACTS
BY BUREAU STAFF IN OUTSIDE (NON-BUREAU) PUBLICATIONS

PAPERS


Tinker, S. W., 2003, Reservoir characterization—from 1-D to 4-D across three generations: Business Briefing: Exploration and Production 2003, January.


ABSTRACTS


Band, L., Reckhow, K., Famiglietti, J., Kerans, Charles, and Band, L., Reckhow, K., Famiglietti, J., 2003 Comprehensive Report 35 biostratigraphic ages, Corpus Christi internationally accepted isotopic and stratigraphy calibrated with basinal frameworks using sequence high-frequency chronostratigraphic frameworks (abs.): Eos, v. 84, no. 47, Abstract 121-06.


Gale, J. F. W., Gomez, Leonel, Laubach, S. E., Marrett, Randall, Olson, J. E., Holder, Jon, and Reed, R. M., 2003, Predicting and characterizing fractures in the Ellenburger: using the link between diagenesis and fracturing (abs.), in New methods for locating and recovering remaining hydrocarbons in the Permian Basin: The University of Texas at Austin, Bureau of Economic Geology; Petroleum Technology Transfer Council; and University Lands West Texas Operations, p. 8.


Kane, Jeff, 2003, Estimation of interparticle/intercrystalline porosity from resistivity logs (abs.), in New methods for locating and recovering remaining hydrocarbons in the Permian Basin: The University of Texas at Austin, Bureau of Economic Geology; Petroleum Technology Transfer Council; and University Lands West Texas Operations, p. 13.


Kerans, Charles, and Loucks, R. G., 2003, Evolution of Late Aaptian/Albian carbonate platforms of the northwest Gulf of Mexico (ext. abs.), in Structure and stratigraphy of South Texas and northeast Mexico: applications to exploration: Gulf Coast Section SEPM Foundation and South Texas Geological Society, p. 79–83.


Knox, P. R., 2003, Stratigraphic hierarchy of flooding-event shales and possible controls on seal quality (abs.): Austin Geological Society Newsletter, v. 37, no. 6, p. 9.


Loucks, R. G., 2003, Overview of breccia and fracture forming processes in Ordovician carbonates (ext. abs.), in Trenton/Black River Core Workshop and case studies possibilities within the Michigan Basin and similarities outside the basin: Michigan PTTC Satellite at the Michigan Basin Core Research Laboratory, Western Michigan University, and Michigan Oil and Gas Association, p. 44–87.


Loucks, R. G., Mescher, Paul, Entzminger, David, and Braaten, Dennis, 2003, Reservoir geology of the Willard Unit in the San Andres Nassau field, West Texas (abs.), in CD-ROM Transactions, Southwest Section American Association of Petroleum Geologists Convention, Fort Worth, Texas, March 1–5, unpaginated.


Lucia, F. J., and Jones, Rebecca, 2003, Vertical distribution of permeability and petrophysical class within the Lower Clear Fork and Wichita: inputs for reservoir modeling at Fullerton field (abs.), in New methods for locating and recovering remaining hydrocarbons in the Permian Basin: The University of Texas at Austin, Bureau of Economic Geology; Petroleum Technology Transfer Council; and University Lands West Texas Operations, p. 21.


Reckhow, K., Scanlon, B., and Shabman, L., 2003, Surface water, groundwater, and social science measurements in a prototype hydrologic observatory (abs.): Eos, v. 84, no. 47, Abstract H121-03.


Rouby, Delphine, Robin, Cécile, Guillocheau, François, Granjeon, Didier, Bouroullec, Renaud, and Raillard, Stéphane, 2003, Quantification and modeling of the distortion of the stratigraphic architecture of the syn-sedimentary infill of the normal fault (offshore


Tinker, S. W., 2003, Upstream technology for the coming natural gas economy (abs.): South Texas Geological Society, v. 43, p. 5.


**CONTRACT REPORTS**


Gibeaut, J. C., and Tremblay, T. A., 2003, Texas coastal hazards atlas—volume 3: ArcView geographic information systems files: The University of Texas at Austin, Bureau of Economic Geology, final report of the Texas Coastal Coordination Council pursuant to National Oceanic and Atmospheric Administration Award No. NA070Z0134, CD-ROM.


of Economic Geology, and Goldrus Producing Company, semi-annual report prepared for U.S. Department of Energy under, DOE Award Number DE-FC26-02NT15442, 20 p. + 32 figs.

Loucks, Robert, Treviño, Ramon, Hammes, Ursula, Remington, Randy, Sakurai, Shinichi, Brown, L. F., Jr., Zeng, Hongliu, and Jennette, Dave, 2003, Reservoir geology, structure, and sequence stratigraphy of the Oligocene upper-lower Frio Fm., Red Fish Bay field area, South Texas volume I: The University of Texas at Austin, Bureau of Economic Geology, final report prepared for IBC Corporation, variously paginated + CD-ROM.


Tinker, S. W., 2003, Operation of a public geologic core and sample repository in Houston, Texas: The University of Texas at Austin, Bureau of Economic Geology, annual status report prepared for U.S. Department of Energy, under grant no. DE-FG26-02NT15290, 10 p.

Tinker, S. W., 2003, Operation of a public geologic core and sample repository in Houston, Texas: The University of Texas at Austin, Bureau of Economic Geology, final status report prepared for U.S. Department of Energy, under grant no. DE-FG26-02NT15290, 9 p.


Wang, F. P., and Ruppel, S. C., 2003, Quick streamline analysis and recommendations for modification of the proposed ExxonMobil infill drilling program, Fullerton Clear Fork Unit: The University of Texas at Austin, Bureau of Economic Geology, interim report prepared for ExxonMobil Corporation, 17 p.


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* No-Stipend Appointment
** Contract or Temporary