Research Consortia at the Bureau

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Director
Scott W. Tinker

Associate Directors
Mark Shuster, Energy Division
Michael H. Young, Environmental Systems Division
Jay P. Kipper, Administration and Finance

External & Governmental Affairs
Mark W. Blount

Research and Administrative Office and Laboratories
J. J. Pickle Research Campus, 10100 Burnet Road, Austin, Texas, 78758-4445
512-471-1534, Switchboard
512-471-0320, Public Information
512-471-0140, Fax
512-471-7144, Publication Sales
1-888-839-4365, Toll-free phone (USA)
1-888-839-6277, Toll-free fax (USA)

Media Manager
Cathy J. Brown

Senior Graphic Designer
Jamie H. Coggin
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 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, 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 nongovernmental 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—collectively, housing 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
- More than 50 keynote addresses made annually
- Bureau researchers’ frequently being made presidents of international professional societies and editors of major professional journals, and being recognized by their peers with top medals and awards in their fields
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

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 wellbore integrity, seal integrity, and cement integrity for additional applications such as geothermal energy; carbon capture and storage; nuclear waste monitoring and power generation; and water use optimization and recycling, are areas of clear potential impact.
Research Thrusts

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.
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, 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 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.
Research Challenges (continued)

- 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
- Salt sutures

Membership

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

Contact

Michael R. Hudec, michael.hudec@beg.utexas.edu, (U.S.) 512-471-1428
www.beg.utexas.edu/agl
Mission

The Center for Integrated Seismicity Research (CISR) is a multidisciplinary, intercollegiate research consortium managed by the Bureau of Economic Geology. 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 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; The Departments of Petroleum, Geosystems, 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 is pursuing head-on.

Saltwater disposal into the Fort Worth Basin showing number of active disposal wells, cumulative injection, and monthly count of Mw ≥ 2.5 earthquakes.

Interpretation of potentially seismogenic faults in Dallas-Fort Worth area colored by slip potential, which is a probabilistic measure of hazard.
Membership

All 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.

Portion of Delaware Basin, TexNet seismic monitoring stations, earthquakes of all magnitudes as cataloged by TexNet in 2017–18 (amber dots), fault-plane solutions (red and white balls), and new structural model in development.

Contact

TexNet and Center for Integrated Seismicity Research

Peter Hennings, PI–Subsurface Integration and Ind. Liaison, peter.hennings@beg.utexas.edu, (U.S.) 512-471-0156
Ellen Rathje, PI–Hazard and Risk, e.rathje@mail.utexas.edu, (U.S.) 512-232-3683
Alexandros Savvaidis, PI–Seismology and TexNet Manager, alexandros.savvaidis@beg.utexas.edu, (U.S.) 512-475-9549

www.beg.utexas.edu/cisr
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—to improve prediction and diagnosis of fracture attributes in hydrocarbon reservoirs and accurately simulate their influence on production. Research is organized around the Fracture Research and Application Consortium (FRAC), together with scientists from member companies. Students are an important part of our program.

Research Thrusts

Accurate prediction and characterization of fractures holds 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 that 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).

Contact

Dr. Stephen E. Laubach, steve.laubach@beg.utexas.edu, (U.S.) 512-471-6303
Dr. Julia F. W. Gale, julia.gale@beg.utexas.edu, (U.S.) 512-232-7957
Dr. Jon Olson, jolson@austin.utexas.edu, (U.S.) 512-471-7375

www.beg.utexas.edu/frac
http://www.jsg.utexas.edu/sdi/
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.

Interpreted seismic to identify storage prospects in offshore Gulf of Mexico.

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.

Katherine Romanak collecting soil gas data globally.
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.

Contact

Dr. Susan D. Hovorka, susan.hovorka@beg.utexas.edu, (U.S.) 512-471-4863

www.beg.utexas.edu/gccc
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 multiscalar heterogeneities of mudrocks be effectively characterized and models leading to better predictions of reservoir quality be developed.

Research Thrusts

- 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

- Calibration and interpretation of borehole geophysical data
- Nanopore analysis: field-emission SEM microscopy, Ar-ion milling, N2 adsorption, and X-ray CT
- Elemental and mineralogical composition: field-emission SEM, cathodoluminescence, and light microscopy; XRD, ICP-MS, XRF, and stable-isotope analysis
- Fluid-flow modeling
- Organic matter and hydrocarbon analysis: Rock Eval, GC, vitrinite reflectance, and kerogen analysis
- Attribute distribution: integrated outcrop, core, and geophysical analysis
Mudrock Systems Research Laboratory

Research Challenges

Mudrock systems in many ways constitute a last frontier in sedimentological research. Despite their abundance in the 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.

Contact

Toti Larson, toti.larson@beg.utexas.edu, (U.S.), 512-471-1856
Farzam Javadpour, farzam.javadpour@beg.utexas.edu, (U.S.), 512-232-8068

www.beg.utexas.edu/msrl
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—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: 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.
Quantitative Clastics Laboratory

Research Challenges

The QCL has two research themes: 1) reservoir-scale depositional system characterization, modeling, and flow simulation to better understand 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 analysis of flow diagnostics of digital stratigraphic models to evaluate the effect of stratigraphic evolution and facies architecture on fluid flow during production.

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. 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.

Contact

Jacob (Jake) Covault, jake.covault@beg.utexas.edu, (U.S.) 512-475-9506
www.beg.utexas.edu/qcl
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 explain and describe the 3D reservoir environment, and to improve hydrocarbon recovery factors. In addition, 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 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 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 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.
Membership

The RCRL sponsor contribution to the program 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.

Contact

Bob Loucks, loucksb@beg.utexas.edu, (U.S.) 512-762-0391
Charlie Kerans, charles.kerans@beg.utexas.edu, (U.S.) 512-471-1368
www.beg.utexas.edu/rcrl
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 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; (2) imaging and characterization of lithology, facies, and micro-pore systems in unconventional reservoirs; and (3) advanced seismic mapping techniques for imaging potential oil and gas reservoirs.
Research Challenges

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

Membership

No costs are associated with participation in the STARR program, 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.

Contact

William Ambrose, william.ambrose@beg.utexas.edu, (U.S.) 512-471-0258
www.beg.utexas.edu/research/programs/starr
Mission

- To address the most important and challenging research problems in computational geophysics as experienced by the energy industry
- To educate the next generation of research geophysicists and computational scientists

Research Challenges

The Texas Consortium for Computational Seismology (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
- Assisting the seismic interpreter by automating common interpretation and signal-processing tasks
Research Thrusts

- 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
- Extracting Seismic Events by Predictive Painting and Time Warping
- Lowrank Reverse Time Migration for Subsalt Imaging
- High-Resolution Seismic Attributes for Fracture Characterization in Grosmont Formation
- Waveform Tomography with Cost Function in the Image Domain
- Multiazimuth Seismic Diffraction Imaging for Fracture Characterization in Low-Permeability Gas Formations
- Seismic-Wave Focusing for Subsurface Imaging and Enhanced Oil Recovery

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.

Contact

Sergey Fomel, sergey.fomel@beg.utexas.edu, (U.S.) 512-475-9573
www.beg.utexas.edu/tccs
Mission

To provide all stakeholders with reliable and up-to-date estimates, projections, models, fundamental understanding and insights at the basin scale for the major US unconventional plays by conducting innovative, integrated research of in-place resource and recoverable volumes, play and well economics and production forecasts with environmental implications.

Research Thrusts

The TORA multidisciplinary team employs a bottoms-up, highly iterative resource evaluation process. The TORA research model allows team members from different disciplines to analyze data, share information and inform study results. Team members are experts in their respective fields, including geology, petrophysics, basin modeling, engineering, economics, statistics and data analytics.

Original oil-in-place estimates across the Midland Basin

Midland Basin well trajectories color coded by landing formation (e.g., WCB = blue)
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 geo-cellular models, statistics and economics. That workflow will produce estimates of ultimate hydrocarbon recoveries, economic viability, drilling locations and play-wide production outlooks. TORA studies tight oil and gas formations in order to produce unbiased, comprehensive yet granular, publicly-available results. Recent focus has been on the Permian Basin, where optimization of recovery in thick tight, oil reservoir sections and estimation of associated gas and water production are key research questions. Regular updates are provided for the other major unconventional plays in the US, including the Bakken, Eagle Ford, Marcellus, Barnett, Haynesville and Fayetteville.

Membership

Membership in TORA is $50,000 annually. Benefits to industry partners include (1) detailed insights 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; and (5) 3-D geologic models of each basin.