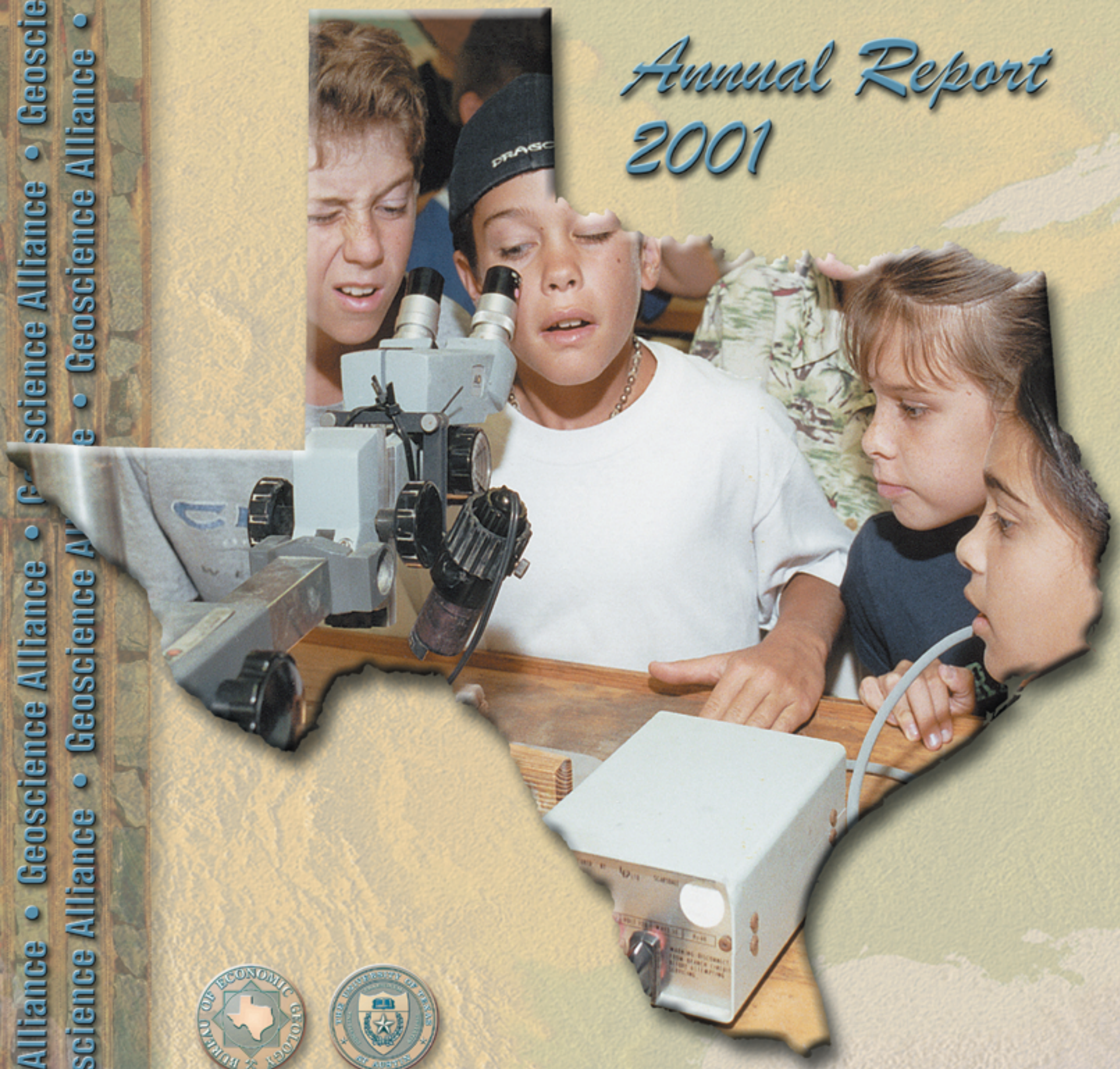
Annual Report 2001



Bureau of Economic Geology

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Director's Message

My two oldest kids were educated in a Montessori school until the age of 6. There were three simple rules in the Montessori environment: Don't harm yourself. Don't harm others. Don't harm the classroom. The order attained by these three simple rules was remarkable to behold. Children from around the globe interacted peacefully, humanely, and with respect for themselves, others, and the environment around them, in many ways at a level far above that which adults in our world seem to achieve.

Respect yourself, respect others, and respect the environment—rules shattered on September 11. These were not acts of bravery carried out on military targets in a time of war; these were acts of cowardice carried out on civilians in a time of peace. Suicide is not noble; murder is not righteous. My initial reaction was one of deep-seated, soul-wrenching sadness. Sadness for the victims and their families, sadness that America would be forced again into a no-win response situation, and sadness that in our world there are people with such innate despair that they dedicate their lives to acts of fear and violence.

The sadness remains, and will for a very long time. To sadness, I add the seemingly conflicting emotions of hopelessness and hope. *Hopelessness* that the response forced upon the United States and the world—a response that results in harm to the good people of Afghanistan—will not result in long-term betterment. *Hope* in a collective worldwide resolve—a unified petition for freedom, liberty, and peace, and intolerance of those who would have it otherwise—that may liberate the world.

Osama bin Laden, as Adolf Hitler before him, is terrified of human difference. The elegance of human civilization is celebrated in our differences and glorified in our diversity. With the predictable exception of a few misguided individuals and factions, the world voice is singing in strong unison—violent acts of inhumanity that attempt to promulgate ritualistic and tribal ideals using God's name in vain as a false shield will not be tolerated. We are no longer scared, and in that I find hope.

Aristotle said, "It is the mark of an educated mind to be able to entertain a thought without accepting it." Education, it seems, carries on her wings hope for salvation, for lasting peace. Education is required of us all. The citizens of the United States of America must become better educated in regard to the impact that our powerful society has on the world, and to the remarkable people that make up all civilization on Earth. And in turn, the world must become better educated about the melting pot that is America. Throughout history, for better and sometimes worse, and in spite of the predictable naysayers, America has made earnest attempts to defend, protect, and honor life, liberty, and democracy for all people on Earth. We celebrate difference. Every American—African, Arab, Asian, Australian, European, Latin, and Native—in this great country has the freedom to entertain a thought without accepting it.

In the context of such global issues, to speak of the Bureau seems on the one hand insignificant, but on the other hand, more important than ever before. Our 136 employees, including student assistants, represent 15 nations from 5 continents. The Bureau embodies the melting pot that is America. As you will read in the pages of this *Annual Report*, we continue to do world-class research that will impact energy and environmental issues facing our Earth, with a strong emphasis on Texas. Our funding base is now balanced among our stakeholders, and our project focus is aligning with our mission to do long-term, highest quality research and publish the results. With the new opportunities afforded us by the John A. and Katherine G. Jackson School of Geosciences, we can embrace true collaboration with our colleagues in the Department of Geological Sciences and Institute for Geophysics, enhancing our diverse strengths and achieving common goals in a framework that allows each component to flourish.

I am proud of the great history of the Bureau and the diverse Bureau family. I am proud of the United States of America. And I am humbled by the opportunity that we each have to educate the world, one mind at a time.

2001 News at the Bureau

John A. and Katherine G. Jackson School of Geosciences

The John A. and Katherine G. Jackson School of Geosciences ("the Jackson School") was created in July with the third-largest single gift to The University of Texas at Austin ($25 million) from UT alumnus and retired Dallas oilman John A. Jackson, along with his late wife, Katherine. The Jackson School brings together more than 125 faculty and research scientists from the Bureau, the Department of Geological Sciences, and the Institute for Geophysics in a collaborative environment that promises to make UT one of the premier geoscience centers in the world. Former Bureau Director William L. Fisher was named the first Director of the Jackson School and will work with the component departments to develop the new program. Earnings from the Jackson endowment will provide funds for research by faculty, students, and research staff; salary support for research staff who participate in teaching; graduate student fellowships; visiting scientists and postdoctoral scientists; endowed fellowships for meritorious research staff; and expanded holdings of the Geology Library.

New Associate Director

The Bureau is excited to welcome Eric C. Potter, who joined the Bureau in May as the Associate Director for Energy Research. A geologist and manager at Marathon Oil Company for 25 years, Eric administers and coordinates the Bureau's energy research. Fellow Associate Directors are Douglas C. Ratcliff in Administration and Jay A. Raney in Environmental Research.

DOE Funding for Bureau Research

The U.S. Department of Energy, through the National Petroleum Technology Office in Tulsa, Oklahoma, selected two Bureau proposals to receive funding as part of its ongoing petroleum research program to increase the production of domestic oil. The first project, led by Stephen C. Ruppel, received $500,000 to improve Permian Basin Clear Fork reservoir characterization efforts through better comparisons to same-age rock outcrops. Shirley P. Dutton will lead a $1 million project to update and expand Permian Basin data contained in the *Atlas of Major Texas Oil Reservoirs,* published by the Bureau in 1983.

Bureau Contributions at Conventions

AAPG Annual Meeting, Denver

A multitude of Bureau researchers attended the June 2001 American Association of Petroleum Geologists Annual Convention in Denver, Colorado. Researchers delivered 15 technical papers and 17 poster presentations; conducted workshops and short courses; co-chaired technical and poster sessions; and received distinguished awards during the 2001 President's Reception and Awards Ceremony. The Bureau's presence also included prominent exhibit booths and a very successful, first-ever Bureau alumni gathering that brought together many past and present Bureau employees.

SEG Annual Meeting, San Antonio

Senior Research Scientist Bob A. Hardage served as Technical Program Chairman for the September 2001 Society of Exploration Geophysicists International Exposition and 71st Annual Meeting held in San Antonio, Texas. Bureau staff manned exhibit booths and assisted guests who visited the Bureau's geophysical field laboratory, the Devine Test Site, near San Antonio.

Stronger Ties with Mexico

This has been a significant and productive year for research and collaboration between the Bureau and geoscientists at PEMEX Exploration and Production. One of two multidisciplinary, collaborative Bureau–PEMEX studies of basins in Eastern Mexico was completed, on time and within budget. The second project is on schedule for a December 2001 completion. Relationships with Mexico continue to expand, as the 52-year-old AMGP (Asociación Mexicana de Geólogos Petroleros) was welcomed as a full member into the Gulf Coast Association of Geological Societies. The Bureau was quite involved in the 4th Joint AMGP/AAPG International Conference, "Exploration and Development of Gas Plays," in Veracruz, Mexico, for which Bureau Director Scott W. Tinker served as a member of the Steering Committee. Bureau researchers presented technical papers and poster sessions; conducted short courses; and co-chaired technical sessions.

GCAGS

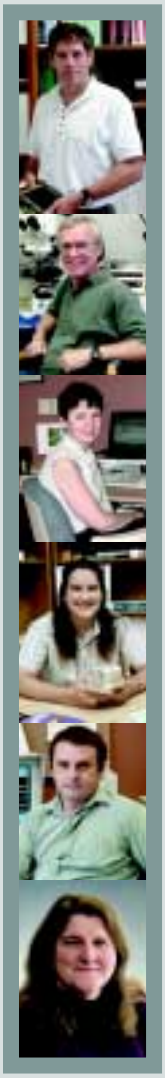
The Bureau is playing a major role in preparing for the 2002 Gulf Coast Association of Geological Societies Annual Convention scheduled for October 30 through November 1, in Austin, Texas. Many Bureau employees, including Associate Director Doug Ratcliff, General Chairman, and Director Scott W. Tinker, Technical Program Chairman, have begun in-depth planning for nearly all aspects of the meeting. For complete information about the convention, please visit the Bureau's Website at www.beg.utexas.edu/gcags2002.

In addition to GCAGS convention planning, the Bureau now handles the sale and distribution of selected GCAGS publications. The *GCAGS Publications Catalog* is posted on the Bureau's Website at www.beg.utexas.edu; a printed catalog is available from the Publication Sales office at 512-475-9513.

Award Winners

Bureau researchers, continuing their long-standing commitment to excellence, received the following awards in 2001:

William L. Fisher received the William H. Twenhofel Medal for Excellence in Sedimentary Geology, the highest award given by SEPM (Society for Sedimentary Geology). **Scott W. Tinker** was named a Distinguished Lecturer in the inaugural (2002) joint lecture series of the Society of Petroleum Engineers/Society of Exploration Geophysicists/American Association of Petroleum Geologists. **Bob A. Hardage** was awarded the A. I. Levorsen Memorial Award for Best Paper for his presentation of "3-D Seismic Evidence of the Effects of Carbonate Karst Collapse on Overlying Clastic Stratigraphy and Reservoir Compartmentalization" at the 2001 Southwest Section, AAPG Annual Meeting. A paper titled "Predicting Permeability from Well Logs in Carbonates with a Link to Geology for Interwell Permeability Mapping," written and presented by **James W. Jennings, Jr.,** and coauthor **F. Jerry Lucia** for the Society of Petroleum Engineers, was selected as a highlight article for the November 2001 issue of the *Journal of Petroleum Technology* and chosen to be presented again in the "Best of SPE" session at the 2002 AAPG Annual Meeting. **Charles Kerans** was chosen as an AAPG International Distinguished Lecturer for 2002. **Stephen E. Laubach** received Honorable Mention for Poster Presentation at the 2001 SEPM Annual Meeting for "Degradation beyond the Emergent Threshold." **Robert G. (Bob) Loucks** received second place in the Thomas A. Philpott Excellence in Presentation Awards for his poster session at the 2001 Annual Convention of the Gulf Coast Association of Geological Societies, "Modern Analogs for Paleocave Sediment Fills and Their Importance in Identifying Paleocave Reservoirs." **Bridget R. Scanlon** and Robert E. Mace, Texas Water Development Board, received the 2000 Barton Springs Edwards Aquifer Conservation District Award for Research for their groundwater model of the Barton Springs Segment of the Edwards aquifer. **Julia F. W. Stowell** (now Gale) received Honorable Mention for Oral Presentation at the 2001 SEPM Annual Meeting for her paper "Understanding Fractured Carbonate Reservoirs," coauthored by **S. Laubach**, R. Marrett, and J. Olson. **Bruno C. Vendeville** was named a Fellow in the Geological Society of America. **Lesli J. Wood** received the J. C. "Cam" Sproule Memorial Award for 2001 from AAPG for her paper "Chronostratigraphy and Tectonostratigraphy of the Columbus Basin, Eastern Offshore Trinidad." She also received Honorable Mention for Poster Presentation at the 2001 SEPM Annual Meeting for "Predicting Tidal-Bar Architecture within a Sequence Stratigraphic Framework: Examples from Ancient and Modern Systems."



Photos: (top to bottom, left column) Fisher, Tinker, Hardage, Jennings, Lucia, Kerans; (right column) Laubach, Loucks, Scanlon, Stowell (Gale), Vendeville, Wood

Research at the Bureau

Energy

Industrial Associate Programs

Applied Geodynamics Laboratory (AGL)

Martin P. A. Jackson, Bruno C. Vendeville, Daniel D. Schultz-Ela, and Michael R. Hudec

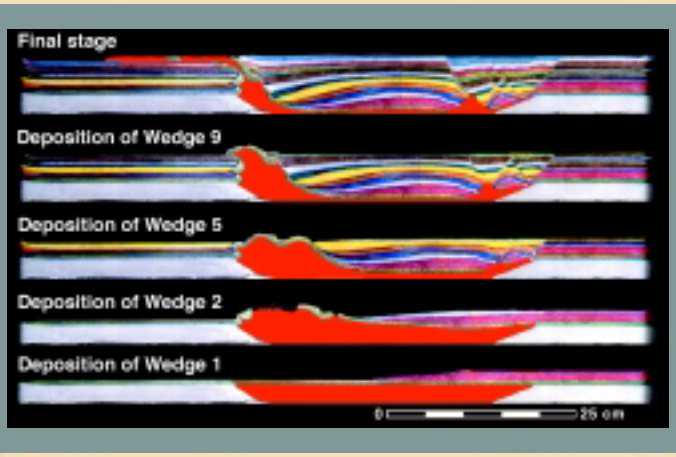
Several major advances were made in AGL research during 2001, including the release of the first module of *The Salt Mine*, a digital atlas of salt tectonics. New research was launched for a second large state-of-the-art 3-D seismic volume, and the AGL's first set of 3-D numerical models was completed.

Research continued into salt tectonics and basin evolution along the Angola Margin. Well data, potential-field data, and 2-D seismic data lent by Shell enabled investigations to continue into the effects of tectonic segmentation on salt-tectonic styles along a passive margin. Outstanding-quality 3-D seismic data from deepwater Gabon was lent by TotalFinaElf to begin investigations of synsedimentary thrusting of salt-related structures and crestal faulting in anticlines. Results of these studies are then applied to investigations of poorly imaged subsalt structures in the Gulf of Mexico.

The Salt Mine, a browser-based, interactive atlas of salt tectonics features an exhaustive collection of salt structure images and the best models produced during the lab's 14-year history. Compilation began for two other atlas modules, all of which are available only to AGL sponsors.

The figure below (experiment by B. C. Vendeville) is a series of cross-section restorations illustrating how loading of a salt tongue (bright red) under successive wedges of synkinematic overburden causes proximal extension (right-hand side), seaward salt expulsion, distal diapiric rise (left-hand side), and lateral contraction of the diapir and seaward salt spreading.

The AGL has conducted research into tectonic and salt processes associated with hydrocarbon traps since 1988. Researchers use computer-controlled rigs to simulate structural styles while overhead photographs, serial sections, time-lapse videos, and CT scans assist in reconstructing and analyzing structural evolution. Modeling investigations include turtle structures, growth folds, diapir drag, strike-slip along allochthonous salt sheets, and extension above basement steps.



Exploration Geophysics Laboratory (EGL)

Bob A. Hardage, Milo M. Backus, Robert J. Graebner, Michael V. DeAngelo, and Paul E. Murray

Several joint studies with industry sponsors this year resulted in the acquisition of multicomponent seismic data for exploration applications as well as a large amount of multicomponent marine data donated for Gulf of Mexico research. EGL research also included a study in which a predicted fracture orientation (from converted S-waves) led to the drilling of a confirmation horizontal well. Joining the staff this year was geophysicist Paul E. Murray, previously with PGS (Petroleum Geophysical Services) in Houston, Texas.

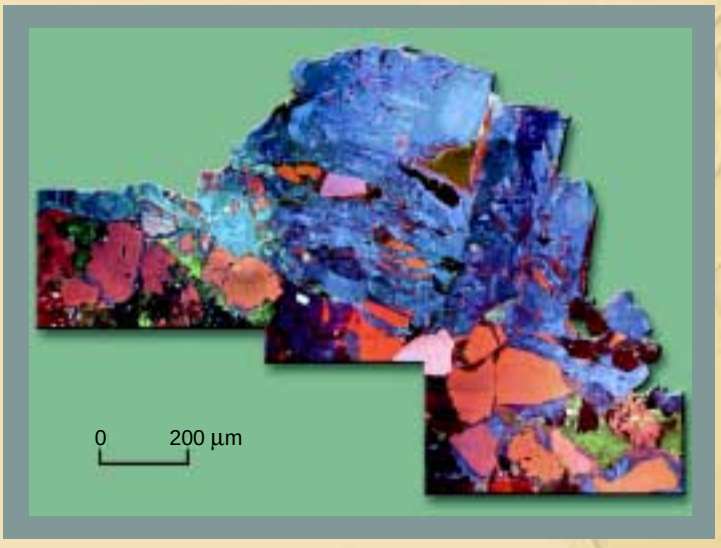
The EGL develops technologies, such as seismic field-recording techniques and data-processing and data-interpretation software, to image reservoirs using all components of the seismic wavefield. The goal is independent compressional-wave (P-wave) and shear-wave (S-wave) images of reservoir systems. As these images are combined, researchers are gaining insight into petrophysical rock properties, pore structure, pore-fluid properties, sequence-stratigraphic relationships, and spatial distributions of lithologies, fractures, and anisotropic properties of complex reservoirs.

Past donations by sponsors have enabled the acquisition of 2,000-channel seismic recording systems and access to a fully staffed seismic research crew. These resources are now used to record nine-component, three-dimensional (9C3D) data over test properties. More than 40 mi^2 of 9C3D research data have been recorded across several onshore prospects over the course of the research program.

Fracture Research and Application Consortium (FRAC)

Stephen E. Laubach, Randall A. Marrett (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), Julia F. W. Gale, Kitty L. Milliken (Department of Geological Sciences, The University of Texas at Austin), and Robert M. Reed

The Fracture Research and Application Consortium (FRAC) enjoyed remarkable success this year and is now sponsored by 12 companies worldwide. The goal of FRAC is to develop new understanding of fractures and faults that influence the successful extraction of resources. Research is under way to better characterize, predict, and simulate reservoir-scale structures. Many fractures are difficult



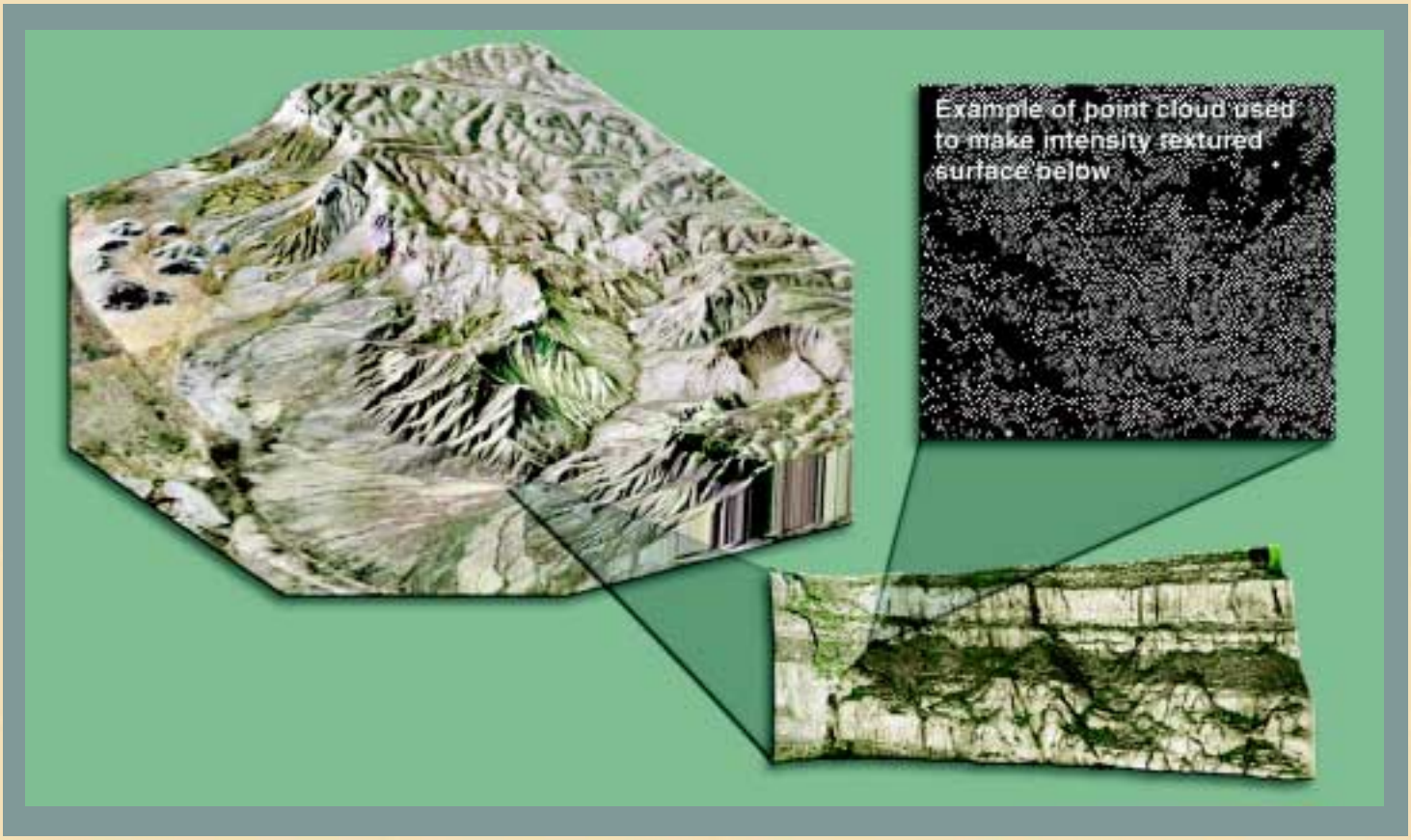
The image to the left is a color scanned cathodoluminescence mosaic showing well-developed crack-seal texture in synkinematic quartz cement lining a macrofracture. Sample is from a sandstone of the Upper Cretaceous Cozzette Formation in the Piceance Basin, Colorado. Sample depth is 7,218 ft.

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 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. 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 to design drilling and stimulation programs and as input in fluid-flow simulators.

Reservoir Characterization Research Laboratory (RCRL)

Charles Kerans, F. Jerry Lucia, James W. Jennings, Jr., and Jerome A. Bellian

The Reservoir Characterization Research Laboratory (RCRL) has developed several new research directions in 2001. Fundamental research into a unified method for calculating permeability in carbonates from wireline log data resulted in the presentation of a model at this year's Society of Petroleum Engineers meeting by Jim Jennings and Jerry Lucia. This presentation was selected as part of the "Best of SPE for AAPG" session for the 2002 American Association of Petroleum Geologists annual meeting in Houston. Icehouse carbonate reservoirs have been a major focus of this year's geological research. Unique outcrops of Early Permian carbonates in the Victorio Canyon area have permitted continuous mapping of shelf, slope, and basin depositional units. Lowstand platforms and lowstand basin-floor fans appear as key reservoir elements that have not previously been studied in detail. New laser imaging technology has been added to the program in late fall to facilitate 3-D mapping of these features. Jerry Bellian, who is newly associated with the RCRL, brings expertise in 3-D laser imaging. He will spearhead the first attempt to integrate state-of-the-art ILRIS imaging technology in the Victorio Canyon area.



Subsurface reservoir modeling has resulted in generation of a 3-D reservoir simulation for the Lower Clear Fork reservoir at the Oxy Wasson Unit. Detailed core, log, and 3-D seismic interpretation to develop an integrated static model of the Pennsylvanian SACROC unit of the Horseshoe Atoll is under way. Seismic data are revealing a highly complex upper Pennsylvanian framework that should provide new understanding of the complex flow unit architecture.

The RCRL, supported by an industrial consortium since 1989, works to develop new techniques for characterizing carbonate reservoirs worldwide. RCRL expertise includes carbonate sequence stratigraphy and facies analysis, carbonate-rock-fabric facies analysis and petrophysics, 3-D geological modeling, geostatistics, and reservoir engineering.

The images at the bottom of page 5 give a perspective view of Victorio Canyon (mosaic of U.S. Geological Survey orthophotograph quarter-quadrangles draped on USGS 7.5-minute digital elevation data) with the area of interest in lower inset showing the mouth of Victorio Canyon scanned using the recently acquired ILRIS 3-D lidar scanning instrument to generate high-resolution 3-D outcrop images. This single image is made up of more than 2.5 million *x*, *y*, and *z* points, each with an associated intensity value at an average of 7-cm point spacing (top right inset). From these data, stratigraphic horizons are interpreted and high-resolution reservoir models are generated and analyzed, the spatial integrity of the original outcrop being preserved.

Clastics

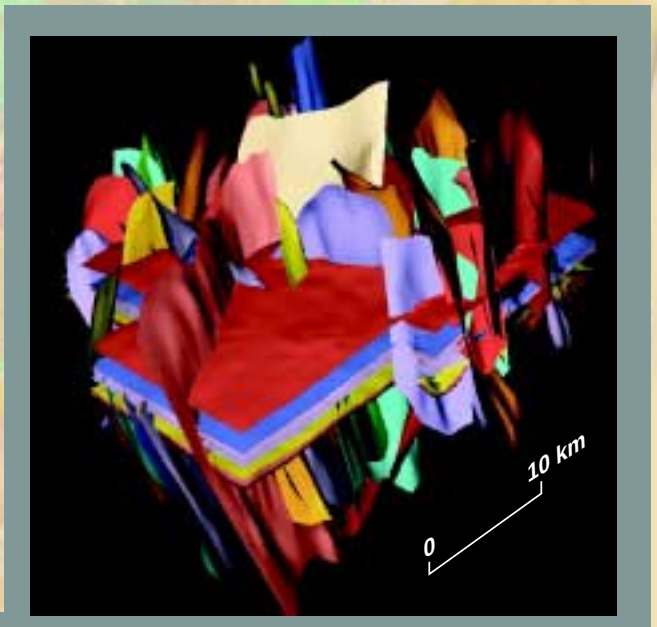
Targeting Reserve Growth Opportunities in the Northern Gulf of Mexico Basin: Transferring Secondary Gas Recovery Technology to the Offshore Environment

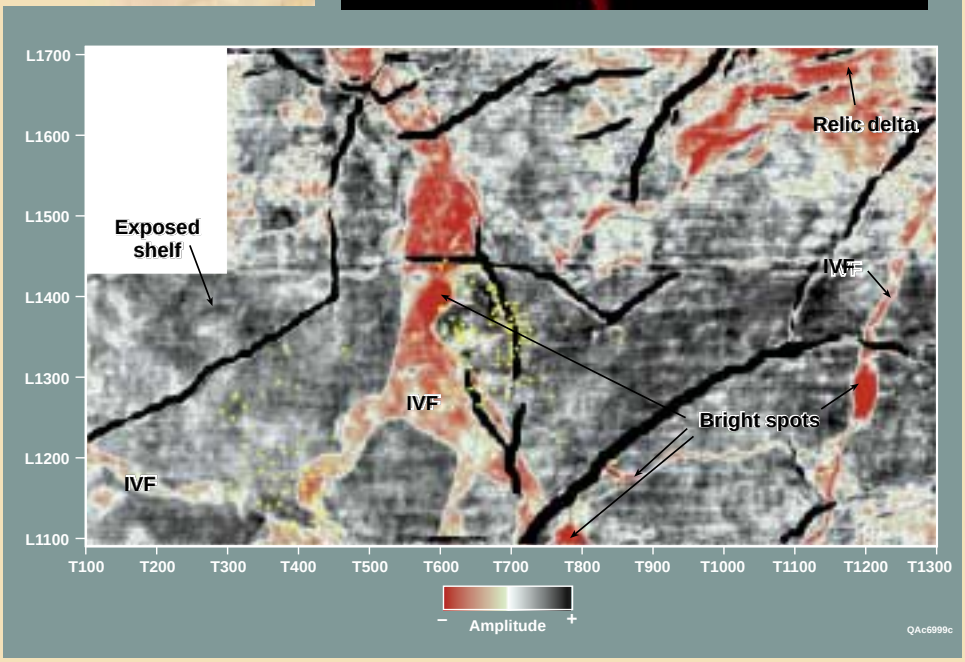
Lesli J. Wood, Tucker F. Hentz, Hongliu Zeng, Michael V. DeAngelo, Mark H. Holtz, Ke-Sheng Chan, and Paul R. Knox

As the United States moves from an oil-based economy to a natural-gas economy, programs such as Offshore Secondary Gas Recovery (Offshore SGR) continue to play a vital strategic role for the United States. This year, detailed architectural frameworks have been developed to model reservoir flow patterns and target bypassed zones. In the 3-D structural model (top right image) a regional-scale overview shows the extent of seismically derived data; 7 maximum flooding surfaces and 73 normal faults are displayed, demonstrating the geologic complexity of the study area. Stratigraphic and saddle-perched structural traps have been defined to extend the traditional field boundaries and open up new targets.

Stratal slicing (or proportional slicing) was used to create more coherent amplitude maps (see bottom right image) for initial identification of several low-sinuosity, high-amplitude features throughout the data volume. One of two prospect ideas developed by the team and successfully drilled by industry partner Texaco contained probable recoverable reserves of 5.7 Bcf (lower right corner of bottom image).

Offshore SGR, a joint venture between the Bureau and the U.S. Department of Energy begun in 1998, is charged with identifying new technologies and processes to aid in the recovery of hydrocarbons from known fields. The current project extends investigations into the northern, offshore Gulf of Mexico (GOM) Federal Outer Continental Shelf, where nearly 10,000 gas- and oil-producing reservoirs are found





in more than 1,000 fields. The research is focused on the Miocene-age reservoirs that comprise 42 percent of original proven reserves in the GOM. Because of the stratigraphic and structural complexity of the Tertiary-age section in this region, there is potential for significant gas resources to have been bypassed even in densely drilled fields. We anticipate that project results will add significantly to current resource assessments in the region and provide operators and interested companies with a road map to success in the GOM on-shelf Miocene.

Evaluation of Tertiary Plays of Eastern Mexico Basins

Edgar H. Guevara, David C. Jennette, William A. Ambrose, Jerome A. Bellian, Dallas B. Dunlap, Shirley P. Dutton, Khaled Fouad, Mark H. Holtz, Michael R. Hudec, Martin P. A. Jackson, Rebecca Jones, Luis A. Sánchez-Barreda, Suhas Talukdar (consultant), and Timothy F. Wawrzyniec

The Bureau is a leader in state-of-the-art basin analysis, which integrates a broad range of data types and vintages to interpret structural, stratigraphic, and play systems in complex sedimentary basins. No project illustrates this modern approach to basin analysis better than the joint Bureau–PEMEX Exploration and Production study of the Macuspana and Veracruz Basins in Eastern Mexico, which was completed at the end of the year. The gas plays in the Miocene-Pliocene section of the on-land and offshore portions of the basins were defined and assessed during this 20-month project. The multidisciplinary, integrated study provided a regional synthesis of the geological framework, petroleum systems, and petrophysical and engineering characteristics of the basins. The study involved close cooperation and participation of PEMEX management and staff. Topical reports of selected aspects of approaches and results of the study will be jointly published by PEMEX and Bureau scientists.

Oil and Gas Field Studies

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

Robert G. Loucks, L. Frank Brown, Jr., Jeff A. Kane, Randy L. Remington, Ramón H. Treviño III, and Eugene M. Kim

During the past 6 years, STARR researchers and oil and gas operators have undertaken reservoir characterization studies and extended development, including the drilling of new wells, recompleting old wells, and developing enhanced recovery programs, for 15 State Lands oil and gas fields. Investigations during 2001 centered on two offshore field areas, Mustang Island Block 889 and Red Fish Bay.

The studies integrate geophysical, geological, and engineering data, and advanced sequence stratigraphy concepts help to define stratigraphic architecture and delineate reservoir types. Landmark Graphics Corporation software is used extensively to analyze 3-D seismic data, model seismic attributes, and correlate wireline logs.

STARR is a State of Texas program designed to increase royalty payments—a result of drilling profitable 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.

ULARI: University Lands Advanced Recovery Initiative

Stephen C. Ruppel, Eugene M. Kim, Stephen E. Laubach, Julia F. W. Gale, and Fred P. Wang

The University Lands program in many ways establishes a new model for technology application. The University of Texas, as royalty owner, provides financial support for the Bureau to partner with oil and gas operators on University-owned lands. The goal of the program is to apply advanced reservoir characterization technology to improve field management strategies and enhance oil and gas recovery. Both the operator and the royalty owner invest in, and benefit from, the results.

In 2001, recovery activities were concentrated in three areas: (1) continued reservoir studies in the fracture-dominated Ellenburger reservoir at Barnhart field in Reagan County (see oriented rotary-drilled sidewall cores at top of page); (2) a new study of low-pressure gas resources in the Permian Basin; and (3) preparation for a new reservoir characterization study of Fullerton field, a major carbonate reservoir in Andrews County operated by ExxonMobil. This field is one of many typified by low recovery from carbonate platform rocks. Next year promises to be an exciting one in the ULARI program.

Geophysics

Devine Test Site

Bob A. Hardage, Paul E. Murray, Milo M. Backus, Robert J. Graebner, James A. Doss, Jr., and George T. Bush

The Devine Test Site, managed by the Bureau's Exploration Geophysics Laboratory, continues to gain recognition within the geophysical community. During the 71st Annual Meeting of the Society of Exploration Geophysicists (SEG) in San Antonio in September, seismic industry firm Input/Output (I/O) used the test site to demonstrate new seismic data-acquisition technologies to SEG delegates. During the convention, I/O provided transportation for groups of scientists to visit the site and observe the field demonstrations. I/O demonstrated new vibrator designs, VectorSeis sensors, and integrated cable and radio acquisition systems (top left photo), as well as a multi-axis Sidewinder vibrator and VectorSeis sensors/cables (foreground of bottom left photo; test well number 9 is in background). The low level of cultural noise at the site plus 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 previous owner British Petroleum, and conditions for use by non-university individuals, can be found on the Bureau's Website at www.beg.utexas.edu/indassoc/egl.

Environment

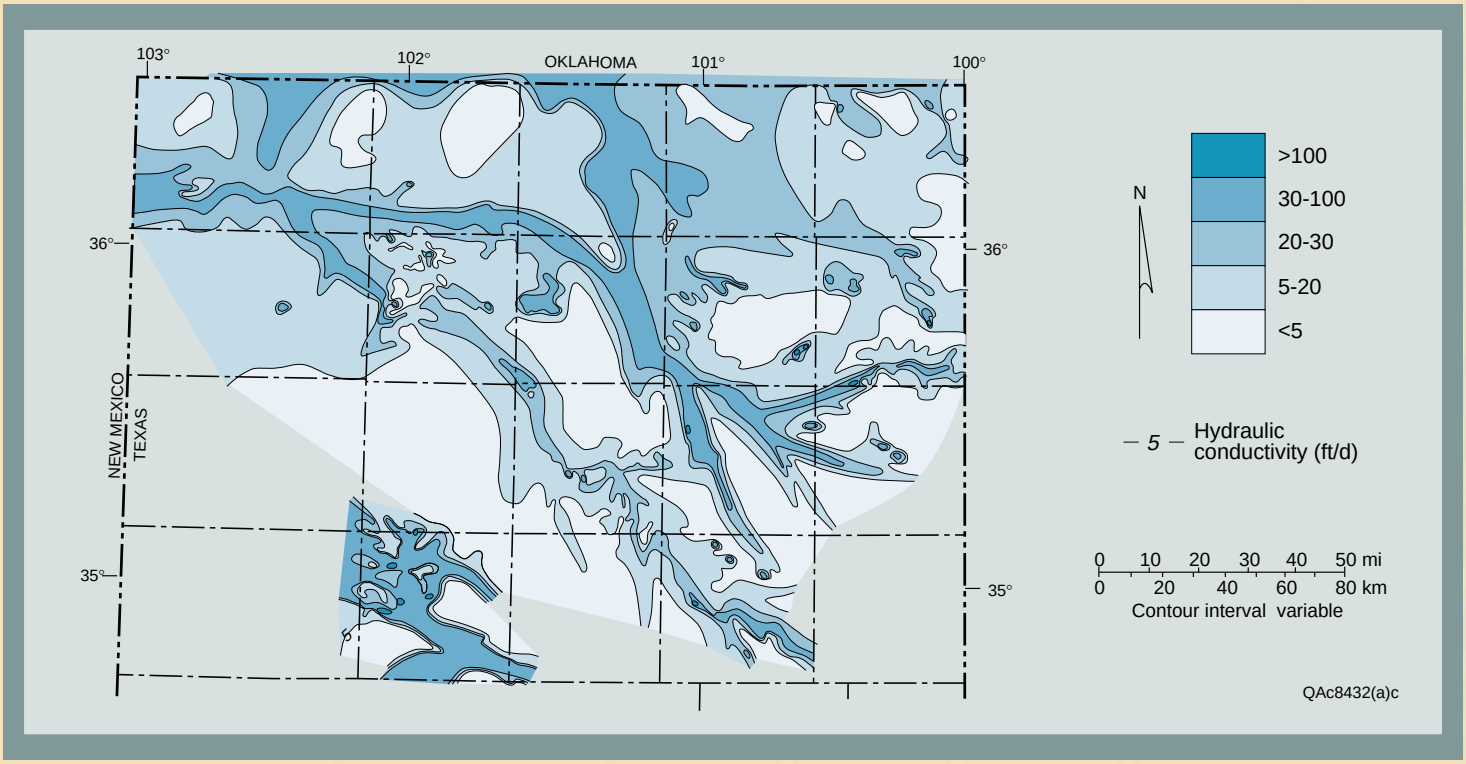
Water Resources

Development of Computer Models of Aquifers to Determine Groundwater Availability

Alan R. Dutton, Bridget R. Scanlon, Susan D. Hovorka, and Robert C. Reedy

During 2001, modeling studies were begun that target five major Texas aquifers: Central Carrizo-Wilcox aquifer between the Neches and Guadalupe Rivers; Ogallala aquifer beneath the Southern High Plains; Ogallala aquifer in the Central High Plains, which builds on work during 1999–2000 and fits together with the Southern High Plains Ogallala aquifer model; Edwards (Balcones Fault Zone) aquifer in the San Antonio and Comal and San Marcos Springs areas and their upgradient recharge zone; and Edwards (Balcones Fault Zone) aquifer in the watershed of Barton Springs in Travis and Hays Counties. The importance of groundwater modeling is demonstrated by the impressive list of project sponsors and collaborators: Texas Water Development Board (TWDB), Panhandle Water Planning Group and Panhandle Regional Planning Commission, Edwards Aquifer Authority, U.S. Department of Defense, U.S. Geological Survey, Lower Colorado River Authority, and Lower Colorado Regional Water Planning Group.

Building the aquifer models requires developing realistic and accurate representations of physical processes such as recharge, discharge, and pumping and of aquifer water budgets. A map of the Ogallala aquifer (page 9), the largest aquifer in the United States, shows high-permeability zones of the Ogallala Formation (Cenozoic) that are controlled by depositional systems. The work also involves interacting with public stakeholders who have oversight and advisory roles. Completed models will be used by stakeholders, such as groundwater conservation districts, regional water planning groups, and the TWDB, to assess availability of groundwater resources in their regions.



Environmental Quality

Ecological Resource Assessment of the Rio Grande Riparian Corridor

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

During 2001, progress was made in the areas of current land-use mapping, vegetation surveys, remote data classification, data acquisition, geographic information system (GIS) development, and analysis/modeling in the GIS environment. In addition, historical distribution patterns of riparian vegetation and the location and magnitude of losses were digitized and analyzed using early-1900 U.S. Geological Survey topographic maps.

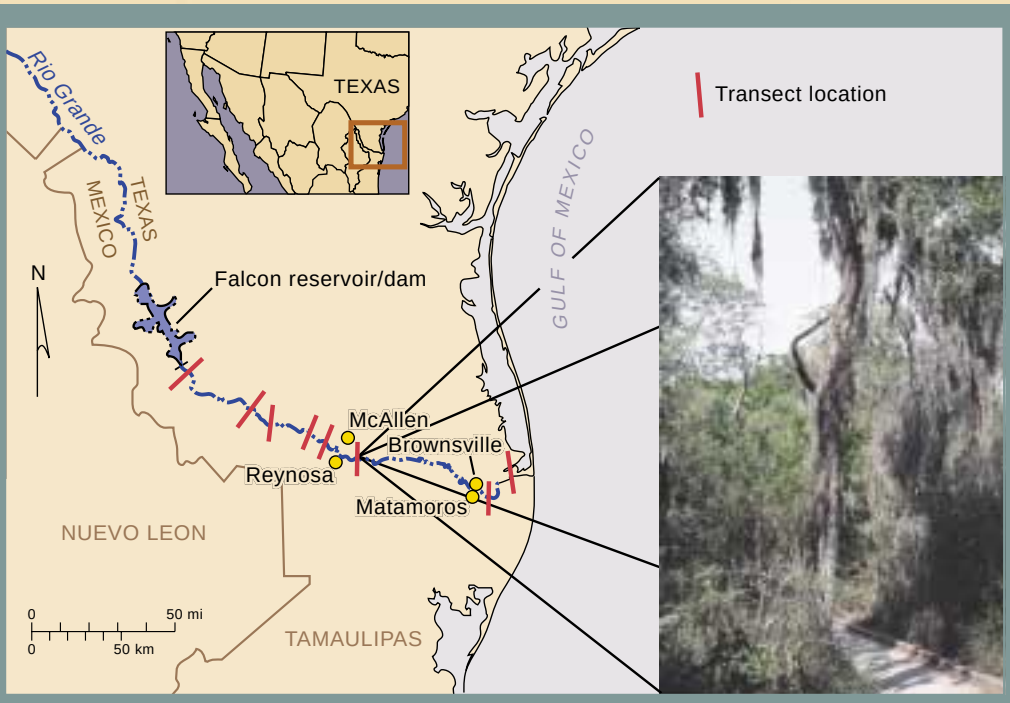
This ongoing assessment of southwestern U.S. riparian ecosystems along the Lower Rio Grande Valley of Texas and Mexico is supported by a grant from the U.S. Environmental Protection Agency's Science to Achieve Results program. Researchers work to collect and analyze high-resolution, remotely sensed data from multiple sensors; integrate existing and new field data and remotely sensed data into a GIS; determine if native vegetation communities are maintaining themselves and identify the factors that perpetuate these communities; interpret spatial and temporal variations in riparian habitats; and develop a foundation for future analysis of riparian floodplain communities by linking local and remotely sensed regional data using GIS.

Local-scale vegetation transects (see map on page 10, which shows an inset photo of a riparian community along the Rio Grande) are being correlated with high-resolution remote-sensing data to delineate the spatial extent and composition of the riparian community. GIS is being used to examine links between riparian ecology and parameters such as geology, topography, soils, water quality, hydrology, and land cover/land use.

Monitoring and Modeling Issues Related to Engineered Covers for Waste Containment

Bridget R. Scanlon and Robert C. Reedy; Craig Benson (University of Wisconsin) and Jirka Simunek (U.S. Salinity Laboratory)

During the past year, seven codes were compared for simulating near-surface water balance using data from the project's site in West Texas and from the Idaho National Environmental and Engineering Laboratory. Simulation results were quite variable and are explained by the way in which various codes handle boundary conditions and hydraulic properties. These results underscore the importance of testing models extensively before using their results, as performance of numerical models cannot be evaluated without reliable monitoring data. Various types of instrumentation for monitoring subsurface flow in unsaturated zones, and their reliability, were also evaluated in 2001, with the conclusion that neutron probe logging and heat dissipation sensors are much more reliable than time-domain reflectometry and thermocouple psychrometry.



Texas Shoreline Change Project (TSCP) research is conducted per the Coastal Erosion Planning and Response Act (CEPRA), which authorized the General Land Office of Texas to conduct a coastal-erosion response 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 their research and creating a comprehensive, digital database of historical shoreline positions and average annual rates of shoreline change that will be made available to the public through the Internet. 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.

Engineered covers are used to minimize the seepage of water into current and future solid- and hazardous-waste disposal facilities and to minimize contamination at sites where remediation is not feasible. This study, funded by the U.S. Environmental Protection Agency, analyzes different monitoring strategies and numerical models in order to evaluate the long-term performance of engineered covers of various design. Bureau researchers use monitoring data from engineered covers installed in the Chihuahuan Desert of Texas. These results are compared with results from the Nevada Test Site and the Idaho National Environmental and Engineering Laboratory. Optimal project results depend upon the collaborative efforts of researchers involved in writing codes, monitoring field sites, and analyzing data.

Coastal Processes

Texas Shoreline Change Project

James C. Gibeaut, William A. White, Tiffany L. Hepner, Thomas A. Tremblay, Roberto Gutierrez, John R. Andrews, Rebecca C. Smyth, and Jerome A. Bellian

During 2000 and 2001, the Bureau conducted detailed topographic surveys of the Gulf of Mexico beaches and dunes using airborne Light Detection and Ranging (lidar) surveys, providing accurate and continuous models for beach-erosion assessments. These data will now be compared with shorelines mapped from historical vertical aerial photographs to help document rates of shoreline change. For the bay systems, shoreline positions were updated using 1990's-vintage digital orthophotos. Ground surveys of two bay shorelines, Corpus Christi and Baffin Bays, were completed and supplement the aerial photograph study.

Status and Trends of Wetlands on Barrier Islands, Central Texas Coast

William A. White, Thomas A. Tremblay; Thomas R. Calnan (General Land Office of Texas)

Among the significant findings of this investigation during the past year is a major active surface fault traceable for more than 5 km across Matagorda Peninsula. The fault 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 the fault.

This research, funded by the National Oceanic and Atmospheric Administration through the Coastal Management Program and administered by the General Land Office of Texas, seeks to determine the status and trends—and the probable causes—of coastal wetlands on barrier islands in the Matagorda Bay system along the central Texas coast. The wetlands, including marshes, are part of a highly productive ecosystem on which a variety of flora and fauna depend (see photos, page 11).

Maps, historical and recent aerial photographs, and field surveys are used to analyze spatial and temporal changes in the marshes, mangroves, tidal flats, and water bodies on barrier islands and peninsulas stretching from Matagorda Bay to Mesquite Bay. Digital imagery to be acquired in early 2002 will be used to determine the current status of the research area. Previous Bureau studies document substantial losses resulting from subsidence and associated relative sea-level rise. Some of these losses have occurred along surface faults that have become active as a result of underground fluid production. Such losses have occurred in some areas on the Matagorda barriers, yet in other areas, gains have occurred as marsh vegetation spreads over wind-tidal flats.

Establishing Acceptable Ground Motion at the Texas Department of Agriculture Metrology Laboratory

Jeffrey G. Paine

The Texas Department of Agriculture is responsible for the calibration of commercial weights, volumes, and measures for the State of Texas. Among other things, they certify flow rates of gasoline pumps and the accuracy of scales in supermarkets. Their current calibration facility (the Metrology Laboratory) is located in Austin, where urban activities generate seismic noise that commonly renders their most sensitive instruments unusable. Bureau researchers are measuring ground-motion characteristics of their current laboratory and helping to establish acceptable levels of ground motion for a new calibration laboratory.

Commercial vibration monitoring systems, based on electromagnetic geophone technology and used primarily for blast monitoring, are not capable of accurately measuring the low-level vibrations that disrupt calibration activities at the laboratory. The Bureau is designing and constructing an accelerometer-based, three-component instrument for indoor/outdoor use to help compare vibration characteristics at the current and proposed laboratory sites. These portable instruments will show how vibration intensity diminishes with distance from the source at each site. These data will be used to help select the best site for a new laboratory and to establish design criteria for the new buildings that will be constructed in 2002.

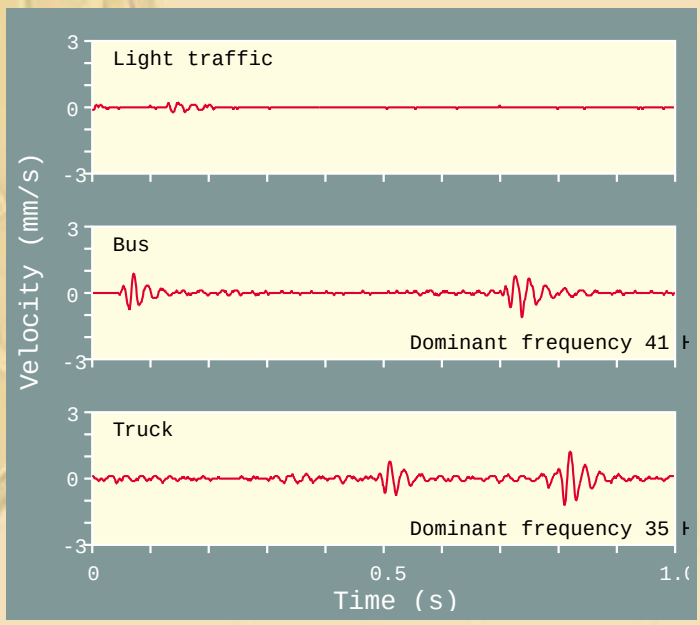
The graph below shows a comparison of vertical ground motion generated by light traffic, a bus, and a heavy truck

Near-Surface Geophysics

Assessing Lacy Creek Salinization Using Airborne Geophysics

Jeffrey G. Paine

The Upper Colorado River Authority and the Texas Water Development Board are funding the use of innovative airborne geophysical methods to study potential salinization of Lacy Creek, a tributary of the North Concho River in Sterling County, Texas. Electromagnetic induction (EM) survey data were acquired in August using Fugro Airborne Surveys' MEGATEM system. The high-resolution airborne survey covers an area of 100 km^2 with a flight-line spacing of 100 m and provides electrical conductivity measurements of the ground to a depth of about 200 m. These data will be used to delineate the lateral extent and intensity of salinization in the area, to determine whether Lacy Creek is being affected by salinization, and, if so, to identify possible sources of salinization.



along Congress Avenue in Austin, Texas. The early event in each record is generated when the front wheels of the vehicles pass over a road bump; the later, larger event occurs when the rear wheels (carrying more weight) pass over the same bump. The time between the two events differs because the vehicles have different wheelbases and are traveling at differing speeds.

Geological and Terrain Mapping

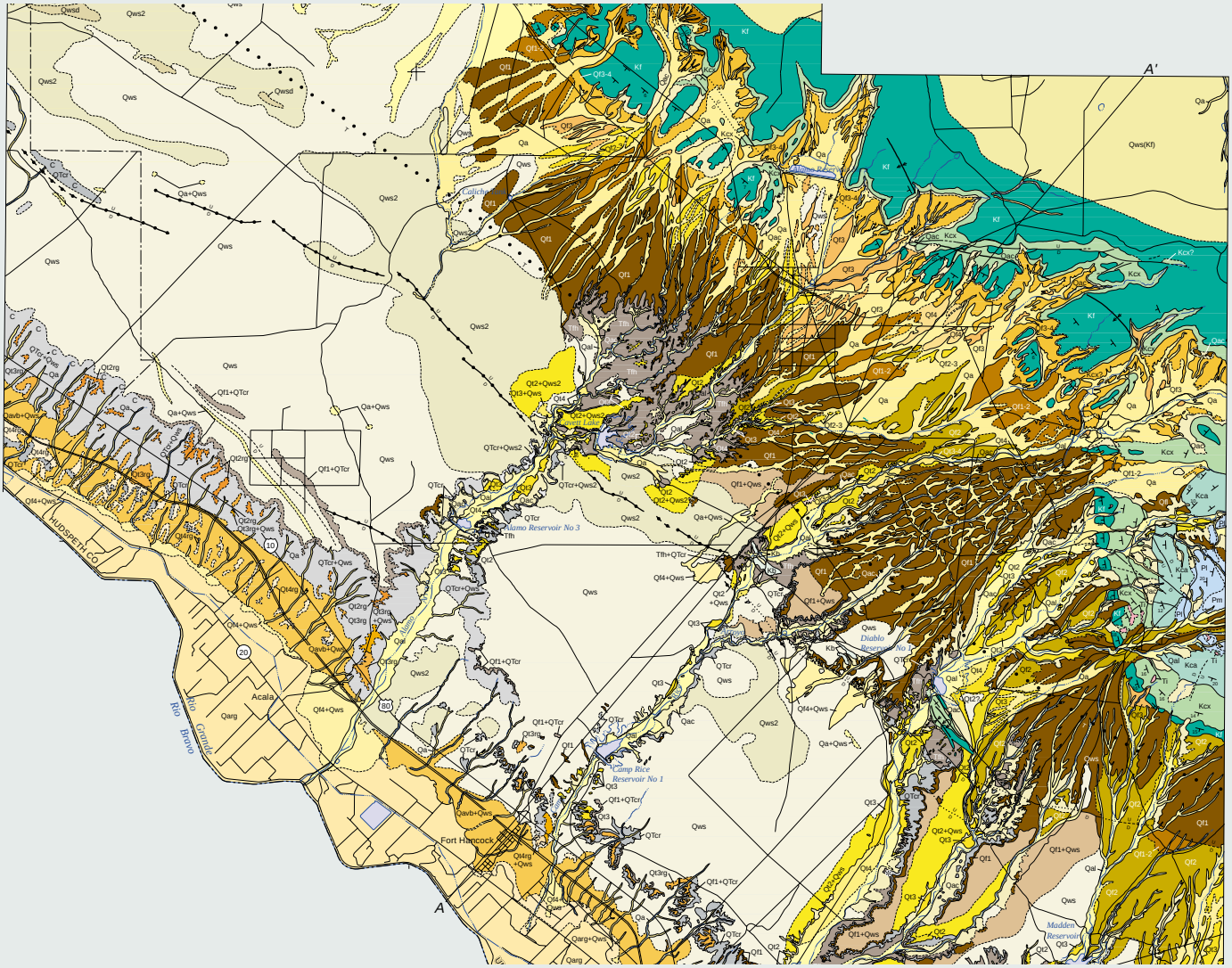
Geologic Mapping of Urban Corridors and Critical Aquifers of Texas

Jay A. Raney and Edward W. Collins

During 2001, geologic mapping focused on the critical aquifers and urban growth corridors of Central Texas, including the Carrizo-Wilcox aquifer and the corridor east of Austin; the northern segment of the Edwards aquifer that coincides with the corridor north of Austin; the urban corridor west of Austin and the Hill Country Trinity aquifer; and the San Antonio segment of the Edwards aquifer west of San Antonio. Study of these areas has improved the understanding of deposits that host the major groundwater resources.

The *Geologic Map of the Central Hueco Bolson, Acala–Fort Hancock–Esperanza Region, Texas* (see excerpt below), to be published by the Bureau in 2002, illustrates the surficial and bedrock geology of a large area of the Texas-Mexico border region southeast of El Paso.

This mapping program is funded by the U.S. Geological Survey National Cooperative Geologic Mapping and Texas STATEMAP programs for the production of geologic maps to augment the Texas and national geologic database. The maps are used by scientists and the public to study and address issues related to urban growth, land use and Earth resources, water quality, groundwater management, construction practices, engineering properties of near-surface materials.

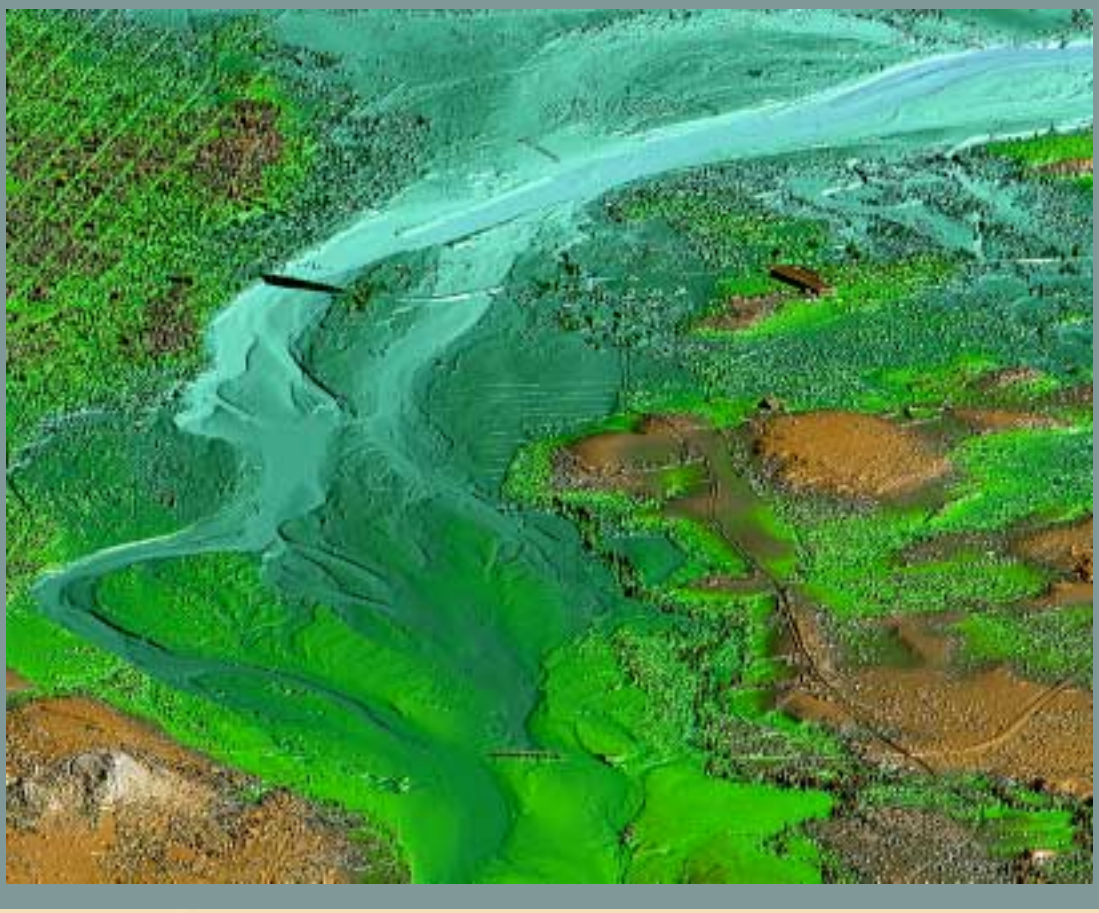


Laser Terrain Mapping, Lidar Research

Roberto Gutierrez, James C. Gibeaut, Rebecca C. Smyth, Tiffany L. Hepner, John R. Andrews, and Jerome A. Bellian

The Bureau is one of only two universities in the country to own and operate a lidar (Light Detection and Ranging) system, enhancing our growing drive to become a leader in remote sensing research and technology. The airborne laser mapping technology of lidar is used to generate 3-D electronic representations of diverse terrains. Bureau researchers are using one of the many specialized types of lidar known as ALTM (Airborne Laser Terrain Mapping), which allows repeated, precise measurements of a topographic surface whose change reflects some geologic, hydrologic, or human-caused process. Current uses of ALTM include archaeological investigations, land use planning, flood hazard mapping, landslide studies, shoreline change analysis, and water resource development. Bureau researchers are developing new, nonstandard ALTM data collection and processing procedures to generate state-of-the-art, high-precision terrain maps. These new procedures include flight calibration procedures and algorithms and vegetation-removal algorithms. Detailed information regarding Bureau lidar research is posted on the Bureau's Website at www.beg.utexas.edu/coastal.

The large lidar image below shows the Choluteca River in southern Honduras where river channel morphology changed dramatically during flooding from Hurricane Mitch, causing a newly constructed bridge to be washed out. The smaller image is a digital elevation model (DEM) of the same view, incorporating lidar-acquired elevation data.



Public Outreach and Education

The Texas High School Coastal Monitoring Program: A Project in Education, Public Awareness, and Coastal Management

James C. Gibeaut, Tiffany L. Hepner, and Rachel 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, the students enhance their science education and provide coastal communities with valuable data on their changing shoreline.

The TCMP, in its fifth year of operation, receives funding from TCMP, Conoco, and the Exxon Foundation. The participating schools are Ball (5 years in the program), Port Isabel, and Port Aransas (3 years in the program) High Schools. During the 2000–2001 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/.

A portion of the Texas coast monitored through the efforts of the Texas Coastal Monitoring Program is shown below.

Earth Science Week

Sigrid J. Clift and Scott W. Tinker

Earth Science Week (ESW) was observed nationwide October 7–13, and the Bureau celebrated by sponsoring a Book Drive that collected nearly $2,000 for the Austin Public Library and by hosting its Second 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 600 Austin-area middle school students to a day of learning about earth science careers from earth science professionals. In the above photo Cindy Carr (right), Austin Community College, describes core for students while Bureau Director Scott W. Tinker looks on. Other presenters included Bureau researchers Susan D. Hovorka, who discussed global warming, and Dallas B. Dunlap and John R. Andrews, who presented a 3-D view of the Earth using the Bureau's virtual reality stage. To find out more about ESW in Austin and in cities throughout Texas, visit the Texas ESW Website at www.beg.utexas.edu/esw.

Petroleum Technology Transfer Council (PTTC)

Scott W. Tinker, Sigrid J. Clift, Sylvia J. Jennette, Eric C. Potter, and Amanda R. Masterson

The PTTC Texas Region, for which the Bureau serves as Regional Lead Organization, sponsored a variety of workshops for Texas independent producers during 2001: Predicting Reservoir Quality Using Diagenetic Models, Well-Bore Management, Putting the Internet to Work, Optimized Horizontal Well Technology, Field-Oriented Projects for Independents, and Cross-Section-Generation Computer Workshops. The Texas Region also publishes the quarterly newsletter *ProducerNews*, which is distributed by mail to more than 650 independent oil and gas producers and by e-mail to another 350 recipients.

Public Information Resources

In addition to being a research unit of The University of Texas at Austin, the Bureau serves the State of Texas as the Texas Geological Survey. In this role, the Bureau maintains the following public resources and facilities: Core Research Centers, Data Center (composed of the Geophysical Log Facility and the Reading Room), and Publication Sales. These facilities are open to the public Monday through Friday from 8:00 a.m. to 5:00 p.m. Comprehensive information about these resources can be found on the Bureau's Website at www.beg.utexas.edu under the menu *Public Resources*.

The Data Center

The Data Center comprises a Reading Room and Geophysical Log Facility, housed on the first floor of the Bureau's headquarters in Austin. The Reading Room maintains a collection of geological reference materials, including periodicals, maps, publications, and reports from various governmental and nongovernmental earth science entities. Inquiries about Texas geology may be made by phone at 512-471-0320 or e-mail at beg.utexas.edu.

The Geophysical Log Facility (GLF) stores downhole log data received from private donations, Bureau research projects, and the Railroad Commission of Texas, which by law receives a copy of geophysical logs from every new, deepened, or plugged well drilled in Texas. Data available for public research include wireline electric logs, well records, and scout tickets from hundreds of thousands of Texas wells. Sample logs from the 1930's through the 1950's are also stored and made available for public research. Copies of logs can be requested either in person or by mail, telephone, fax, or e-mail. For information, please call the GLF Manager at 512-471-7139.

Publication Sales

The Bureau publishes and sells maps and reports of research conducted by Bureau staff from 1915 to the present and, in 2001, began handling the sales of select Gulf Coast Association of Geological Societies (GCAGS) publications. Bureau publications include reports of investigations, guidebooks, handbooks, cross sections, maps, oil and gas atlases, seismic data sets, geologic folios, geologic atlas sheets, page-sized maps of Texas, classroom teaching aids, out-of-print publications, and most Bureau contract reports.

The Publication Sales office is located on the first floor of the Bureau's headquarters in Austin. Orders for publications can be made either in person or by mail, telephone, fax, e-mail, or through our Website at www.beg.utexas.edu. For information, please call the Publication Sales Manager at 512-475-9513.

Free copies of the current year's *List of Publications, Annual Report,* and *Midyear Report* are available upon request.

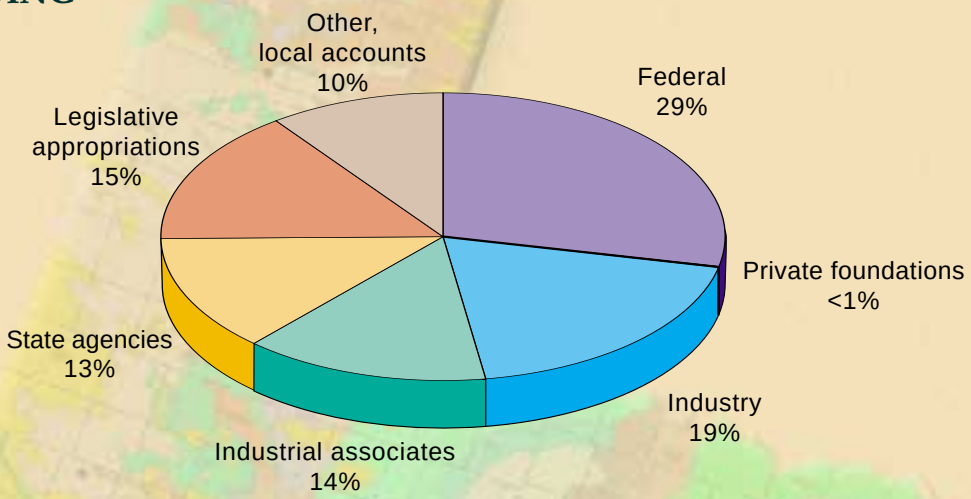
Core Research Centers

The Core Research Centers (CRC's) are research and storage facilities in Austin and Midland that house core and rock material donated to the University. The Austin CRC, the Bureau's central core repository, is located adjacent to Bureau headquarters on the University's J. J. Pickle Research Campus. This 95,000-ft^2 facility contains more than 655,000 boxes of core and well cuttings. The Midland CRC, donated to the University in 1994 by Shell Oil Company, now holds more than 495,000 boxes of core and well cuttings.

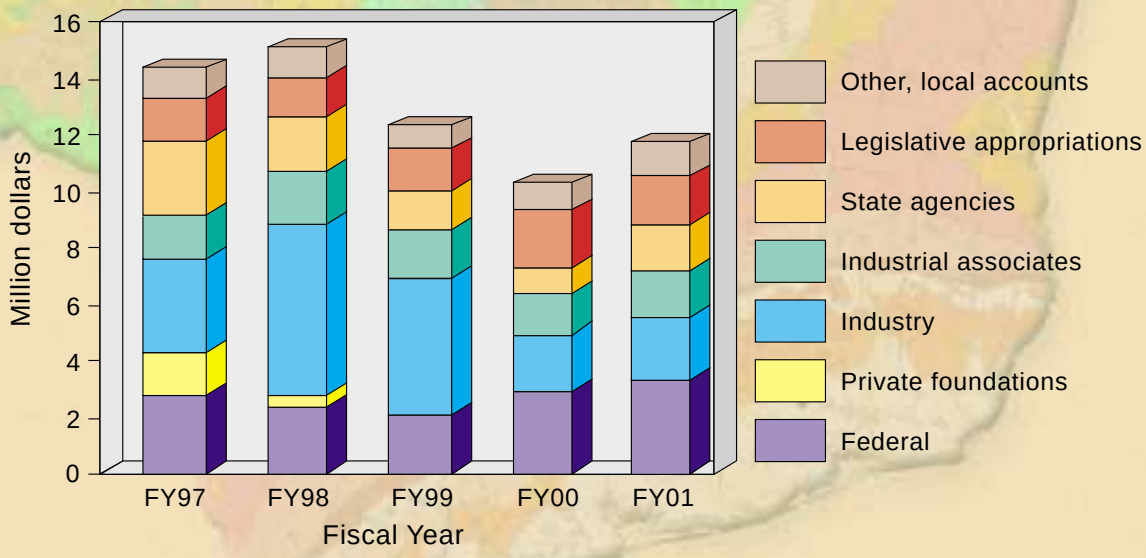
Public facilities include core examination rooms, processing rooms for slabbing core, and office space. For-a-fee services are available, such as core photography and CD's of CRC inventories. For information, please call the Austin CRC Manager at 512-471-0402.

Bureau Finances and Staff

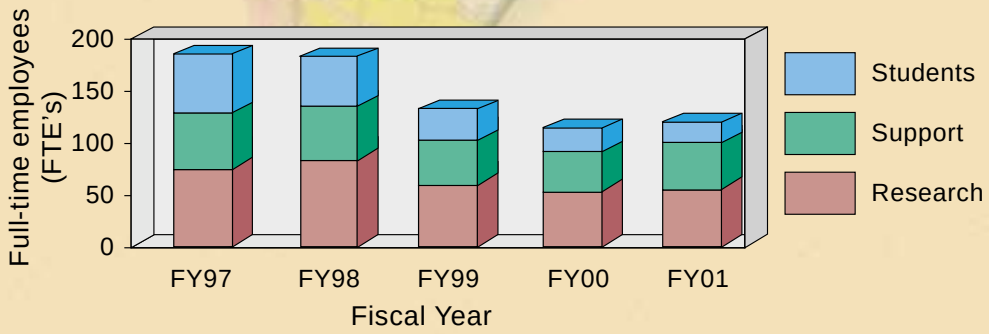
Sources of Funding



Five-year Budget Trends



Staff Trends



On the Web

Scott D. Rodgers, Sylvia J. Jennette, Amanda R. Masterson, Kerza A. Prewitt, and David M. Stephens

The Website has become a high-profile part of Bureau life this year. Features on the home page cover current events and news of the Bureau, research staff and their work, visitors to the Bureau, current public outreach, and new Bureau publications, to name but a few. Bureau Web staff have redesigned some pages, reorganized some areas, and most fun of all, added Web biographies for each Bureau researcher. Among other new features, the Bureau now hosts the Websites of Texas Earth Science Week and Texas Environmental Awareness Network (TEAN). To satisfy the many requests Bureau scientists receive for copies of talks they present at various professional meetings, the Bureau has begun posting copies of these presentations on the Website.

The Website continues to provide basic information about the Bureau, including its mission, areas of research and public outreach, public services, staff, and publications. The site also has links to State, Federal, and industrial organizations, as well as links to geologic and earth science resources.

Visit us at www.beg.utexas.edu.

A Farewell to Friends

Don R. Boyd

The Bureau and the geoscience community lost a good friend when Don Boyd passed away on December 20, 2000, in Corpus Christi. Don was a member of the Bureau's Advisory Committee and a longtime supporter and member of the Geology Foundation Advisory Council at UT. He and his wife, Patricia, established the Don R. and Patricia Kidd Boyd Lectureship in Petroleum Exploration at the Department of Geological Sciences. For his extensive service to professional societies, Don was awarded Honorary Membership in the American Association of Petroleum Geologists in 1989. Don was also the first recipient of the Don R. Boyd Medal for Excellence in Gulf Coast Geology, which was established in his honor by the Gulf Coast Association of Geological Societies in 2000.

Claude R. Hocott

Another Bureau friend and longtime UT professor, Claude Hocott, died September 9, 2001, in Austin. After retiring from the Department of Petroleum Engineering, Claude worked part time for the Bureau from 1984 to 1994, and on special appointments for several years thereafter, assisting the Bureau in reservoir characterization projects and related engineering problems. Claude was instrumental in promoting the understanding of the concept of reservoir heterogeneity championed by former Bureau Director William L. Fisher and colleagues. He also mentored junior staff in the practical aspects of petroleum engineering. Claude was active in professional societies and in 1988 was inducted into the Legion of Honor of the Society of Petroleum Engineers, of which he was a Distinguished Member. He also served as a Distinguished Lecturer for SPE.

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