Annual Report 2015

Bureau of Economic Geology

Contents

Front and inside cover images:
Specimen from the W. Cooper C-1 well in Glasscock County, Texas. Recovered at a depth of 8185.5 ft on the eastern edge of the Midland Basin during a Mudrock Systems Research Laboratory study of basinal mudrocks. Possible *Neodimorphoceras*, a goniatite ammonoid; tentative ID from Dr. Royal H. Mapes, Department of Geological Sciences, Ohio University.

A Letter from the Director

Staff at the Bureau often send me e-mail telling me about good deeds that a colleague has done. A recent note said, "I would like to let you know about something Chuck did today that was awesome. Well, he does a lot of awesome stuff, but this was just what I noticed today."

That's the Bureau in a nutshell. Terrific people conducting top science that impacts the public, government, industry, and education. And then still finding time to do something nice for a colleague.

At times we get lost in the challenges and hardships facing us. To be sure, 2016 will not be an easy year for the Bureau. Economic cycles are a reality of the soft-money research culture. But I am constantly reminded of the quality of our people—both intellectually and in terms of moral and ethical fabric; this bolsters my confidence and reignites my commitment to pressing forward in support of all of the "awesome stuff" being accomplished by our people at the Bureau!

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Thriving in a Down Cycle

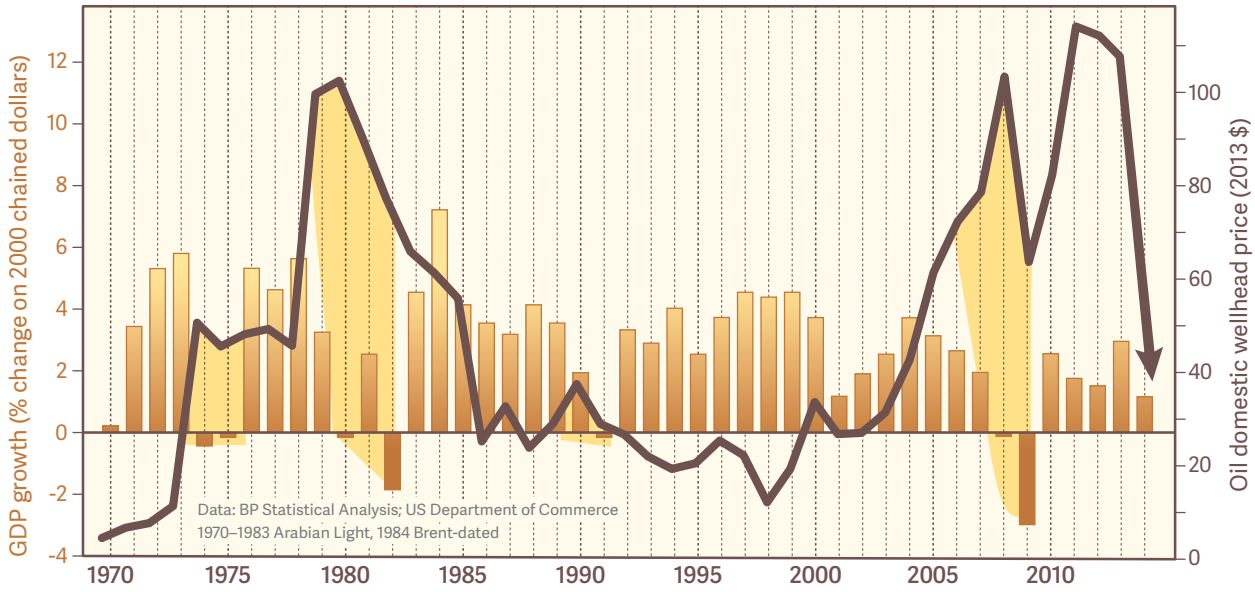
by Scott W. Tinker
Director, Bureau of Economic Geology

Price cycles in the oil and gas industry are nothing new. Since 1970, there have been several relatively rapid increases in oil price: 1972–74, 1978–79, 1989–90, 1998–99, 2003–07, and 2010–11. Each of these spikes was followed by a brief contracted period in the U.S. economy, often where GDP growth went negative (recession) for up to a year or more. Correlation is not causation—economies respond to many things other than oil price—but the relationship between high oil prices (as a proxy for cost of energy) and a struggling economy is undeniable, as is the relationship between stable and low oil prices and a healthy economy (fig. 1). For instance, the Clinton presidency of the 1990's saw the lowest and most stable oil prices of the past half century and a correspondingly healthy economy.

What goes up usually comes down, and each oil price spike was followed soon after by a notable oil price drop. Low-price environments were often influenced by one or several OPEC interventions to cut production, bring supply/demand back into balance, and pull up price (fig. 2). In each of these price valleys, the oil and gas industry saw accelerated mergers, acquisitions, and layoffs and a slowdown in exploration, drilling, and research spending.

Today, global demand for oil is ~93 million barrels/day, whereas supply is ~96 million barrels/day. This ~3% supply/demand gap is one of the larger and more sustained in recent years; it underpins the substantial decline in the price of oil, from over $100/barrel in 2011–13 to well under $40/barrel in late 2015 at the time of writing. Although the timing, magnitude, and pace of a future oil price increase are unknowable, some combination of demand for oil in developing economies, stress in supply from slowdown in U.S shale oil production, eventual OPEC action to reduce production, new sources of oil coming online or going offline as a function of regional conflicts, and speculation will create an increasing-price environment.

During and following the 1997–98 contraction, many U.S. oil and gas operators closed their



▲ Figure 1. U.S. economy and oil price implications.

research and technology laboratories. I worked in Marathon's Petroleum Technology Center (PTC) from 1988 to 2000 and left to join the Bureau of Economic Geology (Bureau) 10 months before the PTC closed its doors permanently in late 2000. In the current low–oil price environment, staff layoffs in the upstream oil and gas industry—both operating and service companies—are substantial. An ongoing and significant reduction in external research spending is also taking place. These industry cycles have a direct and real impact on the Bureau.

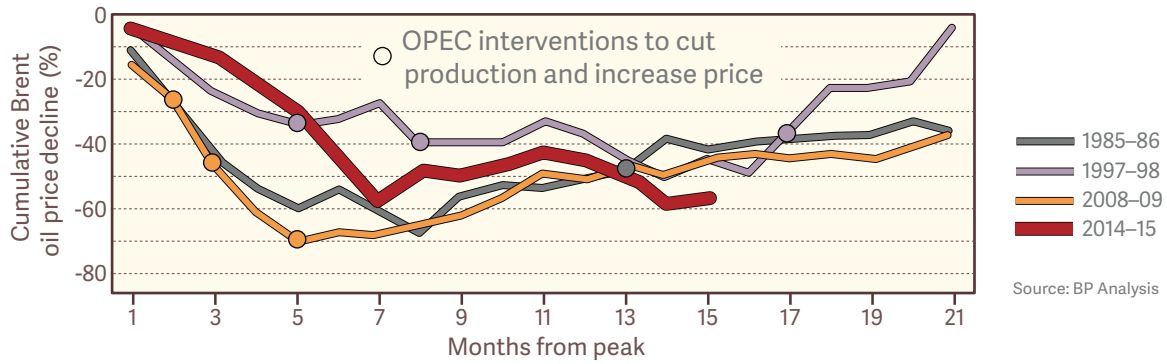
Formed in 1909, the Bureau has also experienced cycles. Head count remained small until the 1970's, when substantial growth occurred as the Bureau expanded into new federal-funding opportunities. With the unexpected and sudden curtailment in 1987 of federal funding for nuclear-waste disposal—a major Bureau program in the 1980's—staff contracted. Since 2000, external revenue and staff have grown steadily to a point today where we have around 250 full-time equivalent staff (including students and postdocs) and attract ~$30 million/yr in annual research bookings.

Addressing the great challenges facing society requires industry, government, NGO's, and academe to work together. I call this overlap space, where real solutions are determined, the Radical Middle. "Radical" because it can appear at times as if the loudest and most publicly influential voices lie outside of the actual solution space, content to provoke but not to solve problems. The Radical Middle is the playground of the Bureau, where we work hard to address major challenges in energy, the economy, and the environment.

The Bureau is a soft-money organization, which means we attract a substantial component of our funding (>90%) from external sources: through competitive grants and contracts with federal and state governments, from science-funding foundations, and from industry (mostly oil and gas). Oil and natural gas satisfied over 55% of global energy demand in 2015. Although the global oil and natural-gas resource base is substantial (>5X cumulative global production and consumption to date), these resources are also "unconventional"—and thus more expensive to extract. In other words, while demand for oil and gas remains high, the substantial resource base is also complicated and expensive. Thus, oil and natural-gas research is vital.

In its search for funding, the Bureau faces a classic catch-22. On the one hand, some claim that any government support for oil and gas research represents "corporate welfare" and

(continued on page 4)



▲ Figure 2. Brent oil price response and interventions.

that universities should seek oil- and gas-research support from industry. Yet when universities conduct research supported by industry, those in certain advocacy groups and NGO's claim that the research must be biased. Fortunately, the current leadership in the Department of Energy is outstanding and sees the need to foster and grow subsurface research in water, geothermal, uranium and thorium, metals, rare-earth elements, and, yes, oil and natural gas. Such encouragement should help to grow U.S.-based student talent needed in energy-related STEM fields in the future.

At the Bureau, about half of our external funding comes from industry—primarily as industrial associates programs (consortia) and as sponsored research. We expect our results to speak for themselves, regardless of funding source, and we defend and protect the objectivity of our work. With the substantial and sudden drop in the price of oil and natural gas, industry research support for the Bureau began to decrease in 2015. Our industrial-associate memberships, sponsored research, graduate-student support and hiring, and external gifts are all down.

We anticipated and planned for this decrease to the extent possible and are currently (1) using new sources of funding that we developed during the past decade to help bridge the downturn; (2) shifting staff from budget-stressed projects to those with need for talent and the funding to support them; (3) working with key companies to develop long-term, integrated programs in key research areas of mutual interest; and (4) working closely with our nonindustrial partners in governments, national labs, and foundations to engage them in what we do.

Down cycles are not all bad. For one thing, they enable us to hire remarkably talented people from industry who are exiting for a variety of reasons. They also enable us to structure longer-term research partnerships that bring industry, federal and state governments, other academic institutions, and even thoughtful NGO's together to take on real-world challenges and seek Radical Middle solutions.

Recent examples of such partnerships include

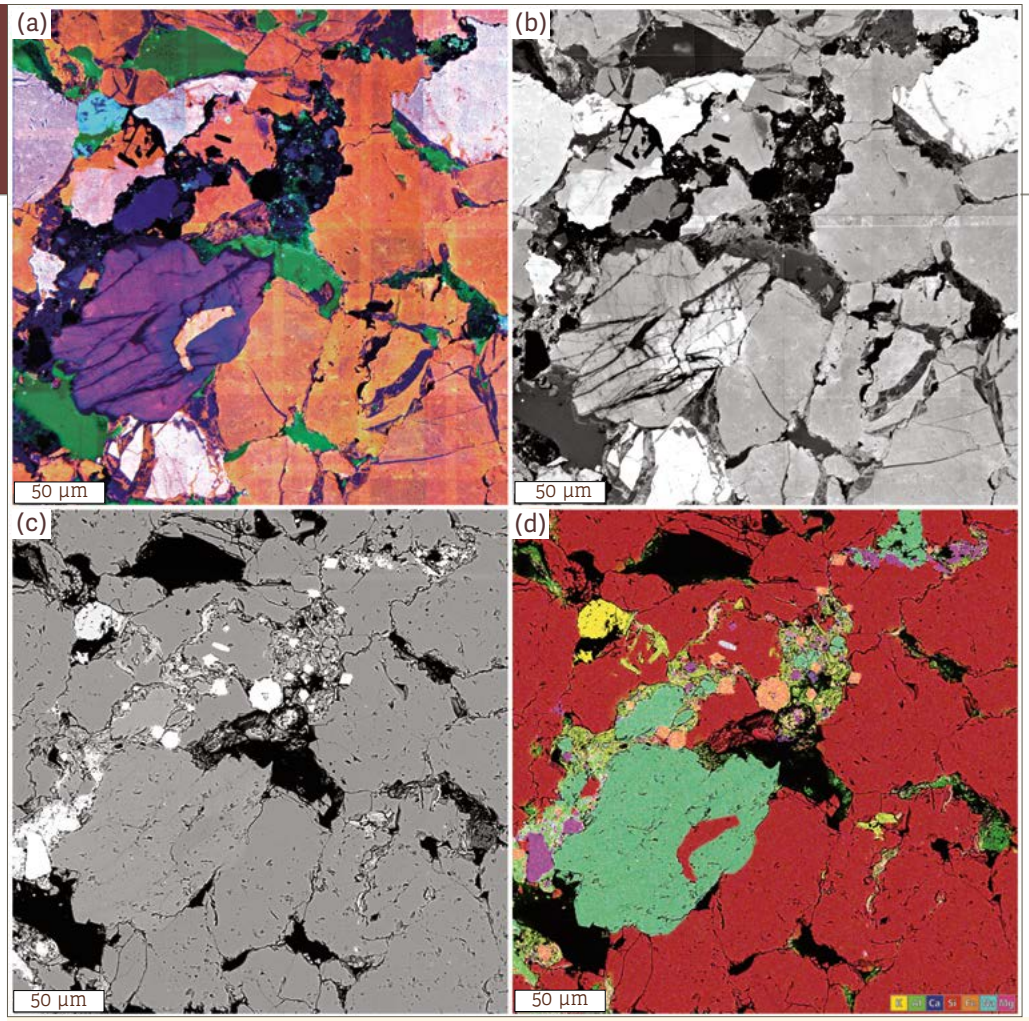
- TexNet/CISR, our integrated seismicity research program, which brings together state government, industry, and academe to look at natural and potentially induced seismicity in Texas, and into which we have hired two very talented PhD researchers;
- the Advanced Energy Consortium (AEC), which brings together industry, global academe, and, hopefully soon, the federal government to investigate subsurface micro- and nanosensors for a variety of applications;
- shale-water research, which brings together key foundation funding and industry and builds on our shale-gas and shale-oil reserves work to investigate the full cycle of water use in oil field operations;
- a partnership with the new UT System–supported University Lands company to investigate key research problems on 2.1 million acres and help to maximize return to the Permanent University Fund; and
- collaboration with the Sandia National Lab to respond to federal solicitation for subsurface research (SubTER) and bring together federal government, industry, and academe in Texas.

The Bureau will survive and prosper, as we always have. But we depend on you, our friends, to spread the word about the outstanding work that we do and to partner with us financially and scientifically.

It is good for the Radical Middle, and it is good for the future. ■

Focus on Future Technologies

One key aspect of moving forward in a down cycle is to focus on future technologies. Understanding basic fracture properties is an area where technology can have a big impact by reducing geological risk and, therefore, reducing well costs and increasing oil and gas recovery. Many low-matrix-porosity hydrocarbon reservoirs are productive because permeability or engineering procedures are influenced by fractures and faults. And fractured reservoirs—including many carbonate reservoirs that contain some 50–60 percent of the world's oil and gas reserves—remain important targets.



▲ Our ZEISS SIGMA FE-SEM is equipped with a Gatan MonoCL4™ cathodoluminescence detector (A: color cathodoluminescence; B: panchromatic cathodoluminescence), a permanent angle-selective backscattered electron detector (C), and an Oxford Instruments X-ray Energy Dispersive Spectroscopy detector (D), each of which provide different information about a sample.

The Bureau's Fracture Research and Application Consortium (FRAC) team studies the origins of and controls on fractures in sandstones, mudrocks, and carbonate rocks, as well as how hydraulic-fracture treatments interact with natural fractures. Much of this research relies on a state-of-the-art, high-resolution Field Emission Scanning Electron Microscope (FE-SEM) facility with a focus on large-area cathodoluminescence imaging (SEM-CL). The unique SEM lab contains our ZEISS SIGMA field-emission instrument and the FEI Nova Nano 430 Field Emission SEM configured for large-area imaging. In separate laboratory space, the Bureau's Core Research Center also houses the Fluid Inclusion Laboratory and the experimental Hydrothermal Laboratory. Ongoing research includes fracture-size and spatial-arrangement analysis, fracture evolution, modeling of fracture timing, and structural petrology.

GeoFORCE Wins Presidential Award, Inspires Bureau Scientist

In 2015, President Obama honored the Jackson School of Geosciences' GeoFORCE Texas program with the Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring, the highest such honor from the U.S. government.

GeoFORCE Texas, an educational outreach program founded in 2005 by former Bureau associate director Doug Ratcliff, takes high school students from disadvantaged areas in inner-city Houston and rural Southwest Texas on field trips each summer throughout high school to visit geologically significant sites across the country.

Since its inception, GeoFORCE has been a remarkable success, with 100 percent of participating students graduating from high school and 96 percent going on to college; 64 percent of college students focus on STEM (science, technology, engineering, math) majors—more than double the national average.

Bureau Research Scientist Associate **Daniel Enriquez** is an alumnus of the GeoFORCE program, where he was instructed by Bureau researchers **Jeffrey Paine**, **Sigrid Clift**, and others. In 2015, Enriquez, in collaboration with

GeoFORCE director Samuel Moore (second from right), former director Doug Ratcliff (right), and other honorees meet with President Obama. Photo by Pete Souza.

UT's Applied Research Laboratories and Chemistry Department, invented a device to solve a long-standing problem of core analysis: studying in situ fluid compositions under shale reservoir conditions, which is problematic because volatiles can be easily lost during core drilling and post-core transport. Enriquez's invention uses a cutting blade inside a vacuum chamber to efficiently pierce the core plug's thick coating and capture gases for analysis. Enriquez says that the GeoFORCE program left a lasting impression on him, strongly influencing his decision to pursue studies in geology and a career at the Bureau.

Join Our LinkedIn Group!

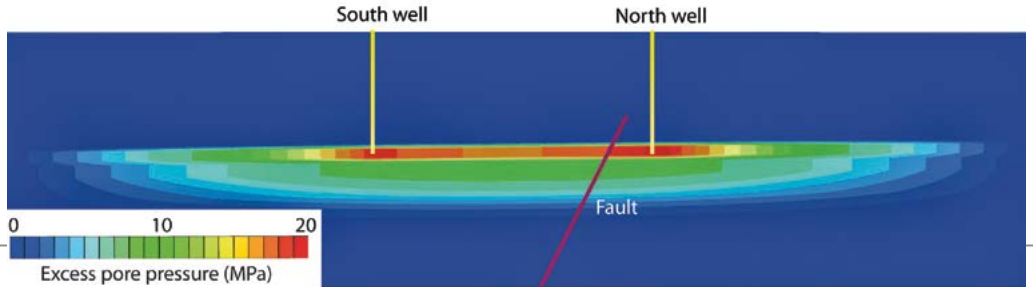
LinkedIn The Bureau of Economic Geology's new LinkedIn group invites energy and environmental researchers, friends and supporters, industry and academic partners, and government and agency representatives to join this new social media community. The group was established to share our latest research achievements and current news related to the Bureau. To join, please go to: https://www.linkedin.com/groups/Bureau-Economic-Geology-6684253/about.

Bureau Core Research Building and Lab Renovation

Just before leaving office last May, former University of Texas at Austin president Bill Powers worked with Bureau director **Scott W. Tinker** to facilitate a University investment of $7.5 million to jump-start the Bureau of Economic Geology's effort to renovate existing laboratories and to build a new core research building. Along with previous vital gifts toward the initiative, this investment allowed the Bureau to move forward with planning for specific renovations to the labs and with the layout and architectural aspects of the new building. The overall project will allow Bureau researchers to conduct their research in a truly state-of-the-art facility.

Bureau associate director **Jay Kipper** is leading the renovation process. Opportunities exist for donors to support the project's goal for the new core research building to include a rooftop terrace for meetings and activities. Plans are also in discussion to construct a beautiful (and apropos!) rock garden under the canopy of the large trees between the existing buildings and the new building. Interested donors should contact **Mark W. Blount** (mark.blount@beg.utexas.edu), Bureau External Affairs, for information about supporting these innovative features of the project.

▼ Architectural rendering of rock garden of the core research building.



Simulation by Zhiqiang Fan, BEG.

TexNet and CISR Lead Texas Seismicity Research

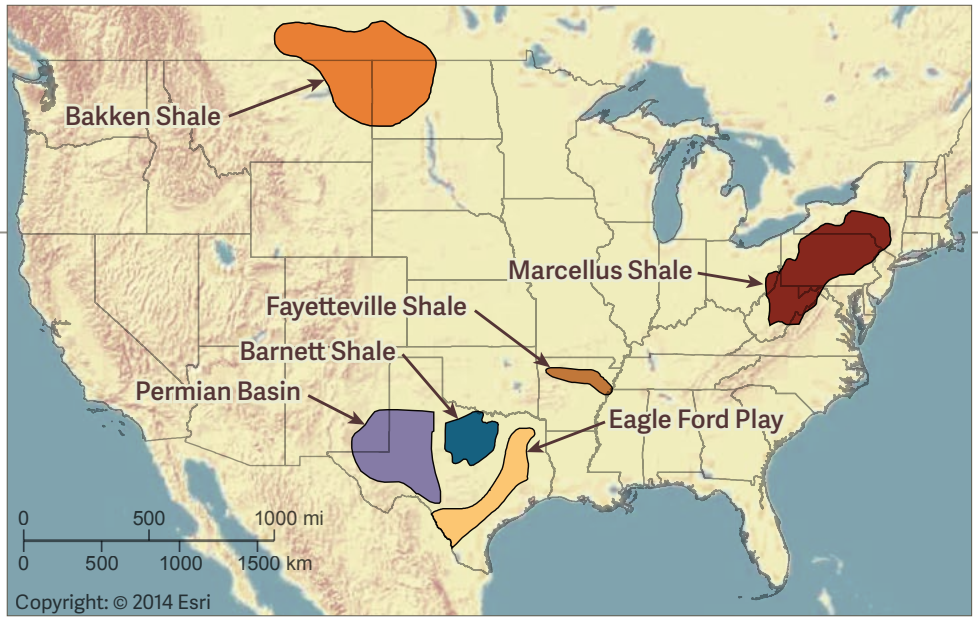
In 2015, the governor of Texas signed legislation authorizing funding of $4.47 million for the **TexNet Seismic Monitoring Program**, an initiative led by the Bureau of Economic Geology, which also serves as the State Geological Survey of Texas. **Dr. Alexandros Savvaidis** will serve as the initial project manager for TexNet. The collaborative effort will place seismometers throughout the state, enhancing the ability of researchers to gather information about subsurface seismic activity. "We're very grateful to Governor Abbott and the state legislature for providing the tools to gather new data and produce data research that will help guide decision makers as they contemplate future policy regarding these events," said **Scott W. Tinker**, State Geologist of Texas and director of the Bureau, who facilitated the creation of the program and the state's investment.

TexNet will create a continuously operating statewide seismic-monitoring and data-collection network capable of detecting and locating earthquakes with magnitudes of 2.0 and greater. It will also improve scientists' ability to rapidly investigate earthquake sequences in Texas through the deployment of temporary seismic monitoring stations for site-specific assessments. TexNet will advance the understanding of both natural and induced earthquakes, including those in or near urban areas or in locations where human activities may be inducing earthquake activity. Data from TexNet will augment a worldwide integrated seismic network with partners from industry, academia, and state and federal agencies. Results will be shared broadly with the public and will improve regional hazard analysis and communication.

The Bureau's new multi-institutional, multidisciplinary research consortium, the **Center for Integrated Seismicity Research** (CISR), will assist in analyzing TexNet data, using it to underpin diverse research efforts in seismology, geomechanics, reservoir analysis, earthquake engineering, and psychology and communication. CISR will pool the resources and expertise of its academic, agency, and industry partners to generate a deep, unbiased understanding of significant earthquakes occurring in Texas. **Dr. Peter Hennings** and **Professor Ellen Rathje** will serve as initial PI's of CISR.

During an October meeting at the Bureau's Houston Research Center to launch the Industrial Associates sector of CISR, over 50 representatives from a wide range of companies—as well as federal, state, and local government and other organizations—learned about the anticipated mission and expected outcomes of CISR. At the meeting, Director Tinker asked industry representatives to strongly consider providing vital geophysical and other subsurface data as well as technical expertise to make the consortium a true partnership. For more information about the Center for Integrated Seismicity Research, or to join the CISR consortium, contact **Mark W. Blount** (mark.blount@beg.utexas.edu), Bureau External Affairs.

Bureau Awarded Grants to Study Water–Energy Nexus



Locations of the Permian Basin and five major U.S. shale plays.

The interdependence of water and energy is becoming increasingly apparent with declining water resources and increasing water demands for energy extraction, particularly in oil and gas production using horizontal drilling and hydraulic fracturing in unconventional reservoirs. In 2015, Bureau researchers **Bridget Scanlon**, **Bob Reedy**, **J.-P. Nicot**, and **Svetlana Ikonnikova** received funding from the **Cynthia and George Mitchell Foundation** to study water–energy issues in the Permian Basin, a major source of oil production in the United States. The Bureau also received funding from the **Alfred P. Sloan Foundation** to assess water–energy issues in five other major U.S. shale plays, including the Marcellus, Fayetteville, Barnett, Eagle Ford, and Bakken. This work on water and energy linkages builds on previous and current studies conducted by the Bureau energy and economics team to assess the oil and gas resources in these plays.

Methodologies of these studies will include quantification of past and projected water demands for hydraulic fracturing using different databases to assess data reliability. The increasing time periods over which hydraulic fracturing has been practiced provide a greater opportunity to assess temporal trends in water use and potential controls on water use in different plays. The studies will compare water demand for hydraulic fracturing to water supplies in different plays to determine vulnerability to water shortages, particularly for plays in semiarid regions, such as the Eagle Ford and Permian Basin. The studies will also examine a variety of potential water sources, including fresh surface water and groundwater, brackish groundwater, municipal wastewater, and flowback and produced water. The research will also project volumes of produced water over the lifetime of the plays and optimal approaches for managing the water.

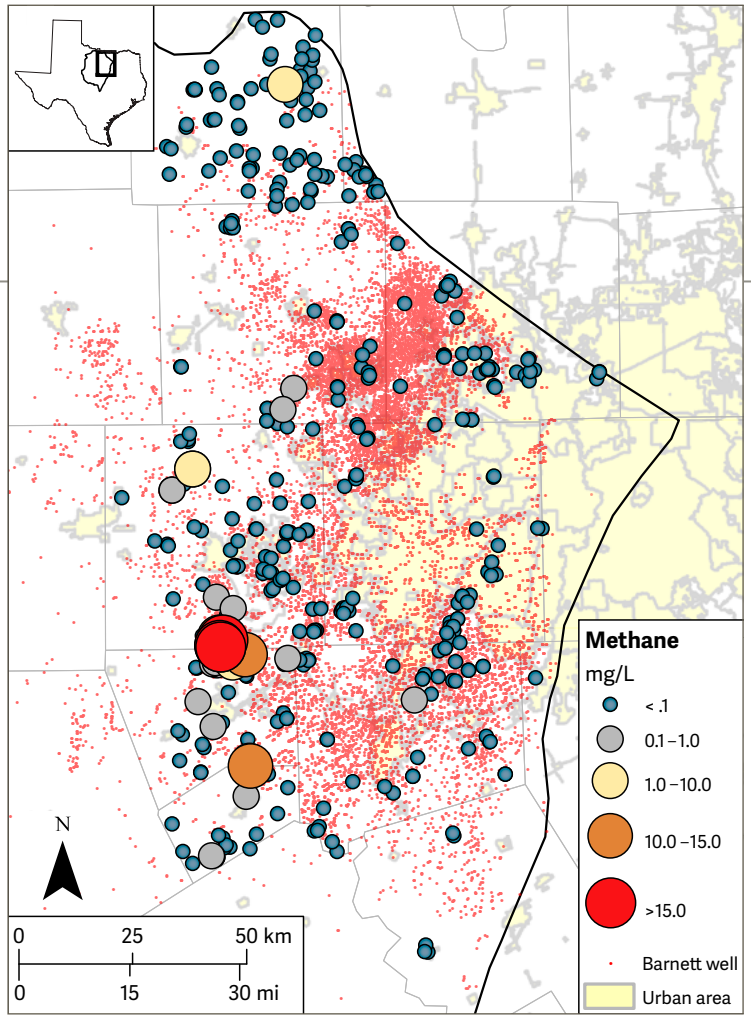
These studies funded by the Mitchell Foundation and the Sloan Foundation offer an opportunity to conduct comprehensive assessments of water and energy interdependencies that highlight controls on water use and assess the value of such use relative to increased energy production. Extended analyses will also determine the water footprint by considering the entire life cycle of the oil and gas produced, including use in electricity generation and transportation. Integration of the geology, resource assessments, and economics of shale plays from previous and current studies at the Bureau with these future water–energy studies should significantly advance our understanding of the water–energy nexus relative to shale oil and gas production.

High Concentrations of Dissolved Methane Not Widespread

The recent increase in oil and gas production because of hydraulic-fracturing stimulation has generated some concern about the potential presence of dissolved methane in the shallow surface, as documented in the Marcellus Shale footprint in the northeastern United States. Methane is not considered toxic but could be an explosive hazard at high dissolved concentrations.

In order to document and assess the potential presence of dissolved methane in Texas fresh-water aquifers, Bureau researchers **J.-P. Nicot**, **Patrick Mickler**, **Roxana Darvari**, and **Rebecca Smyth**, in collaboration with the University of Michigan at Ann Arbor, undertook a RPSEA-funded large sampling (900+ water samples) campaign of aquifers in the footprint of major Texas hydraulic-fracturing plays: the Barnett Shale in North Central Texas, Eagle Ford Shale in South Texas, Haynesville Shale in East Texas, and Delaware Basin in West Texas. The water samples were analyzed for, among other elements, carbon isotopes, which help determine whether the methane is of microbial (biogenic) and shallow origin or of thermogenic origin (resulting from the exposure of organic matter to high pressures and temperatures). Finding thermogenic methane migrated from deeper reservoirs to the shallow subsurface does not necessarily suggest that its presence is related to oil or gas production; natural pathways can also explain its presence.

The overall conclusion of the study is that high concentrations of dissolved methane are not widespread, even if the vast majority of water wells show some small but measurable methane. High methane concentrations affect a total of ~20 wells and were observed in all plays. In the three shale plays, investigated samples with high dissolved methane are spatially organized in clusters (see figure). Dissolved methane is likely natural and sourced from shallow natural-gas accumulations in the Barnett Shale footprint, lignite beds associated with a fault in the Haynesville Shale footprint, and lignite and degradation of oil and deep organic matter associated with a fractured zone in the Eagle Ford Shale footprint. The Delaware Basin samples show no dissolved methane other than that associated with a recent blowout.



Gas wells (small red dots) producing from the Barnett Shale. Most water wells show very little or no dissolved methane (larger aqua dots). Only one area (large red dot) contains several water wells with high methane concentration.

GCCC Key in International CCUS Efforts

The Bureau's **Gulf Coast Carbon Center** (GCCC) is an international leader in the development of carbon capture, use, and storage (CCUS), key technologies in fighting climate change and producing cleaner energy.

Bureau Director Tinker (seated, second from right) with representatives of the U.S.–China Climate Change Working Group. Image Credit: U.S. Trade and Development Agency.

In 2015, in support of the CCUS initiative of the U.S.–China Climate Change Working Group (CCWG)—part of the effort to address the urgent need for pollution control and carbon management of existing power and coal conversion plants—GCCC researchers **Tip Meckel**, **Susan Hovorka**, and **Jiemin Lu** attended a series of meetings and workshops in China to promote CCUS research in the Gulf of Mexico and offshore Guangdong, as well as to continue to establish working relationships with various Chinese research groups and industrial partners involved in potential offshore CCUS projects in China's Pearl River Mouth Basin. GCCC efforts at the meetings focused on facilitating technical transfer with the UK–China (Guangdong) CCUS Centre to support the development of offshore CCUS demonstration projects in both countries. The trip was hosted by the U.S. Department of Energy.

Later in 2015, officials from China and the United States met in Washington, D.C., as part of the U.S.–China Strategic and Economic Dialogue, which builds on the historic 2014 announcement that the two countries would work together to decrease carbon dioxide emissions. Because of its significant expertise both in the field and in the lab, the GCCC was also tapped to participate in these efforts. At the meeting, Bureau director **Scott W. Tinker**, representing the GCCC, signed a Memorandum of Understanding of collaboration and knowledge sharing with the UK–China (Guangdong) CCUS Centre, Southern Company, and Clean Air Task Force.

The GCCC was also busy on our own continent in 2015. In December, energy officials from across North America met at the Bureau to discuss how the United States, Canada, and Mexico can collaborate to advance CCUS. Nineteen officials representing government, industry, policy, and academic institutions attended the event to discuss their own experience in CCUS development and to plan best practices for collaboration between their countries and organizations.

"We're really proud to host such a committed and dynamic group of countries interested in climate change mitigation through CCUS," said Hovorka.

Research Consortia

The Bureau of Economic Geology conducts research on subjects of high interest to the energy industry and to environmental firms, and a broad spectrum of companies and agencies actively participate in the 13 research consortia described here. These unique industry partnerships study research subjects as diverse as salt tectonics, carbonate reservoir characterization, natural fractures and geophysics, carbon storage, nanotechnology, quantitative clastics, computational seismology, mudrock reservoirs, and energy economics. Collectively, these 13 consortia enjoy the support of over 70 corporations globally, with some companies participating in as many as nine separate programs. Each industry consortium was designed to complement industry efforts to understand a key exploration, production, environmental, or energy economics problem.

Participation in each research consortium 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 companies. Each Bureau research consortium has a dedicated team of full-time researchers, including postdocs, that combines seasoned experts with early-career specialists. Many consortia also host groups of talented graduate students. A number of researchers have industry backgrounds, and all share a passion for university-based research.

We hope you enjoy learning about the impressive research successes of the Bureau of Economic Geology's varied research consortia in this publication and that you will seek more information about them by contacting their principal investigators.

In a series of small-scale field experiments, AEC researchers have successfully demonstrated the capability of remote imaging of various electromagnetic proppant additives to illuminate actual geometry of hydraulic fractures. The accuracy of AEC's inversion software has been validated by excavating the site.

First-generation prototype multisensing microsystems.

Advanced Energy Consortium

Who We Are—One of the most dynamic areas of modern science, nanotechnology has already revolutionized industries as diverse as food, health care, and the military. Energy is next.

The Advanced Energy Consortium (AEC) has effectively created a brand new scientific space through its marriage of nanotech with oil and gas. The consortium has funded a team of international experts for specific research projects devised with direct input from consortium members. This inspired strategy has attracted overwhelming interest from both academia and industry since the consortium was first established in 2008.

Current membership includes a select set of the largest oil and gas production and service companies in the industry. Members play an active role in the AEC, with a Board of Managers meeting every quarter to help set the overall strategic direction.

What We Do—The AEC funds over 30 universities worldwide to develop a better understanding of what occurs in the subsurface. Building upon fundamental research performed in the initial years of the consortium, the AEC now directs its energy to scientific research with a much more applied focus, creating and integrating its findings into a specific set of real-life applications. Incredible progress in the last 12 months includes a number of successful lab and field tests.

Current Research Focus/Vision for the Future—David Chapman, **Mohsen Ahmadian**, and **Carla Thomas**, project managers for the AEC, oversee the research and use-case portfolio. One of the first technologies further developed for subsurface applications is the concept of "smart dust"—nanoparticle sensors that can be delivered into a reservoir to give measurements of everything from pressure and temperature to resistivity and pH levels.

The AEC has successfully tested millimeter-scale temperature and pressure sensors, at 125˚C and 7200 psi—rugged enough to survive and function at typical subsurface reservoir conditions. This flexible microsystem platform will be expanded to include additional technology-improving electronics capabilities.

The AEC has also invested research time and money in hydraulic-fracturing diagnostics. Improving understanding of existing fracturing networks would likely lead to notable technological advances for the industry; particularly exciting are opportunities nanotech might create in this space.

Through its patented "lab on a chip," "contrast agent," and "payload delivery" technologies, the AEC will be able to "illuminate" fracking wells and show where fractures are occurring as well as where waterfloods take place in conventional reservoirs. Consortium members have exclusive access to these advanced technologies.

The AEC is dedicated to achieving a transformational understanding of subsurface oil and natural gas reservoirs through the deployment of unique microsensors and nanosensors. In only 8 years, the group's remarkable progress includes more than 200 peer-reviewed papers with university collaborators and a patent portfolio of more than 50 inventions. The AEC is also close to completing commercial-scale proof-of-concept tests, giving current sponsors "first look" benefits.

At this critical phase of its existence, and cognizant of the current economic climate, the AEC has adopted a financial model that allows existing members to maintain involvement while also attracting new industry partners—all with an understanding of how central nanotechnology will become to the energy industry of the future.

Principal Investigators: Scott W. Tinker and Jay P. Kipper
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AGL welcomed 291 registered delegates to the 27th AGL Annual Review Meeting, held in Austin in November. Attendees heard 22 presentations on salt tectonics in the Precaspian Basin, Santos Basin, and Gulf of Mexico, and viewed physical and numerical models.

Applied Geodynamics Laboratory

Who We Are—Interest in pure and applied research into salt tectonics has grown steadily in recent years, a fact reflected in the number of new members joining the Applied Geodynamics Laboratory (AGL). Over the last decade, the consortium has doubled in size and, despite the recent economic downturn, maintained consistent support from its industry associates.

The drop in the price of oil has no doubt impacted current levels of interest in deepwater exploration around the Gulf of Mexico. The high costs and even higher risks involved have effectively forced some producers out of the market. Successfully drilling through salt in the Gulf and elsewhere remains one of the biggest obstacles that deepwater exploration companies must contend with. Those still in the game, however, rely on the AGL's research into critical areas such as how salt structures evolve and how to interpret their development from seismic data.

The majority of AGL consortium members are major oil and gas producers from all over the world. However, given its strong reputation in a highly specialized field, the AGL also attracts a number of seismic data vendors who donate their own data in lieu of a membership fee.

What We Do—The AGL divides its research into three core areas: geologic studies, geomechanical modeling, and physical modeling.

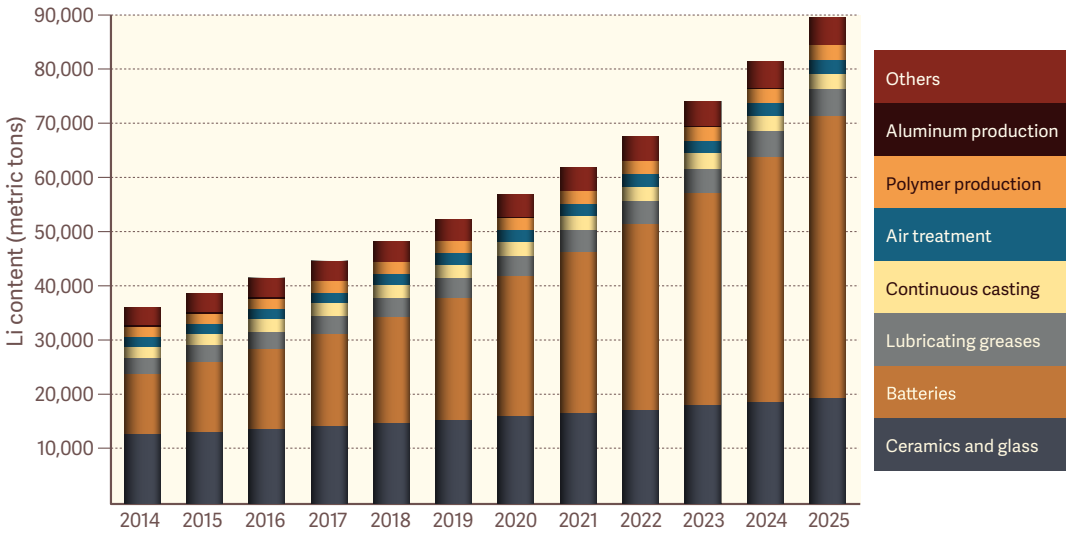
Geologic studies examine real salt basins to try to better understand the workings and processes at play there. In geomechanical modeling (mostly using the finite-element technique), researchers build computer models of salt structures to help interpret the pressures and stresses developing around the structures as they evolve. Understanding the physics of salt tectonics is important both for drilling wells and for processing more-informed seismic data. In physical modeling, lab-based physical models are used to determine how structures might be evolving. Researchers use these models to mimic activity in salt basins.

The three legs of research are inextricably linked. By layering data collected from observations of real salt basins onto the physics determined from geomechanical models and then extrapolating evolution patterns through physical modeling, the AGL provides its members with the most reliable and advanced understanding of salt tectonics.

Current Research Focus/Vision for the Future—While AGL research output is predominantly focused on the Gulf Coast basin, the consortium has also conducted studies in Brazil, the North Sea, and West Africa. In addition, researchers have just begun a major study in Kazakhstan of the Precaspian Basin, a huge salt basin that has remained relatively unstudied until now. The AGL has gained access to a large 3D seismic data set and is conducting one of the first modern, public-domain studies of geology in the region.

The consortium is also working to overcome a significant industry challenge. Flawed overpressure prediction costs deep-sea oil and gas producers millions of dollars each year. With its finger firmly on the pulse of current industry needs, the AGL has developed new finite-element models for fluid flow around salt diapirs that will improve the predictability of fluid pressure.

Principal Investigator: Michael R. Hudec
michael.hudec@beg.utexas.edu



Lithium demand projection: base case.

Center for Energy Economics

Who We Are—The global energy scene is constantly changing, influenced by variables including geopolitics, local legal frameworks, and commercial interests, not to mention good old-fashioned supply and demand.

As regions adopt more diverse energy portfolios, successfully navigating energy markets has become even more challenging. Using comparative research, the Bureau's Center for Energy Economics (CEE) educates stakeholders on energy economics and commercial frameworks to facilitate energy development.

The CEE research program has retained its strong reputation for dependable global analysis in part through its commitment to a continuous exploration of energy-value-chain economics—the fundamentals and drivers that affect energy production, distribution, transformation, and use. CEE consortium contributors support an evolving body of research on fronts such as domestic and national oil company (NOC) performance; natural gas development and use; commercial framework prerequisites for gas and power investment; and the structure and evolution of energy sectors in various countries and regions.

The centrality of energy as a vital economic input is reflected by the diverse sources of support the CEE program has enjoyed throughout its roughly 20-year history. CEE research and analysis has spanned Africa, Asia, Australia, Europe, Russia, and the Americas, as well as the Lone Star State. Much of CEE's international work has been supported by grants from sources like the U.S. Agency for International Development initiatives in Africa and South Asia, the World Bank's funding of NOC research, and the U.S. Department of State's Bureau of Energy Resources for technical support of upstream reform in Mexico.

What We Do—The CEE research team works closely with contributors, advisors, and other stakeholders to prioritize research questions concerning everything from commodity market fundamentals to power market design. CEE annual meetings and other symposia are conducted with an eye to the big picture, using formats that provide guidance for CEE research as well as market and strategic intelligence for contributors and other participants.

Current Research Focus/Vision for the Future—As markets diversify, so too do CEE areas of expertise. The team recently launched a new effort exploring nuclear energy economics and regulatory approaches, including costs and financing as well as critical factors such as global uranium supply.

Nonfuel minerals is another emerging area of research. With the rising interest in electric cars and electricity storage in general, understanding the market for battery components like lithium has never been so important.

These new areas of analysis demonstrate the Bureau of Economic Geology's ability to adapt to changing needs while melding science and economics to explore opportunities and challenges across resources, technologies, and markets.

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Seismometer station, Muleshoe, Texas. (source: usarray.org)

Center for Integrated Seismicity Research

Who We Are—Insufficient data and misinformation have made it difficult to bring all stakeholders together on the issue of induced seismicity, resulting in a series of inconsistent responses.

Out of the newly formed TexNet—a seismic monitoring program funded in 2015 by the Texas Legislature and based at the Bureau of Economic Geology (Bureau)—comes the Center for Integrated Seismicity Research (CISR), a brand new consortium responsible for shedding light on all seismic activity in Texas, both natural and man-made.

Given its position as the State Geological Survey, the Bureau is in a uniquely strong position to interact with the public, the legislature, and industry on a subject that has become highly politicized. The Bureau already enjoys a reputation for presenting data of all kinds in an impartial manner; its respected research is a strength crucial to reaching consensus among all parties.

What We Do—First and foremost, CISR will assist in analyzing seismic data collected by TexNet through the planned installation of 22 new permanent seismometers in various locations across Texas and selective deployment of 35 portable seismometers.

A key objective will be to bring academics, government, industry, and NGO's together to understand and monitor all earthquake activity. Focusing efforts solely in areas where seismic activity has (rightly or wrongly) been attributed to oil and gas activity would only decontextualize the issue and further misinform the public. Instead, driven by its commitment to objective research, the Bureau will undertake a holistic approach to examine seismic activity across the Lone Star State. Research output will be based on a more-complete suite of data to help promote informed judgments on the likely cause of seismic activity.

The consortium's interdisciplinary team of structural geologists, seismologists, geophysicists, petroleum engineers, civil engineers, communications experts, and psychologists includes seismologist and TexNet project manager **Alex Savvaidis**, and structural geologist **Peter Hennings**, who is co–principal investigator of CISR along with civil-engineering professor **Ellen Rathje**. CISR will not only address the hard science but also assess human psychological response to earthquakes and best communication strategies to inform the public.

Current Research Focus/Vision for the Future—Approximately 7,500 of the approximately 35,000 fluid-injection wells in Texas are permitted disposal wells. A small number of these may be intersecting fault lines and could potentially initiate induced seismicity. The only way to know, however, is by locating the intersections and better understanding the conditions of both the injection and the fault itself.

This vital information has, until now, been lacking. CISR is committed to becoming an integrated consortium where public representatives and environmental groups can work together with industry and academia. Because the complicated problems being tackled require a multipronged approach, CISR hopes to attract mid-sized operators, service and fluid-disposal companies, environmental agencies and firms, and large multinational corporations.

Literally billions of dollars' worth of infrastructure lie buried under the state of Texas in the form of compressors, wells, and pipelines, not to mention critical aboveground infrastructure in our cities and towns that could also be affected by increased seismic activity. Learning more about the causes of seismicity will benefit us all.

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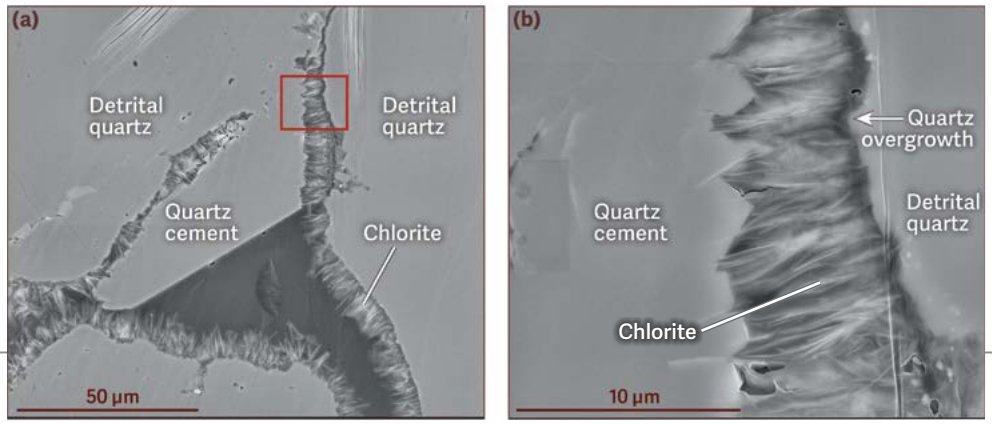

SEM photomicrographs of ion-milled sandstone sample showing that chlorite coats on detrital grains inhibited quartz cement.

Deep Reservoir Quality Gulf of Mexico

Who We Are—The Deep Reservoir Quality Gulf of Mexico (GOM) consortium, also known as the "Deep Shelf Gas" project, provides both data and informed analysis to numerous major industry players trying to forecast reservoir quality, reservoir architecture, and associated risk factors in drilling deep to ultradeep (15,000–35,000 ft) targets beneath the GOM shelf and deepwater.

The consortium adds valuable updip regional knowledge for companies focused on downdip deepwater exploration. Researchers predict the characteristics of rock formations—such as porosity, permeability, and diagenesis—deep under the GOM, using data from onshore cores of these formations.

What We Do—The Deep Reservoir Quality GOM consortium has access to a large collection of cores from deep onshore reservoirs in Texas, Louisiana, and Mississippi. After representative cores from the wells are described, and depositional environment and sequence-stratigraphic setting are interpreted, thin sections are prepared from the samples and point-counted to quantify grain size, sorting, detrital mineralogy, cement, and pore types. Core plugs taken from the same zones are measured for porosity and permeability.

The consortium provides members with a range of useful data sets and analyses through multidisciplinary studies conducted by a team of experienced geoscientists. A number of steps are taken to provide the most reliable data possible: petrographic analysis of rock samples, statistical analysis of porosity/permeability relationships to controlling parameters, burial-history modeling of key wells, and interpretation of sequence-stratigraphic systems-tract framework. The consortium also provides catalogues of GOM sandstone porosity and permeability organized by formation, depth, temperature, and pressure in a web-based search system.

Current Research Focus/Vision for the Future—Research in the current phase of the project has investigated reservoir quality of Upper Jurassic Cotton Valley sandstones from East Texas to Mississippi to evaluate their reservoir potential in the deep shelf play and in the deepwater GOM. The consortium's current research is also focused on the reservoir quality and sequence-stratigraphic framework of upper Wilcox sandstones in the western GOM using cores from Fandango Field in Zapata County, far South Texas. Potential future research may include petrographic analysis of parameters such as grain size, sorting, matrix, ductile-grain content, and diagenesis in cores of lower Wilcox turbidite sandstones deposited in a Paleocene submarine-canyon system.

Wilcox sandstones from Zapata County provide information about the composition and diagenesis of Wilcox reservoirs in the Rio Grande Delta system and are particularly applicable to understanding Wilcox sandstones in the Perdido fold belt area along the boundary between U.S. and Mexican waters—an important future economic target for many deepwater oil and gas exploration companies working in the GOM. As Mexican authorities continue to gradually open up resources for exploration by outside companies, this area will undoubtedly generate huge interest from industry. Many deepwater lease blocks are yet to go out for tender, so now is the time to research the area's potential.

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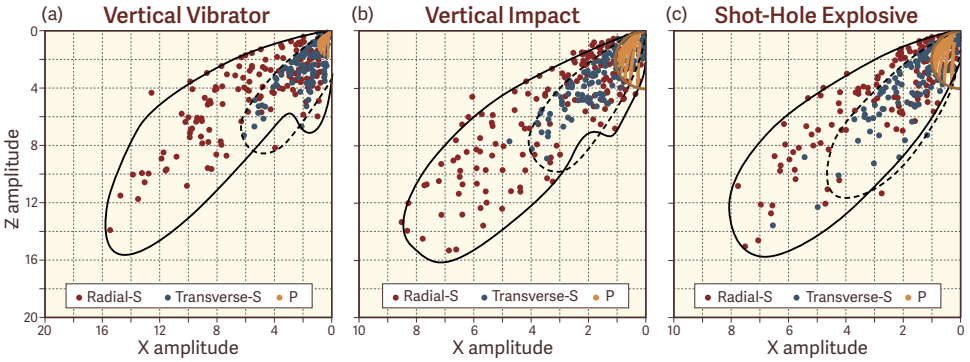

Measured P and S radiation patterns from three types of seismic sources.

Exploration Geophysics Laboratory

Who We Are—The Exploration Geophysics Laboratory (EGL) is a highly specialized unit of the Bureau whose primary focus is developing and applying multicomponent seismic technology. Within this niche area, the EGL develops new technologies to improve seismic field-recording techniques as well as data-processing and data-interpretation procedures. The group has already developed technology that images reservoirs, using all P-wave and S-wave components of a seismic wavefield.

Current membership consists of major oil and gas producers, engineering firms, and custom seismic-product manufacturers. The EGL's international research team brings together expertise in 2D, 3D, and 9C3D seismic interpretation; seismic survey design; the development of vector-wavefield technologies; multicomponent seismic analysis; depth imaging; geophysical software; statistical rock physics for reservoir characterization; and quantitative integration of geological and seismic data.

What We Do—For decades, the hydrocarbon exploration industry has depended on incomplete seismic wavefield data because existing technology has focused on collecting only the compressional-wave (P-wave) component of seismic wavefields for prospect evaluation. Through the development of various case histories documenting the value of multicomponent seismic data, the EGL has demonstrated how more rock and fluid information is revealed by simultaneously collecting P-wave and shear-wave (S-wave) images of stratigraphic systems.

The consortium is now focused on unified interpretation of land-based geological targets with P- and S-wave imaging technology. EGL works in tandem with its industry partners to demonstrate the use of new low-cost, vector-seismic sources that can be deployed across any land surface (including swamps, marshes, dense timber, and mountains) to optimize multicomponent data-acquisition and data-processing procedures, and to extract S-wave data from legacy vertical-geophone P-wave data stored in seismic data libraries.

Research output from the EGL has improved geophysicists' understanding in a wide range of areas, including petrophysical rock properties, pore structure, pore-fluid properties, sequence-stratigraphic relationships, spatial distributions of lithologies, fracture distributions, and anisotropic properties of complex reservoirs.

Current Research Focus/Vision for the Future—The EGL works with The University of Texas at Austin's Office of Technology Commercialization to develop technology beneficial to UT, with nine patents granted since the consortium's establishment in 1997. **Bob Hardage**, EGL PI and former president of the Society of Exploration Geophysicists, has most recently reviewed four patents with the UT Board of Regents describing an advanced processing technique for providing geophysicists with all P and S components of a seismic wavefield at low cost by utilizing only a single common P-wave seismic source. The technology has been successfully tested at several locations, including the Wolfberry Play in the Midland Basin.

Hardage and UT are part owners of VertiShear, the company that licenses this new technology that will significantly improve seismic acquisition and subsurface imaging through the inclusion of S-wave data from simple, low-cost, vertical-component seismic data sets. Given the EGL track record thus far, current and future members of the consortium will likely have exclusive access to many more successful innovations.

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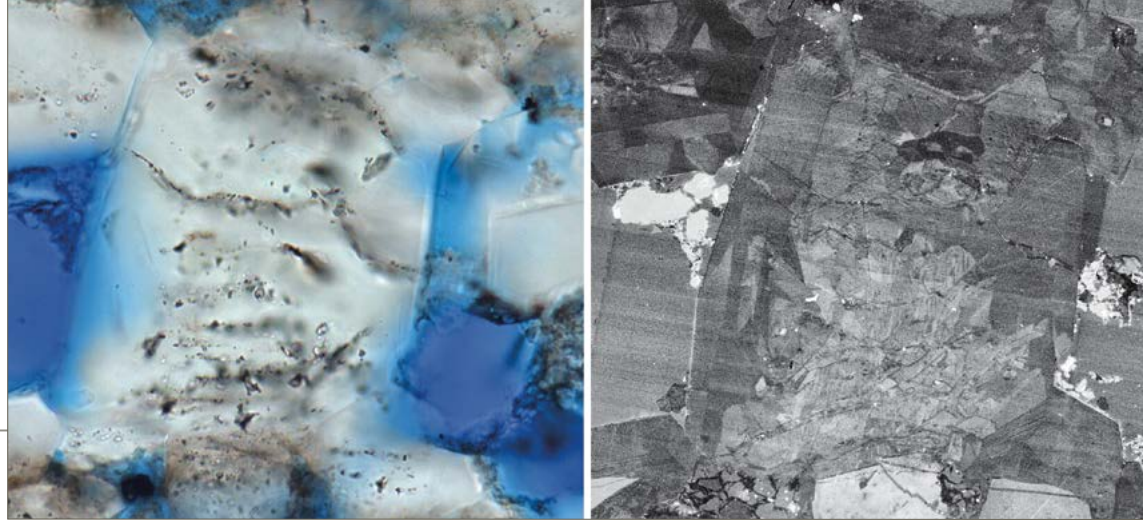

A quartz cement bridge with trails of fluid inclusions (left), and a panchromatic SEM-CL image of the same bridge (right). Sandstone, Frontier Formation, Wyoming.

Fracture Research and Application Consortium

Who We Are—The primary objectives of the Fracture Research and Application Consortium (FRAC) are the accurate characterization and prediction of natural fractures in the subsurface, and an understanding of how these fractures influence production operations, including their interaction with hydraulic fractures.

Established in 1998, FRAC has been involved with companies engaged in naturally fractured reservoirs, unconventionals, and hydraulic-fracturing practices. Industrial associates of the FRAC consortium are directly involved in oil and gas exploration both in Texas and beyond. Given the nature of the research, members tend to already have a long-standing serious research commitment, recognizing how important understanding the mechanics of fractures is to their business.

What We Do—Naturally occurring fractures, as well as those created by stimulation, are commonly found in many oil and gas targets, including unconventionals. Despite the fact that hydraulic fracturing has been around for decades, little is known about how hydraulic fractures interact with preexisting natural fractures. Accurately predicting the attributes of natural fractures is key to cost-effective resource extraction. FRAC uses a wide range of approaches, from subsurface analysis to outcrop studies, and deploys a wide range of expertise, from engineering to structural diagenesis.

The FRAC consortium is dedicated to learning all it can about the patterns of natural and induced fractures. The group has pioneered new approaches to analyzing fractures and fracture interaction. A unique aspect of FRAC's approach is to combine rigorous mechanics and geochemistry to understand the feedbacks in natural fracture growth, and to incorporate these effects in geomechanical models that take geochemical feedbacks into account. Combined with breakthrough analytical approaches to fracture size distributions and spatial arrangements, the FRAC approach has resulted in many fundamental breakthroughs in fracture analysis.

Current Research Focus/Vision for the Future—FRAC has developed operational software, available to consortium members, that can be used to assess the kind of natural fractures one might expect in the subsurface.

The team is working on improvements to its geomechanical model for hydraulic fracture growth, and several companies are now using the software—which has proven effective in efficiently predicting multistranded fracture growth.

FRAC has the technology, techniques, and expertise ready to be deployed to better target some of the challenges facing the industry.

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Piston coring of shallow sediments off the shore of San Luis Pass, Texas. Seismic and geochemical indications of natural-gas migration at the site have implications for long-term retention of carbon dioxide.

Gulf Coast Carbon Center

Who We Are—Rapid reductions in atmospheric CO_2 emissions require capture from industrial sources and deep subsurface injection for utilization and permanent storage. Before investing significantly in such endeavors, organizations turn to the Gulf Coast Carbon Center (GCCC) to address technical questions essential for gaining public confidence and financial underwriting. GCCC research focuses on key challenges of subsurface performance, including storage capacity, geologic characterization, flow simulation, monitoring strategies, and risk and economics.

The growth of the Center's interdisciplinary research team—extensively skilled in geology, petroleum engineering, hydrogeology, soil gas, economics, and marine geophysics—has been notably influenced by the group's industrial consortium members, who help guide the direction of GCCC research. The Center, which has one of the most diverse membership bases at the Bureau, has expanded to include a variety of organizations such as wholesale power providers, oil and gas producers, national CCS organizations, environmental NGO's, and the Department of Energy. While some members join for specific projects, others recognize the value of long-term progress through their continued support; some major oil and gas corporations, for example, have remained loyal members since the consortium was first established back in 2003.

What We Do—Utilization of the subsurface is evolving. Traditional extractive practices (hydrocarbon and groundwater production) continue, while the need to reintroduce fluids (industrial water and CO_2 disposal) grows in importance. The volume, movement, and accumulation of fluids in the subsurface therefore remain important aspects of geoscience investigation.

The GCCC excels at the application of research concepts in applied field-project settings. Summarizing past technical experience to enhance performance of future projects, the Center provides its members with everything from initial surveys of geologic storage options to detailed guidance for any organization working to aggressively reduce its global CO_2 emissions. Despite its mostly technical focus, output from the GCCC frequently informs policy-relevant work by providing policy makers with data in a format they can absorb.

Current Research Focus/Vision for the Future—Current GCCC research themes, developed with industry to address hot topics centering around the geological sequestration of CO_2 to mitigate atmospheric emissions, include "How Much, How Far, How Fast?" which looks at capacity-related practicalities such as impacts on capacity resulting from stratigraphic heterogeneity at mesoscale; an assessment of the evolution of fluid chemistry from deep reservoir to near surface (and the implications of this process for risk and monitoring); and a targeted study of possible changes to future CO_2 enhanced oil recovery (EOR) operations when storage of large amounts of CO_2 is part of the business model. Other focuses include the commercialization of monitoring methods (making them more cost effective while simultaneously improving reliability) and a more in-depth look at U.S. and global offshore storage sinks.

As the technology, viability, and awareness of geological sequestration continue to improve, the Center finds itself playing a more influential role on an even bigger stage as it provides closer analysis of offshore storage possibilities to inform its growing number of international partners. The coming years will be significant as various research areas move from theoretical to more practical and commercial elements of effective carbon removal and storage.

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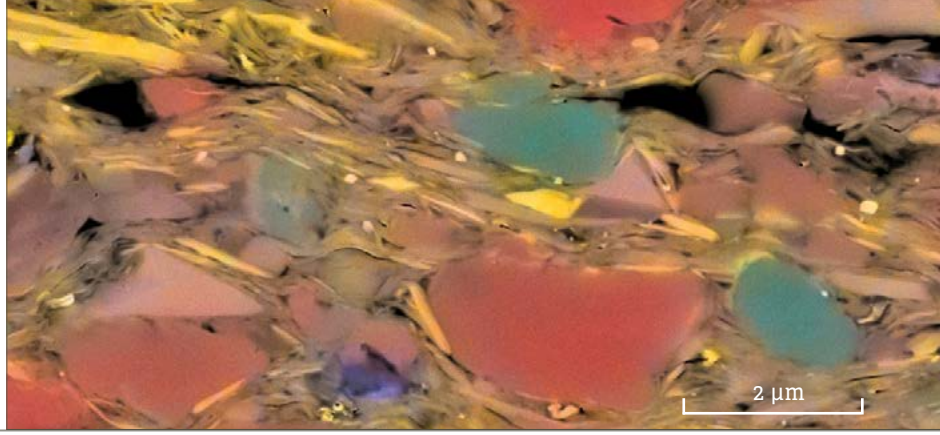

Very fine silty, argillaceous mudstone deposited in a deeper-water lacustrine setting. Sample has an EDAX elemental map overlying the SEM photomicrograph.

Mudrock Systems Research Laboratory

Who We Are—Often referred to as the "last frontier" of sedimentological research, mudrocks remain one of the more enigmatic geological systems. Significant knowledge gaps still exist, but current interest in these rocks is high—due in no small part to their potential as oil and gas reservoirs.

A key goal of the Mudrock Systems Research Laboratory (MSRL), internationally recognized for geological mudrock research studies, is to develop new paradigms for interpretation and analysis of mudrocks by bringing together expertise from the Bureau, researchers from affiliated organizations, industry members, and graduate and postdoctoral students.

The consortium has an average of 25 member companies per year, ranging from large multinational corporations to small independents.

What We Do—The central focus of the MSRL is integrated multidisciplinary research that addresses a spectrum of mudrock questions by collecting a wide array of data about mineralogy, sedimentology, pore systems, hydrocarbon chemistry, rock strength, wireline-log characterization, isotope and element chemistry, depositional environment, and flow properties.

The consortium's geological focus varies depending on data availability but is currently directed at the Eagle Ford, Bakken, and Wolfcamp successions—three of the most prolific oil-producing units in North America. Special attention is currently being given to the Eagle Ford, where the MSRL already has a wealth of data, ranging from the nanopore to interwell scale. The group is currently working to fully integrate these data into a geologically based reservoir model that can be used to examine flow properties.

The consortium adopts its research focus with input from industry. Over the years, it has become increasingly adept in a number of areas, expanding the technology and expertise in each. For example, recent key research has included FE-SEM and microscopy of Ar ion–milled surfaces; FIB-SEM microscopy and CT scanning to reveal pore architecture; analysis of mechanical properties to define rock strength; element and isotope geochemistry to better define facies and their continuity; delineation and modeling of depositional and diagenetic facies distribution; and integration of atomic-force microscopy and multiple methods of porosity and permeability measurement to determine and model flow.

Current Research Focus/Vision for the Future—A number of key research articles have been published, with several more on the way in 2016. The latter include studies of how organic-matter pores develop and evolve with increasing levels of maturity; variations in lateral Eagle Ford facies continuity based on closely spaced subsurface cores; depositional processes that control Eagle Ford facies architecture and continuity (crucial for modeling facies variations in the subsurface); and the similarities and differences among various techniques for determining porosity in mudrocks.

The current downturn in hydrocarbon commodity prices is an ideal time to develop a better understanding of mudrocks while the demands of well drilling and completion operations are reduced. During this challenging time, MSRL researchers continue to work with member companies to confront the geological uncertainties that are a fundamental aspect of successful exploitation of mudrock reservoirs.

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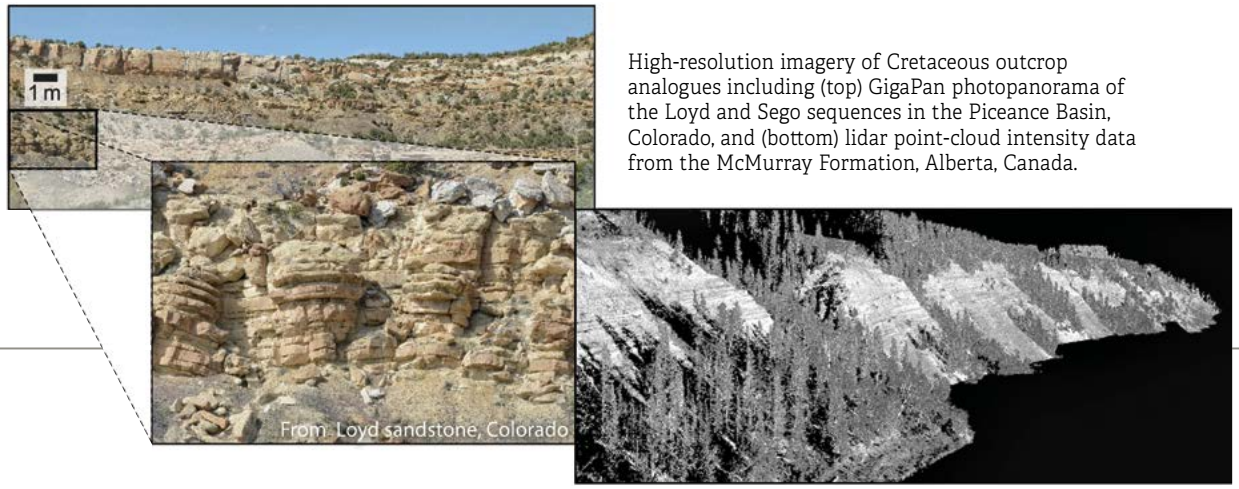

High-resolution imagery of Cretaceous outcrop analogues including (top) GigaPan photopanorama of the Loyd and Sego sequences in the Piceance Basin, Colorado, and (bottom) lidar point-cloud intensity data from the McMurray Formation, Alberta, Canada.

Quantitative Clastics Laboratory

Who We Are—Key challenges in the exploration and development of natural resources are the evaluation of reservoir presence and quality in data-limited frontier basins, and the characterization of connectivity and heterogeneity of reservoirs. The Quantitative Clastics Laboratory (QCL) provides quantitative information on clastic depositional system architecture and dimensions, and develops predictive models for processes and controls on sediment transport and stratigraphic evolution.

The QCL research team—which includes expertise in deepwater as well as fluvial, deltaic, and shallow-marine systems—is committed to applied stratigraphic research focusing on industry challenges of reservoir characterization and reservoir-presence prediction.

Membership of the consortium, which was established in 2001, consists almost entirely of integrated oil and gas companies of various sizes; one future member includes the U.S. Bureau of Ocean Energy Management (BOEM), which recently announced that it will be joining in 2016.

In 2015, the QCL welcomed a new principal investigator (PI), **Jacob Covault**. Jake comes to the Bureau from the oil and gas industry and brings with him a wealth of expertise from this experience as well as from his time at Stanford.

What We Do—The QCL leverages the resources of the Bureau and the Jackson School of Geosciences in order to investigate applied challenges in prospective sedimentary basins around the world. The group has conducted research in the North Slope of Alaska, the Gulf of Mexico, the Caribbean, West Africa, and onshore basins of North America, including the Permian Basin.

The consortium uses the types of subsurface data sets that industry is already accustomed to working with, including seismic reflection, wireline log, and drill core.

Current Research Focus/Vision for the Future—A central goal for the QCL is to provide more valuable digital and 3D architectural measurements (WellCAD sections, Delft3D models, Petrel models) to its members. The group is also developing a number of integrated projects in reservoir characterization, including subsurface data, outcrops, and numerical models.

The QCL houses one of the largest databases of clastic depositional systems available. Plans are to further improve the existing legacy database by expanding current search options and making the archive more intuitive so that members can more efficiently find information on any aspect of clastic depositional systems. The team also plans to expand the number of QCL graduate students and postdocs by fall 2016.

Members of the consortium can expect a comprehensive approach as QCL researchers undertake integrated geologic studies at multiple scales in their development of models for processes and controls in sediment transport and the stratigraphic evolution of depositional systems. With such a broad range of experts on-site, research is always focused, with tremendous breadth and depth.

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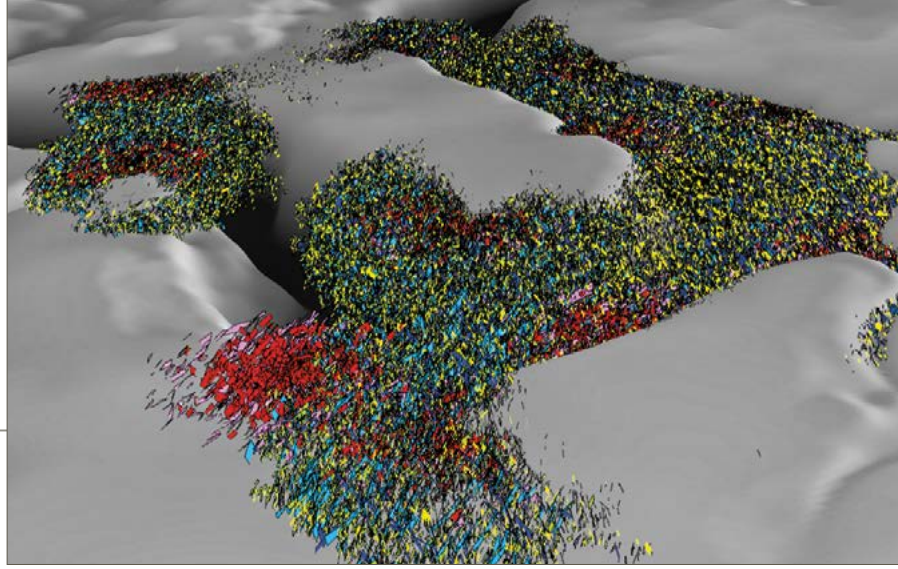

Oblique view to northwest of hierarchy discrete fracture network within the Madison Sequence IV. Black Eagle Point, Montana. Gray surface is DEM.

Reservoir Characterization Research Laboratory

Who We Are—The Reservoir Characterization Research Laboratory (RCRL) is one of two original consortia at the Bureau. Since its establishment in 1987, some of the world's largest oil and gas producers have depended on its research to make informed evaluations of prospective carbonate reservoirs.

Widely considered to be one of the premier carbonate outcrop research facilities in the world, the RCRL includes specialists from a variety of backgrounds who provide consortium members with a comprehensive suite of carbonate expertise, at a scale of investigation from nanopores to basinal architecture.

Membership largely consists of oil and gas producers, both small and large, some of whom joined the consortium when it was founded three decades ago and have remained industrial affiliates ever since. The RCRL also has a growing number of international members, including companies from China, Japan, Saudi Arabia, Germany, Canada, Britain, Norway, and Spain.

What We Do—Using outcrop and subsurface geologic and petrophysical data from carbonate reservoir strata, the consortium's primary research focuses on 3D modeling of geologic facies; petrophysical rock-fabric elements and fractures; mapping, characterization, and modeling of nonmatrix and micropore systems; and seismic imaging.

While RCRL research is predominantly centered on geology within the United States, all rock analyses are used as analogs so that they can inform research anywhere else in the world where similar stratigraphic formations are found.

Fracture analysis in a stratigraphic framework has been a key area in fostering the RCRL's reputation as a global leader in reservoir characterization. Until recently, access to reliable fracture analysis was patchy at best.

For decades, industry has been calling for more precise research; in response, the RCRL has made significant progress in its analysis of carbonates in recent years. Contemporary studies, for example, have included the adoption of drone technology. Using drones with photogrammetry has complemented an already established lidar technology to improve 3D digital outcrop models.

Current Research Focus/Vision for the Future—The RCRL plans to focus on five key research areas over the next 2 years: platform scale stratigraphy, reservoir architecture and intraplay evolution, structural and geomechanical characterization, pore-network characterization, and geochemical and chemostratigraphic analysis of carbonate systems.

The RCRL has a suite of the most advanced tools and technology available to gather vital data from outcrop or core. Studying the mechanical properties of rocks has become an increasingly important area, especially after recently acquiring new state-of-the-art equipment designed to advance understanding of exactly how rock deforms and breaks. With the investment in this technology, the RCRL has demonstrated its commitment to delivering the most informed analysis of reservoir characterization anywhere in the world.

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Participants at the May 2015 STARR workshop "Depositional Systems and Facies Variability in the Wilcox Group in Texas," held at the Houston Core Research Center. STARR presenter Jinyu Zhang at right.

State of Texas Advanced Resource Recovery Program

Who We Are—The Texas oil and gas industry is driven by companies of all sizes. Economies of scale enjoyed at the top allow big firms to commission large-scale reports on potential new plays, thereby improving the probability of success.

Such reports are a luxury most small- to medium-sized enterprises can't afford. The State of Texas Advanced Oil and Gas Resource Recovery (STARR) program, however, provides critical technology-transfer services relating to all aspects of oil and gas production to any Texas operator.

Since being established in 1995, STARR, a unique state-funded cooperative research program at the Bureau of Economic Geology, has provided invaluable services for dozens of oil and gas producers who must cope with expertise gaps. While the majority of its partners tend to be companies lacking the staff and resources to perform due diligence on new plays, STARR has also worked with some of the largest oil and gas producers in Texas.

What We Do—The mission is simple: help energy operators anywhere within the state to produce more oil and gas. Recent work has frequently centered on activity in the Eagle Ford and Wolfberry plays, principally because of significant drilling activity and hydrocarbon production in South Texas and the Permian Basin.

STARR provides expertise based on available data to any company, Texan or otherwise, planning to drill within the state. Its services include core descriptions, seismic-data interpretation, well-log correlations, and subsurface mapping of geological properties. In addition to generating numerous products to help companies make more-informed decisions on where to drill new wells, STARR also handles requests relating to old wells with zones that were previously overlooked. These interpretations may be used to complement a firm's in-house expertise. STARR can undertake a variety of project types, but results depend on variables such as the geographic area, the formation of interest, and available data sets.

STARR keeps a particularly close eye on the potential severance tax revenue generated by its research efforts; these data are reviewed with the assistance of the State Comptroller. In order to make a strong case for biennial funding, STARR must be revenue neutral. It has, however, consistently proven to be revenue positive. In its most recent 2-year funding cycle, STARR generated $16 for every $1 of state money invested.

Current Research Focus/Vision for the Future—STARR's positive revenue numbers are impressive. Still, nothing can be taken for granted in these lean times. Downturn or not, the team has never taken a passive approach to its research. In addition to the 60 field characterizations over the past 2 years that it has completed or is currently completing, STARR also provides outreach to industry in the form of core workshops, presentations at professional conferences, and peer-reviewed publications.

STARR can take on projects in regions of interest without any specific request from industry, like its current analysis of the Eaglebine play in southeast Texas. The Eaglebine may not rival the likes of Eagle Ford or Wolfberry in terms of output, but for operators in southeast Texas, it is still an interesting play. STARR is focused on using its expertise to help Texas at large, not just the regions currently experiencing good times.

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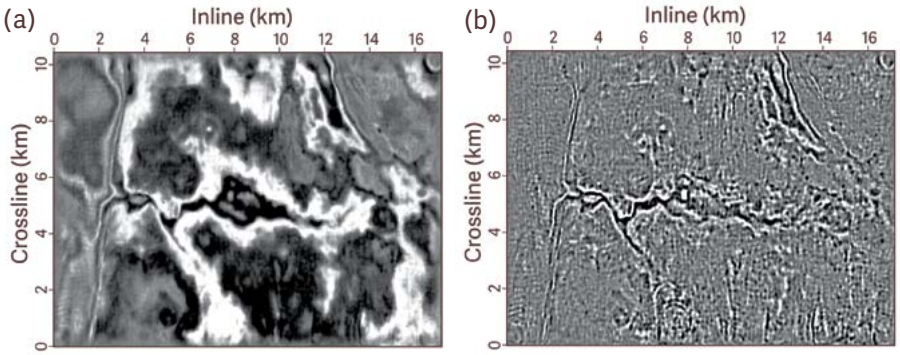


Conventional reflection image (a) and diffraction image (b) of unconventional reservoir in western Australia.

Texas Consortium for Computational Seismology

Who We Are—The Texas Consortium for Computational Seismology (TCCS) is a joint initiative of the Bureau of Economic Geology and the Institute for Computational Engineering and Sciences (ICES) at The University of Texas at Austin. Its primary mission is to tackle the most challenging research questions in computational geophysics currently facing the energy industry.

The consortium continues to have strong support from several major geophysical service companies as well as national and international oil and gas producers.

What We Do—The TCCS has established a reputation for the highest-quality computational geophysics research output with direct applications in both industry and academic settings. Its research team regularly collaborates with other Bureau consortia, such as the Fracture Research and Application Consortium, Quantitative Clastics Laboratory, and Reservoir Characterization Research Laboratory.

Current projects include estimating seismic velocities through the use of full waveform information; developing accurate and efficient algorithms for seismic modeling and imaging; increasing the resolution of seismic reservoir characterization by using novel attributes such as seismic diffraction imaging; and assisting seismic interpreters by automating common interpretation and signal-processing tasks.

TCCS research output is highly sought after, not simply because of its consistently high quality but also for the philosophy under which it is governed: all computational research must be reproducible. The results of each computational experiment reported to the sponsors are accompanied by open software code required for reproducing and verifying the experiment. Consortium PI **Sergey Fomel** is leading the development of a computational geophysics resource now used worldwide. "Madagascar" is an innovative open-source research-sharing platform designed for computational geophysicists who want to distribute their research freely among their peers for scrutiny.

Current Research Focus/Vision for the Future—Madagascar is a valuable resource for academic researchers that also advances solutions to contemporary industry challenges. Working on problems highlighted by consortium members is the driving force of TCCS research output.

Recent accomplishments include research into surface-consistent amplitude and time corrections; the development of an efficient diffraction-imaging workflow based on direct and analytical path-integral evaluation; and a method that optimizes stacking using a regularized inversion to zero offset.

Recently accomplished focused research projects include seismic-wave focusing for subsurface imaging and enhanced oil recovery; the extraction of seismic events by predictive painting and time warping; lowrank reverse-time migration for subsalt imaging; high-resolution seismic attributes for fracture characterization; waveform tomography with cost function in the image domain; and multiazimuth seismic-diffraction imaging for fracture characterization in low-permeability gas formations.

Through its engagement with the Institute for Computational Engineering and Sciences (ICES), TCCS creates a bridge between computational geophysics and applied mathematics that has led to exciting advances in computational algorithms applied to geophysical problems.

Principal Investigator: Sergey Fomel
sergey.fomel@beg.utexas.edu

Jackson School Outstanding Service Award: Eric Potter

▲ Eric Potter, BEG associate director, Energy Division, and JSG dean Sharon Mosher.

Bureau associate director **Eric Potter** was honored in 2015 by the Jackson School of Geosciences (JSG) for his "outstanding service to a unit, the School, the University, or the profession."

Said JSG dean Sharon Mosher of Potter: "His geologic insights and expertise are broadly sought across Texas and beyond by professional societies, industry, governments, and fellow academics. His administrative experience and counsel is a critical part of the Bureau's success.... For 15 years, Eric has served the Bureau and the School selflessly, consistently deflecting credit from himself to others, and being quick to recognize the best in others. He embodies the idea of service."

Potter, who will retire this year, was also praised by Bureau director **Scott W. Tinker**: "For over 25 years now, I have had the great pleasure to work for and with Eric Potter, the Bureau's associate director of Energy Research. In 2015, Eric told me that he planned to retire at the end of the year, or as soon as we could bring a replacement on board. The truth is that nobody is going to be able to replace Eric. He has managed a diverse, talented, and independent group of energy researchers for over 15 years, building cooperation and camaraderie, and motivating his staff to conduct and publish exceptional research. Eric provides candid, wise, and trusted counsel, which has been integral to the Bureau's success. Eric and his wife, Phyllis, are close personal friends. Please join me in thanking Eric for his tremendous contribution to the Bureau, congratulating him on a job well done, and wishing him and Phyllis the very best in retirement."

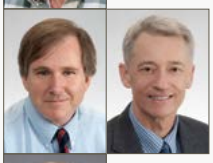
AAPG Awards

Bureau geoscientists brought home noteworthy awards and accolades from the 2015 **American Association of Petroleum Geologists** (AAPG) Annual Convention and Exhibition in Denver.

Kitty Milliken was honored with the **Robert R. Berg Outstanding Research Award** in recognition of singular achievement in petroleum geosciences research for "her contribution to improving the understanding of how diagenetic processes convert sediments to sedimentary rocks."

Milliken and **Tongwei Zhang** shared the **Wallace E. Pratt Memorial Award** for best AAPG *Bulletin* article published in 2013.

Bureau director **Scott W. Tinker** was presented with the **AAPG Honorary Member Award**, which is given to "persons who have distinguished themselves by their service and devotion to the science and profession of petroleum geology and to the Association."



Bill Ambrose and **J.-P. Nicot** were awarded **Certificates of Merit** by the **AAPG Division of Environmental Geosciences** "for outstanding contribution to and meritorious service for the betterment of the Division and its membership."

Former Bureau director **William "Bill" Fisher** was recognized with the **AAPG Foundation Chairman's Award** for his "extraordinary contributions…to the AAPG Foundation."

GCAGS Convention and Awards

At the 2015 Annual Convention of the **Gulf Coast Association of Geological Societies** (GCAGS) held in Houston, Bureau researcher **Dallas Dunlap** received the group's **Distinguished Service Award** for his exemplary service to the GCAGS over the years. In addition, Bureau scientists **Bob Loucks** and **Robert Reed** earned the group's **President's Award for Outstanding Paper**, 2014, for "Scanning-Electron-Microscope Petrographic Evidence for Distinguishing Organic-Matter Pores Associated with Depositional Organic Matter versus Migrated Organic Matter in Mudrocks."

Dallas Dunlap (right) receives his award from GCAGS president Charles Sternbach.

Robert Reed (left) and Bob Loucks (right) receive awards from GCAGS president Sternbach.

The convention also hosted a special session featuring Bureau director **Scott W. Tinker**, who was joined by his father, Tom Tinker, and son, Nathan Tinker, for a fascinating and poignant panel discussion, "Geo Generations: 60 Years in the 'Patch' and Counting," outlining the cyclical history and technological progress of the oil and gas industry as experienced by three generations of geoscientists.

Three generations of Tinkers: Tom, Scott, and Nathan.

GSA Fellow: J.-P. Nicot

The **Geological Society of America** (GSA) has named Bureau senior research scientist **J.-P. Nicot** a **2015 GSA Fellow** in recognition of his distinguished contributions to the geosciences. Nicot was nominated for the honor by Bureau colleague **Bridget Scanlon**, who cited his publication record with an *h*-index of 12 (ISI) or 16 (Google Scholar), including over 1100 citations. Added Scanlon, "His 2008 seminal paper on CO_2 storage is…the foundation for research on greenhouse gases and climate change, energy security, and sustainability of water resources." GSA members are elected to Fellowship in recognition of distinguished contributions to the geosciences.

Pettijohn Medal: Charles Kerans

The **Society for Sedimentary Geology** awarded the **Francis J. Pettijohn Medal** to Bureau senior research scientist **Charles Kerans** in recognition of his "excellence in sedimentology and stratigraphy." Kerans currently holds the Robert K. Goldhammer Chair in Carbonate Geology.

SPE's "A Peer Apart": Steve Laubach

The **Society of Petroleum Engineers** (SPE) recognized Bureau senior research scientist **Stephen Laubach** for his contributions as editor for the Society and its publications by naming him "**A Peer Apart**"; the title honors those who have reviewed 100 or more technical papers as a member of the SPE Editorial Review Committee. Laubach joins 8 other 2015 honorees and is one of only 143 in the history of the Society to have received the honor.

Bureau Publication Awards

Maria Nikolinakou and Dr. Scott Tinker.

The **Tinker Family BEG Publication Award** is presented each year to a Bureau researcher (or researchers) for the best peer-reviewed publication in the previous year. Cash award recipients this year were **Maria Nikolinakou**, **Peter Flemings**, and **Michael Hudec** for two articles, "Modeling stress evolution around a rising salt diapir" and "Comparison of evolutionary and static modeling of stresses around a salt diapir," which both appeared in *Marine and Petroleum Geology*. Unanimous runners-up for the Tinker Award were **Julia Gale**, **Steve Laubach**, **Peter Eichhubl**, and **Andras Fall** for "Natural fractures in shale: a review and new observations," published in the AAPG *Bulletin*.

At its annual **First Author Publication Awards Dinner** held in April, the Bureau paid tribute to researchers who were first authors of papers published in 2014. Thirty-six first authors were recognized at this year's event, eight for the first time. **Akand Islam**, a Bureau postdoc, had the most first-author publications in 2014, with a remarkable five articles. **Bill Ambrose** and **Bob Loucks** shared the distinction of being honored the most times, seven, with at least one first-author publication every year since the ceremony's inception in 2009.

UT President's Staff Award: Melissa Garcia

The Bureau's human resources coordinator **Melissa Garcia** was one of only 30 to be honored with a **President's Outstanding Staff Award**, which recognizes nonteaching UT Austin employees who have made outstanding or invaluable contributions to the continuing success of the university.

Outreach, Events, and Meetings

Industry Day

Bureau of Economic Geology researchers and graduate students met at the Houston Research Center (HRC) in 2015 to celebrate the Bureau's annual Industry Day, which focused this year on "The Power of Research in a Down Cycle." Invited guests from the oil and gas industry, government agencies, and nongovernmental organizations were treated to a wide range of posters illustrating the breadth of the Bureau's energy, environmental, and energy-economics research. Participants also toured the HRC's massive repository of 800,000 boxes of core and other rock material for a firsthand look at how vital this archive has been, and will be, to the world's understanding of Earth's subsurface.

Industry Day participants.

Marilu Hastings at Industry Day.

Speakers at Industry Day included **Marilu Hastings**, vice president of Sustainability Programs at the Cynthia and George Mitchell Foundation, who presented "George P. Mitchell's Sustainability Legacy in the Shale Age"; **Mark Houser**, new chief executive officer of University Lands, University of Texas and Texas A&M systems, who spoke about "Effectively Managing Resources Through Down Cycles"; and Bureau director **Scott W. Tinker**, who provided a thorough assessment of the world's current energy situation in his presentation, "The Upsides of a Down Cycle."

Bureau Research Symposium

As the range and specialization of research at the Bureau continue to grow, so does the value of collaboration among its scientists. The 3rd Annual **Bureau Research Symposium**, held in September, showcased the latest scientific work and provided researchers with the opportunity to share insights into approaches, methodologies, and the application of emerging technologies. The Bureau-wide event, attended by more than 100 scientists, featured 33 posters highlighting earth science research in energy and the environment. Sharing honors for the top three presentations, as selected by those attending, were Visiting Scientist **Sen Wang** and coauthors of "Molecular Study of Oil Flow in Shale Nanopores"; Research Scientist **Tongwei Zhang** and coauthors of "Insights into Reservoir Development Based on Integrated Studies of Organic Matter and Pore Size in a Lacustrine Shale: Triassic Yanchang Formation, Ordos Basin, China"; and Senior Scientist **Jeff Paine** and coauthors of "Quantifying Subsidence and Assessing Sinkhole Potential in the Hendrick Field, Permian Basin, Texas, Using Airborne Lidar, Radar Interferometry, and Microgravity."

3rd Annual Bureau Research Symposium.

Resource Center

In 2015, the Bureau served the geoscience community, educators, and the public through its Resource Center, which includes the Public Information Office, Geophysical Log Facility, Map Room, and Texana Library, as well as The Bureau Store. The Resource Center is open weekdays from 8:00 a.m. to 12:00 p.m. and from 1:00 p.m. to 5:00 p.m. Outreach activities for 2015 included presentations and onsite tours for professional groups, Texas educators, community service organizations, Scouts, and school groups. This year, **Linda Ruiz McCall**, Information Geologist and Resource Center manager, was invited to speak about Texas geology by community groups including the Osher Lifelong Learning Institute (Marble Falls, Fredericksburg, and Junction), the Good Water Master Naturalists (Georgetown), the Boy Scout STEMboree (Austin), and the Llano Eco Summit (Llano). Linda also served on the Texas Groundwater Protection Committee Public Education and Outreach subcommittee. For more information: http://www.beg.utexas.edu/info/res_ctr.php.

Bureau booth at the Texas Regional Collaboratives Annual Meeting.

Explore UT

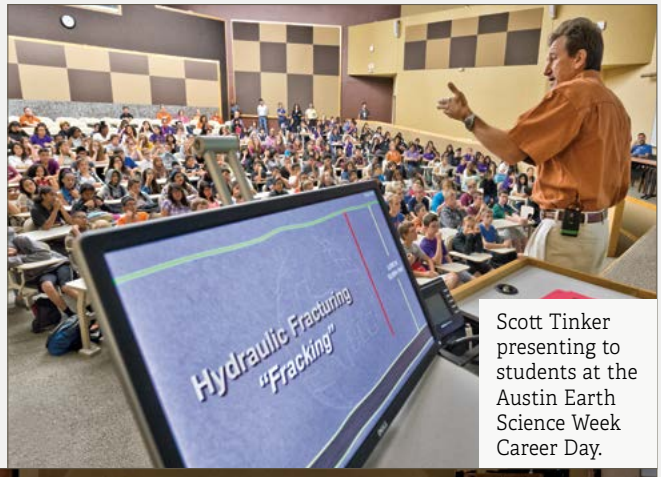
Bureau staff joined the 16th Annual **Explore UT: The Biggest Open House in Texas** in March, when the entire Forty Acres was open to schoolchildren from across the state. Bureau activities developed by senior research scientist **Sue Hovorka** included "What to Do with CO_2: Cure for the Feverish Earth" and "Find Gold." Students were also treated to a 3D geology visualization show by **Dallas Dunlap** and **John Andrews**. **Linda Ruiz McCall** led the Bureau team, which included 16 volunteers.


Sue Hovorka and Donnie Brooks demonstrating CO_2 activities.


Kim LaValley showing Explore UT participants how to pan for gold.

Earth Science Week Career Day

The Bureau hosted the 16th Annual **Earth Science Week Career Day** in October. Over 350 middle-school students from the Austin area came to UT's J. J. Pickle Research Campus for a day of engaging presentations, exhibits, and face-to-face interaction with 70 geoscience professionals. Along with Bureau staff, participating organizations included the U.S. Geological Survey, the Austin Geological Society, Statoil, Schlumberger, Parsley Energy, Navigator Oil and Exploration, the Subsurface Library, and the Jackson School of Geosciences.



Scott Tinker presenting to students at the Austin Earth Science Week Career Day.


Linda Ruiz McCall addressing students attending Career Day.


Tour guides at the Austin Earth Science Week Career Day.

GeoFORCE Program

Bureau scientists **Tiffany Caudle**, **Ruth Costley**, **Peter Flaig**, **Greg Frébourg**, and **Jeffrey Paine** joined university faculty and industry partners to lead over 600 Texas students on spectacular field trips for the JSG GeoFORCE program. Since 2005, the program has proven successful in preparing Texas high school students to become part of the geosciences workforce.

Instructor Peter Flaig with GeoFORCE GEAR UP students in Arizona.

Texas High School Coastal Monitoring Program

This year, the Texas High School Coastal Monitoring Program, led by **Tiffany Caudle**, marked 18 years of engaging Texas coastal residents in the study of their natural environment. Bureau scientists provide the tools and training needed for students and teachers to learn how to measure the topography, map the vegetation line and shoreline, and observe weather and wave conditions.

Palacios High School students collecting beach profile data.

Workshops and Training

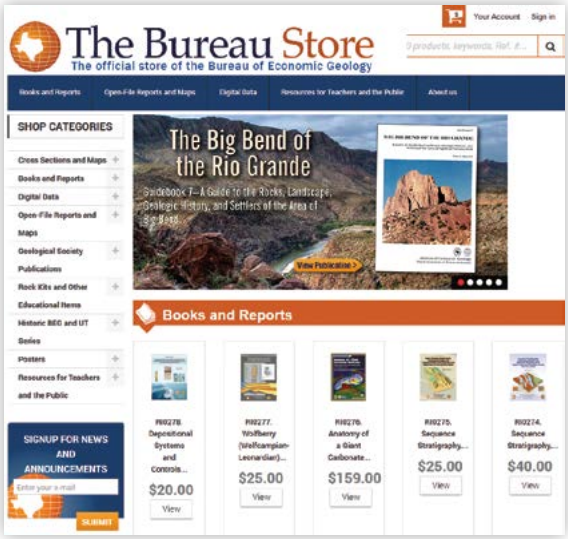
Linda Ruiz McCall and **Heather Christensen**, Jackson School of Geosciences (JSG) graduate student, presented "Texas Through Time: Lone Star Geology, Landscapes, and Resources" at a professional development workshop in Dallas attended by 90 science teachers at the **Conference for the Advancement of Science Teaching** (CAST) in November. The Bureau also contributed 50 Earth Science Week toolkits and Bureau map sets at the **Texas Earth Science Teachers Association** (TESTA) Sharathon, where hundreds of Bureau maps and information sheets were also distributed to conference attendees from the Bureau's exhibit booth.

Industrial Minerals Educator Workshop attendees.

James Donnelly demonstrating salt core.

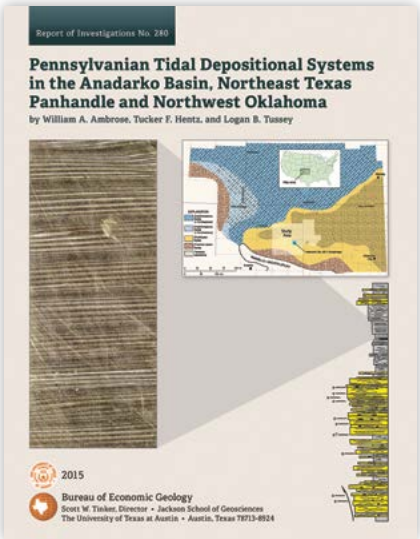
The Bureau partnered with the Texas Mining and Reclamation Association to train 25 educators at the **Industrial Minerals Educator Workshop** held at the Bureau's administrative offices in July, where teachers listened to expert presentations and toured the Core Repository and Texas Advanced Computing Center. **Brent Elliott**, **James Donnelly**, **Nathan Ivicic**, **John Andrews**, and **Linda Ruiz McCall** presented to the group. This year, Linda also presented a rainwater harvesting and watershed lesson to educators at the **Groundwater to the Gulf Summer Institute** in Austin.

The Bureau Store



The Bureau Store, the official store of the Bureau of Economic Geology, serves the geoscience community, educators, and the general public by offering more than 2,000 books, maps, and digital products published by the Bureau's research staff. The store also sells publications issued by UT's Texas Memorial Museum, the Gulf Coast Association of Geological Societies (GCAGS) and several of its member societies, and the Gulf Coast Section of SEPM (GCSSEPM). Items on the store's List of Publications (http://www.beg.utexas.edu/pubs/LOP.pdf) can be purchased online (http://begstore/beg.utexas.edu/store/) or at the J. J. Pickle Research Campus in North Austin. Contact store staff members **Amanda R. Masterson** and **Dennis J. Campa** at pubsales@beg.utexas.edu or by phone at 512-471-7144.

Report of Investigations

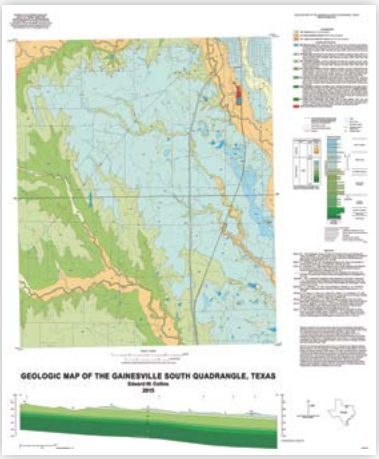


Pennsylvanian Tidal Depositional Systems in the Anadarko Basin, Northeast Texas Panhandle and Northwest Oklahoma
Ambrose, W. A., Hentz, T. F., and Tussey, L. B., 2015,
The University of Texas at Austin, Bureau of Economic Geology
Report of Investigations No. 280, 40 p., 12 tables.

A thick succession of Desmoinesian to Virgilian (Pennsylvanian) strata in the northwest part of the Anadarko Basin contains a variety of tide-modified deposits. This succession—which encompasses the Marmaton Group (upper Desmoinesian), Cleveland Formation (Missourian), and Douglas Group (Virgilian)—records progradation of highstand tide-modified delta and littoral systems punctuated by lowstand incised-valley deposits. Tidal stratification in this succession includes asymmetric, double-draped ripples; reactivation surfaces; flaser bedding; rhythmic, laminar stratification; upper-flow-regime planar stratification; and minor herringbone stratification. Tidal amplification and reworking of deltaic and littoral sediments was controlled by (1) basin configuration, consisting of a broad, shallow shelf merging northward with an extensive epicontinental seaway in the U.S. Midcontinent, and (2) the formation of embayments during periods of relative sea-level fall, notably in the Cleveland Formation, in which an east–west-trending, lowstand paleovalley contains a vertical succession of coarse-grained fluvial-channel, tidal-channel, sandy tidal flat, muddy tidal flat, and transgressive-estuarine facies.

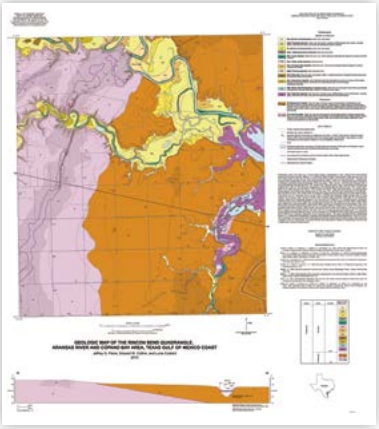
Maps

Geologic Map of the Gainesville South Quadrangle, Texas
Collins, E. W., 2015, The University of Texas at Austin,
Bureau of Economic Geology, Open-File Map, OFM0217, scale 1:24,000.



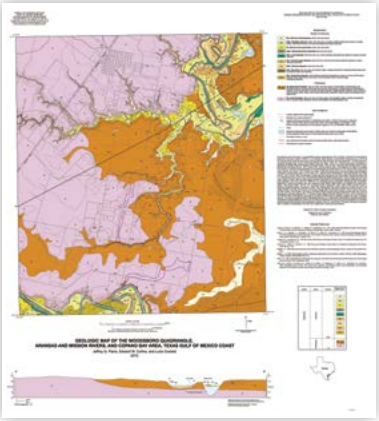
The geologic map of the Gainesville South Quadrangle is one of several 1:24,000-scale maps of the North Central Texas transportation corridor north of Fort Worth and Dallas. Geology of this quadrangle consists of Lower Cretaceous shelf and shore-zone deposits including Duck Creek limestone; Fort Worth limestone; Denton clay and shale; and Weno marl, clay, and shale. Lower Cretaceous deposits in the subsurface of the area include Antlers sand, clay, and conglomerate; Walnut limestone and marl; Goodland limestone; and Kiamichi marl and clay. Antlers deposits in the subsurface compose the Trinity Aquifer, a major aquifer of the region.

Geologic Map of the Rincon Bend Quadrangle: Aransas River and Copano Bay Area, Texas Gulf of Mexico Coast
Collins, E. W., 2015, The University of Texas at Austin,
Bureau of Economic Geology, Open-File Map, OFM0218, scale 1:24,000.

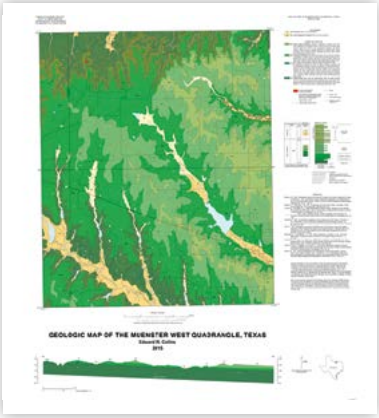


The geologic map of the Rincon Bend Quadrangle is a 1:24,000-scale map illustrating the geology of the Aransas and Mission rivers/deltas area at Copano Bay, Texas Gulf of Mexico Coast. The map of this quadrangle depicts part of the Aransas River and delta. Geology of the area partly consists of upland Pleistocene Lissie fluvial sand, silt, clay, and lesser gravel, as well as Beaumont clay, silt, sand, and minor gravel of fluvial–deltaic interdistributary and distributary settings. Sand-rich channel facies of the Lissie and Beaumont Formations are displayed. Modern to Holocene fluvial floodplain, levee, crevasse splay, point bar, clay dune, channel-bar, and terrace deposits occur within the Aransas River valley. Delta-plain deposits and tidal flats are adjacent to Copano Bay.

Geologic Map of the Woodsboro Quadrangle: Aransas and Mission Rivers, Copano Bay Area, Texas Gulf of Mexico Coast
Collins, E. W., 2015, The University of Texas at Austin,
Bureau of Economic Geology, Open-File Map, OFM0219, scale 1:24,000.

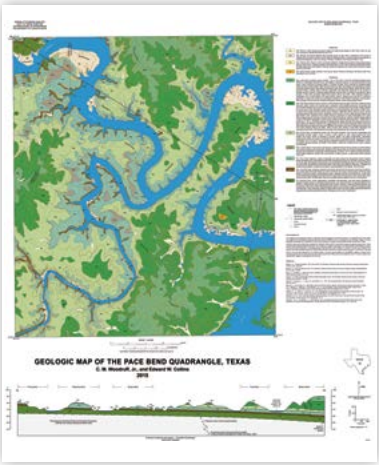


This map is one of four 1:24,000-scale maps of the Aransas and Mission rivers/deltas area at Copano Bay, Texas Gulf of Mexico Coast. This study area lies within Modern to Holocene Aransas and Mission fluvial–deltaic and bay–estuary settings. Here, the Aransas and Mission River valleys dissect Pleistocene fluvial–deltaic deposits of the Beaumont and Lissie Formations. The map of the Woodsboro Quadrangle depicts the geology for parts of the Aransas and Mission River valleys a short distance upstream from where the Aransas and Mission Deltas prograded into Copano Bay during the mid- to late Holocene. The maps illustrate a variety of geologic elements, including (1) floodplain alluvium, (2) valley-margin deposits, (3) levee deposits, (4) crevasse-splay deposits, (5) abandoned-channel deposits, (6) point-bar deposits, (7) channel-bar deposits, (8) terrace alluvium, (9) upper Pleistocene Beaumont Formation deposits with some areas composed of sand-rich channel facies, and (10) Pleistocene Lissie Formation deposits.



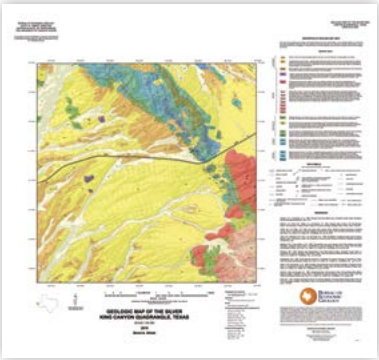
Geologic Map of the Muenster West Quadrangle, Texas
Collins, E. W., 2015, The University of Texas at Austin,
Bureau of Economic Geology, Open-File Map, OFM0220, scale 1:24,000.

This quadrangle is one of several for the mapping study of the North Central Texas transportation corridor north of Fort Worth and Dallas. Maps for this corridor provide a basic geologic framework to aid in managing water and earth resources, planning land use, identifying aquifer recharge areas, and identifying sources of aggregate and other earth resources. Geologic units exposed across this corridor comprise about 1,500 ft of Cretaceous shelf and shore-zone deposits. This map depicts the upper Antlers sand, clay, and conglomerate; Walnut limestone and marl; Goodland limestone; Kiamichi marl and clay; Duck Creek limestone; and Fort Worth limestone. Goodland limestone and Antlers sand—potential earth resources—are quarried locally and in adjacent areas. Antlers deposits in the subsurface compose the Trinity Aquifer, a major aquifer of the region.



Geologic Map of the Pace Bend Quadrangle, Texas
Woodruff, C. M., Jr., and Collins, E. W., 2015,
The University of Texas at Austin, Bureau of Economic Geology,
Open-File Map, OFM0221, scale 1:24,000.

The Pace Bend Quadrangle lies mostly within Travis County but also includes southeastern parts of Burnet County. Landscape in the map area consists of rolling terrain formed on diverse substrate (sandstone, conglomerate, limestone, and local shale). High ground is underlain by hard and soft limestone strata, sculpted into stepped terrain typical of the Central Texas Hill Country. Quaternary alluvial deposits (sand, gravel, silt, and clay) occur as terraces at or above lake level and as discontinuous valley deposits along tributary streams. Quaternary colluvial deposits occur along steep lakeside bluffs that represent areas of potentially unstable slopes. All of the relatively recent (Quaternary) deposits are of localized areal extent, whereas most of the map comprises basal parts of the Cretaceous section in Central Texas. The sequence of Cretaceous bedrock units makes up the three parts of the Trinity Aquifer, an important source of groundwater across the Hill Country region.



Geologic Map of the Silver King Canyon Quadrangle, Texas
Elliott, B. A., 2015, The University of Texas at Austin,
Bureau of Economic Geology, Open-File Map, OFM0222, scale 1:24,000.

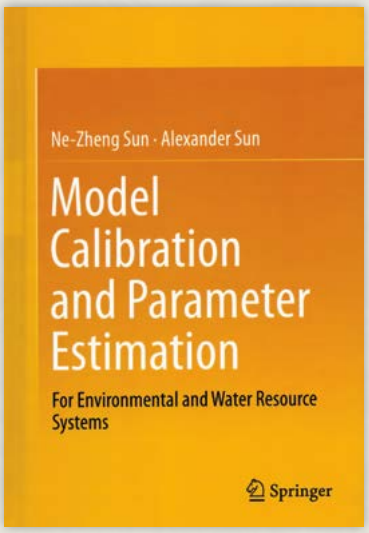
This map is one of several 1:24,000-scale maps of the Trans-Pecos region, focusing on mineral resources associated with Tertiary intrusive and volcanic rocks of West Texas. Maps for this region provide a basic geologic framework to aid in managing water and earth resources; planning land use; and identifying sources of rare earth elements, precious and base metals, uranium, thorium, fluorine, beryllium, and other earth resources. This study area covers the Paleozoic and Mesozoic rocks of the Malone Hills and Tertiary volcanic rocks south of the Sierra Blanca peak, including the volcanic caldera intrusive rocks of the Quitman Mountains and the Square Peak volcanic series. Igneous rocks in the map area intrude and overlie the Bluff Mesa limestone, Torcer Formation, Yucca Formation, and Malone Formation stratigraphies. The Tertiary intrusive and volcanic rocks provide excellent potential for hydrothermal mineral resource formation, skarn development, and magmatic ore resources in West Texas.

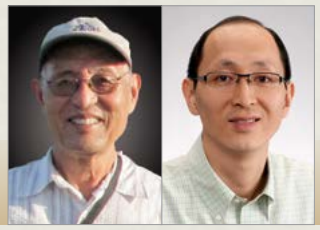
Geologic Map of the Spice Rock Quadrangle, Texas
Elliott, B. A., 2015, The University of Texas at Austin, Bureau of Economic Geology, Open-File Map, OFM0223, scale 1:24,000.

This map is one of several 1:24,000-scale maps of the region north of the Llano Uplift, focusing on sand resources in the Cambrian and Ordovician stratigraphy of 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 sources of dimension stone, aggregate, construction sand and specialty sand, gravel, and other earth resources. This study area lies within the eolian to near-shore setting of the Cambrian-age Hickory Formation, transitional to the marine-transgressional Tanyard Formation and Cretaceous limestones. The Hickory Formation is an important sand resource in Central Texas, and the Hickory aquifer recharge zone is important for water resource management in the region.

Father-and-Son Collaboration

Researchers frequently collaborate on the publication of papers and articles. Rarely, however, are such collaborators father and son. ***Model Calibration and Parameter Estimation For Environmental and Water Resource Systems*** was written by Ne-Zheng Sun of the Civil and Environmental Engineering Department at UCLA and his son, the Bureau's own **Alex Sun**. The book, published in 2015 and available for purchase through Springer, provides a comprehensive introduction to topics such as model calibration, parameter estimation, reliability assessment, and data-collection design. Theoretical examples and real-world studies elucidate concepts and methods. It is a must-read for both students and professionals, and a tribute to the expertise and extensive research of the father–son team.





Ne-Zheng Sun (left) and Alex Sun (right) ▶

2015 Peer-Reviewed Publications by Bureau Researchers

Agartan, E., Trevisan, L., Cihan, A., Birkholzer, J. T., Zhou, Q., and Illangasekare, T. H., 2015, Experimental study on effects of geologic heterogeneity in enhancing dissolution trapping of supercritical CO_2: Water Resources Research, v. 51, no. 3, p. 1635–1648, http://doi.org/10.1002/2014WR015778.

Alkhalifah, T., Fomel, S., and Wu, Z., 2015, Source–receiver two-way wave extrapolation for prestack exploding-reflector modelling and migration: Geophysical Prospecting, v. 63, no. 1, p. 23–34, http://doi.org/10.1111/1365-2478.12162.

Alzayer, Y., Eichhubl, P., and Laubach, S. E., 2015, Non-linear growth kinematics of opening-mode fractures: Journal of Structural Geology, v. 74, p. 31–44, http://doi.org/10.1016/j.jsg.2015.02.003.

Ambrose, W. A., Breton, C., Nuñez-López, V., and Gülen, G., 2015, EOR potential from CO_2 captured from coal-fired power plants in the Upper Cretaceous (Cenomanian) Woodbine Group, East Texas Basin, and southeastern Texas Gulf Coast, USA: Natural Resources Research, v. 24, no. 2, p. 161–188, http://doi.org/10.1007/s11053-014-9242-z.

Ambrose, W. A., Hentz, T. F., and Tussey, L. B., 2015, Pennsylvanian tidal depositional systems in the Anadarko Basin, northeast Texas Panhandle and northwest Oklahoma: The University of Texas at Austin, Bureau of Economic Geology, Report of Investigations No. 280, 40 p., 12 tables.

Ambrose, W. A., Loucks, R. G., and Dutton, S. P., 2015, Sequence-stratigraphic and depositional controls on reservoir quality in lowstand incised-valley-fill and highstand shallow-marine systems in the Upper Cretaceous (Cenomanian) Tuscaloosa Formation, Louisiana, U.S.A.: GCAGS Journal, v. 4, p. 43–66.

Amsler, H. E., Reusser, E., Milliken, K., and Strasser, M., 2015, Elemental distribution and microfabric characterization across a buried slump scar: new insights on the long-term development and reactivation of scar surfaces from a microscopic perspective, *in* Krastel, S., ed., Submarine mass movements and their consequences: Switzerland, Springer International Publishing, Advances in Natural and Technological Hazards Research, v. 37, p. 23–32, http://doi.org/10.1007/978-3-319-00972-8.

Bedayat, H., and Dahi Taleghani, A., 2015, Two interacting ellipsoidal inhomogeneities: applications in geoscience: Computers & Geosciences, v. 76, p. 72–79, http://doi.org/10.1016/j.cageo.2014.12.003.

Bhandari, A. R., Flemings, P. B., Polito, P. J., Cronin, M. B., and Bryant, S. L., 2015, Anisotropy and stress dependence of permeability in the Barnett Shale: Transport in Porous Media, v. 108, no. 2, p. 393–411, http://doi.org/10.1007/s11242-015-0482-0.

Bourne, M. D., Feinberg, J. M., Strauss, B. E., Hardt, B., Cheng, H., Rowe, H. D., Springer, G. S., and Edwards, R. L., 2015, Long-term changes in precipitation recorded by magnetic minerals in speleothems: Geology, v. 43, no. 7, p. 595–598, http://doi.org/10.1130/G36695.1.

Burnett, W., Klokov, A., Fomel, S., Bansal, R., Liu, E., and Jenkinson, T., 2015, Seismic diffraction interpretation at Piceance Creek: Interpretation, v. 3, no. 1, p. SF1–SF14, http://doi.org/10.1190/INT-2014-0091.1.

Chen, L., Long, X, Young, M. H., Yin, J., Yu, Z., and van Genuchten, M. Th., 2015, Optimal parameters for the Green-Ampt infiltration model under rainfall conditions: Journal of Hydrology and Hydromechanics, v. 63, no. 2, p. 93–101, http://doi.org/10.1515/johh-2015-0012.

Chen, Y., and Fomel, S., 2015, Random noise attenuation using local signal-and-noise orthogonalization: Geophysics, v. 80, no. 6, p. WD1–WD9, http://doi.org/10.1190/geo2014-0227.1.

Collignon, M., Fernandez, N., and Kaus, B. J. P., 2015, Influence of surface processes and initial topography on lateral fold growth and fold linkage mode: Tectonics, v. 34, no. 8, p. 1622–1645, http://doi.org/10.1002/2015TC003843.

Corti, G., and Dooley, T. P., 2015, Lithospheric-scale centrifuge models of pull-apart basins: Tectonophysics, v. 664, p. 154–163, http://doi.org/10.1016/j.tecto.2015.09.004.

Costard, L., and Paine, J. G., 2015, Characterizing initial-state conductivity distribution at a CO_2 injection site with airborne, surface, and borehole electromagnetic induction methods: Environmental Geosciences, v. 22, no. 3, p. 75–83, http://doi.org/10.1306/eg.06191515004.

Damuth, J. E., and Olson, H. C., 2015, Latest Quaternary sedimentation in the northern Gulf of Mexico Instraslope Basin Province: 1. Sediment facies and depositional processes: Geosphere, v. 11, no. 6, p. 1689–1718, http://doi.org/10.1130/GES01090.1.

Decker, L., Janson, X., and Fomel, S., 2015, Carbonate reservoir characterization using seismic diffraction imaging: Interpretation, v. 3, no. 1, p. SF21–SF30, http://doi.org/10.1190/INT-2014-0081.1.

Dixon, T. E, and Romanak, K. D., 2015, Improving monitoring protocols for CO_2 geological storage with technical advances in CO_2 attribution monitoring: International Journal of Greenhouse Gas Control, v. 41, p. 29–40, http://doi.org/10.1016/j.ijggc.2015.05.029.

Dooley, T. P., Jackson, M. P. A., and Hudec, M. R., 2015, Breakout of squeezed stocks: dispersal of roof fragments, source of extrusive salt and interaction with regional thrust faults: Basin Research, v. 27, p. 3–25, http://doi.org/10.1111/bre.12056.

Dooley, T. P., Jackson, M. P. A., Jackson, C. A.-L., Hudec, M. R., and Rodriguez, C. R., 2015, Enigmatic structures within salt walls of the Santos Basin–Part 2: Mechanical explanation from physical modeling: Journal of Structural Geology, v. 75, p. 163–187, http://doi.org/10.1016/j.jsg.2015.01.009.

Duffy, O. B., Bell, R. E., Jackson, C. A-L., Gawthorpe, R. L., and Whipp, P. S., 2015, Fault growth and interactions in a multiphase rift fault network: Horda Platform, Norwegian North Sea: Journal of Structural Geology, v. 80, p. 99–119, http://doi.org/10.1016/j.jsg.2015.08.015.

Duffy, O. B., Brocklehurst, S. H., Gawthorpe, R. L., Leeder, M. R., and Finch, E., 2015, Controls on landscape and drainage evolution in regions of distributed normal faulting: Perachora Peninsula, Corinth Rift, Central Greece: Basin Research, v. 27, p. 473–494, http://doi.org/10.1111/bre.12084.

Duncan, I. J., 2015, Does methane pose significant health and public safety hazards?—a review: Environmental Geosciences, v. 22, no. 3, p. 85–96, http://doi.org/10.1306/eg.06191515005.

Dutton, S. P., Loucks, R. G., and Ambrose, W. A., 2015, Factors controlling permeability variation in onshore, deep Paleogene Wilcox sandstones in the northern Gulf of Mexico basin: targeting high-quality reservoirs: GCAGS Journal, v. 4, p. 1–14.

Elahi Naraghi, M., and Javadpour, F., 2015, A stochastic permeability model for the shale-gas systems: International Journal of Coal Geology, v. 140, p. 111–124, http://doi.org/10.1016/j.coal.2015.02.004.

Fall, A., Eichhubl, P., Bodnar, R. J., Laubach, S. E., and Davis, J. S., 2015, Natural hydraulic fracturing of tight-gas sandstone reservoirs, Piceance Basin, Colorado: Geological Society of America Bulletin, v. 127, no. 1–2, p. 61–75, http://doi.org/10.1130/B31021.1.

Fernandez, N., and Kaus, B. J. P., 2015, Pattern formation in 3D numerical models of down-built diapirs initiated by a Rayleigh–Taylor instability: Geophysical Journal International, v. 202, no. 2, p. 1253–1270, http://doi.org/10.1093/gji/ggv219.

Fomel, S., 2015, Reproducible research as a community effort: lessons from the Madagascar project: Computing in Science and Engineering, v. 17, no. 1, p. 20–26, http://doi.org/10.1109/MCSE.2014.94.

Ford, W. I., Fox, J. F., Pollock, E., Rowe, H. D., and Chakraborty, S., 2015, Testing assumptions for nitrogen transformation in a low-gradient agricultural stream: Journal of Hydrology, v. 527, p. 908–922, http://doi.org/10.1016/j.jhydrol.2015.05.062.

Ford, W. I., Fox, J. F., and Rowe, H. D., 2015, Impact of extreme hydrologic disturbance upon the sediment carbon quality in agriculturally impacted temperate streams: Ecohydrology, v. 8, no. 3, p. 438–449, http://doi.org/10.1002/eco.1514.

Frohlich, C., Walter, J. I., and Gale, J. F. W., 2015, Analysis of transportable array (USArray) data shows earthquakes are scarce near injection wells in the Williston Basin, 2008–2011: Seismological Research Letters, v. 86, no. 2A, p. 492–499, http://doi.org/10.1785/0220140180.

Fu, Q., Horvath, S., Potter, E., Roberts, F., Tinker, S. W., Ikonnikova, S., Fisher, W., and Yan, J., 2015, Log-derived thickness and porosity of the Barnett Shale, Fort Worth basin, Texas: implications for assessment of gas shale resources: AAPG Bulletin, v. 99, no. 1, p. 119–141, http://doi.org/10.1306/07171413018.

Ganjdanesh, R., Pope, G. A., and Sepehrnoori, K., 2015, Production of energy from saline aquifers: a method to offset the energy cost of carbon capture and storage: International Journal of Greenhouse Gas Control, v. 34, p. 97–105, http://doi.org/10.1016/j.ijggc.2015.01.004.

Gülen, G., and Bellman, D. K., 2015, Scenarios of resource adequacy in ERCOT: mandated reserve margin, impact of environmental regulations and integration of renewables: The Electricity Journal, v. 28, no. 2, p. 89–100, http://doi.org/10.1016/j.tej.2015.01.011.

Gülen, G., Ikonnikova, S., Browning, J., and Tinker, S. W., 2015, Fayetteville shale-production outlook: SPE Economics & Management, v. 7, no. 2, p. 47–59, http://doi.org/10.2118/173187-PA.

Gülen, G., Ikonnikova, S., Smye, K. G., Browning, J., and Tinker, S. W., 2015, Production scenarios for the Haynesville shale play: SPE Economics & Management, v. 7, no. 4, p. 138–147, http://doi.org/10.2118/176022-PA.

Hackley, P. C., Warwick, P. D., Ambrose, W. A., Hammes, U., and 32 others, 2015, Unconventional Energy Resources: 2015 Review: Natural Resources Research, v. 24, no. 4, p. 443–508, http://doi.org/10.1007/s11053-015-9288-6.

Hamlin, H. S., and de la Rocha, L., 2015, Using electric logs to estimate groundwater salinity and map brackish groundwater resources in the Carrizo-Wilcox Aquifer in South Texas: GCAGS Journal, v. 4, p. 109–131.

He, Y., Zeng, H., Kerans, C., and Hardage, B. A., 2015, Seismic chronostratigraphy at reservoir scale: statistical modeling: Interpretation, v. 3, no. 2, p. SN69–SN87, http://doi.org/10.1190/INT-2014-0136.1.

Heidari, M., and Tonon, F., 2015, Ground reaction curve for tunnels with jet grouting umbrellas considering jet grouting hardening: International Journal of Rock Mechanics & Mining Sciences, v. 76, p. 200–208, http://doi.org/10.1016/j.ijrmms.2015.03.021.

Hooker, J. N., Larson, T., Eakin, A., Laubach, S. E., Eichhubl, P., Fall, A., and Marrett, R., 2015, Fracturing and fluid flow in a sub-décollement sandstone; or, a leak in the basement: Journal of the Geological Society, v. 172, p. 428–442, http://doi.org/10.1144/jgs2014-128.

Hosseini, S. A., Javadpour, F., and Michael, G. E., 2015, Novel analytical core-sample analysis indicates higher gas content in shale-gas reservoirs: SPE Journal, v. 20, no. 6, p. 1397–1408, http://doi.org/10.2118/174549-PA.

Hu, H., Zhang, T., Wiggins-Camacho, J. D., Ellis, G. S., Lewan, M. D., and Zhang, X., 2015, Experimental investigation of changes in methane adsorption of bitumen-free Woodford Shale with thermal maturation induced by hydrous pyrolysis: Marine and Petroleum Geology, v. 59, p. 114–128, http://doi.org/10.1016/j.marpetgeo.2014.07.029.

Hu, J., Fomel, S., and Ying, L., 2015, A fast algorithm for 3D azimuthally anisotropic velocity scan: Geophysical Prospecting, v. 63, no. 2, p. 368–377, http://doi.org/10.1111/1365-2478.12180.

Hu, Q., Ewing, R. P., and Rowe, H. D., 2015, Low nanopore connectivity limits gas production in Barnett formation: Journal of Geophysical Research: Solid Earth, v. 120, p. 8073–8087, http://doi.org/10.1002/2015JB012103.

Ikonnikova, S., Browning, J., Gülen, G., Smye, K. G., and Tinker, S. W., 2015, Factors influencing shale gas production forecasting: empirical studies of Barnett, Fayetteville, Haynesville, and Marcellus Shale plays: Economics of Energy & Environmental Policy, v. 4, no. 1, p. 19–35, http://doi.org/10.5547/2160-5890.4.1.siko.

Ikonnikova, S., and Gülen, G., 2015, Impact of low prices on shale gas production strategies: The Energy Journal, v. 36, p. 43–62, http://doi.org/10.5547/01956574.36.SI1.siko.

Ikonnikova, S., Gülen, G., Browning, J., Tinker, S. W., and Smye, K. G., 2015, Profitability of shale gas drilling: a case study of the Fayetteville shale play: Energy, v. 81, p. 382–393, http://doi.org/10.1016/j.energy.2014.12.051.

Islam, A., 2015, Rainy/non-rainy day pattern analysis for North Carolina: American Journal of Climate Change, v. 4, no. 1, p. 1–8, http://doi.org/10.4236/ajcc.2015.41001.

Islam, A., Patzek, T. W., and Sun, A. Y., 2015, Thermodynamics phase changes of nanopore fluids: Journal of Natural Gas Science and Engineering, v. 25, p. 134–139, http://doi.org/10.1016/j.jngse.2015.04.035.

Islam, A., and Sun, A. Y., 2015, Quantification of CO_2 masses trapped through free convection process in isothermal brine saturated reservoir: International Journal of Heat and Mass Transfer, v. 87, p. 128–137, http://doi.org/10.1016/j.ijheatmasstransfer.2015.03.083.

Jackson, C. A.-L., Jackson, M. P. A., and Hudec, M. R., 2015, Understanding the kinematics of salt-bearing passive margins: a critical test of competing hypotheses for the origin of the Albian Gap, Santos Basin, offshore Brazil: Geological Society of America Bulletin, v. 127, no. 11/12, p. 1730–1751, http://doi.org/10.1130/B31290.1.

Jackson, C. A.-L., Jackson, M. P. A., Hudec, M. R., and Rodriguez, C. R., 2015, Enigmatic structures within salt walls of the Santos Basin—Part 1: Geometry and kinematics from 3D seismic reflection and well data: Journal of Structural Geology, v. 75, p. 135–162, http://doi.org/10.1016/j.jsg.2015.01.010.

Janson, X., Lee, K., Zahm, C., and Kerans, C., 2015, Ground-penetrating radar imaging of Albian rudist buildups, central Texas: Interpretation, v. 3, no. 3, p. SY67–SY81, http://doi.org/10.1190/INT-2014-0273.1.

Javadpour, F., and Ettehadtavakkol, A., 2015, Gas transport processes in shale, *in* Rezaee, R., ed., Fundamentals of gas shale reservoirs: Hoboken, New Jersey, John Wiley & Sons, Inc., p. 245–266, SBN-13: 978-1118645796; ISBN-10: 1118645790.

Javadpour, F., McClure, M., and Naraghi, M. E., 2015, Slip-corrected liquid permeability and its effect on hydraulic fracturing and fluid loss in shale: Fuel, v. 160, p. 549–559, http://doi.org/10.1016/j.fuel.2015.08.017.

Karagunduz, A., Young, M. H., and Pennell, K. D., 2015, Influence of surfactants on unsaturated water flow and solute transport: Water Resources Research, v. 51, no. 4, p. 1977–1988, http://doi.org/10.1002/2014WR015845.

Karegar, M. A., Dixon, T. H., Malservisi, R., Yang, Q., Hosseini, S. A., and Hovorka, S. D., 2015, GPS-based monitoring of surface deformation associated with CO_2 injection at an enhanced oil recovery site: International Journal of Greenhouse Gas Control, v. 41, p. 116–126, http://doi.org/10.1016/j.ijggc.2015.07.006.

Karimi, P., and Fomel, S., 2015, Stratigraphic coordinates: a coordinate system tailored to seismic interpretation: Geophysical Prospecting, v. 63, no. 5, p. 1246–1255, http://doi.org/10.1111/1365-2478.12224.

Karimi, P., Fomel, S., Wood, L., and Dunlap, D., 2015, Predictive coherence: Interpretation, v. 3, no. 4, p. SAE1–SAE7, http://doi.org/10.1190/INT-2015-0030.1.

Kim, S., and Hosseini, S. A., 2015, Hydro-thermo-mechanical analysis during injection of cold fluid into a geologic formation: International Journal of Rock Mechanics & Mining Sciences, v. 77, p. 220–236, http://doi.org/10.1016/j.ijrmms.2015.04.010.

Klokov, A., Irkabaev, D., Ogiesoba, O. C., and Munasypov, N., 2015, Correlation between seismic diffractions extracted from vertical seismic profiling data and borehole logging in a carbonate environment: Interpretation, v. 3, no. 2, p. T121–T129, http://doi.org/10.1190/INT-2014-0156.1.

Klokov, A., Irkabaev, D., Sharova, T., and Munasypov, N., 2015, Reef delineation by offset vertical seismic profiling and seismic diffractions: Journal of Seismic Exploration, v. 24, no. 2, p. 135–150.

Lander, R. H., and Laubach, S. E., 2015, Insights into rates of fracture growth and sealing from a model for quartz cementation in fractured sandstones: Geological Society of America Bulletin, v. 127, no. 3/4, p. 516–538, http://doi.org/10.1130/B31092.1.

Lee, H. P, Olson, J. E., Holder, J., Gale, J. F. W., and Myers, R. D, 2015, The interaction of propagating opening mode fractures with preexisting discontinuities in shale: Journal of Geophysical Research: Solid Earth, v. 120, no. 1, p. 169–181, http://doi.org/10.1002/2014JB011358.

Li, S., and Fomel, S., 2015, A robust approach to time-to-depth conversion and interval velocity estimation from time migration in the presence of lateral velocity variations: Geophysical Prospecting, v. 63, no. 2, p. 315–337, http://doi.org/10.1111/1365-2478.12191.

Liu, M., Xu, X., and Sun, A. Y., 2015, Decreasing spatial variability in precipitation extremes in southwestern China and the local/large-scale influencing factors: Journal of Geophysical Research: Atmospheres, v. 120, no. 13, p. 6480–6488, http://doi.org/10.1002/2014JD022886.

Liu, M., Xu, X., Sun, A. Y., Wang, K., Yue, Y., Tong, X., and Liu, W., 2015, Evaluation of high-resolution satellite rainfall products using rain gauge data over complex terrain in southwest China: Theoretical and Applied Climatology, v. 119, no. 1–2, p. 203–219, http://doi.org/10.1007/s00704-014-1092-4.

Liu, Y., Fomel, S., and Liu, C., 2015, Signal and noise separation in prestack seismic data using velocity-dependent seislet transform: Geophysics, v. 80, no. 6, p. WD117–WD128, http://doi.org/10.1190/geo2014-0234.1.

Long, D., Longuevergne, L., and Scanlon, B. R., 2015, Global analysis of approaches for deriving total water storage changes from GRACE satellites: Water Resources Research, v. 51, p. 2574–2594, http://doi.org/10.1002/2014wr016853.

Loucks, R. G., Reed, R. M., and Ambrose, W. A., 2015, Analysis of pore networks and reservoir quality of the Upper Cretaceous Woodbine sandstone in the high-recovery-efficiency, giant East Texas Field: GCAGS Journal, v. 4, p. 88–108.

Lu, J., Larson, T. E., and Smyth, R. C., 2015, Carbon isotope effects of methane transport through Anahuac Shale—a core gas study: Journal of Geochemical Exploration, v. 148, p. 138–149, http://doi.org/10.1016/j.gexplo.2014.09.005.

Lu, J., Ruppel, S. C., and Rowe, H. D., 2015, Organic matter pores and oil generation in the Tuscaloosa marine shale: AAPG Bulletin, v. 99, no. 2, p. 333–357, http://doi.org/10.1306/08201414055.

Luo, G., Flemings, P. B., Hudec, M. R., and Nikolinakou, M. A., 2015, The role of pore fluid overpressure in the substrates of advancing salt sheets, ice glaciers, and critical-state wedges: Journal of Geophysical Research: Solid Earth, v. 120, no. 1, p. 87–105, http://doi.org/10.1002/2014JB011326.

Male, F., Islam, A., Patzek, T. W., Ikonnikova, S., Browning, J., and Marder, M. P., 2015, Analysis of gas production from hydraulically fractured wells in the Haynesville Shale using scaling methods: Journal of Unconventional Oil and Gas Resources, v. 10, p. 11–17, http://doi.org/10.1016/j.juogr.2015.03.001.

Meckel, T., Bryant, S. L., and Ravi Ganesh, P., 2015, Characterization and prediction of CO_2 saturation resulting from modeling buoyant fluid migration in 2D heterogeneous geologic fabrics: International Journal of Greenhouse Gas Control, v. 34, p. 85–96, http://doi.org/10.1016/j.ijggc.2014.12.010.

Melo, D., Xavier, A. C., Bianchi, T., Oliveira, P., Scanlon, B. R., Lucas, M. C., and Wendland, E., 2015, Performance evaluation of rainfall estimates by TRMM Multi-satellite Precipitation Analysis 3B42V6 and V7 over Brazil: Journal of Geophysical Research: Atmospheres, v. 120, no. 18, p. 9426–9436, http://doi.org/10.1002/2015JD023797.

Mori, H., Trevisan, L., and Illangasekare, T. H., 2015, Evaluation of relative permeability functions as inputs to multiphase flow models simulating supercritical CO_2 behavior in deep geologic formations: International Journal of Greenhouse Gas Control, v. 41, p. 328–335, http://doi.org/10.1016/j.ijggc.2015.05.023.

Morshed, K., Sharif, M., and Islam, A., 2015, Laminar mixed convection in a lid-driven square cavity with two isothermally heated square internal blockages: Chemical Engineering Communications, v. 202, p. 1176–1190, http://doi.org/10.1080/00986445.2014.912634.

Moscardelli, L., and Wood, L., 2015, Morphometry of mass-transport deposits as a predictive tool: Geological Society of America Bulletin, v. 128, no. 1–2, p. 47–80, http://doi.org/10.1130/B31221.1.

Mukhopadhyay, S., Doughty, C., Bacon, D., Li, J., Wei, L., Yamamoto, H., Gasda, S., Hosseini, S. A., Nicot, J.-P., and Birkholzer, J. T., 2015, The Sim-SEQ Project: comparison of selected flow models for the S-3 site: Transport in Porous Media, v. 108, p. 207–231, http://doi.org/10.1007/s11242-014-0361-0.

Nance, H. S., and Rowe, H. D., 2015, Eustatic controls on stratigraphy, chemostratigraphy, and water mass evolution preserved in a Lower Permian mudrock succession, Delaware Basin, west Texas, USA: Interpretation, v. 3, no. 1, p. SH11–SH25, http://doi.org/10.1190/INT-2014-0207.1.

Nestell, G. P., Nestell, M. K., Ellwood, B. B., Wardlaw, B. R., Basu, A. R., Ghosh, N., Lan, L. T. P., Rowe, H. D., Hunt, A., Tomkin, J. H., and Ratcliffe, K. T., 2015, High influx of carbon in walls of agglutinated foraminifers during the Permian–Triassic transition in global oceans: International Geology Review, v. 57, no. 4, p. 411–427, http://doi.org/10.1080/00206814.2015.1010610.

Nicot, J.-P., Lu, J., Mickler, P., and Solano, S. V., 2015, Chapter 26: Impact of CO_2 impurities on storage performance and assurance, *in* Gerdes, K. F., ed., Carbon dioxide capture for storage in deep geologic formations—results from the CO_2 Capture Project, Volume 4: CCS Technology Development and Demonstration Results (2009–2014): UK, CPL Press, p. 385–400.

Ogiesoba, O. C., and Hernandez, R., 2015, Diapiric shale and coast-perpendicular, fault-related subbasins, south Texas Gulf Coast: Interpretation, v. 3, no. 2, p. T43–T56, http://doi.org/10.1190/INT-2014-0016.1.

Ogiesoba, O. C., Klokov, A., and Hernandez, R., 2015, Diffraction imaging of polygonal faults within a submarine volcanic terrain, Maverick Basin, south Texas: Interpretation, v. 3, no. 1, p. SF81–SF99, http://doi.org/10.1190/INT-2014-0105.1.

Olariu, M. I., and Olariu, C., 2015, Ubiquity of wave-dominated deltas in outer-shelf growth-faulted compartments: Journal of Sedimentary Research, v. 85, p. 768–779, http://doi.org/10.2110/jsr.2015.51.

Oldenburg, C. M., Nicot, J.-P., Jordan, P. D., Zhang, Y., Pan, L., Houseworth, J. E., Meckel, T., Carr, D. L., and Bryant, S. L., 2015, Chapter 32: Health, safety, and environmental risk assessment of geologic carbon sequestration: overview of the certification framework, example application, and selected special studies 2010–2014, *in* Gerdes, K. F., ed., Carbon dioxide capture for storage in deep geologic formations—results from the CO_2 Capture Project, Volume 4: CCS Technology Development and Demonstration Results (2009–2014): UK, CPL Press, p. 569–592.

Olson, H. C., Snedden, J. W., and Cunningham, R., 2015, Development and application of a robust chronostratigraphic framework in Gulf of Mexico Mesozoic exploration: Interpretation, v. 3, no. 2, p. SN39–SN58, http://doi.org/10.1190/INT-2014-0179.1.

Paine, J. G., Andrews, J. R., Saylam, K., and Tremblay, T. A., 2015, Airborne LiDAR-based wetland and permafrost-feature mapping on an Arctic coastal plain, North Slope, Alaska, *in* Tiner, R. W., Lang, M. W., and Klemas, V. V., eds., Remote sensing of wetlands: applications and advances: London, CRC Press, p. 413–434.

Pei, H., Scanlon, B. R., Shen, Y., Reedy, R. C., Long, D., and Liu, C., 2015, Impacts of varying agricultural intensification on crop yield and groundwater resources: comparison of the North China Plain and U.S. High Plains: Environmental Research Letters, v. 10, no. 4, paper 044013, 14 p., http://doi.org/10.1088/1748-9326/10/4/044013.

Peng, S., Yang, J., Xiao, X., Loucks, R. G., Ruppel, S. C., and Zhang, T., 2015, An integrated method for upscaling pore-network characterization and permeability estimation: example from the Mississippian Barnett Shale: Transport in Porous Media, v. 109, no. 2, p. 359–376, http://doi.org/10.1007/s11242-015-0523-8.

Phelps, R. M., Kerans, C., Da-Gama, R. O. B. P., Jeremiah, J., Hull, D., and Loucks, R. G., 2015, Response and recovery of the Comanche carbonate platform surrounding multiple Cretaceous oceanic anoxic events, northern Gulf of Mexico: Cretaceous Research, v. 54, p. 117–144, http://doi.org/10.1016/j.cretres.2014.09.002.

Pierre, J. P., Abolt, C. J., and Young, M. H., 2015, Impacts from above-ground activities in the Eagle Ford Shale play on landscapes and hydrologic flows, La Salle County, Texas: Environmental Management, v. 55, no. 6, p. 1262–1275, http://doi.org/10.1007/s00267-015-0492-2.

Pommer, M., and Milliken, K., 2015, Pore types and pore-size distributions across thermal maturity, Eagle Ford Formation, southern Texas: AAPG Bulletin, v. 99, no. 9, p. 1713–1744, http://doi.org/10.1306/03051514151.

Reed, R. M., and Loucks, R. G., 2015, Low-thermal-maturity (<0.7% VR) mudrock pore systems: Mississippian Barnett Shale, southern Fort Worth Basin: GCAGS Journal, v. 4, p. 15–28.

Reeve, M. T., Bell, R. E., Duffy, O. B., Jackson, C. A.-L., and Sansom, E., 2015, The growth of non-colinear normal fault systems; What can we learn from 3D seismic reflection data?: Journal of Structural Geology, v. 70, p. 141–155, http://doi.org/10.1016/j.jsg.2014.11.007.

Romanak, K. D., Womack, G. L., Bomse, D. S., and Dodds, K., 2015, Chapter 37: Field practical guide to environmental and leak characterization using a process-based soil gas monitoring method, *in* Gerdes, K. F., ed., Carbon dioxide capture for storage in deep geological formations—results from the CO_2 Capture Project, Volume 4: CCS Technology Development and Demonstration Results (2009–2014): UK, CPL Press, p. 705–732.

Santillan, E.-F. U., Shanahan, T. M., Omelon, C. R., Major, J. R., and Bennett, P. C., 2015, Isolation and characterization of a CO_2-tolerant Lactobacillus strain from Crystal Geyser, Utah, U.S.A.: Frontiers in Earth Science, v. 3, p. 1–11, http://doi.org/10.3389/feart.2015.00041.

Santos, R. F. V. C., Miranda, T. S., Barbosa, J. A., Gomes, I. F., Matos, G. C., Gale, J. F. W., Neumann, V. H. L. M., and Guimaraes, L. J. N., 2015, Characterization of natural fracture systems: analysis of uncertainty effects in linear scanline results: AAPG Bulletin, v. 99, no. 12, p. 2203–2219, http://doi.org/10.1306/05211514104.

Scanlon, B. R., Zhang, Z., Reedy, R. C., Pool, D. R., Save, H., Long, D., Chen, J., Wolock, D. M., Conway, B. D., and Winester, D., 2015, Hydrologic implications of GRACE satellite data in the Colorado River Basin: Water Resources Research, v. 51, p. 9891–9903, http://doi.org/10.1002/2015WR018090.

Schwartz, R. C., Baumhardt, R. L., Scanlon, B. R., Bell, J. M., Davis, R. G., Ibragimov, N., Jones, O. R., and Reedy, R. C., 2015, Long-term changes in soil organic carbon and nitrogen under semiarid tillage and cropping practices: Soil Science Society of America Journal, v. 79, no. 6, p. 1771–1781, http://doi.org/10.2136/sssaj2015.06.0241.

Siebert, S., Kummu, M., Porkka, M., Doll, P., Ramankutty, N., and Scanlon, B. R., 2015, A global dataset of the extent of irrigated land from 1900 to 2005: Hydrology and Earth System Sciences: Discussions, no. 11, p. 13207–13258, http://doi.org/10.5194/hessd-11-13207-2014.

Skaggs, T., Young, M. H., and Vrugt, J., 2015, Reproducible research in vadose zone sciences: Vadose Zone Journal, v. 14, no. 10, 5 p., http://doi.org/10.2136/vzj2015.06.0088.

Springer, G. S., Poston, H. A., Hardt, B., and Rowe, H. D., 2015, Groundwater lowering and stream incision rates in the Central Appalachian Mountains of West Virginia, USA: International Journal of Speleology, v. 44, no. 1, p. 99–105, http://doi.org/10.5038/1827-806X.44.1.9.

Sripanich, Y., and Fomel, S., 2015, On anelliptic approximations for qP velocities in transversely isotropic and orthorhombic media: Geophysics, v. 80, no. 5, p. C89–C105, http://doi.org/10.1190/geo2014-0534.1.

Sueki, S., Acharya, K., Huntington, J., Liebert, R., Healey, J., Jasoni, R., and Young, M. H., 2015, Defoliation effects of *Diorhabda carinulata* on tamarisk evapotranspiration and groundwater levels: Ecohydrology, v. 8, p. 1560–1571, http://doi.org/10.1002/eco.1604.

Sun, A. Y., Chen, J. L., and Donges, J., 2015, Global terrestrial water storage connectivity revealed using complex climate network analyses: Nonlinear Processes in Geophysics, v. 22, p. 433–446, http://doi.org/10.5194/npg-22-433-2015.

Sun, A. Y., Lu, J., and Hovorka, S. D., 2015, A harmonic pulse testing method for leakage detection in deep subsurface storage formations: Water Resources Research, v. 51, no. 6, p. 4263–4281, http://doi.org/10.1002/2014WR016567.

Sun, A. Y., Miranda, R. M., and Xu, X., 2015, Development of multi-metamodels to support surface water quality management and decision making: Environmental Earth Sciences, v. 73, no. 1, p. 423–434, http://doi.org/10.1007/s12665-014-3448-6.

Sun, J., Zhu, T., and Fomel, S., 2015, Viscoacoustic modeling and imaging using low-rank approximation: Geophysics, v. 80, no. 5, p. A103–A108, http://doi.org/10.1190/geo2015-0083.1.

Tahmasebi, P., Javadpour, F., and Sahimi, M., 2015, Multiscale and multiresolution modeling of shales and their flow and morphological properties: Scientific Reports, v. 5, no. 16373, 11 p., http://doi.org/10.1038/srep16373.

Tahmasebi, P., Javadpour, F., and Sahimi, M., 2015, Three-dimensional stochastic characterization of shale SEM images: Transport in Porous Media, v. 110, p. 521–531, http://doi.org/10.1007/s11242-015-0570-1.

Talling, P. J., Allin, J., Armitage, D. A., Arnott, R. W. C., Cartigny, M. J. B., Clare, M. A., Felletti, F., Covault, J., Girardclos, S., Hansen, E., Hill, P. R., Hiscott, R. N., Hogg, A. J., Clarke, J. H., Jobe, Z. R., Malgesini, G., Mozzato, A., Naruse, H., Parkinson, S., Peel, F. J.,

Piper, D. J. W., Pope, E., Postma, G., Rowley, P., Sguazzinni, A., Stevenson, C. J., Sumner, E. J., Sylvester, Z., Watts, C., and Xu, J., 2015, Key future directions for research on turbidity currents and their deposits: Journal of Sedimentary Research, v. 85, p. 153–169, http://doi.org/10.2110/jsr.2015.03.

Trevisan, L., Pini, R., Cihan, A., Birkholzer, J. T., Zhou, Q., and Illangasekare, T. H., 2015, Experimental analysis of spatial correlation effects on capillary trapping of supercritical CO_2 at the intermediate laboratory scale in heterogeneous porous media: Water Resources Research, v. 51, no. 11, p. 8791–8805, http://doi.org/10.1002/2015WR017440.

Ukar, E., and Cloos, M., 2015, Magmatic origin of low-T mafic blueschist and greenstone blocks from the Franciscan melange, San Simeon, California: Lithos, v. 230, p. 17–29, http://doi.org/10.1016/j.lithos.2015.05.002.

van der Kolk, D. A., Flaig, P. P., and Hasiotis, S. T., 2015, Paleoenvironmental reconstruction of a Late Cretaceous, muddy, river-dominated polar deltaic system: Schrader Bluff - Prince Creek Formation transition, Shivugak Bluffs, North Slope of Alaska, U.S.A: Journal of Sedimentary Research, v. 85, p. 903–936, http://doi.org/10.2110/jsr.2015.58.

Wang, S., Feng, Q., Javadpour, F., Xia, T., and Li, Z., 2015, Oil adsorption in shale nanopores and its effect on recoverable oil-in-place: International Journal of Coal Geology, v. 147–148, p. 9–24, http://doi.org/10.1016/j.coal.2015.06.002.

Weijermars, R., Hudec, M. R., Dooley, T. P., and Jackson, M. P. A., 2015, Downbuilding salt stocks and sheets quantified in 3-D analytical models: Journal of Geophysical Research: Solid Earth, v. 120, no. 6, p. 4616–4644, http://doi.org/10.1002/2014JB011704.

Wolaver, B. D., Coogan, J. C., Horton, B. K., Bermudez, L. S., Sun, A. Y., Wawrzyniec, T. F., Zhang, T., Shanahan, T. M., Dunlap, D. B., Costley, R., and de la Rocha, L., 2015, Structural and hydrogeologic evolution of the Putumayo basin and adjacent fold-thrust belt, Colombia: AAPG Bulletin, v. 99, no. 10, p. 1893–1927, http://doi.org/10.1306/05121514186.

Xu, G., Xu, X., Liu, M., Sun, A. Y., and Wang, K., 2015, Spatial downscaling of TRMM precipitation product using a combined multifractal and regression approach: demonstration for South China: Water, v. 7, p. 3083–3102, http://doi.org/10.3390/w7063083.

Yan, D., Wang, H., Fu, Q., Chen, Z., He, J., and Gao, Z., 2015, Geochemical characteristics in the Longmaxi Formation (Early Silurian) of South China: implications for organic matter accumulation: Marine and Petroleum Geology, v. 65, p. 290–301, http://doi.org/10.1016/j.marpetgeo.2015.04.016.

Yan, D., Wang, H., Fu, Q., Chen, Z., He, J., and Gao, Z, 2015, Organic matter accumulation of Late Ordovician sediments in North Guizhou Province, China: sulfur isotope and trace element evidences: Marine and Petroleum Geology, v. 59, p. 348–358, http://doi.org/10.1016/j.marpetgeo.2014.09.017.

Yang, C., Hovorka, S. D., Treviño, R. H., and Delgado-Alonso, J., 2015, Integrated framework for assessing impacts of CO_2 leakage on groundwater quality and monitoring-network efficiency: case study at a CO_2 enhanced oil recovery site: Environmental Science & Technology, v. 49, p. 8887–8898, http://doi.org/10.1021/acs.est.5b01574.

Yang, C., Treviño, R. H., Hovorka, S. D., and Delgado-Alonso, J., 2015, Semi-analytical approach to reactive transport of CO_2 leakage into aquifers at carbon sequestration sites: Greenhouse Gases Science and Technology, v. 5, no. 6, p. 786–801, http://doi.org/10.1002/ghg.1527.

Yang, P., and Fomel, S., 2015, Seislet-based morphological component analysis using scale-dependent exponential shrinkage: Journal of Applied Geophysics, v. 118, p. 66–74, http://doi.org/10.1016/j.jappgeo.2015.04.003.

Zeng, H., 2015, Predicting geometry and stacking pattern of thin beds by interpreting geomorphology and waveforms using sequential stratal-slices in the Wheeler domain: Interpretation, v. 3, no. 3, p. SS49–SS64, http://doi.org/10.1190/INT-2014-0181.1.

Zeng, H., and Marfurt, K. J., 2015, Recent progress in analysis of seismically thin beds: Interpretation, v. 3, no. 3, p. SS15–SS22, http://doi.org/10.1190/INT-2014-0232.1.

Zeng, H., Zhao, X., Zhu, X., Jin, F., Dong, Y., Wang, Y., Zhu, M., and Zheng, R., 2015, Seismic sedimentology characteristics of sub-clinoformal shallow-water meandering river delta: a case from the Suning area of Raoyang sag in Jizhong depression, Bohai Bay Basin, NE China [in Chinese with English abstract]: Petroleum Exploration and Development, v. 42, no. 5, p. 1–11, http://doi.org/10.1016/S1876-3804(15)30057-4.

Zhu, J., Sun, D., Young, M. H., Caldwell, T., and Pan, F., 2015, Shrub spatial organization and partitioning of evaporation and transpiration in arid environments: Ecohydrology, v. 8, p. 1218–1228, http://doi.org/10.1002/eco.1576.

Transitions

In Memoriam

Chester "Chet" Garrett, Jr., a Bureau researcher from 1980 to 1996, passed away July 16, 2015.

After serving as a naval pilot in World War II, Chet completed his degree in petroleum engineering at the University of Tulsa, then went on to a 32-year career in petroleum exploration before joining the Bureau as a research science associate. At the Bureau—where he was praised for his "indefatigable enthusiasm" and "strong sense of commitment to the geological community"—Chet was author or coauthor of two geological circulars (GC8402 and GC8503), one Report of Investigations (RI 203), and six oil and gas atlases. During his career, he served as the president of the Austin Geological Society and was a long-standing member of the House of Delegates of the AAPG. After retiring from the Bureau, Chet received numerous awards from Austin organizations (including the Kiwanis, St. David's Medical Center, and the Foundation for the Homeless) in recognition of his volunteer work.

Mary McBride, the Bureau's public information geologist from 1981 to 1991, passed away May 22, 2015.

Mary received her BS in geology from The University of Texas at Austin and her MS in geology from the University of Oklahoma. She taught geology at the University of Houston and science in the Richardson ISD before joining the Bureau in 1979 as a research scientist associate. She was first author (with co-authors Chock Woodruff and L. E. Craig) of "Facies Distribution within the Hosston Formation, Central Texas—Implications to Low Temperature Geothermal Waters," and authored numerous other publications and articles, including the annual "Mineral Industry of Texas" reports that appeared in *The Texas Almanac*. The Bureau honors her memory and many contributions.

Ron Russell, the Bureau's IT manager from 1998 to 2015, passed away April 5, 2015. Ron was highly regarded for his tenacious work ethic and his 24/7 presence in guiding the growth of the Bureau's massive Information Technologies and Data Management systems. He is remembered by staff as "tough," "fair," "diligent," "caring," and "a person of integrity."

A private person of few words, Ron was dedicated to his family, faith, and community. He was a service veteran of 32 years, and earned a BS in business management from the University of Maryland and an MA in economics from the University of Oklahoma. Ron's consistent excellence and steadfast presence will be long remembered and deeply missed.

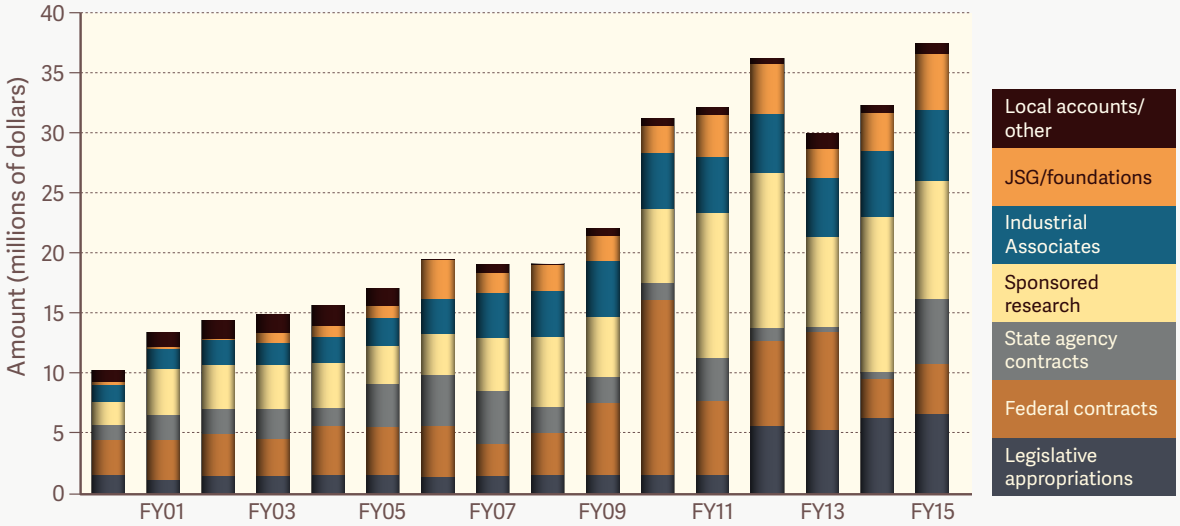
Retirement

Tom Tremblay, the Bureau's pioneer GIS expert and coastal wetlands scientist, retired at the end of August 2015.

His 26-year tenure at the Bureau began in 1989 as a graduate research assistant. Throughout his career, Tom combined knowledge from his University of Texas at Austin BA in geology and MA in geography to build GIS capability and continue the Bureau's long history in Texas coastal wetlands mapping and analysis, among many other research topics. He served as leader or co-leader of 15 projects funded by several state agencies and nonprofit organizations, including the General Land Office, Texas Parks & Wildlife Department, Texas Commission on Environmental Quality, and Coastal Bend Bays and Estuaries Program. He contributed GIS expertise to many other Bureau projects and served as author or co-author of two books, a book chapter, 18 articles, 12 atlases and maps, 42 abstracts, and 49 contract reports.

Finances

Grants, Contracts, and Other Revenue



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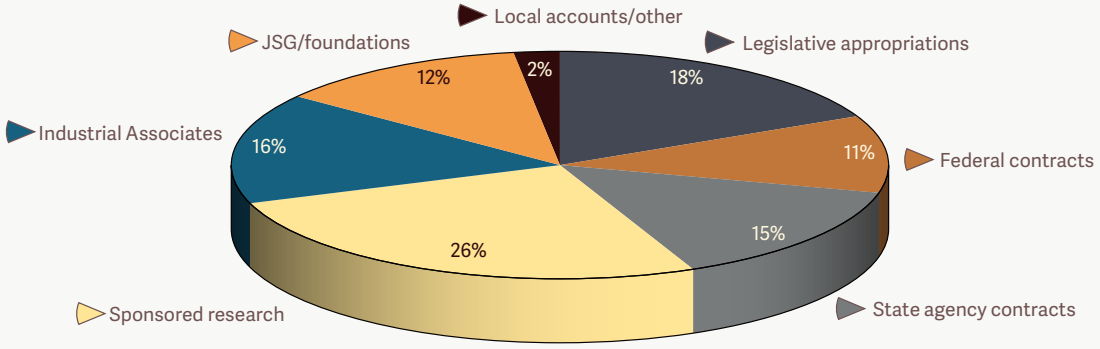

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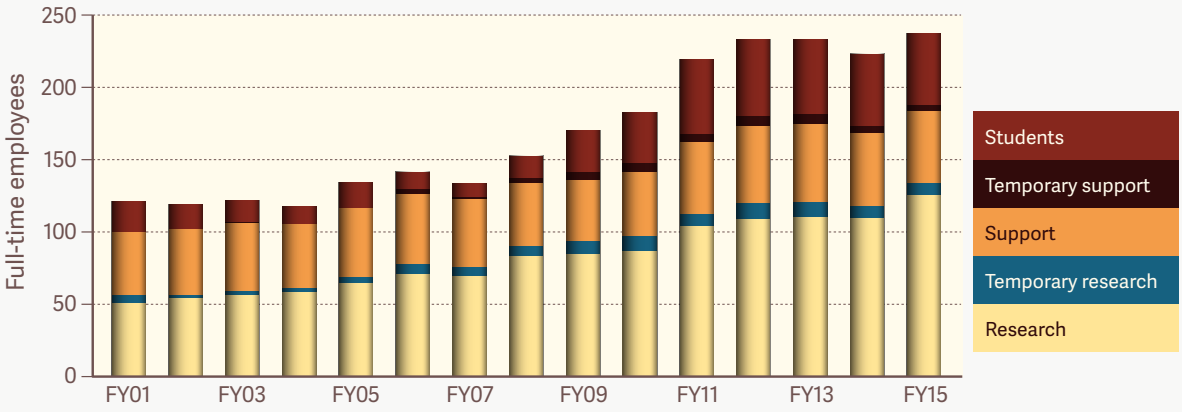

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