

2018 Annual Report



BUREAU OF
ECONOMIC
GEOLOGY

Scott W. Tinker
Director



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Sandstone mesas of the Permian-age Brushy Canyon Formation.
(Photo credit: Charles Kerans and Chris Zahm)

Message from the Director

It is often said that strategic plans are not much use but that the planning process is invaluable. There is some truth in this; therefore, the written plan must be succinct and accessible.

The Bureau went through a strategic planning process this year. We kept our written plan intentionally short in order to be easy to understand and communicate. We focused on vision and mission, core values, succinct objectives and goals, tactics to reach each goal, and metrics to measure progress. Our strategic plan is not etched in stone but instead intended as a guideline for what we feel is important. The plan will be used as a basis for action in the coming years and adapted as needed.

Our Vision—to be a trusted scientific voice to academia, industry, government, and the public, whom we serve—and our Mission—to serve society by conducting objective, impactful, and integrated geoscience research on relevant energy, environmental, and economic issues—sum it up. We seek to be trusted, objective, impactful, and relevant, and in so doing, to serve. When we serve, we succeed.

It has been an honor for me to serve the Bureau, the University, the State of Texas, and the nation these past 19 years. Before embarking on my third decade as director, I decided to take a partial sabbatical. Mark Shuster (Associate Director: Energy Division) is acting as director, with full support from associate directors Mike Young and Jay Kipper, and the rest of the leadership team. The Bureau is in very capable hands.

A sabbatical is not a vacation; quite the opposite. But it does offer a chance for me to pursue my passion of energy education. The *Switch* Energy Alliance group is creating two new films, an energy course, a leading energy website, and possibly even a book. Check us out at SwitchOn.org and on Instagram @doctinker.

With energy!



Scott W. Tinker

Strategic Plan *Mission, Vision, Values*

- Our **Mission** is to serve society by conducting objective, impactful, and integrated geoscience research on relevant energy, environmental, and economic issues.
- Our **Vision** is to be a trusted scientific voice to academia, industry, government, and the public, whom we serve.
- Our **Values**: At the Bureau, we are Authentic, Respectful, Innovative, Impactful, and Collaborative.

The essence of what the Bureau of Economic Geology is, what it hopes to achieve, and what its people find to be most important to the organization has been captured in its **Strategic Plan**. Completed in 2018, the plan is the result of months of analysis, contemplation, and thorough discussion. The planning process was facilitated by Dr. Douglas Dierking, assistant chair of the Department of Management in the UT McCombs School of Business, who donated his time and expertise in organizational planning to the effort.

The Bureau's Planning Task Force—led by Director **Scott W. Tinker**; associate directors **Jay Kipper**, **Mark Shuster**, and **Michael Young**; and External Affairs Manager **Mark Blount**—included a diverse cross section of researcher and staff representatives, including **Cathy Brown**, **Poe Chen**, **Jake Covault**, **Julia Gale**, **Gürcan Gülen**, **Nathan Ivicic**, **Kim LaValley**, **Linda McCall**, **Jeff Paine**, and **Katherine Romanak**. The task force participated in several sessions to hone the plan and sought feedback on the content of the evolving draft from Bureau colleagues. The result is a concise plan that will help to guide the work of the Bureau.

The new Strategic Plan is highlighted in this Annual Report. In addition to the Mission and Vision, the plan sets out the Values that make our staff and researchers such a dynamic team. To illustrate what those Values mean, several members of our task force have prepared the following brief explanations.

Values



Katherine Romanak Research Scientist

Authentic

At the Bureau of Economic Geology, “authentic” describes our approach to our work and to our relationships. Foremost is the quality of our research. Authentic research means that we make extra effort to be thorough in our analyses and assessments. We do not gloss over any

stage of our work but care enough to ensure that all potential relevant information is accessed and reviewed. Authentic research requires at its foundation a balanced and impartial approach implemented with methods and procedures that are transparent and reproducible. It also requires that data are handled with integrity—protected and kept confidential. We strive to ensure that conclusions and recommendations are unbiased, objective, and based solely on the evidence presented by our science.

Authenticity also describes our relationships with our collaborators and contract partners. We listen to, and care about, our partners' goals, and strive to find creative ways to work toward those goals. Genuine and honest communication is the foundation of our partnerships. Agreements are made in earnest, and any challenges that arise are openly discussed. Keeping to deadlines and fulfilling obligations is important to us, ensuring that we provide value on a consistent and dependable basis. Within the Bureau, authentic relationships mean that we hold each other to high standards as we rely on one another for support, problem solving, and teamwork. As a team, each member works hard, giving 100% effort to support coworkers and sharing equally in both successes and failures.



Nathan Ivicic Warehouse Supervisor

Respectful

Being respectful of one another is a value that we strive for while working at the Bureau. Respectful behavior is often something that does not come naturally to us; rather, we have to be intentional about it. Considerable time is spent at work each week by each Bureau employee, and we need to be careful

and intentional about how that time is spent. The Bureau is a dynamic and diverse workplace filled with many unique and talented individuals who represent numerous countries, cultures, and beliefs that span the globe, and it is highly important to be respectful of one another. Respect can begin with how we greet each other, such as "How are you?" versus "Did you get my e-mail?" Respectful behavior means considering how the other person appreciates being treated. Seeing each person as valuable and part of the greater Bureau puzzle is essential if the individual pieces are to all fit well together. It is not up to the director-level leadership to create a respectful environment; instead, it is each individual's responsibility because influence occurs at every level. At the Bureau, we each try to do our part to be the kind of workforce in which we are present; listen well; heed boundaries; and develop healthy, respectful working relationships.



Jake Covault Research Scientist

Innovative

Why are we innovative? We have to be innovative at the Bureau of Economic Geology to accomplish our mission to perform transformative, impactful research for society. Moreover, much of the funding for scientific research at the Bureau is externally supported; innovative

proposals tend to be successful, which fosters an entrepreneurial spirit. Throughout the cycle of a research project, Bureau geoscientists are thinking of new ways to do science that set them apart as leaders in applied research.

How are we innovative? Innovation is fostered by a diversity of experience within individual research groups and the willingness of Bureau researchers to engage colleagues across the Jackson School of Geosciences. Three examples of successful, innovative research groups are the [Applied Geodynamics Laboratory](#), the [Reservoir Characterization Research Laboratory](#), and the [Gulf Coast Carbon Center](#). These groups enlist multidisciplinary talent in areas as diverse as numerical modeling, physical experimentation, and geological/geophysical reservoir characterization to address major scientific questions of salt tectonics, oil and gas exploration and development, and carbon capture and storage. These groups also draw on expertise in other disciplines at the Bureau, such as sedimentology/stratigraphy in my group, the [Quantitative Clastics Laboratory](#), and across the broader Jackson School to deliver uniquely multi- and interdisciplinary insights to sponsors.

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Strategic Plan

Values (continued from previous page)



Julia Gale Senior Research Scientist

Impactful

At the Bureau, our work on challenging topics includes the continuing goal of having an impact on science and society. Improved scientific understanding is intrinsically impactful—but especially amplified when the work is applied to a societal need.

Examples of Bureau impact across many sectors include the work of the award-winning CO₂ sequestration group, the [Gulf Coast Carbon Center](#) (GCCC), which has developed innovative methods and tools in seven field-research projects that can now lead to full-scale application; Bureau descriptions of hydraulic fractures and proppant distribution in core taken through a stimulated oil reservoir, which impact hydraulic fracture design and modeling; and the new seismic network for Texas, [TexNet](#), which provides a catalog of earthquakes in the state that is available to the public as well as to the scientific community.

The Bureau's work has global, as well as local and national, impact. Bureau researchers communicate results in peer-reviewed journals and at international meetings; many of our scientists are leaders in scientific and engineering organizations, and editors for major journals. These roles allow us to set the agenda for future research, meetings, and publications, all of which are impactful in their own right as we share new understanding with educators, decision makers, and the public.



Jeffrey Paine Senior Research Scientist

Collaborative

"Collaborative" is one of those words that is commonly employed in management circles as a virtuous goal for any organization. Collaboration for the sake of collaboration, though, can be a needless waste of time and effort and can reduce the time individuals have available to actually do the work to which they and their organization are

committed. Fortunately, the Bureau is inherently collaborative in a frugal way, both with external research partners and among Bureau staff. Few individuals have all the skills, knowledge, or time required to do such diverse yet necessary tasks as prepare proposals, manage projects and researchers, monitor expenditures, conduct research, write reports and papers, and disseminate results. Each Bureau employee has ready access to willing and competent managers, researchers, and administrative staff who together help ensure scientific progress is made, schedules are followed, and deliverables are met. This just-enough (but not too much) collaborative approach helps ensure that the Bureau continues to be known for high-quality science and making that science readily available to research sponsors, other scientists, governmental agencies, educators, private industry, and interested citizens everywhere.

Research Consortia



Research Partnerships with the Bureau of Economic Geology

The Bureau of Economic Geology conducts impactful research on subjects of high interest to the energy industry and to environmental firms, and a broad spectrum of companies and other organizations actively participate in its 11 research consortia. These unique partnerships study subjects as diverse as salt tectonics, carbonate reservoir characterization, natural fractures and geophysics, carbon storage, nanotechnology, quantitative clastics, computational seismology, and mudrock reservoirs.

Collectively, these 11 consortia enjoy the support of more than 45 partners globally, with some companies and organizations participating in multiple separate programs. Each research consortium was designed to complement industry efforts to explain a key exploration, production, environmental, and/or economic problem. Participation is on a subscription basis. Member benefits vary but generally include first-look privileges at research outcomes, access to research teams, invitations to annual review meetings, and office visits by researchers for presentation and interaction. Members also benefit from interactions with counterparts in fellow sponsoring organizations.

Each Bureau research consortium has a dedicated team of full-time researchers, including postdocs. Many of them host talented graduate students, the teams combining seasoned experts and early-career specialists. A number of researchers have industry backgrounds, and all share a passion for university-based research.

We invite you to contact the principal investigator of any program of interest to you. If you would like further information about these research consortia, or about the breadth of your organization's engagement with the Bureau, please contact us at www.beg.utexas.edu, or by phone at 512-471-1534.

The Rio Grande in far West Texas on its way to the Gulf of Mexico; the view at Boquillas.

Advanced Energy Consortium

Mission

Our mission is to illuminate the subsurface reservoir using novel micro- and nanosensing technology developed collaboratively with Advanced Energy Consortium (AEC) members and the global community.

Research Thrusts

This research organization is dedicated to achieving a transformational understanding of subsurface oil and natural gas reservoirs through the deployment of unique micro- and nanosensors. However, the technologies developed by the AEC are showing themselves to have much broader potential applications than just oil and gas. Areas such as hot-dry rock geothermal, seal integrity, and other applications for monitoring in carbon capture and storage, as well as cement integrity in nuclear waste and nuclear power generation, are areas of clear potential.

Research Challenges

Since its inception, the AEC has invested more than \$50 million in research with 30 university and research facilities around the world and has progressed from fundamental to applied research. It is now targeting commercial applications ("use cases") that will help its members enhance their commercial extraction of oil and natural gas.

Membership

In only 10 years, progress of the consortium has been remarkable. The AEC has created a whole new scientific space, published hundreds of peer-reviewed papers, created a patent portfolio exceeding 50 inventions (including the world record for smallest subsurface-conditions battery and pressure sensor), and is now on the verge of completing commercial-scale proof-of-concept tests. Membership is \$375,000 per year, with an initial 2-year membership commitment.



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Applied Geodynamics Laboratory

Mission

Pure and applied research in salt tectonics has been a strong component of the Bureau's research program since the late 1970's. At the heart of this research is the Applied Geodynamics Laboratory (AGL), an industry-funded consortium dedicated to producing innovative concepts in salt tectonics. Research comprises a mix of physical and mathematical modeling; seismic- and field-based mapping; and structural-stratigraphic analysis of some of the world's most spectacular salt basins—including those of the Gulf of Mexico, West Africa, Brazil, the Mediterranean, and the Canadian High Arctic. Research has also been applied extraterrestrially to Mars and Triton.

Research Thrusts

Concepts and terminology pioneered by the AGL over the last quarter-century have profoundly influenced salt tectonics and are now widely disseminated throughout the oil industry. AGL strives to effectively communicate these results via a variety of media, including *The Salt Mine: A Digital Atlas of Salt Tectonics*, a book and interactive DVD designed to be the most comprehensive collection of salt-tectonic images and animations ever assembled.

Research Challenges

The primary goals of the AGL are to develop a conceptual framework for the full range of salt tectonics; to analyze connections between physical models, mathematical models, seismic data sets, and field examples from all over the world; and to disseminate complex technical information to a constantly shifting spectrum of industrial and academic supporters. Areas of focus include salt weld; salt canopy; reactive, falling, and squeezed diapirs; shape of passive diapirs and sheets; fault families (with University of Colorado); extrusive salt sheets (with BP, Exxon); extensional turtle and mock turtle; mechanics of salt-sheet advance; origin of minibasins; intrusive salt plumes; and salt sutures.

Membership

The many supporting companies of the Applied Geodynamics Laboratory include a wide range of industry partners from around the world.



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Center for Integrated Seismicity Research

Mission

The Center for Integrated Seismicity Research (CISR) is a multidisciplinary, intercollegiate research consortium managed by the Bureau of Economic Geology. CISR and TexNet are two parts of a whole; the latter is the state-funded network of seismometers across Texas that conducts research into earthquake causation in key areas. With its industry partnerships, CISR significantly extends and deepens the scope of research and monitoring toward an understanding of the processes that influence seismicity, quantification of the hazards, and improvement of standards of practice for mitigation.

Research Thrusts

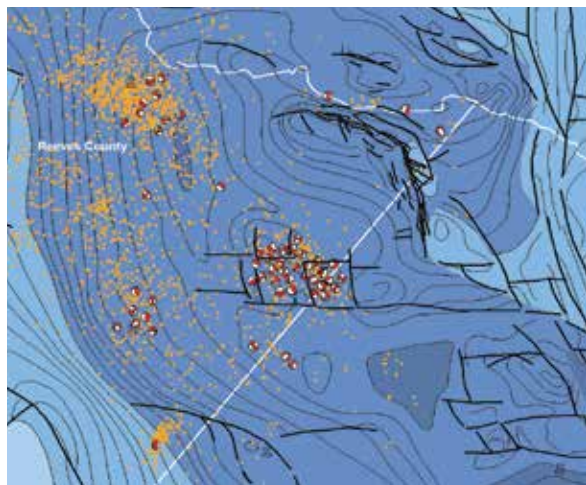
CISR conducts fundamental and applied research to better explain seismicity of all causes and its associated hazards. CISR brings together researchers from UT's Bureau of Economic Geology; Institute for Geophysics; Department of Petroleum and Geosystems Engineering; and Department of Civil, Architectural, and Environmental Engineering. Researchers at SMU, Texas A&M, the University of Houston, UT Dallas, and UT El Paso also contribute.

Research Challenges

Over the last decade, the rate of seismicity in the south-central United States has increased markedly, especially in unconventional play areas where water management has become an important challenge. Understanding the interplay between complex operational drivers and interdependent subsurface physical processes is a daunting challenge that the Bureau has adopted head-on.

Membership

Most of the major energy companies that operate in Texas unconventional plays are CISR members. A member of each company serves on the CISR Advisory Committee, which meets in person quarterly to discuss the design and application of TexNet-CISR research. Member companies are encouraged to contribute proprietary data and information that can guide and advance CISR research. Proprietary data are protected by UT Austin's strong intellectual property controls.



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Fracture Research and Application Consortium

Mission

Natural-fracture research at The University of Texas at Austin seeks fundamental understanding of fractures and fracture processes with the aim of finding new geological, geophysical, and engineering methods to explain and successfully predict, characterize, and simulate reservoir-scale structures.

The purpose of this research is both fundamental and practical—to improve prediction and diagnosis of natural-fracture attributes in hydrocarbon reservoirs and accurately simulate their influence on production. Research is organized around the Fracture Research and Application Consortium (FRAC), an alliance of scientists from the Bureau and the departments of Petroleum and Geosystems Engineering and Geological Sciences, together with scientists from member companies. Student participation is an important part of our program. Many students find placement with member companies.

Research Thrusts

More accurate prediction and characterization of fractures hold great potential for improving production by increasing the success and efficiency of exploration and recovery processes. New analytical methods will lead to more realistic characterization and prediction of fractured and faulted hydrocarbon-bearing carbonate, mudstone, and sandstone reservoir rocks. These methods produce data that can enhance well-test and seismic interpretations and that can readily be used in reservoir simulators. We are developing new and more reliable and efficient methods to predict hydraulic-fracture propagation in naturally fractured and other unconventional reservoirs.

Research Challenges

Many faults and fractures are difficult or impossible to characterize adequately using currently available technology. Fractures have been intractable to effective description and interpretation, posing serious challenges to exploration and development, as well as to accurate reservoir simulation and reservoir management. Our approach is helping to overcome the limitations of current methods.

Membership

Our research includes measurement, interpretation, prediction, and simulation of fractures in carbonate rocks, mudstones, and sandstones. Training in techniques, software, and our workflow is a benefit of membership.



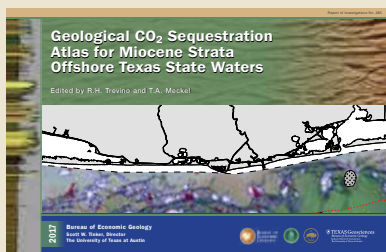
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CO₂ Sequestration Potential in Texas Offshore Waters

The **Geological CO₂ Sequestration Atlas of Miocene Strata, Offshore Texas State Waters** (RI0283)

is a resource for exploring the geological CO₂ sequestration potential of the near-offshore waters of Texas via large-scale regional and qualitative, as well as detailed quantitative, information that can help operators quickly assess CO₂ sequestration potential at specific sites. This is the first comprehensive attempt to accomplish this goal in the near offshore Gulf Coast and United States.

The atlas summarizes research undertaken as part of a multiyear study (2009–2014) of Texas State Waters and the adjacent Federal Offshore Continental Shelf. The goal of the study was to analyze existing data from historical hydrocarbon-industry activities in a regional transect of the Texas coast in order to verify the ability of Miocene-age rocks of the region to safely and permanently store large amounts of anthropogenic (industrial) CO₂.

Gulf Coast Carbon Center

Mission

The Gulf Coast Carbon Center (GCCC) conducts research and outreach in geologic storage technologies used to reduce emissions of carbon dioxide. Carbon dioxide produced by combustion of fossil fuels and from other industrial processes is captured and injected into porous rocks at locations where it is stored.

Research Thrusts

GCCC research into large-volume CO₂ storage (1) improves structural and stratigraphic characterization methods and simulation approaches to identify suitable locations and increase confidence in the technologies; (2) creates workflows for characterization at basin scale that prepare multiple sites to be operated at maximum injection rates and over prolonged time periods; and (3) assesses storage resources in offshore subsea settings in Gulf of Mexico and globally.

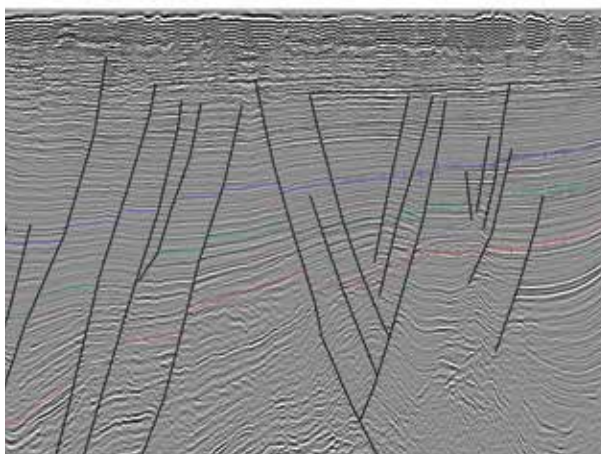
CO₂-enhanced oil recovery (EOR) research allows assessment of the best methods and economic value of use of CO₂ for EOR in various traditional and novel settings, as well as of the intersection of economic value with storage value to develop a transparent life cycle that accounts for storage and EOR.

Research Challenges

Carbon capture and storage (CCS) deployment is not happening at the rate and scale needed to achieve emissions-reduction goals. Many influential stakeholders, from industrial investors to policymakers to journalists, do not have the information needed to see the critical role of CCS in attaining these goals and the viability of CCS.

Membership

Members meet twice a year (sometimes jointly with other related groups) and receive a quarterly newsletter.



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Mudrock Systems Research Laboratory

Mission

The Bureau's Mudrock Systems Research Laboratory (MSRL) program brings together a broad spectrum of research expertise necessary to confront the complicated, multidisciplinary questions that are key to a better understanding of mudrock systems. The goal of the program is to integrate observations and data from all scales, ranging from nanoscale pores to regional basin settings, from element maps to borehole and 3D geophysics, from fractures to flow modeling, and from clay diagenesis to sequence stratigraphy. Only through this kind of integrated approach can the multiscale heterogeneities of mudrocks be effectively characterized and models leading to better predictions of reservoir quality be developed.

Research Thrusts

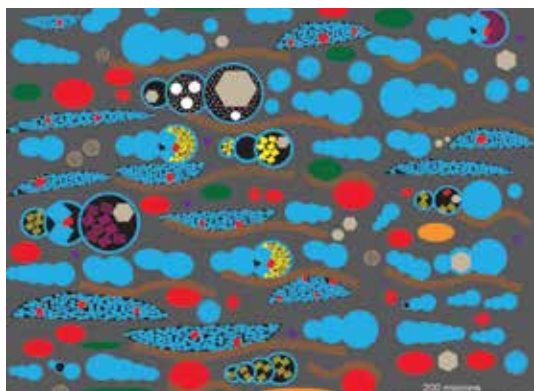
MSRL research includes the following: FE-SEM and atomic-force microscopy of Ar-ion-milled surfaces to reveal pore architecture; analysis of mechanical properties of mudrocks in time and space; application of element and isotope geochemistry to better define facies and their continuity; delineation and modeling of regional and local trends in depositional and diagenetic facies distribution; development of more accurate ways to determine porosity, permeability, and model flow; critical appraisal of conventional methods of mudrock analysis techniques, history, thermal maturation, and rock-attribute development; and calibration and interpretation of borehole geophysical data.

Research Challenges

Mudrock systems in many ways constitute a last frontier in sedimentological research. Despite their abundance in Earth's crust, these rocks are much less well understood than other systems. The current explosion of interest in these rocks stems from their potential as oil and gas reservoirs. However, few, if any, of the approaches used for more conventional sandstone and carbonate hydrocarbon successions are applicable. The challenge is to develop new methodologies for characterizing these rocks. Much of this work must be carried out on high-precision, high-resolution instruments that are not required or commonly utilized in other sedimentary rock systems.

Membership

Consortium members receive exclusive priority access to all research data, interpretations, and reports. Results are distributed to program participants through annual workshops, seminars, field trips, and the web.



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Quantitative Clastics Laboratory

Mission

The mission of the Quantitative Clastics Laboratory (QCL) is to carry out integrated geologic studies for our industry members at multiple scales to develop predictive models for processes and controls on sediment transport and the stratigraphic evolution of depositional systems.

Research Thrusts

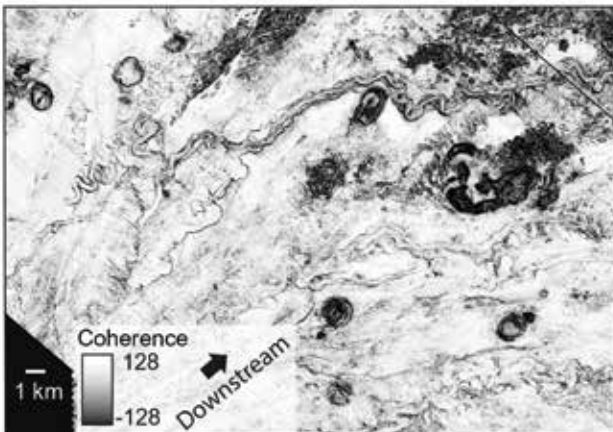
QCL researchers leverage the broad, world-class expertise of the Jackson School of Geosciences (JSG)—including collaborations with groups specializing in structural geology, Texas and Gulf of Mexico depositional syntheses, seismic interpretation, and burgeoning technology in geochronology and thermochronology—to address key challenges in the exploration and development of natural resources: the evaluation of reservoir presence and quality in data-limited frontier basins, and the characterization of connectivity and heterogeneity of reservoirs. The QCL has unique clastic research consortia access to industry subsurface data, including global seismic-reflection datasets and Bureau core repositories.

Research Challenges

The *Reservoir Analog Architecture and Dimensional Database* is being improved to provide an intuitive, searchable source of quantitative information on reservoir architecture to our industry members. QCL aims to provide quantitative distributions, not just ranges, of reservoir architectural elements in a variety of settings. QCL has established search functionality for legacy data and is organizing the database according to a simplified scheme of architectural elements of fluvial, shallow-marine, and deep-water depositional elements.

Membership

Each year's research calendar begins January 1 and runs through December 31. Multiple meetings, workshops, and face-to-face consultation with industry members are held annually. Website and database access is limited to active members; however, annual meeting presentation material, field-trip guides, and publications remain available to inactive members for their membership years. The QCL offers industry members unique access to expertise of the JSG, industry subsurface data, investigations of multiple scales of depositional environments and their interconnections, and an evolving quantitative database on clastic depositional-systems architecture.



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Reservoir Characterization Research Laboratory

Mission

RCRL's mission is to use outcrop and subsurface geologic, geophysical, and petrophysical data from carbonate reservoir strata as the basis for developing new and integrated methodologies and concepts to better explain and describe the 3D reservoir environment, and to improve hydrocarbon recovery factors. In addition to this research mission, RCRL is dedicated to technology transfer and education, and consistently offers state-of-the-art training in the form of short courses, field seminars, in-house reviews of selected assets, and extensive graduate student supervision and guided research.

Research Thrusts

RCRL approaches reservoir characterization through four main scales of investigation: (1) platform-to-basin-scale stratigraphy; (2) reservoir architecture, including both matrix and nonmatrix systems (e.g., fractures and paleokarst); (3) structural and geomechanical properties characterization; and (4) pore networks and their reservoir distribution. Research questions for each theme are developed using both subsurface data and outcrop analogs. RCRL emphasizes quantifying what is observed so that its research is applicable to reservoir models and is valuable in providing predictive relationships and conceptual tools for reservoir characterization and play analysis.

Research Challenges

RCRL areas of investigation include the following: Early Permian shelf-to-basin synorogenic to early post-orogenic stratigraphy of the Delaware and Midland Basins; Gulf of Mexico carbonate reservoir settings, pore systems, fracture character, and margin variability; Cenozoic carbonate-platform systems, high-resolution stratigraphy, and structural configuration of shelf margins; fractured carbonate reservoir characterization in outcrop and subsurface analogs; origin and petrophysics of tight limestone and dolomite reservoirs; regional reservoir characterization of the Austin Chalk trend; and carbonate rock mechanics and acoustic-properties research.

Membership

The RCRL sponsor contribution to the program is \$55,000 per year. Sponsors are encouraged to commit to a 2-year agreement to better plan a longer-range research program. Industrial sponsors receive research results at annual review meetings; in short courses; during mentoring activities; in publications; and on the continually updated, members-only RCRL website database (<http://www.beg.utexas.edu/rcrl/members/>), which contains digital presentations, core workshop guidebooks, and field-trip guidebooks.



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State of Texas Advanced Oil and Gas Resource Recovery

Mission

The mission of the State of Texas Advanced Oil and Gas Resource Recovery (STARR) program at the Bureau of Economic Geology is to conduct geologic research that increases the production and profitability of oil and gas in the State of Texas. Since its inception in 1996, STARR has helped raise \$515.6 million in severance-tax revenues, offsetting Texas' \$39.8 million funding investment. In its more than 20-year history, STARR has undertaken more than 60 field (reservoir characterization) and 15 regional studies, with over 50 Texas oil and gas operators participating in the program.

Research Thrusts

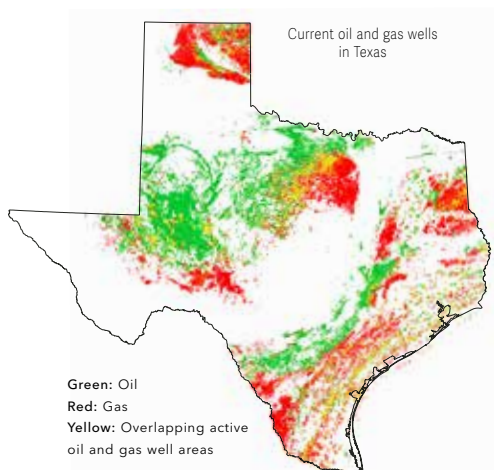
Research thrusts of the STARR program are applied toward technology transfer to operators in the oil and gas industry in Texas in three main areas: (1) integrated geologic characterization studies that employ seismic, core, wireline-log, and petrophysical data for documenting areas with additional oil and gas potential, at both field and regional scales; (2) imaging and characterization of lithology, facies, and micro-pore systems in unconventional reservoirs, including shale-gas systems; and (3) advanced seismic mapping techniques for imaging potential oil and gas reservoirs not currently contacted by existing well bores.

Research Challenges

The main challenge in the STARR group is to explain controls on oil and gas production in the wide variety of oil and gas reservoirs in Texas. Geoscientists at STARR employ a technical approach that emphasizes rock data for better characterizing reservoir quality and continuity, two important factors in determining oil and gas producibility. The STARR group, wherever possible, integrates rock-property data in both field- and regional-scale projects, drawing upon its extensive well-core collection at the Bureau of Economic Geology.

Membership

No costs are associated with participation in the STARR program, which is funded by the State of Texas. STARR partners receive a variety of technical products that include stratigraphic and structural interpretations; facies and depositional systems analysis from cores, wireline logs, and seismic data; and interpretations of geologic controls on reservoir quality.



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Texas Consortium for Computational Seismology

Mission

The mission of the Texas Consortium for Computational Seismology (TCCS) is to address the most important and challenging research problems in computational geophysics as experienced by the energy industry, and to educate the next generation of research geophysicists and computational scientists.

Research Thrusts

TCCS research areas include the following: high-resolution imaging of the Barroilka Dataset using diffraction attributes; characterization of fractured shale reservoirs using anelliptic parameters; phase correction of prestack seismic data using local attributes; extracting seismic events by predictive painting and time warping; lowrank reverse time migration for subsalt imaging; high-resolution seismic attributes for fracture characterization in the Grosmont Formation; waveform tomography with cost function in the image domain; multiazimuth seismic diffraction imaging for fracture characterization in low-permeability gas formations; and seismic-wave focusing for subsurface imaging and enhanced oil recovery.

Research Challenges

The TCCS is a collaboration between the Bureau of Economic Geology and the Institute for Computational Engineering and Sciences (ICES) involved in estimating seismic velocities by using full waveform information; identifying the most accurate and efficient seismic imaging algorithms while controlling the trade-off between accuracy and efficiency; increasing the resolution of seismic reservoir characterization; and assisting the seismic interpreter by automating common interpretation and signal-processing tasks.

Membership

TCCS publications follow the discipline of reproducible research: results of each computational experiment are supplied with open-source software code required for reproducing and verifying the experiment.

The TCCS group consists of scientists from five countries who are united in their goal to advance science. Research staff include two principal investigators, six Ph.D. students, three M.S. students, a postdoc, a B.S. student, a senior research fellow, and a visiting scholar.



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Tight Oil Resource Assessment

Mission

The Tight Oil Resource Assessment (TORA) program is an industry consortium created in 2016 to fund a multi-disciplinary study of tight-oil producing horizons in the Midland and Delaware Basins. In 2018, other tight, resource-reservoir evaluations and studies completed by the Bureau of Economic Geology were combined into the TORA consortium. TORA has built on a century of the Bureau's Permian research, and the recently completed national shale-play resource and production rate studies, to analyze this complex gas- and oil-rich source-rock system.

Research Thrusts

The TORA multidisciplinary team employs a bottom-up, highly iterative resource-evaluation process. The TORA research model allows team members from different disciplines to share information and inform study results. Team members are experts in their respective fields, which include geology and petrophysics, engineering, economics, and water management.

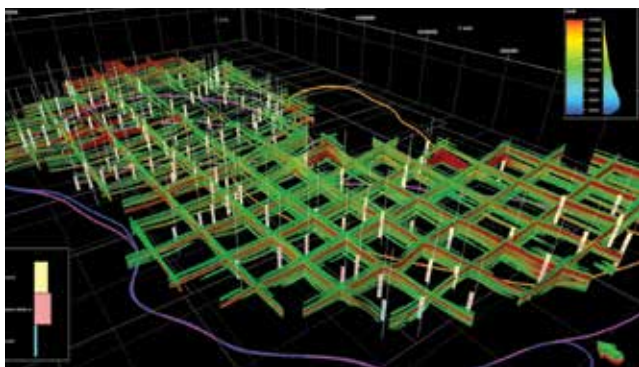
Research Challenges

TORA narrows the range of recoverable resource estimates, building integrated, market-independent basin outlooks. TORA researchers employ a newly developed workflow utilizing 3D geocellular models. That workflow will predict ultimate hydrocarbon recoveries, economic viability, and playwide production rates. TORA studies tight oil and gas formations in order to produce unbiased, comprehensive, and publicly available results.

The program brings together an integrated, multidisciplinary team that creates production outlooks and investigates the following topics: optimal well spacing and fracture design, impacts of formation characteristics on fracture extent and effectiveness, optimization of recovery in thick stratigraphic sections, detailed facies description and analysis, and assessment of alternatives in areas having low recovery efficiency.

Membership

Membership in TORA is \$50,000 annually. Benefits to industry partners include (1) detailed insights from geologic, petrophysical, engineering, statistical, and economic methodologies in the form of semiannual-update meetings and annual reports; (2) access to the multidisciplinary TORA research team; (3) leveraged funding through State of Texas support and other operator contributions; and (4) consortium-supported data sharing between companies and the Bureau.



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Events

Director Highlights Middle East Energy, Growth at GEO 2018

In March, Bureau of Economic Geology director **Scott W. Tinker** was invited to present the keynote address "Energy, Poverty, and Climate: Seeking the Radical Middle" at the opening ceremony of the GEO 2018 Middle East Geosciences Conference and Exhibition held in Bahrain.

GEO, inaugurated in 1994, is a pre-eminent showcase of oil and gas exploration technology and services in the Middle East that attracts thousands of attendees, including international government leaders and industry professionals interested in the latest developments in the energy field.

"The growth and development in the Middle East is remarkable," Dr. Tinker said. "It is underpinned by energy. I appreciated the opportunity to discuss climate, poverty, and energy with leaders from the region, probably for the first time in such a public setting. These issues must be addressed as the region moves forward."

After the conference, Dr. Tinker remained in the area, appearing as the Dean's Distinguished Visitor at King Abdullah University of Science and Technology (KAUST) north of Jeddah, Saudi Arabia. There, he presented the seminar "The Future of Fossil Fuels."



Saudi ARAMCO geologist Dana A. Jishi and Director Tinker at GEO 2018.



Director Tinker at the opening ceremony of the GEO 2018 conference.

Bureau and China Continue Collaboration

In May, the Bureau hosted a contingent of officials from the China University of Petroleum in Qingdao (CUP), the next step in developing a framework for future research and scientific and academic geosciences collaborations between the institutions. The University of Texas at Austin (UT Austin) and CUP recently signed a Joint Laboratory Agreement building on a Memorandum of Understanding between the Bureau and CUP. The agreement includes potential projects in geologic and seismic characterization of unconventional shale reservoirs, tight oil and gas, fractured reservoirs, and clastic and carbonate depositional systems.

CUP representatives were welcomed to the Bureau on the Pickle Research Campus by Director **Scott W. Tinker** and Associate Director (Energy Division) **Mark Shuster**. The Chinese delegation participated in discussions with Bureau researchers and students and toured Bureau facilities, including the Scanning Electron Microscopy (SEM) and geochemistry laboratories and the core warehouse.



In China, Associate Director Shuster presents an overview of the Bureau's unconventional research.

Representing CUP were Professor Fang Hao, President; Professor Ming Zha, Director of the Center for Petroleum Geology and Exploration; Professor Yangwen Pei, Vice Dean of the School of Geosciences; and Dr. Bin Yuan, Secretary General, and Dr. Kai Wang, Deputy Secretary General, of the North America Young Professionals Association.

"I believe the discussions were very productive in helping lay the groundwork for future efforts," said Shuster. "In addition to adding clarity to our research and academic goals, we also began addressing the protocols and processes, including funding, required to make it all happen."

As part of the Joint Laboratory Agreement, a Bureau contingent then traveled to China in July for discus-



Bureau researcher Kitty Milliken with CUP president Fang Hao.

sions with key Chinese researchers and industry sponsors. Associate Director Shuster and researchers **Hongliu Zeng** and **Tongwei Zhang** met with CUP president Hao and other senior administrators, faculty, and students to discuss the latest advances in unconventional research, organic geochemistry, and seismic sedimentology at CUP's School of Geosciences. Shuster noted that the school "is one of the leading geoscience schools in China, with research focus in petroleum applications including unconventional, seismic methods, reservoir geology, and diagenetic modeling. Collaboration affords a fantastic opportunity for the Bureau and UT to develop joint projects in China in these areas."

In Beijing, the Bureau group met separately with its longtime industry sponsor, RIPED—the research arm of the China National Petroleum Corporation (CNPC)—and with Sinopec to discuss proposed projects with both companies. The Bureau and Sinopec are in the initial stages of a joint proposal for the characterization of the Triassic tight-gas sandstone reservoir and sweet target prediction in the Sichuan Basin.

At a final visit, Zhang and Shuster lectured at the China Oil and Gas Survey and discussed the Bureau's ongoing collaboration with the group. In the future, the Survey's Dr. Cong Zhang will begin an extended visit at the Bureau to work with Zhang and others on geochemical research of gas-bearing shales in China.



Researchers Tom Newman, Brent Elliott, and Vanessa Santos on a field trip at the 54th Forum on the Geology of Industrial Minerals.

Bureau Hosts Geology of Industrial Minerals Forum

In April, the Bureau hosted the **54th Forum on the Geology of Industrial Minerals (FGIM)**. Bureau researcher **Dr. Brent Elliott** welcomed geologists and mining professionals from around the world who gathered to exchange information and research on geology and industrial minerals. It was the first meeting in Austin since the 4th FGIM in 1968.

Over 20 presenters at the forum covered topics including the geology of minerals and energy production,

a rockfall hazard-appraisal system, aggregates research, sand mining in the Permian Basin, diamond exploration in Indonesia, and lithium extraction from oilfield brine. Attendees also participated in numerous field trips to sites of geologic and industrial interest that showcased industrial mineral operations in Central Texas, including clay (brick), limestone aggregate and cement, granite dimension stone, and silica frac-sand quarries.

New Tech Locates Proppants at Devine Test Site

Over the past 2 years, the Bureau's **Advanced Energy Consortium** (AEC) has been conducting downhole tests of electromagnetic (EM) proppants at its Devine Test Site in South Texas. The tests are run to help identify the location of proppants and fluids in hydraulic and natural fractures near the wellbore and in the inter-well space with greater accuracy than current technology has previously allowed.

Dr. Mohsen Ahmadian, AEC program manager and lead researcher on the experiment, said, "If we validate the experimental model with these tests, we may one day soon be able to use this technology at scale."

Characterizing hydraulic-fracture geometries (height, length, spacing, orientation, and shape) is key when trying to maximize oil and gas production and ultimate recovery within a field. Last year, an approximately 300-ft-deep



Mohsen Ahmadian looks on as Lucie Costard adjusts an EM induction logging tool.



View of AEC's Devine Test Site.

well was fracked using EM proppant in an effort to characterize the resulting fracture pattern. To validate these results, nearby offset wells that transected the fracture pattern of the fracking operation were drilled and cored. Fractures and EM proppant from the fracked well were clearly visible in the cores.

As a secondary check, the Bureau's **Near Surface Observatory** (NSO)—with its Principal Investigator **Dr. Jeffrey Paine** and Research Scientist Associate **Lucie Costard**—brought NSO logging equipment to the site to log the new offset wells. Conductivity, gamma-ray, and mini-resolution logs were run in the wells in an effort to sense the EM proppant in fractures and to correlate those readings with what is observed in the actual cores. Analysis of the results is ongoing, but the initial results of the experiment have been very positive.

Devine Geophysical Test Site

The Devine Geophysical Test Site is a state-of-the-art geophysical research facility for academia and industry located near Devine, Texas, southwest of San Antonio. The readily accessible site sits in a flat area with an elevation of approximately 600 ft. Located in an active oil and gas province a few miles north of the Eagle Ford Shale play, the site contains oil and gas reservoirs of various ages. It is an ideal laboratory for conducting experiments in a controlled, low-cost setting and has, for many years, served as host for a variety of geotechnical experiments. Management of the site by the Bureau provides an optimum research facility for researchers and minimizes the risks related to accessing the site over long periods of time.

For information about utilizing the Devine Geophysical Test Site, contact **Dr. Mohsen Ahmadian**.

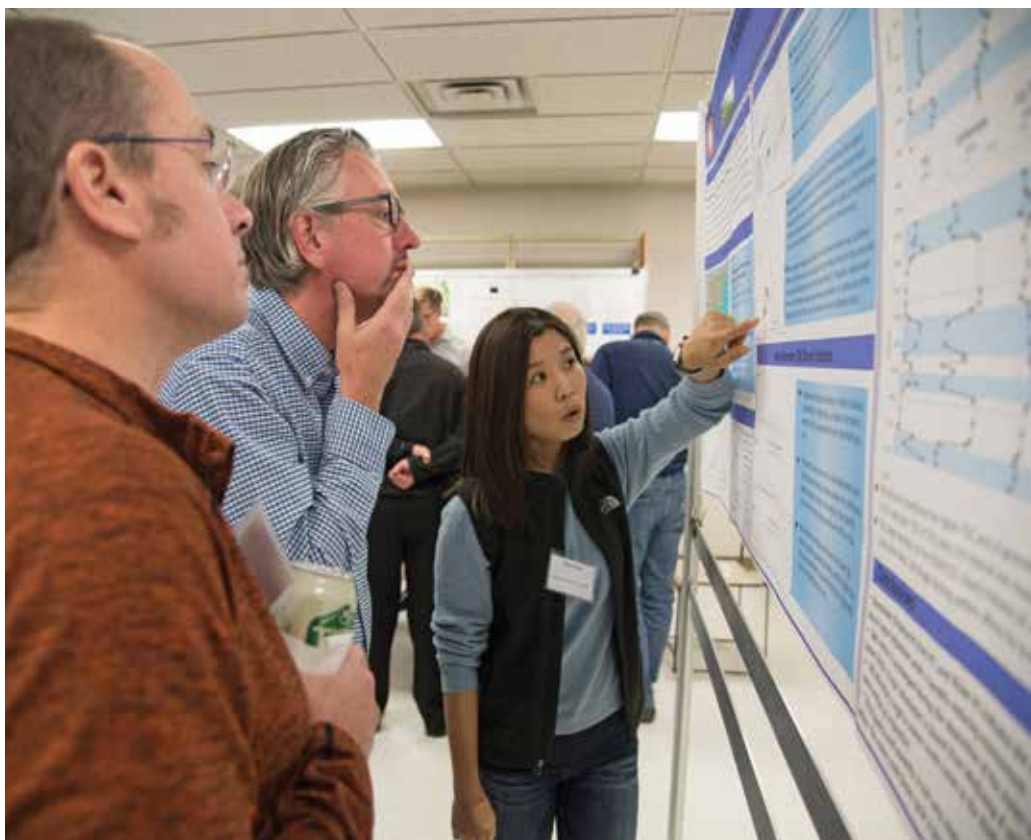
MSRL Convenes on Pickle Campus

In March, the Bureau's **Mudrock Systems Research Laboratory** (MSRL) hosted more than 60 industry geologists representing 15 companies at its annual members meeting, held on the UT Austin Pickle Campus. Over 4 days, members attended 25 oral and 15 poster presentations on the latest research findings in mudrocks, a core workshop, and a short course on mudrock systems.

Bureau MSRL presenters included **Ahmed Alnahwi, Robin Dommissie, Ian Duncan, Farzam Javadpour, Lucy Ko, Toti Larson, Bob Loucks, Justin Mauck, Sheng Peng, Rob Reed, Steve Ruppel, Peter Schemper, Evan Sivil, Xun Sun, and Tongwei Zhang**. Guest presenters Paul Hackley, Jonathan Knapp, Tobi Kosanke, and Andy Pepper described how advances in organic petrology, XRF core scanning, hyper-spectral core imaging, and hydrocarbon saturation analysis are improving our understanding of mudrock attributes.



Dr. Steve Ruppel discusses core at the MSRL meeting.



Dr. Xun Sun presents her poster at the MSRL meeting.

TCCS Scientists Host Sponsors

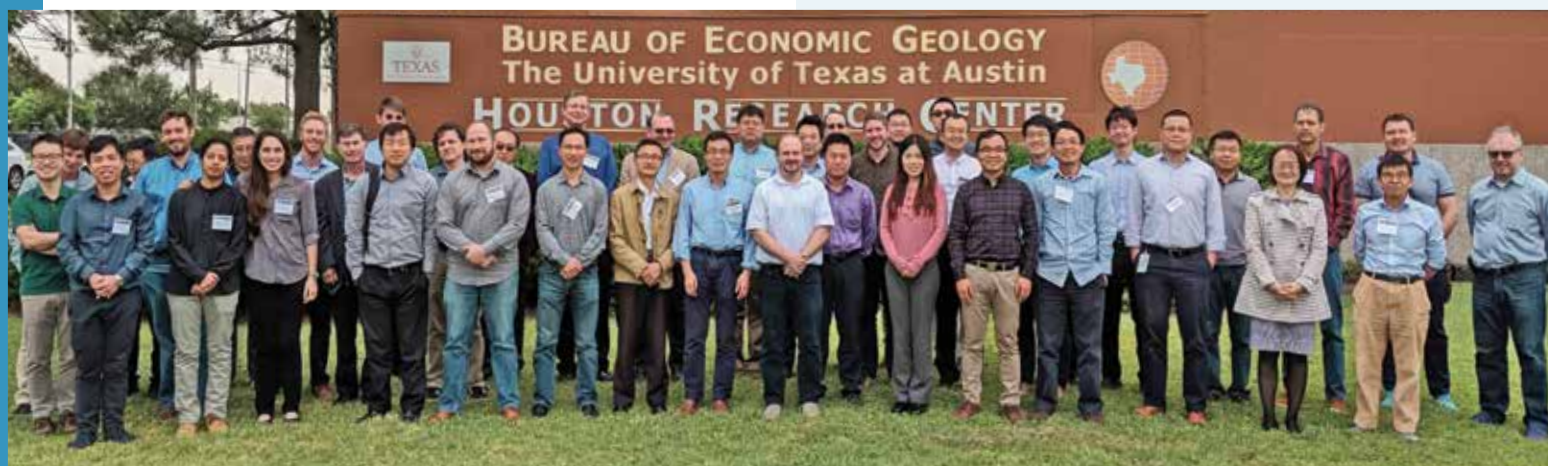
The **Texas Consortium for Computational Seismology** (TCCS), a joint initiative of the Bureau and UT Austin's Institute for Computational Engineering and Sciences (ICES), held two Sponsors Meetings in 2018 to discuss the most important and challenging research problems in computational geophysics confronting the energy industry.

At the Spring meeting, hosted by the Bureau's Houston Research Center in April, more than 60 people, including representatives from eight sponsor companies, attended 15 research presentations by TCCS staff that covered topics such as full waveform inversion,

high-resolution seismic imaging, deconvolution, and machine learning in application to seismic inversion and interpretation. Lei Huang (Prairie View A&M University) and Clement Kostov (Schlumberger) gave invited presentations. At the Fall meeting, held at the UT Austin Pickle Campus in November, participants saw 15 presentations on the general topics of seismic data analysis, imaging and inversion, and deep learning.

TCCS principal investigator **Sergey Fomel** presided over both events. For more information about TCCS, please contact Fomel: sergey.fomel@beg.utexas.edu.

Members of TCCS at the Spring Sponsors Meeting in Houston.



Mentoring Part of TCCS Mission

An important part of the TCCS mission is the education and encouragement of the next generation of research geophysicists and computational scientists. The mentoring skills of TCCS principal investigator **Sergey Fomel** play a meaningful role in the scientific development of his students. Former TCCS graduate research assistant Sean Bader, now at EOG Resources, says, "During my time with TCCS... it was amazing to see how productive and encouraging my colleagues were, even as the problems grew more complex. Dr. Fomel is extremely kind and approachable; he allows us to work on projects that interest us, providing guidance and insight when we need it. Dr. Fomel's breadth and depth of knowledge are incredible, and he encouraged us to understand our research problems at a very deep level and to test the bounds of what is known in geophysics. I can honestly say that joining TCCS is one of the best decisions I have ever made. I hope that TCCS will always be the welcoming family that inspires a passion for research in geophysics."



TCCS PI Sergey Fomel (second from right) with his students at 2018 UT Austin graduation ceremonies.

TORA Research Model Expands

In the spring, the Bureau's **Tight Oil Resource Assessment** (TORA) research consortium held its Annual Meeting and announced that a key element of the group's research will now be to continually refresh the Bureau's renowned U.S. shale-play studies.

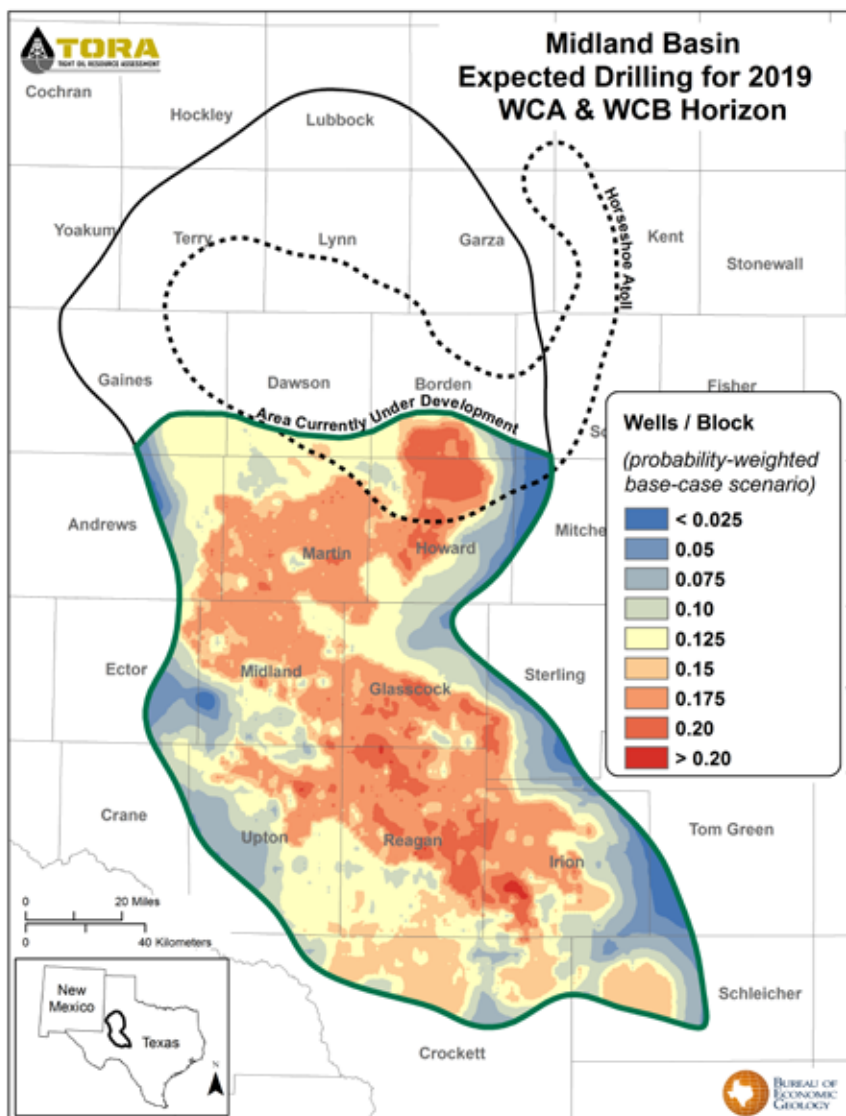
For many years, the Bureau has been a world leader in the study of production and reserve potential of unconventional reservoirs—specifically, the U.S. Barnett, Haynesville, Fayetteville, and Marcellus shale-gas plays, as well as the Bakken and Eagle Ford shale-oil plays. Most of the shale-study research-team members have now transitioned to TORA and will use their proven research model to analyze the complex unconventional reservoirs of the Permian Basin (Midland and Delaware Basins).

TORA manager **Bill Fairhurst** said, "TORA will continue primary focus and effort on the Midland and Delaware Basins resource-reservoir study." He added, however, that the multiple shale-play evaluations "will allow study and reporting of unique parameters and common characteristics of these resource reservoirs and assist in the economic development and exploration of future economic opportunities."

One advantage of bringing both the Permian and the shale studies under the TORA umbrella is that all of the plays will be evaluated by the same team, and new knowledge will be transferred across the studies. Another advantage is that TORA sponsors will gain the perspective of the Midland and Delaware Basins in the framework of all of the other resource-reservoir plays.

TORA Annual Meeting participants also heard informative updates about progress made in characterizing the premier resource reservoirs—the Wolfcamp, Spraberry, and Bone Spring—currently being developed by the industry in the Midland and Delaware Basins.

For information about becoming a member of TORA, please contact **Bill Fairhurst**: bill.fairhurst@beg.utexas.edu.



TORA consortium analytical model of expected 2019 drilling density in Midland Basin, Wolfcamp A and Wolfcamp B horizons.

Explore UT

In March, Bureau staff members and volunteers participated in the campus-wide Explore UT open house, which is designed to motivate students in Texas toward achieving higher education after high school. The Bureau engaged participants in four activities: **Sue Hovorka, Faye Wang, Katie Graves, and Pooneh Hosseininoosheri** offered a hands-on demonstration for “What to Do with CO₂: Cures for the Feverish Earth.” **Dallas Dunlap** and **John Andrews** presented “Exploring Earth’s Natural Energy Resources with 3D Visualization.” In the “Finding Gold” activity, **Linda Ruiz McCall, Nayeli Silva, Mariana Olariu, Sara Elliott, Mahdi Haddad, Mahdi Heidari, and Maksat Zhazbayev** helped students learn about density sorting by panning for gold. And, new to the Explore UT program, **Bissett Young** and **Dino Huang** presented “TexNet: Monitoring Earthquakes in Texas with the Texas Seismological Network.”



Research Associate Mahdi Heidari shows students how to pan for gold at Explore UT.

Engaging the Public at Family Science Days



Information Geologist Linda Ruiz McCall (left) and Research Scientist Rebecca Smyth at AAAS Family Science Days.

In February, Bureau staff and students joined in the American Association for the Advancement of Science (AAAS) Family Science Days held at the Austin Convention Center. Family Science Days feature presentations and interactive activities that highlight diverse areas of scientific study and demonstrate a commitment to promoting public engagement with science. Scientists are also on hand to listen to questions from the public.

In response to the AAAS call for public outreach, Bureau staff members **Linda Ruiz McCall** and **Rebecca Smyth** talked with attendees about Texas rocks and the Bureau’s new radio program, **EarthDate**, which explores the natural wonders of our planet. **Sarah Prentice** and **Peter Tutton**, graduate students with the Bureau’s **Gulf Coast Carbon Center**, engaged families with demonstrations about carbon capture.

6th Annual Bureau Research Symposium



Graduate student Pooneh Hosseininoosheri (right) discusses her poster with Research Program Coordinator Emily Moskal at the Bureau Research Symposium.

The Annual Bureau Research Symposium promotes project collaborations and the interchange of ideas by showcasing research-project posters and informative 10-minute “nano-talks” by Bureau researchers.

The September symposium—organized for the sixth year by Information Geologist **Linda Ruiz McCall** and implemented by a team that included **Jessica Rowling, Kenneth Edwards, Cathy Brown, Roanne Draker, Chuck Garza, Daniel Ortuño, and Dennis Campa**—included the following winners by popular vote:

Best Poster: “CO₂-EOR/storage: How black turns to green” presented by Ph.D. candidate **Pooneh Hosseininoosheri**

Best Nano-Talk: “RAPID machine learning-based extraction and measurement of ice wedge polygons in airborne lidar data” presented by Ph.D. candidate **Chuck Abolt**

19th Annual Austin Earth Science Week Career Day

In October, the Bureau hosted the 19th Annual Austin Earth Science Week Career Day, which engages students in discovering Earth science careers and provides a venue for geoscientists to share their knowledge with students. Participants included 250 students from Bastrop, Webb, Cedar Creek, and Bedicheck middle schools, joined by the Austin Area Homeschoolers Science Team, Eco-Explorers, and Homegrown Learners.

In the opening ceremony, Bureau acting director **Mark Shuster** encouraged students to consider geoscience careers by sharing how his own childhood curiosity about Earth and nature led him to a rewarding career in exploration geology. Equinor's Laura Zahm also addressed the students about her experiences and opportunities to build a satisfying career in Earth science.



Laura Zahm

Bureau information geologist **Linda Ruiz McCall** organized the event, which was made possible through partnership with 65 geoscience volunteers from the UT Austin Jackson School of Geosciences; U.S. Geological Survey Texas Water Science Center; Texas Water Development Board; City of Austin; Lower Colorado River Authority; KOKE FM radio; Texas Commission on Environmental Quality; UT Austin Department of Civil, Architectural and Environmental Engineering; and others. Financial sponsors included Equinor (underwriting sponsor), Parsley Energy, Austin Geological Society, and The Subsurface Library of Midland.



Bureau acting director Mark Shuster addresses students at the opening ceremony of the 19th Annual Austin Earth Science Week Career Day.

Conference for the Advancement of Science Teaching

In November, Bureau staff joined the Conference for the Advancement of Science Teaching (CAST) in Fort Worth to reach out to educators about ways to bring real-world research into the classroom. Each year, over 5,000 science educators and advocates from across the state gather at CAST to provide professional development and resources to advance K-12 science education in Texas.



Dino Huang

Bureau seismologist **Dino Huang** and information geologist **Linda Ruiz McCall** presented a workshop on "TexNet: The Texas Statewide Earthquake and Research Program." Attendees learned about historic seismicity in Texas, why the TexNet program was established, how seismic monitors work, the location of TexNet stations, and how to access the online [TexNet Earthquake Catalog](#). **Sarah Prentice** and **Izaak Ruiz**, graduate students with the [Gulf Coast Carbon Center](#), shared lesson plans at the Texas Earth Science Teacher's Share-a-thon and demonstrated hands-on experiments to participants. Educators were also given information about the [EarthDate](#) public radio series, which has now completed a total of 101 episodes and is being broadcast by 354 radio stations in all 50 states and four foreign countries. All of the staff, including Bureau Media Group project manager **Scott Rodgers**, interacted with the teachers at the exhibit booth where hundreds of maps and rock kits were distributed.



Graduate students Sarah Prentice and Izaak Ruiz demonstrate carbon capture activities with teachers at the Conference for the Advancement of Science Teaching.

Educational Workshops and Training

In 2018, Bureau research and support staff once again reached over 1,500 Texas K-16 educators, students, and community group members with educational workshops, presentations, training, and field experiences. ■

Outreach to K-12 teachers, led by Information Geologist **Linda Ruiz McCall**, included information and training on the **TexNet Seismic Monitoring Program**, **CO₂ storage science**, **Economic Mineral Resources Program**, Balcones Fault Zone Aquifer, groundwater/surface water interactions, geologic maps, and rocks and minerals. ■

The **Texas High School Coastal Monitoring Program**, led by **Tiffany Caudle**, provides middle

Bureau staff **Jeff Paine**, **Peter Flaig**, **Tiffany Caudle**, and **Linda Ruiz McCall** served as instructors for high school students in the Jackson School's **GeoFORCE Summer Academy** program. GeoFORCE is designed to increase the number of students pursuing STEM degrees in college and moving into rewarding STEM careers. ■

In December, the **State of Texas Advanced Resource Recovery** (STARR) program, led by Research

Scientist **Bill Ambrose**, hosted an all-day workshop for the Austin Geological Society that featured an in-depth discussion of Wilcox Group stratigraphy and depositional systems in Texas. Attendees received a hands-on view of five key cores with an extensive review of depositional environments and upper slope facies. Presenters included Ambrose, **Iulia Olariu**, and **Jinyu Zhang** of the Bureau, and Cornel Olariu and Ronald Steel of UT Austin's Department of Geosciences. ■



Texas High School Coastal Monitoring Program students collecting data for a beach profile. ■



Research Associate Peter Flaig instructing GeoForce 10th Grade Academy students in Utah.



Linda Ruiz McCall and Nathan Ivicic (left) with teachers from the Texas Mining and Reclamation Association Industrial Minerals workshop.



Bureau researcher Bill Ambrose shows core samples to visiting scientists from Petrobras.

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Information Geologist **Linda Ruiz McCall** met with undergraduate students in the Jackson School of Geosciences (JSG) EDGE (Enhancing Diversity in Geoscience Graduate Education) program, which is designed to encourage students traditionally underrepresented in the geosciences to apply to train with JSG faculty and research scientists whose research agendas are of interest. The students toured the new Austin Core Repository viewing room and were encouraged to contact Bureau researchers working in areas of interest for graduate studies. ■

The Bureau hosted Petrobras geoscientists, who were given an overview of the Bureau and a tour of the Austin Core Repository by Acting Director **Mark Shuster**, **Mark Blount**, and **Linda Ruiz McCall**. ■



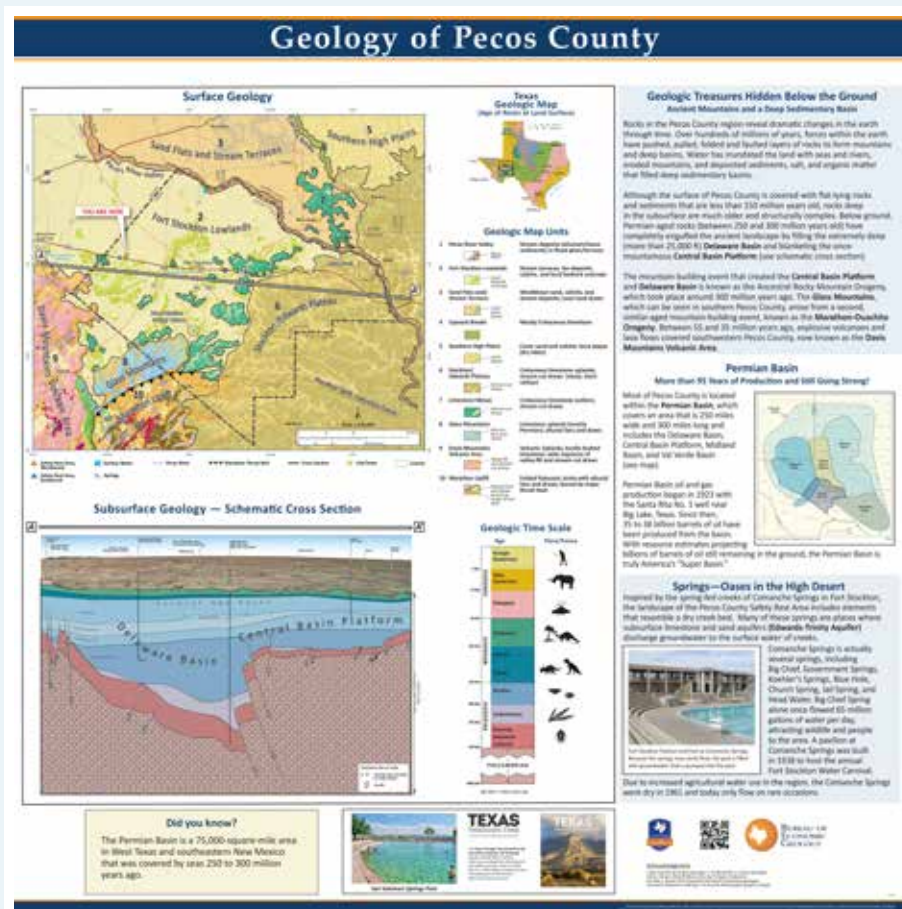
Students learn about surface water/groundwater interactions at a Lady Bird Johnson Wildflower Center Nature Nights events in June.

Texas GeoSign Project

In September, the **Texas GeoSign Project**, which has a mission to enhance public understanding of and appreciation for the geology and geologic history of Texas, installed a new sign—**Geology of Pecos County**—at two Texas Department of Transportation Safety Rest Areas about 25 miles west of Fort Stockton off Interstate 10. Bureau staff also donated relevant rock and fossil samples, which are on exhibit at these rest areas.

The new sign features a new surface geology map created for Pecos County by Bureau researcher **C. M. "Chock" Woodruff** and a schematic Delaware Basin cross section by researcher **Elizabeth (Lily) Horne** of the **Center for Induced Seismicity** (CISR) program. Sign information covers ancient mountain ranges and deep sedimentary basins, oil and gas production from the Permian Basin, and water resources at the oases in the high desert of Comanche Springs and nearby San Solomon Springs.

Bureau information geologist **Linda Ruiz McCall** led the Bureau GeoSign team, which included **Caroline L. Breton**, **Francine Mastrangelo**, **Amanda Masterson**, **Cathy Brown**, **Jay Kipper**, and **Mark Blount**.



"Geology of Pecos County" sign installed at the TxDot Pecos County Safety Rest Area west of Fort Stockton.

Honors

SEG Honors Bureau for Distinguished Achievement

Researcher Fomel and Students Also Recognized



On behalf of the Bureau, Sergey Fomel accepts the Distinguished Achievement Award from SEG past president Nancy Jo House.

The Society of Exploration Geophysicists (SEG) honored the Bureau of Economic Geology with its 2018 **Distinguished Achievement Award**, presented at its 88th Annual Meeting in Anaheim, California. The honor was bestowed for Bureau contributions that have "substantially advanced the science of exploration geophysics." The Bureau's contributions to the geophysics of oil and gas exploration and development over the last century include the early development of reflection seismology and seismic stratigraphy; the transfer of 3D seismic technology

to independents in Texas and surrounding states; the release of 3D digital seismic data sets to the public; oversight and management of the Devine Test Site; several dedicated seismic research labs; graduate student training; geoscience education for K-12 students; and maintaining the largest core repository in the U.S.

Bureau senior researcher **Sergey Fomel** was also recognized at the meeting as co-author (along with Rui Zhang, currently an assistant professor at the University of Louisiana at Lafayette) and winner of the **2017 Best Paper in Interpretation Award** for "Time-variant wavelet extraction with a local-attribute-based time-frequency decomposition for seismic inversion." *Interpretation* is co-published by the SEG and the American Association of Petroleum Geologists.



Sean Bader



Dmitrii Merzlikin

Fomel's M.S. student **Sean Bader** received the award for **Top Student Poster Paper Presented at SEG's 87th Annual Meeting**: "Semiautomatic seismic well ties and log data interpolation." Fomel's Ph.D. student **Dmitrii Merzlikin** received an **Award of Merit** [runner-up] for his presentation "Diffraction-based migration velocity analysis using double-path summations." About 300 oral papers and 200 posters were presented by students for competition at the meeting. Over the past 5 years, Fomel's students have received three out of five Top Student Poster Paper awards from SEG, as well as three Awards of Merit.

AGI Medal in Memory of Ian Campbell: Scott Tinker



Scott W. Tinker

Bureau director **Scott W. Tinker** is the 2018 recipient of the **AGI Medal in Memory of Ian Campbell for Superlative Service to the Geosciences**—the American Geosciences Institute's highest award—given “in recognition of singular performance in, and contributions to, the profession of geology.” Candidates for the award are measured against the career and legacy of Dr. Ian Campbell, a

renowned geoscientist, educator, administrator, and public servant who exemplified superlative service to the geosciences.

Tinker received the medal at the November Geological Society of America (GSA) Annual Meeting awards ceremony in Indianapolis, where presenters of the award lauded Tinker's “genuine commitment to science; his passion for helping the public and policy makers find solutions to complex energy-environmental-economic problems; and his fair, reasoned, and successful leadership of geoscience organizations.” The presenters also noted Tinker's “distinguished

career of impressive depth and breadth” that indicate his “service to our profession and to fostering public awareness of the importance of geoscience to society.”

Tinker has served as Texas State Geologist and director of UT Austin's 250-person Bureau of Economic Geology since 2000; he is also a professor holding UT's Allday Endowed Chair in Subsurface Geology. He has served as president of the AGI, the Association of American State Geologists, the American Association of Petroleum Geologists, and the Gulf Coast Association of Geological Societies. Tinker co-produced and is featured in the award-winning energy documentary film *Switch* and is currently working on two new films that address global energy poverty and the energy transition.

Said Tinker, “Receiving the Campbell Medal is a great honor. Working to bring academia, government, industry, and NGO's together to tackle major earth science challenges—CCUS, induced seismicity, shale development and resource characterization, subsurface nanosensors, global energy education, sustainable energy development—is not for the faint of heart. My efforts have benefited tremendously from interaction with mentors and friends across all of these sectors. You have been indulgent with my many shortcomings, and I am grateful.”

Philpott Excellence of Presentation: Shirley Dutton



Shirley Dutton

Recently retired Bureau senior research scientist **Shirley Dutton** received the Second Place **Thomas A. Philpott Excellence of Presentation Award** for her paper “Regional variation in composition, diagenesis, and reservoir quality of on-shore

Jurassic Cotton Valley sandstones, northern Gulf of Mexico,” which was presented at the 2017 GCAGS Convention in San Antonio, Texas. As senior author, she received the plaque at the 2018 GCAGS Convention in Shreveport, Louisiana, in September. Her co-authors are Bureau researchers **William Ambrose** and **Robert Loucks**, as well as Bohdan Horodecky.

Scanlon Receives Top Hydrology Awards

Bureau senior research scientist **Bridget R. Scanlon** was the recipient of two prestigious honors in 2018: the **Presidents' Award** from the **International Association of Hydrogeologists (IAH)**, and the **Hydrologic Sciences Award** from the **American Geophysical Union (AGU)**.

The IAH Presidents' Award, established in 1995 and determined by current and past presidents, is given annually to a member who has "made outstanding international contributions to groundwater science and to furthering IAH's mission to promote understanding and management of groundwater resources for the benefit of humankind and the environment."

Scanlon is a member of the Board of Directors of the IAH U.S. National Chapter. She has served as a co-chair of the IAH Commission on Climate Change and is currently serving on the Commission on Groundwater Energy. For several years, she performed editorial roles for IAH's *Hydrogeology Journal*.

The AGU's Hydrologic Sciences Award is granted "for outstanding contributions to the Science of Hydrology over a career, with an emphasis on the past five years. It is the highest disciplinary recognition for senior scientists within the Hydrology section."

Said Bureau director **Scott W. Tinker**, "Dr. Scanlon's work is unparalleled in the field of hydrology, and the Bureau is tremendously fortunate to be able to count her

among our researchers. Her research into water resources and issues, not only here in Texas but throughout the country and the world, is widely respected, and it is broadly utilized by other researchers and decision makers alike. We are very excited that the AGU has recognized her many contributions to the science of hydrology with this significant award."

Scanlon leads the **Sustainable Water Resources** program at the Bureau, where she has conducted research for the past 30 years; her most recent work emphasizes the interdependence of water and energy, including water use for shale oil and gas extraction and electricity generation. She has also recently been evaluating the reliability of global models using GRACE satellite data. Her numerous other honors include being named the 2007 Birdsall Dreiss Distinguished Lecturer and a Fellow of the AGU and GSA; induction into the National Academy of Engineering in 2016; and receiving the M. King Hubbert Award from the National Ground Water Association in 2017.



Bridget Scanlon with AGU president Scott Tyler (left) and past president Jeff McDonnell.

Greenman Award: Sue Hovorka

Susan D. Hovorka, Bureau senior research scientist and principal investigator of the Bureau's **Gulf Coast Carbon Center**, was honored recently at the Greenhouse Gas Control Technologies' GHGT-14 Conference in Melbourne, Australia, with the organization's most prestigious accolade, the **Greenman Award**. The award, widely considered to be the most important distinction presented to a researcher in the field of carbon capture and storage (CCS), is given annually to an individual in recognition of "services to the development of knowledge and understanding of the issues involved with carbon capture and storage and greenhouse gas control technologies."

"Sue Hovorka's leadership of the Gulf Coast Carbon Center has allowed for the development of truly innovative methods and tools that have taken CCS beyond the realm of concept and into real-world application," said **Michael Young**, director of the Bureau's division of environmental research. "Largely because of Sue, the Carbon Center is considered to be a world leader in the crucial research required to mitigate CO₂ emissions."



Susan Hovorka

Photo courtesy of IEAGHG.

Frye Memorial Award: Ramon Treviño and Tip Meckel

Bureau researchers **Ramon Treviño** and **Tip Meckel** have received the **2018 John C. Frye Memorial Award in Environmental Geology** for their 2017 report *Geological CO₂ Sequestration Atlas of Miocene Strata, Offshore Texas State Waters* (RI0283). The award, co-sponsored by the Geological Society of America (GSA) and Association of American State Geologists (AASG), is given for the best publication in the field of environmental geology published by a state geological survey or by GSA during the past 3 years. Editors Treviño and Meckel were presented with the award at the GSA Annual Meeting in Indianapolis, Indiana, in November.

Publications nominated for the Frye award successfully “identify a geologically based environmental issue, provide sound and substantive information pertinent to the problem, relate geology to the issue, and present information directly usable by geologists, other



Ramon Treviño (left) with co-editor Tip Meckel (right) and major contributor Dave Carr.

professionals such as land-use planners and engineers, and ideally also by informed laypersons.” The book is available from [The Bureau Store](#).

UT Hamilton Book Award Finalist and AAPG Distinguished Lecturer: Mike Hudec



Mike Hudec

Bureau senior research scientist **Mike Hudec** was one of four finalists for the UT Austin **2018 Hamilton Book Award** for *Salt Tectonics: Principles and Practice* (Cambridge University Press, 2017), which he co-authored with the late **Martin Jackson**. *Salt Tectonics*, described by one reviewer as a “masterpiece adding new ideas to every branch of salt geology,” is available

from [The Bureau Store](#). Hudec has also been selected as a **2018–19 American Association of Petroleum Geologists (AAPG) Distinguished Lecturer**. His talk on “Evolution of the Salina del Bravo, Mexico: The Bravo Trough, Sigsbee Canopy and Perdido Fold Belt” will be delivered to audiences via AAPG or Geological Society of America (GSA) section-meeting lectures recorded as videos and podcasts, available for download from the AAPG website as well as from GooglePlay® and iTunes®.

Jackson School of Geosciences Awards: Kim LaValley and Tip Meckel



Kim LaValley



Tip Meckel

Bureau employees received two of five annual awards presented by the Jackson School of Geosciences (JSG) in December. Administrative Manager **Kim LaValley** won the **Outstanding Service Award** for her leadership in service to the Bureau and to the JSG. JSG dean Sharon Mosher cited LaValley’s “skill of balancing authority with freedom, thus providing guidance and direction to her employees to be the best they can be.”

Senior Research Scientist **Tip Meckel** received the **Outstanding Educator Award**, in recognition of his exceptional advising, mentoring, training, and teaching of JSG students. Mosher noted the “overwhelming number of nominations” from Meckel’s students, which “attest to his patience, support, and willingness to spend large amounts of time” as a mentor.

Postdoc Prizes



Mahdi Haddad

Cedric K. Ferguson Medal: Mahdi Haddad

Bureau postdoctoral fellow **Mahdi Haddad** has been awarded the **Cedric K. Ferguson Medal** from the Society of Petroleum Engineers (SPE) for his paper "Integration of dynamic micro-seismic data with a true 3D modeling of hydraulic-fracture propagation in the Vaca Muerta Shale" (SPE-179164-PA). The paper's co-authors are Jing Du and Sandrine Vidal-Gilbert, of Total E&P.

The medal, one of the SPE's major awards, is given to researchers under 36 in recognition of professional achievement in petroleum engineering and best paper in an SPE journal. Haddad received the prize at the SPE Annual Technical Conference and Exhibition in September.

At the Bureau, Haddad conducts research on the geomechanics of induced seismicity through the **TexNet** project. He has authored 16 peer-reviewed journal articles and conference papers on multiple-stage hydraulic-fracture design, refracturing optimization, stimulated

naturally fractured reservoir simulation, and smoothed particle hydrodynamics.

Said Haddad in his acceptance speech at the awards ceremony, "I'd like to share this credit with my family, teachers, and friends in Iran and the U.S., and at Sharif University of Technology and UT Austin. My especial gratitude to my father, a great high school physics teacher, who taught me the first lessons of ethics and physics."

TACC Best Poster: Sahar Bakhshian



Sahar Bakhshian

Bureau postdoctoral fellow **Sahar Bakhshian** won **Best Poster** for presenting **Gulf Coast Carbon Center** (GCCC) research on "Development of a parallel pore-scale fluid flow simulator with application to geological storage of CO₂" at the September Texas Advanced Computing Center (TACC) Symposium for Texas Researchers. The symposium is a meeting of scientists, engineers, and scholars from across the state of Texas who use the TACC to advance their research.

Bureau Staff Awards



Eric Potter

The 2018 Staff Awards Reception, hosted in June by Director **Scott W. Tinker**, recognized the exceptional work of Bureau researchers and staff. Highlights of the event included naming former associate director (Energy Division) **Eric Potter** as the Bureau's **Alumnus of the Year** for 2017 for his "thoughtful and ethical leadership." Potter retired in 2016 after 15 years with the Bureau.



Eddie Collins



Tucker Hentz

The reception also featured the presentation of University of Texas Staff Service Awards to Bureau employees. Researcher **Eddie Collins** (now retired) was noted for his 40 years of service; researcher **Tucker Hentz** for his 35 years; and accountant **David Boling** and computer illustrator **Jana Robinson** for 25 years.



David Boling



Jana Robinson

Also in June, Dr. Tinker presented the Bureau's **2017 Staff Excellence Award** to Senior IT Manager **Poe Chen**. Chen received the award for the "outstanding effort



Director Scott Tinker presents the Staff Excellence Award to Senior IT Manager Poe Chen at the staff appreciation cookout in June.

he and his team have made over the last year to keep the organization's computer operations among the best at UT Austin through his innovative and customer-oriented leadership."

Student Awards



Jinyu Zhang

In May, Bureau researcher Bill Ambrose's Ph.D. candidate **Jinyu Zhang**, now a Bureau postdoc, received the **J. C. "Cam" Sproule Memorial Award**—given to recognize younger authors of papers applicable to petroleum geology—at the AAPG Annual Convention and Exhibition in Salt Lake City.

Two of Bureau researcher Chris Zahm's Ph.D. candidates, **Yaser Alzayer** and **Andrea Nolting**, also received awards in 2018. Alzayer was named the "**Best Young Researcher**



Yaser Alzayer



Andrea Nolting

in the Geology Technology Division" of the EXPEC Advanced Research Center at Saudi Aramco; Yaser finalized his dissertation in August and returned to work for Saudi Aramco in Dhahran, Saudi Arabia. Nolting received the **Calvert Memorial Scholarship**

from the Houston Geological Society for the second year in a row; after finishing her dissertation, she joined the ExxonMobil research group in June.

Bureau Publication Awards

In April, the Bureau held its annual **First Author Publication Awards** dinner to celebrate the 2017 peer-reviewed publications of its researchers. Bureau authors produced 174 publications in 2017—24 more than the previous year. Of these, 76 were written or co-written by 47 Bureau first authors; another 13 were written by student first authors directly supervised by Bureau researchers.

This year, postdoc **Xinming Wu** had the most first-authored papers, six; he is the sole author of three of these. Bureau researcher **Sergey Fomel** was noted for co-authoring eight papers that were first-authored by seven of his Ph.D. students. Researchers **Bill Ambrose** and **Bob Loucks** tied for the most years honored for first-author publications—now 10 times each.



Xinming Wu



Sergey Fomel



Bill Ambrose



Bob Loucks

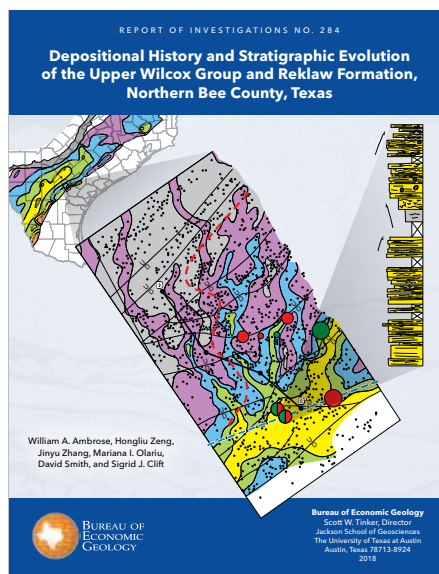


Accepting the Tinker Family BEG Publication Award from Director Scott Tinker on behalf of the late Martin P. A. Jackson are, from left, Becky Jackson, Jo Jackson, Kirsty Jackson, and Britt Garner.

The evening also featured the presentation of this year's **Tinker Family BEG Publication Award** to the late **Martin P. A. Jackson** and co-author **Michael R. Hudec** "in recognition of innovative and seminal contributions to the science of salt tectonics for their book **Salt Tectonics: Principles and Practice**. [See also the "Hamilton Book Award" article earlier in this section.] The book stands out in its breadth, quality of the writing and illustrations, and novel contributions." Members of Dr. Jackson's family accepted the award on his behalf.

Publications

Report of Investigations



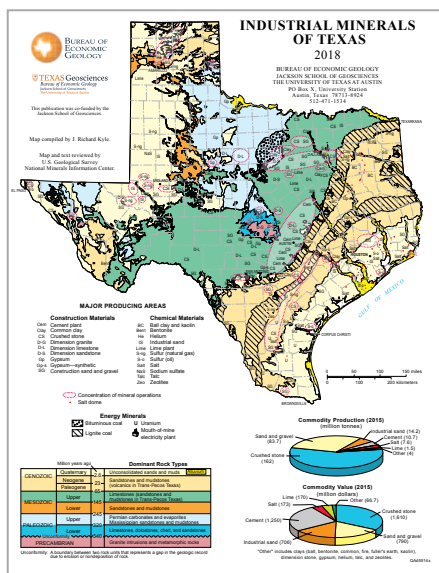
RI0284:

Depositional History and Stratigraphic Evolution of the Upper Wilcox Group and Reklaw Formation, Northern Bee County, Texas

Ambrose, W. A., Zeng, H., Zhang, J., Olariu, M. I., Smith, D., and Clift, S. J., 2018, The University of Texas at Austin, Bureau of Economic Geology, Report of Investigations No. 284, 87 p.

This publication is a detailed study of the upper Wilcox and Reklaw stratigraphic succession in a 190-mi² (~490-km²) area along the upper Wilcox shelf margin in northern Bee County, Texas. By interpreting and mapping 19 high-frequency, fourth-order regressive–transgressive sequences, the authors demonstrate that the upper Wilcox to Reklaw succession contains greater variability in depositional systems, facies, and reservoir sandstone-body geometry than was previously documented.

Maps



Industrial Minerals of Texas

Kyle, J. R., 2018, The University of Texas at Austin, Bureau of Economic Geology, Thematic Map, SM0011.

This map features the varied valuable industrial minerals of Texas, which typically ranks in the top three U.S. states for the value of non-fuel mineral production. The total value of Texas' industrial mineral production for 2016 was ~\$5 billion, with additional value supplied by lignite production. These industrial minerals are used extensively in the construction and chemical industries, and their production typically is a direct reflection of the state's economic vitality. Almost 90% of current Texas industrial mineral value comes from production of cement, crushed stone, construction sand and gravel, and industrial sand. Industrial rocks and minerals are produced in virtually every Texas county, often related to local transportation, construction, and other industrial activities. Industrial-mineral production provides local employment, and unusual mineral concentrations provide specialty products for regional distribution. As Texas' population continues to grow,

production of energy and industrial minerals will continue to satisfy the demands of residential, commercial, and industrial customers.

Geologic Map of the Kamey Quadrangle, Texas Gulf of Mexico Coast

Paine, J. G., Collins, E. W., Costard, L., 2018, The University of Texas at Austin, Bureau of Economic Geology, Open-File Map, **OFM0234**, Sheet 1 scale 1:24,000; Sheet 2, Digital elevation model, time-domain electromagnetic induction soundings, and frequency-domain electromagnetic induction measurements.

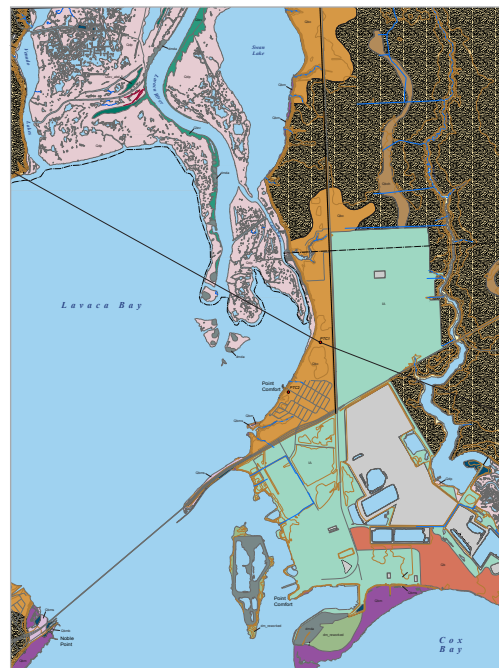
This map illustrates the geology of the area along the northwest margin of Lavaca Bay. Here, deltas of Garcitas and Placedo Creeks are prograding into Lavaca Bay. Geology of the area consists of sediments deposited within a Pleistocene fluvial-deltaic system, and within Holocene bay-estuary and fluvial-deltaic systems. Pleistocene deposits represent Beaumont fluvial-deltaic deposition that lies about 10 mi northwest (landward) of Pleistocene barrier deposits. A large Pleistocene sand-rich, fluvial-channel system of the Beaumont Formation lies across the area. Holocene deposits include a variety of deposits: alluvium, terrace, levee, abandoned-channel, bay margin, bay-margin beach, and delta plain.

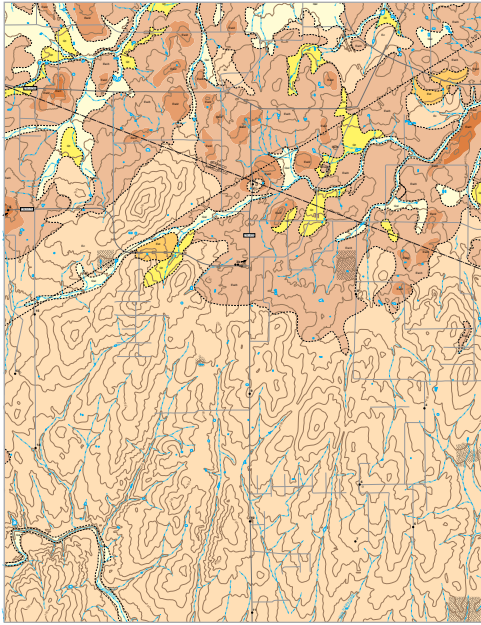


Geologic Map of the Point Comfort Quadrangle, Texas Gulf of Mexico Coast

Paine, J. G., Collins, E. W., and Costard, L., 2018, The University of Texas at Austin, Bureau of Economic Geology, Open-File Map, **OFM0235**, Sheet 1 scale 1:24,000; Sheet 2, Digital elevation model and time-domain electromagnetic induction soundings.

The Point Comfort quadrangle lies along the northeast margin of Lavaca Bay and includes the Lavaca delta where it progrades into the bay. Similar to the geology of the adjacent Kamey quadrangle, the geology consists of sediments deposited within a Pleistocene fluvial-deltaic system (Beaumont Formation), and within Holocene bay-estuary and fluvial-deltaic systems. Holocene geology is dominated by delta-plain deposits of the Lavaca River and Huisache Creek. Other Holocene sediments include alluvium, levee, abandoned levee, bay margin, and bay-margin spit deposits.





Geologic Map of the Somerset Quadrangle, Texas

Elliott, B. A., 2018, The University of Texas at Austin, Bureau of Economic Geology, Open-File Map, **OFM0236**, scale 1:24,000.

This map, one of several 1:24,000-scale maps of the region south of San Antonio, Texas, focuses on sand resources in the Carrizo–Wilcox formations of south-central Texas. Maps for this region provide a basic geologic framework to aid in managing water and earth resources; planning land use; identifying aquifer recharge areas; and identifying earth resources such as dimension stone, aggregate, construction and specialty sand, and gravel. The map illustrates the geology of Quaternary and Tertiary deposits that overlie Cretaceous strata just south of San Antonio. The Eocene-age Carrizo Sand formation is an important mineral-industry resource in the region, and the geologic maps will assist in recognizing additional economic sand resources and aquifer recharge zones that are important for water-resource management in the region.



Geologic Map of Mansfield Dam, Jollyville, Austin West, and Bee Cave Quadrangles, Central Texas (Lower Lake Travis and Lake Austin Vicinity)

Woodruff, C. M. Jr., and Collins, E. W., 2018, The University of Texas at Austin, Bureau of Economic Geology, Open-File Map, **OFM0237**, scale 1:50,000.

This map provides a tool for predicting areas of stable ground for construction as well as sites of importance in the context of land resources such as scenic vistas, water-quality protection, wildlife habitat, and areas having educational value. The Balcones Escarpment region has the highest recurrence of flood-producing storms in the conterminous United States, subjecting valley bottoms and other lower slopes in this map area to periodic inundation. Land development may worsen flood impacts owing to increased runoff from impervious surfaces.

The map encompasses four distinct areas within the Balcones Fault Zone west of Austin, an area experiencing rapid suburban growth with attendant pressures on the natural environment. The following four areas are denoted by the interactions

among bedrock, hydrologic processes, and resultant landforms: (1) Relict uplands of the Jollyville Plateau and adjacent outlying ridges and hilltops constitute remnants of the once-continuous Edwards Plateau. (2) Hilly terrain sculpted by erosion of the formerly continuous plateau uplands is characterized by high drainage density, steep slopes, and stepped terrain underlain mainly by the Glen Rose Limestone. (3) The southeast corner of the map includes intensively faulted terrain that results in abrupt changes in substrate properties between limestone and claystone units. (4) The impounded course of the Colorado River includes the lower reaches of Lake Travis, all of Lake Austin, and upper reaches of Lady Bird Lake.

Peer-Reviewed Publications by Bureau Researchers

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- Abolt, C. J., Young, M. H., Atchley, A. L., and Harp, D. R., 2018, Microtopographic control on the ground thermal regime in ice wedge polygons: The Cryosphere, v. 12, p. 1957-1968, <http://doi.org/10.5194/tc-12-1957-2018>.
- Afsharpoor, A., and Javadpour, F., 2018, Pore connectivity between organic and inorganic matter in shale: network modeling of mercury capillary pressure: *Transport in Porous Media*, v. 125, no. 3, p. 503-519, <http://doi.org/10.1007/s11242-018-1132-0>.
- Alnahwi, A., Loucks, R. G., Ruppel, S. C., Scott, R. W., and Tribovillard, N., 2018, Dip-related changes in stratigraphic architecture and associated sedimentological and geochemical variability in the Upper Cretaceous Eagle Ford Group in South Texas: *AAPG Bulletin*, v. 102, no. 12, p. 2537-2568, <http://doi.org/10.1306/05111817310>.
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- Ambrose, W. A., and Dutton, S. P., 2018, Depositional and diagenetic controls on reservoir quality in deep-water sandstones in the Lower Wilcox Group, Lavaca Canyon Complex in the Hallettsville Embayment, southeastern Texas Gulf Coast: *GCAGS Journal*, v. 7, p. 1-20.
- Ambrose, W. A., Zeng, H., Zhang, J., Olariu, M. I., Smith, D. C., and Clift, S. J., 2018, Depositional history and stratigraphic evolution of the Upper Wilcox Group and Reklaw Formation, northern Bee County, Texas: Austin, Texas, The University of Texas at Austin, Bureau of Economic Geology, Report of Investigations, no. 284, 87 p., <http://doi.org/10.23867/RI0284D>.
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- Blindish, R., Cosh, M. H., Jackson, T. J., Koike, T., Fujii, H., Chan, S. K., Asanuma, J., Berg, A., Bosch, D. D., Caldwell, T. G., Holifield Collins, C., McNairn, H., Martínez-Fernández, J., Prueger, J., Rowlandson, T., Seyfried, M., Starks, P., Thibeault, M., Van Der Velde, R., Walker, J. P., and Coopersmith, E. J., 2018, GCOM-W AMSR2 soil moisture product validation using core validation sites: *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, v. 11, no. 1, p. 209-219, <http://doi.org/10.1109/JSTARS.2017.2754293>.
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- Casini, G., Romaine, I., Casciello, E., Saura, E., Verges, J., Fernandez, N., and Hunt, D. W., 2018, Fracture characterization in sigmoidal folds: insights from the Siah Kuh anticline, Zagros, Iran: *AAPG Bulletin*, v. 102, no. 3, p. 369-399, <http://doi.org/10.1306/0503171615817076>.
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- Chen, Y., and Fomel, S., 2018, EMD-seislet transform: *Geophysics*, v. 83, no. 1, p. A27-A32, <http://doi.org/10.1190/geo2017-0554.1>.
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Transitions

New Employees

The Bureau of Economic Geology continues to attract some of the most talented geoscientists in the world to conduct impactful research on a wide range of energy and environmental questions—and equally talented support staff to help them in their efforts. The year 2018 was no exception as the Bureau brought a diverse group of 18 new people on board. Please help us welcome them to the Bureau!



Amelia Bridges
Administrative
Services Officer



Luis Macias Chapa
Project
Manager



Roanne Draker
Administrative
Assistant



Margo Grace
Research Program
Coordinator



Gwen Hebert
Senior Grants &
Contracts Specialist



Patricia Martone
Research Scientist
Associate II



Francine
Mastrangelo
Computer
Illustrator



Lorri McKim
Administrative
Assistant



Dmitrii Merzlikin
Research
Associate



Emily Moskal
Research Program
Coordinator



Isabelle
Pelletier Tardy
Research Scientist
Associate IV



Reinaldo
Sabbagh
Research Scientist
Associate III



Matthew Shirley
Research Scientist
Associate II



Xun Sun
Research Scientist
Associate III



Marie Victor
Accountant I



Stefanie Whittaker
Project
Manager



Qian Yang
Research
Associate



Inessa Yurchenko
Research
Associate

Creating Living Memorials for the Bureau

Over the years, Bureau employees have changed the world through scientific research and published results, as well as through the mentoring and support of succeeding generations of geoscientists. Many employees build a legacy during decades-long careers at the Bureau, while others have a significant impact during a shorter tenure. In an effort to recognize the lasting contributions of past employees through a living monument, the Bureau adopted the **Memorial Tree Program** in 2013. Every year since its inception, donations by Bureau employees have underwritten the planting of a tree in commemoration of employees whose passing occurred or was noted during the year.

In 2018, the Bureau paid tribute to five former employees: **Milo M. Backus III**, Senior Research Scientist and Research Professor; **Don G. Bebout**, Senior Research Scientist; **Leonard F. Brown, Jr.**, Senior Research Fellow; **Robert Louis Folk**, Senior Research Scientist; and **Doris Jean Tyler**, Senior Secretary. Their memorial tree was planted on Bureau grounds in the fall, and a dedication ceremony will take place in spring 2019. The program is administered by The University of Texas at Austin as part of its **Memorial Tree Program**; an interactive map of the memorial trees can be found [here](#).

In Memoriam



Dr. Milo Morlan Backus III

Dr. Milo Morlan Backus III, Bureau Senior Research Scientist and Shell Chair Emeritus in the Department of Geological Sciences, passed away May 25, 2018, in Dallas, Texas. Milo's career in geophysics included two decades in industry and more than two decades at The University of Texas at Austin. He was noted as one of the greats in the history of exploration geophysics and as a pioneer in 3D seismic imaging. In 1959, his landmark paper solving a major problem in seismic-reflection prospecting significantly furthered efforts to convert the geophysics industry from analog to entirely digital recording and processing, and revolutionized the field of exploration geophysics. Milo joined the Bureau as a Senior Research Scientist in January 1997 and was closely involved with the Bureau's Exploration Geophysics Laboratory.



Dr. Don Gray Bebout

Dr. Don Gray Bebout, who passed away on June 16, 2018, worked for the Bureau for 21 years, retiring in 1994 as a Senior Research Scientist. Directing research of carbonates and evaporates, Don played a key role in geothermal energy studies that led to the first geopressured geothermal test wells in Texas. His work on carbonates was published in numerous papers on carbonate stratal architecture and depositional systems, the relationship of lithofacies to porosity and reservoir quality, and regional-scale investigations of Lower Cretaceous carbonates in Texas and Mexico. His publications for the Bureau include the *Atlas of Major Central and Eastern Gulf Coast Gas Reservoirs* and *Guide to the Permian Reef Geology Trail, McKittrick Canyon, Guadalupe Mountains National Park, West Texas*. Post-retirement, Don enjoyed an equally rich career as a potter, exhibiting his works primarily in the Austin area. Says

former Bureau researcher Shirley Dutton, "Don was a great teacher, mentor, and friend to me and many others during his time at the Bureau. His legacy in both geology and art lives on."



Dr. Leonard F. (Frank)
Brown, Jr.

Dr. Leonard F. (Frank) Brown, Jr., Professor Emeritus of Geological Sciences and a prominent, internationally known geologist, died December 25, 2016, at the age of 88. Renowned for his seminal contributions in siliciclastic depositional systems and systems tracts, Frank not only formulated the initial concepts but also applied them to seismic stratigraphy, sequence stratigraphy, and coastal studies management. During his five-decade career in geology—with nearly 40 years spent at the Bureau and nearly 20 years as a faculty member at UT Austin—Frank was recognized worldwide for his work as a researcher, consultant, and mentor.

Dr. Robert Louis (Luigi) Folk, a Senior Research Scientist with the Bureau from 1988 to 1999 and UT Austin faculty member for over 35 years, died on June 4, 2018, at the age of 93. Luigi, an inspirational teacher and groundbreaking geologist, formulated the world's first carbonate-rock classification, and his "orange book," *Petrology of Sedimentary Rocks*, was essential reading for geology students. He received the Geological Society of America's highest honor, the Penrose Medal, as well as the Geology Foundation Outstanding Teacher Award and the Carolyn G. and G. Moses Knebel Distinguished Teaching Award, both from UT Austin.



Dr. Robert Louis (Luigi)
Folk

Doris Jean Tyler, a Senior Secretary at the Bureau from 1979 to 1983, died March 3, 2018. Doris's administrative support was key to the Bureau's research and operations. An accomplished violinist and a philanthropist, Doris also worked for the Texas House of Representatives and the Texas Higher Education Coordinating Board.



Doris Jean Tyler

Retirements

After 40 years with the Bureau, Research Scientist Associate **Eddie Collins** retired in July.

Lauded for his exceptional skills in field geology, Eddie may be remembered best as long-serving director of the STATEMAP program—part of the National Cooperative Geologic Mapping Program administered by the U.S. Geological Survey—where he was instrumental in identifying and prioritizing geologic map studies throughout Texas. His maps of the Central Texas corridor and the West Texas region, especially the Big Bend National Park, are among some of his most important work. He also played significant roles in numerous other projects, including the Texas Commission on Environmental Quality Colorado River Basin Salinity Project, the Low-Level Radioactive Waste Disposal project in West Texas, and the Superconducting Super Collider project, as well as in studies of the Edwards Aquifer and Wink sinkholes.



Eddie Collins

After receiving his BA and MS in Geology from Trinity University and Stephen F. Austin State University, respectively, Eddie joined the Bureau in April 1978. He is the author of hundreds of publications, including geologic maps, guidebooks, journal articles, field guides, contract reports, conference abstracts, and online applications. Eddie is past president and member of the executive committee of the Austin Geological Society (AGS) and led numerous field trips and outreach activities for AGS and affiliated organizations.

For a look back at Eddie's career and contributions—compiled by fellow Bureau researcher **Jeffrey Paine**, with commentary and photos by Bureau employees past and present—see [Eddie Collins: Images, Stories, and Impressions of a Texas Geologist after Four Decades at the Bureau of Economic Geology](#). Says Paine, "Those of us who have worked with Eddie over his 40 years at the Bureau will miss the daily doses of his humor, generosity, good-heartedness, dry wit, and knowledge of Texas geology that is as deep as it is broad."

(continued on next page)



Julie Duiker

Administrative Services Officer **Julie Duiker** retired in January after nearly 12 years with the Bureau. During her tenure, Julie oversaw the integration of separate Human Resources, Accounting, and Contracts & Grants groups into one cohesive group of research administrators who work together to assist the Bureau's research effort. Some process improvements that Julie shepherded include streamlining Bureau processes with other departments; creating online approval portals for travel, purchasing, and new proposals; creating shared document folders that allow access by other administrative staff and researchers; and sending out regular reports on grants and contracts, funding, spending, and expiring reports. The group also transitioned to a completely electronic retention system, saving time and making file-sharing easier. Julie also encouraged professional development

and certification; the Contracts & Grants group now includes a certified HR specialist and three pending Certified Research Administrators. Julie now plans to complete a longtime renovation project on her home and property in Kosse, Texas, and to travel and spend time with her grandkids.



Shirley Dutton

After a whopping 40.84 years with the Bureau, Senior Research Scientist **Dr. Shirley P. Dutton** retired in May.

Shirley is perhaps most noted for, and proudest of, her studies in the following areas: diagenetic controls on the reservoir quality of deep Gulf of Mexico sandstones, oil reservoir plays in the Permian Basin, outcrop and subsurface sandstones to evaluate the impact of diagenesis on fluid flow in reservoirs, geology of tight gas sands, and petroleum potential of the Palo Duro Basin for the West Texas Waste Isolation Project.

Her numerous accolades include the AAPG Levorsen Memorial Award, SEPM Curtis Medal, GCAGS President's Award, and Jackson School of Geosciences Research Excellence Award, as well as being named an AAPG Distinguished Lecturer and GSA Fellow. Since joining the Bureau in 1977, she authored hundreds of peer-reviewed publications, guidebooks, contract reports, circulars, and reports of investigation. She also taught 18 courses and served on MS and PhD committees for students, as well as on numerous professional committees.

Said the Bureau's acting director **Mark Shuster**, "The Bureau, the research community, and a whole slew of subsurface workers in Industry have benefited from Shirley and her work. She will be missed."

Post-retirement, Shirley plans on continuing to work on geology projects and enjoying summers at the upstate New York home she shares with husband Alan, all the while pondering, "What rock would I like to be? A quart-cemented quartzenite, like the Travis Peak tight gas sand? A granite-wash arkose such as in Mobeetie field in the Anadarko Basin? Perhaps a nice porous sandstone with continuous chlorite coats, like the Tuscaloosa..."



Michelle Michot Foss

After nearly 30 years of building and operating energy economics research and programs at UT Austin and the University of Houston (UH), **Dr. Michelle Michot Foss** retired in August. As chief energy economist and program manager for the Bureau's **Center for Energy Economics** (CEE), Michelle led research on oil, gas/liquefied natural gas (LNG), and power in the U.S., North America, and—through technical assistance assignments and projects—around 20 other countries. Over her tenure, the CEE research team was host to the largest university-based LNG research consortium in the country; supported capacity building in around 40 countries through New Era in Oil, Gas & Power Value Creation (recognized by World Oil Awards); provided research and public education for electric power reform in Texas and elsewhere; and contributed to graduate student development and research at

UT and UH. Michelle will remain an executive instructor for Texas Executive Education at UT's McCombs School of Business and will serve on the advisory council for the Energy and Earth Resources graduate program at UT's Jackson School of Geosciences.

Preeminent geophysicist and Senior Research Scientist **Bob Hardage** retired in January 2018 after 27 years with the Bureau. When he arrived in 1991 after more than two decades with Phillips Petroleum, Bob was tasked with building the Bureau into a world-class center of exploration geophysics—despite having little to no budget or resources. Today, thanks to his guidance, the Bureau has over 400 computers in Austin, Houston, and Midland; more than 150 software licenses that support various areas of seismic research; 12 part-time or full-time research geophysicists; and approximately 20 graduate students doing seismic-related research. Says Bob, “I have good memories of helping the Bureau undergo the transition from near-zero capability in geophysics to its present state of being at the cutting-edge of 3D seismic reflection technology.”



Bob Hardage

In 1999, Bob was named the Bowling Professor of Exploration Geophysics at UT Austin. He served as president of the Society of Exploration Geophysicists (SEG) (2011–12) and as editor of their *Geophysics* journal (1993–95); he is also a Life Member and Honorary Member. Other accolades include the AAPG Distinguished Service Award (2010) and the Jackson School of Geosciences Outstanding Service Award (2012). Among Bob’s publications are ten books—including the influential *Vertical Seismic Profiling* (1983, Pergamon), now in its 3rd edition—and dozens of both peer-reviewed and trade-journal articles; he also holds 11 patents, many shear-wave related.

In the future, says Bob, “I might be available, if needed, for a little part-time work to ensure that the Bureau’s legacy as a global leader in seismic research and technology development is maintained and expanded. It has been a rewarding 27 years.”

Research Scientist Associate **Patrick L. Smith** retired in December after 7 years with the Bureau, where he served as operations manager for the **Scanning Electron Microscope Laboratory** (SEM). After more than 40 years of experience with SEM analytical techniques, Patrick found the Bureau to be his “ideal retirement job... I have enjoyed adapting and applying previous knowledge to unique BEG research problems. One of the driving forces in my life has been about discovery, learning how things works. As a microscopist, sometimes I got to see things for the first time EVER.... It is, of course, always about the people one encounters, specifically the life-changing collaborations and friendships that develop. Thank you people of the Bureau of Economic Geology for everything.” Patrick’s future plans include traveling, flying across the USA (he’s a certified single-engine pilot), and perhaps some consulting work.



Patrick L. Smith

Visiting Committee 2018



From left to right: John Gibson (Tudor, Pickering, Holt & Co.), Jeff Walker (Texas Water Development Board), Mark Havens (Texas General Land office, representing George P. Bush), Scott Anderson (Environmental Defense Fund), Marilu Hastings (Cynthia and George Mitchell Foundation), Jon Niermann (Texas Commission on Environmental Quality), Tim Brittan (Infinity Oil & Gas, Inc.), Christi Craddick (Railroad Commission of Texas), Mike Ming (Baker Hughes), Chuck Williamson (Weyerhaeuser Co. & Paccar), Bud Brigham (Anthem Ventures/Brigham Minerals/Brigham Exploration/Atlas), Scott Tinker (Bureau Director), Dick Stoneburner (Pine Brook Partners), Claudia Hackbarth (Shell Global Solutions US, Inc.), Mark Houser (University Lands), Dan Domeracki (Schlumberger Ltd.), Bud Scherr (Valence Operating Co.), Carol Lloyd (Exxon Mobil Corp.), Phillip Ashley (Texas Comptroller of Public Accounts, representing Glenn Hagar), and Jim Farnsworth (Blackstone Group, Azimuth Capital).

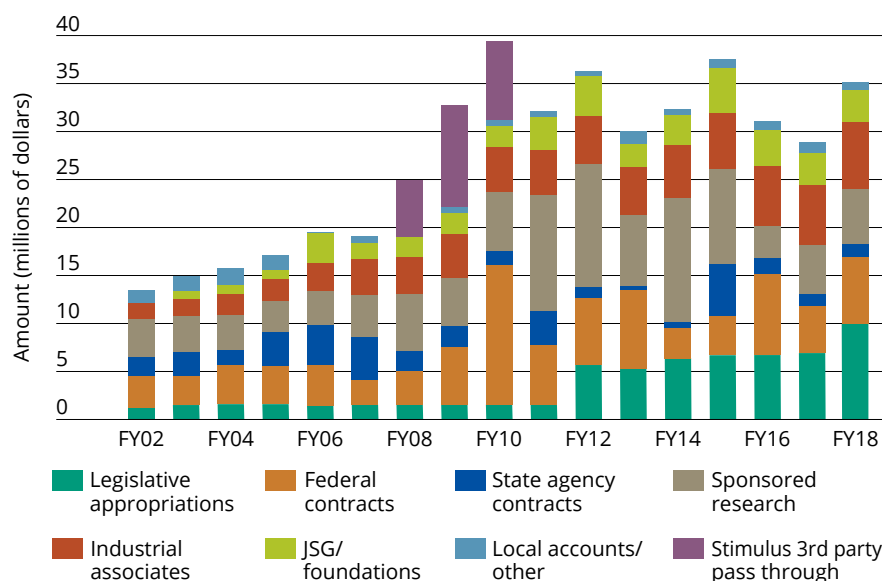
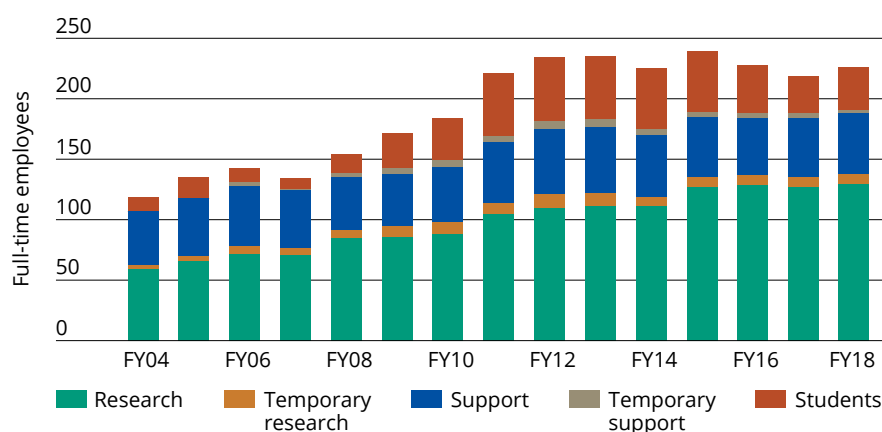
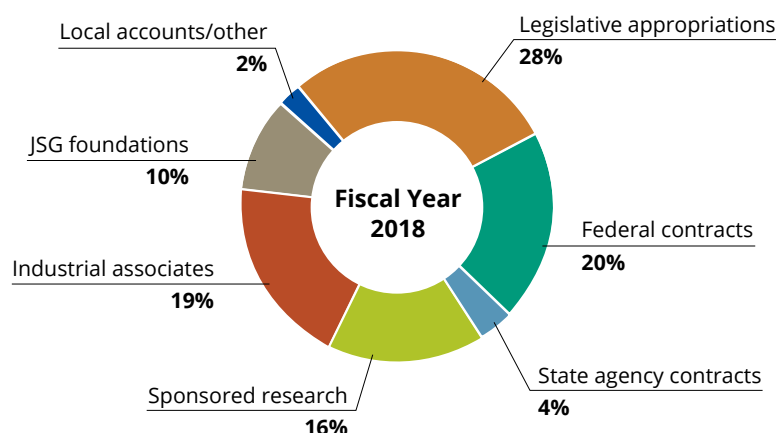
Representatives from Texas state agencies, foundations, and not-for-profit organizations; industry leaders; and major supporters of the Bureau of Economic Geology convened in August for the annual meeting of the Bureau's Visiting Committee, a day of conversation that helps to shape the future direction of Bureau research. The meeting is structured to allow for open discussion and dialogue about new ideas within the space where industry, government, and academia intersect.

This year's agenda included discussion of the Bureau's new Strategic Plan, as well as of the use and re-use of water in the State of Texas. Bureau researchers and

directors reported on items that included the [TexNet](#) earthquake monitoring and mitigation program, the [State of Texas Advanced Resource Recovery](#) (STARR) program, ongoing activities to inform the State Legislature about Bureau initiatives it funds, and the many successful programs of the Bureau's Energy and Environmental divisions.

For more information about the work of the Bureau or its Visiting Committee, please contact **Mark W. Blount**, External & Governmental Affairs: mark.blount@beg.utexas.edu.

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