2020
Research Consortia

Scott W. Tinker, Director
Research Consortia

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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 review this brochure and 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.
Who We Are

Established in 1909, the Bureau of Economic Geology is the oldest research unit at The University of Texas at Austin. The Bureau functions as the State Geological Survey of Texas and has been an integral part of the development of the State’s oil and gas industry through the years. 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, all of whom we serve. Bureau researchers spearhead basic and applied research projects globally in energy resources and economics, coastal and environmental studies, land resources and use, geologic and mineral mapping, hydrogeology, geochemistry, and subsurface nanotechnology. The Bureau provides advisory, educational, technical, and informational services related to the resources and geology of Texas, the nation, and the world.

Bureau Programs

The Bureau is an international leader in a number of research thrusts, working at the intersection of energy, the environment, and the economy, with strengths that include

- Unconventional oil and gas exploration and production
- Salt tectonics
- Natural fractures and structural diagenesis
- Reservoir characterization in carbonates, mudrocks, and sandstones
- Carbon storage in geological reservoirs
- The water-energy nexus
- Energy economics

Talented people are key to the Bureau’s success. The research staff includes more than 120 scientists, engineers, and economists, representing 27 countries, working in integrated, multidisciplinary research teams. Together with 40 skilled graduate students and 15 postdocs, they solve the world’s greatest challenges in energy and environmental research.
Partnerships

Partnerships drive strategy, innovation, and investigation, and the Bureau engages partners both new and old on many levels. Investments in Bureau research provide significant returns. Corporate partners participate in and gain vital new insights from the Bureau’s many productive research consortia, which are described herein. Government, agency, foundation, and non-governmental organization partners include the State of Texas, the Alfred P. Sloan Foundation, the U.S. Department of Energy, and the Environmental Defense Fund.

Facilities

Superb facilities and equipment, some co-funded by industry, give researchers the tools they need to find objective, rock-based research solutions. Such facilities and equipment include:

- More than 18 individual laboratories hosting research teams investigating everything from nanoparticles to shale porosity and permeability
- Three massive well-core research and storage facilities in Houston, Austin, and Midland that collectively house what may be the largest archive of rock material in the world
- One of the largest collections of well logs in the United States
- An extensive inventory of modern imaging devices and integrated technologies for outcrop and land-surface mapping

Results

More than 100 years of producing research results has earned the Bureau an unparalleled reputation. Successful outcomes can be measured by many yardsticks, and Bureau researchers more than measure up:

- More than 170 peer-reviewed articles and books published annually
- Hundreds of abstracts and articles published each year in Conference Proceedings volumes
- More than 50 keynote addresses made annually
- Bureau researchers frequently being made presidents of international professional societies and editors of major professional journals
- Bureau researchers being recognized by their peers with top medals and awards in their fields
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 Challenges

In the decade since its inception, the Advanced Energy Consortium has progressed nanotechnology from fundamental to applied research and is now targeting commercial applications such as precise reservoir imaging of hydraulic fracture networks using electromagnetic contrast agents; microsensor data logging in wellbores, pipelines, and other infrastructure; and targeted payload deliveries in a host of environments.

Over the past decade, the AEC has played a significant role in enabling nanotechnology solutions for the oil and gas industry. In collaboration with our member companies and researchers, the consortium has evolved from fundamental research at individual university labs into a set of integrated, multi-component and multi-institutional applied research programs transforming the technology of subsurface monitoring and creating exciting field demonstrations to validate our technology in 2020.

Research Thrusts

Contrast Agents for Mapping Hydraulic-Fracture Networks

The Use Case 1 (UC1) team is focused on remote characterization of hydraulic-fracture geometries and network permeability using electromagnetic (EM) contrast-agent proppants. Current fracture-imaging technology employs microseismic monitoring, which provides general information about rock mechanics but fails to accurately resolve the extent of connected fracture geometry and fluid permeability within the fractured network. Accurate mapping of hydraulic fractures is instrumental in enhancing completion strategies and mitigating excessive resource usage.
Advanced Energy Consortium

Research Thrusts (continued)

Microelectronic Sensor Systems
The Use Case 2 (UC2) team designs and fabricates micro-electronic sensors capable of acquiring multiple time-stamped measurements in harsh subsurface environments. In 2019 and 2020, the AEC is testing three Smart Subsurface Autonomous Nanosensor Device (Smart-SAND) prototype platforms, as well as continuing to develop new sensor, power, microcontroller, and communications components. The three platforms range in size from 1 to 12 mm and are hermetically sealed, wirelessly charged and programmed, and suitable for characterization of any combination of temperature, pressure, resistivity, or pH (up to 10 kpsi and 125°C).

Payload Delivery Systems
The use Case 4 (UC4) team continues to progress in the development of micro- and nanoscale payload-delivery systems. Timed payload delivery allows for optimal placement of the cargo in the wellbore or reservoir. Two payload delivery-system mechanisms have been developed: (1) burst release with an inside-out, triggered degradation mechanism and (2) core–shell delivery, in which the payload dissolves at desired temperatures and times.

Membership
Now is truly an excellent time to be a part of the AEC family. AEC research revenues are increasing as we attract new members. We have also successfully obtained grants from Sandia National Laboratories and the U.S. Department of Energy that promise to more than double our research budget over the next 3 years. Our level of innovation remains unsurpassed, and we are a recognized leader in nanotechnology research, as demonstrated by our numerous filed patents and papers and our team’s prestigious 2019 Best Paper Award from the Journal of Environmental & Engineering Geophysics.

We invite companies who are ready to transform the future of the energy industry to talk with us about empowering people and protecting the environment using advanced technology.

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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. AGL research has also been applied extraterrestrially to Mars and Triton.

Research Thrusts

Concepts and terminology pioneered by the AGL over the past quarter-century have profoundly influenced salt tectonics and are now widely disseminated throughout the oil industry. The AGL strives to effectively communicate these results via a variety of media, including Salt Tectonics: Principles and Practice, the leading textbook on the subject in the world.

Research Challenges

The primary goals of the AGL are to develop a conceptual framework for the full range of salt tectonics; to analyze connections among physical models, mathematical models, seismic datasets, 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 the University of Colorado); extrusive salt sheets (with BP and ExxonMobil); extensional turtle and mock turtle; mechanics of salt-sheet advance; the origins of minibasins; intrusive salt plumes; and salt sutures.

Numerical model showing contours of strain in sedimentary rocks encasing a salt sheet advancing to the right.
Applied Geodynamics Laboratory
Salt Tectonics

Membership
The 29 supporting companies of the AGL include a wide range of industry partners from around the world.

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Mission
The Center for Integrated Seismicity Research (CISR) is a multidisciplinary, intercollegiate research consortium managed by the Bureau. TexNet and CISR are two parts of a whole; the former 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 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 UT researchers from the Bureau, the Institute for Geophysics, the Department of Petroleum and Geosystems Engineering, and the Department of Civil, Architectural, and Environmental Engineering. Southern Methodist University, UT El Paso, Texas A&M University, the University of Houston, UT Dallas, and Stanford University are also contributing research partners.

Research Challenges
Over the past decade, the rate of seismicity in the south-central United States has increased markedly, especially in unconventional play areas where water management and sustainable development are increasingly important challenges. Understanding the interplay between complex operational drivers and interdependent subsurface physical processes is a daunting challenge that the Bureau is pursuing head-on.
Membership

Most of the major energy companies that operate in Texas unconventional plays are CISR members. Each company has one member who serves on the CISR Advisory Committee, which meets quarterly to discuss the design and application of TexNet-CISR research. Member companies are encouraged to assist with identification of land parcels that can be used for seismic monitoring and 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
Fracture research at The University of Texas at Austin seeks fundamental understanding of 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 research is both fundamental and practical, aiming at improving prediction and diagnosis of fracture attributes in hydrocarbon reservoirs and accurately simulating their influence on production. Research is organized around the Fracture Research and Application Consortium (FRAC), conducted together with scientists from member companies. Students are an important part of our program.

Research Thrusts
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 produce data that can enhance well-test and seismic interpretations and can be used in reservoir simulators. We are developing new and more-reliable methods to predict hydraulic fracture propagation in naturally fractured and unconventional reservoirs.

Research Challenges
Faults and fractures are difficult or impossible to characterize adequately using currently available technology. Fractures have been challenging to sample and model, posing serious challenges to exploration and development. Our approach is helping to overcome the limitations of current methods.
Fracture Research and Application Consortium

Membership

Training in techniques, software, and our workflow is a benefit of membership. Annual meetings cover measurement, interpretation, prediction, and simulation of fractures and mechanical properties in carbonate rocks, mudstones, and sandstones.

Participants examine fractures in tight-gas sandstones in the Canadian Foothills; FRAC field trip, fall 2013.

 Quartz/dolomite/bitumen–filled fracture compacted by folding and faulting; the H1–H2 compacted fracture height is 70 cm; Blocher Member, New Albany Shale, Kentucky.

(a) Fracture-height patterns in New Albany shale roadcut with hierarchical fracture traces, eastern Kentucky. Some fracture traces cut multiple beds (F). Others are bed bounded (Lb = bed boundary). (b–e) Fracture-height classification categories from Hooker et al. (2013).

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Mission
The Gulf Coast Carbon Center (GCCC) conducts research and outreach in geologic storage technologies used to reduce emissions of carbon dioxide (CO₂). Carbon dioxide produced by combustion of fossil fuels and by 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 the Gulf of Mexico and globally.

CO₂-enhanced oil recovery (EOR) research helps to assess (1) the best methods and economic usage of CO₂ for EOR in various traditional and novel settings, and (2) the intersection of economic value with storage value. Together, this information develops 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 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 to basin scale. Only through this kind of integrated analysis can the multiscalar heterogeneities of mudrocks be effectively characterized and models leading to better predictions of reservoir quality be developed.

Research Thrusts
MSRL research activities include the following: field emission scanning electron microscope study of pore architecture, grain types, and diagenesis; analysis of mechanical properties; application of X-ray fluorescence 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 flow; critical appraisal of conventional methods of mudrock-analysis techniques; and core-based calibration of borehole geophysical logs for facies mapping.
Research Challenges

Despite their abundance in Earth’s crust, mudrocks are not as well understood as other reservoir systems. The current explosion of interest in a better understanding of these rocks stems from the need to devise more-efficient ways of extracting oil and gas from these reservoirs. Our challenge is to develop new methodologies for characterizing these rocks and the fluids they contain. We are meeting this challenge by carrying out integrated studies of rock and fluid attributes on high-precision, high-resolution instruments operated by MSRL researchers.

Membership

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

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Mission

The mission of the Quantitative Clastics Laboratory (QCL) is to develop a predictive understanding of processes and controls on sediment transport and the stratigraphic evolution of depositional systems, with applications in reservoir characterization, modeling, correlation, and source-to-sink predictions for frontier exploration.

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 thermochronology—to address key challenges in the exploration and development of natural resources. These challenges include evaluation of reservoir presence and quality in data-limited frontier basins and characterization of reservoir connectivity and heterogeneity. The QCL has unique clastic research consortia access to industry subsurface data, including global seismic-reflection datasets and Bureau core repositories.

Digital elevation model of exhumed Cretaceous channel belts in the Cedar Mountain Formation, Utah (Cole Speed).
Quantitative Clastics Laboratory

Research Challenges
The QCL has two research themes: (1) reservoir-scale depositional system characterization, modeling, and flow simulation for a better understanding of processes that impact connectivity and heterogeneity, and (2) exploration-scale source-to-sink analysis to evaluate correlation, reservoir presence, and quality in the petroliferous Permian Basin and circum-Gulf of Mexico. An exciting update to the QCL program is flow-diagnostics analysis of digital stratigraphic models for evaluating the effect of stratigraphic evolution and facies architecture on fluid flow during production.

Flow simulated reservoir model of a fluvial system that includes facies variability due to the presence of counterpoint bars.

Map showing well pairs used in correlation (left) and the resulting chronostratigraphic diagram for this part of the basin (right).

Memberhsip
Each year’s research calendar begins January 1 and runs through December 31. Multiple meetings, workshops, and face-to-face consultations with industry members are held annually. The QCL offers industry members unique access to JSG expertise, 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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Carbonate Reservoir Characterization Research Laboratory

Mission
The Carbonate Reservoir Characterization Research Laboratory’s (RCRL) 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 explain and describe the 3D reservoir environment and to improve hydrocarbon recovery factors. In addition, the RCRL is dedicated to technology transfer and education and consistently offers state-of-the-art training, such as short courses, field seminars, in-company reviews of assets, and extensive student supervision and guided research.

Research Thrusts
The 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 are developed using both subsurface data and outcrop analogs. The RCRL emphasizes quantifying observations 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 Lower Permian shelf-to-basin stratigraphic and structural architecture 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.
Carbonate Reservoir Characterization Research Laboratory

Membership

RCRL membership is $55,000 per year. Sponsors are encouraged to commit to a 2-year agreement (at $50,000 per year) to better plan a longer-range research program.

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Mission

The mission of the Bureau’s State of Texas Advanced Oil and Gas Resource Recovery (STARR) program is to conduct geologic research that increases oil and gas production 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 over 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 Texas oil and gas industry 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; (2) imaging and characterization of lithology, facies, and micropore systems in unconventional reservoirs; and (3) advanced seismic mapping techniques for imaging potential oil and gas reservoirs.
Research Challenges

The main challenge being undertaken by the STARR group is to explain controls on oil and gas production in Texas reservoirs. 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 integrates rock-property data in both field- and regional-scale projects, drawing upon its extensive core collection at the Bureau.

2018–2020 Biennium

Active Field Studies

Active Regional Studies

Membership

No costs are associated with participation in the STARR program, which is funded by the State of Texas, although research matching support is encouraged. 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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www.beg.utexas.edu/research/programs/starr
Texas Consortium for Computational Seismology

Mission

The Texas Consortium for Computational Seismology (TCCS) is a collaboration between the Bureau and the UT Oden Institute for Computational Engineering and Sciences, which is involved in estimating seismic velocities 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.

The mission of 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.

The TCCS group consists of scientists from five countries who are united in their goal to advance science. Research staff includes two principal investigators, six Ph.D. students, and a visiting scientist.
Research Thrusts

TCCS research areas include the following: high-resolution imaging of the Barrolka dataset using diffraction attributes; characterization of fractured-shale reservoirs using anelliptic parameters; phase correction of prestack seismic data using local attributes; extraction of seismic events by predictive painting and time warping; low-rank, 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.

Membership

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

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Tight Oil Resource Assessment

Mission

Tight Oil Resource Assessment (TORA) was created in 2016 to fund the multidisciplinary study of tight-oil-producing horizons in the Permian Basin and other unconventional reservoirs.

Our mission is to provide our stakeholders with reliable and up-to-date estimates, projections, models, and insights at the basin scale for the major U.S. unconventional plays by conducting innovative, integrated research of in-place resources and recoverable volumes, play/well economics, production forecasts, and environmental implications.

Recent production history for Permian Basin, split out by formation via analysis of landing zones.

Research Challenges

TORA aims to narrow the range of recoverable-resource estimates, building integrated and market-independent basin outlooks. Ongoing TORA work in the Midland Basin has narrowed down the recoverable-resource potential to between 35 and 52 billion barrels for Wolfcamp A and B alone. Similar work is nearly complete in the Delaware Basin.

Building on over a century of Bureau Permian research, TORA studies tight oil and gas formations to produce unbiased, comprehensive, publicly available results. Our team employs a newly developed workflow to predict hydrocarbon recoveries, economic viability, and play-wide production rates. Our investigations are basin-scale in scope yet predict productivity, profitability, and future drilling at a 1-mi² scale.

Original oil-in-place estimates across the Midland Basin.

Midland Basin well trajectories color coded by landing formation (e.g., Wolfcamp B = blue).
Research Thrusts

TORA employs a multidisciplinary, highly iterative evaluation process. Our approach was developed and refined in a series of Sloan- and DOE-funded studies of several major shale plays.

**Geology and Petrophysics.** We interpret the stratigraphic framework to create a basin-wide 3D facies architecture of petrophysical-attribute distribution and to calculate in-place resources.

**Engineering.** We model and match all well-production history before projecting future production, and we perform decline analysis using innovative in-house software.

**Data Analytics.** We relate the productivity of existing wells to key subsurface and operational attributes to model the productivity of all undrilled locations.

**Economics.** We develop the full range of expected outcomes per well, including technological and cost improvements, pricing, logistics, drilling pace, well attrition, and lease accessibility.

**ARC-GIS.** We use digital mapping to spatially link key geologic and operational practices to changes in per well productivity.

Membership

TORA membership is $50,000 annually. Benefits include: detailed geologic, petrophysical, engineering, statistical, and economic insights; semiannual meetings and conference volumes; basin-scale 3D geologic models; access to the multidisciplinary TORA team; leveraged funding through State of Texas support and other operator contributions; and consortium-supported data sharing between sponsors and the Bureau to address specific technical questions.

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