2025 RCRL Research Prospectus

Carbonate Reservoir Characterization Research Laboratory
Bureau of Economic Geology
University of Texas at Austin

Reservoir Characterization Research Laboratory

Photo credit: Josh Malone

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Carbonate Reservoir Characterization Research Laboratory (RCRL)

Mission

The Carbonate Reservoir Characterization Research Laboratory (RCRL) mission is to use outcrop and subsurface geologic, geophysical, and petrophysical data from carbonate reservoir strata as the basis for developing new and integrated methodologies and concepts to better explain and describe the 3D-reservoir parameters, and to improve discovery, production, and storage of gas and fluids in carbonate rocks in the subsurface. In addition to this research mission, RCRL researchers are dedicated to technology transfer and education, continuously offering state-of-the-art training in short courses, field seminars, in-house reviews of selected assets, and extensive graduate student supervision and guided research.

Overall Research Goals

RCRL approaches reservoir characterization through three main scales of investigation, using both outcrop and subsurface datasets: (1) platform-to-basin-scale stratigraphy; (2) reservoir architecture and pore network distribution, including both matrix and non-matrix systems (e.g., fractures and paleokarst); and (3) structural and geomechanical properties characterization related to stratigraphic framework.

Membership and Funding

We invite your company to participate in the continuation of the RCRL Carbonate Reservoirs Research Program. In 2025, the annual RCRL Industrial Associates contribution to the program will be $65,000 per sponsor per year. To encourage sponsors to commit to a 2-year agreement so that we can better plan a longer-range research program and reduce the time and effort in securing agreements, we offer a 2-year (2025 and 2026) rate of $60,000 per year. Participating sponsors will sign a Memorandum of Agreement (MOA) for the 2-year commitment, payment being due in January of each year.

Membership Benefits

Industrial sponsors receive new research results at annual review meetings, in short courses, during mentoring activities, in prepublications, and on the continually updated, member only RCRL website database (http://www.beg.utexas.edu/rcrl/members/). Our searchable website protects the investment in RCRL research and makes previously presented material easy to locate. The data area contains digital presentations, including archived video and annotated presentations, core workshop books, and fieldtrip guidebooks. Supplemental data, such as maps, core photos, porosity and permeability data, and digital outcrop reservoir models, are available through our password-protected database for RCRL members.

Interaction

We host an Annual Review Meeting and an associated Fieldtrip and Core Workshop, in addition to an additional core-based training in Houston in the spring. These workshops are interactive, utilizing subsurface data, along with applicable outcrop analogues to emphasize applications of key elements that are important in understanding carbonate systems and their importance to hydrocarbon production. All presentations from our annual meetings and workshops are presented via Teams and are recorded and available on our member website.

Contact

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TEXAS Geosciences
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The University of Texas at Austin

Reservoir Characterization Research Laboratory

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New Addition to RCRL

We are excited to announce that Dr. Ben Rendall will be joining the RCRL research staff in 2025 as an Assistant Research Professor! Ben brings a renewed energy for both outcrop and subsurface characterization to the group as he blends his love of field work with geologic insight for what is important for subsurface reservoir applications and basin geology. We know Ben's knowledge and enthusiasm for carbonate geology will be infectious for our sponsors.

As many know, Charlie will be retiring from teaching in the Department of Planetary and Earth Sciences after this spring, but we are glad that he will remain involved in research with RCRL to continue to push us toward the 40-year mark and beyond!

RCRL Research Topics in 2025

Regional Stratigraphy Studies

Stratigraphic Validation of the Permian Basin 3D Geomodel (3+ year project)

In 2025, we are planning to take a deep dive into the Permian Basin geomodel that was built over the last 5 years. We want to validate that the stratigraphic relationship between modeled units that RCRL has worked over the last few decades are accurately represented to the best of our collective knowledge in the 3D geocellular model. We also plan to improve the facies classification and distribution in key areas of the regional geocellular model. The goal is to go a step beyond the initial 3 log-based facies classification using lithology calculations derived from multi-mineral petrophysical calculations. This model will form the basis for ongoing machine and deep learning research focused on seismic fault extraction, seismic facies prediction, and machine learning-supported well log correlation, petrophysical, and geomechanical workflows. This effort will be in conjunction with a detailed look at the San Andres and Pennsylvanian intervals as described below.

Basin-wide to Reservoir-Scale Synthesis of San Andres-Grayburg-Avalon-Bone Spring Lime-Brushy Canyon-Cherry Canyon Strata for Highlighting Stratigraphic Traps and High-Grading SWD targets (2-3 year project)

The San Andres and Grayburg Formations, along with their basinal equivalents (Avalon/Bone Spring Lime, Brushy Canyon, and Cherry Canyon), have been pivotal to conventional and, more recently, unconventional resource production in the Permian Basin. Since 1987, RCRL has conducted continuous studies on these intervals at both the outcrop and subsurface levels, spanning reservoir-scale and exploration/shelf-to-basin scales. While industry interest has shifted toward basin-centered unconventional plays over the past decade, there is now renewed focus on the conventional fairways of the San Andres and Grayburg formations. This resurgence is driven by the potential of targeted horizontal drilling and the increasing importance of these formations for saltwater disposal (SWD). To support future industry activities, we aim to develop a comprehensive, basin-wide framework for these intervals.

One of the key challenges of the San Andres-Grayburg system is its inherent complexity—there is no universal model for understanding porosity and seal development, either stratigraphically or structurally. The basinal time equivalents exhibit a wide range of facies, including slope breccias, deep-water muds, turbiditic sandstones, and shallow-water, basin-restricted oolitic shoal complexes associated with the major lowstand event in the terminal San Andres-Cherry Canyon strata. Identifying optimal porosity intervals for disposal and stratigraphically complex, hydrocarbon-bearing zones requires an updated and expanded sequence framework.

To achieve this, we plan to leverage the newly developed Permian Basin supermodel framework and datasets assembled by Robin Dommisse as a foundation. This effort will integrate high-resolution sequence frameworks from key reservoir-scale studies, including Vacuum, Hobbs, Eunice-Monument, Seminole, Wasson, North Cowden, Johnson, South Cowden, Midland Farms, Mabee, and Yates fields, as well as related areas such as Howard-Glasscock and Olson. The result will be a set of regionally relevant examples for industry specialists to utilize. Deliverables will include regional wireline and seismic profiles focused on the San Andres-Grayburg-Avalon-Bone Spring Lime-Cherry Canyon interval, along with detailed core-log-seismic profiles from reservoirs where data are available.

We will integrate the historical injection and production data into the model in preparation for future pore-pressure and fluid flow reservoir simulation work. We plan to use reservoir simulation software capable of running on local RCRL 32-CPU workstations as well as UT's Texas Advanced Computing Center (TACC) high-performance computing cluster systems (e.g., Longhorn6). Software applications like Rock Flow Dynamics tNavigator combine multi-CPU resources with multi-GPU (graphics card) compute resources to achieve multiple-order-of-magnitude faster reservoir simulation runtimes ideally suited for regional simulation studies.

This project will span 2–3 years, with products delivered annually. We also welcome collaboration with groups actively working on related systems, where our expertise could provide valuable insights. These interactions will not only contribute to the project's success but also refine our understanding of this complex system.

Regional synthesis of Pennsylvanian Strata in the Permian Basin

We plan to synthesize the stratigraphic architecture of the Pennsylvanian in the Permian Basin, building on previous RCRL studies in both subsurface and outcrop, as well as insights from published literature. Our objectives include refining the regional cross-section for this interval and updating select paleogeographic maps originally published by Wright (2011). Through this work, we aim to gain a deeper understanding of the Pennsylvanian stratigraphic evolution during the climatic shift toward peak icehouse conditions, associated with the Ancestral Rocky Mountain deformation in the Permian Basin.

Albian-age Shelf- to Intrashelf-Basin Exposures, Facies Patterns, and Structure Models, Southwest Texas (2+ year project)

We are expanding our study of the Devil River Trend in southwest Texas, building on previous work in the Pecos River area and ongoing research by Braden Vines along the Rio Grande River, including exposures along the Devil's River itself. These outcrops offer seismic-scale insights into the subtle intrashelf basin framework, showcasing large coral-rudist reef complexes and prograding grainstone ramp margins across multiple sequences. Additionally, we plan to revisit the more proximal settings in the Leakey/Lost Maples area, where the Devil's River Trend transitions landward into shelfal strata with well-developed cyclicity and remarkable high-energy grainstone complexes. This effort will enhance our understanding of variations in cycle architecture, volumetric and facies partitioning, and grainstone development along both dip and strike. The findings will also provide valuable analogs for similar intra-shelf basin margins in the Middle East.

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Reservoir Characterization

Stratigraphic Architecture of Reservoirs, Central Basin Platform (2+ year project)

RCRL has access to extensive 3D seismic surveys provided by WesternGeco, covering the northwest corner of the Central Basin Platform (CBP). This region hosts significant production from the San Andres and Grayburg Formations (e.g., Eunice North Monument, Hobbs) and the Lower Clearfork (e.g., Abo, Drinkard). Currently, our focus is on the San Andres–Grayburg interval in the northeast corner of the CBP. We plan to expand our study to deeper intervals, leveraging seismic integration to better delineate reservoir architecture and develop advanced strategies for enhanced oil recovery (EOR), water disposal, carbon capture and underground storage (CCUS), and hydrogen storage. This year, we will also utilize newly available cores from the Central Basin Platform to revisit the Grayburg, San Andres, Strawn, and deeper formations, including the Mississippian Lime and Devonian.

San Andres Grayburg Monument field core and 3D seismic integration (2-year project).

We will continue integrating core and 3D seismic data in the Monument Field, utilizing 21 newly available cores provided to RCRL. This expanded dataset will enable a more detailed characterization of the stratigraphic architecture within the field. Our primary focus is on identifying the processes responsible for the complex mounded seismic geometries observed in the thickest parts of the field. Additionally, we aim to assess the lateral variability in both facies and karst extent, evaluating their implications for reservoir quality and performance.

Upper Jurassic Smackover Core-East Texas and Arkansas (3+ year project)

In 2025, we plan to deepen our investigation of the Smackover Formation in Texas and Arkansas. This work will include detailed core descriptions at the BEG to improve the regional understanding of the formation in these areas. Additionally, we aim to collect new data from the described cores for petrographic and petrophysical analyses. Our long-term objective is to better understand the regional facies variability within the Smackover Formation and evaluate how changes along strike and between depositional sequences influence its stratigraphic architecture and reservoir quality.

Salt Creek Field Characterization and Machine Learning Workflows for Facies and Permeability Distributions

Accurate 3D reservoir models are critical for understanding and managing the production behavior of mature reservoirs undergoing carbon dioxide (CO_2) flooding. We have completed a 3D Salt Creek geocellular model based on 16 core descriptions, 24 biostratigraphic wells, stratigraphic well log correlation of 320 wells, resulting in a 200 million cell geocellular model based on 300 seismic horizons. We upscaled and distributed well log and core data, including gamma ray, density, and neutron porosity, sonic, and core porosity and permeability. We plan to refine the seismically guided geobody framework using deep learning-based facies prediction for the 3D distribution of the porous grainstone units identified in core. We will create facies-conditioned permeability distributions using a variety of newly developed machine learning methods. Next, we will estimate well connectivity from production data using capacitance resistance modeling and compare them to geomodel-derived properties using machine learning. This model describes the complex stratigraphy and facies of isolated platform reservoirs and will be used as a basis for future CO_2 enhanced oil recovery and storage 3D reservoir simulation research.

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Slope and Basinal Depositional Systems Studies

Late Wolfcampian-Leonardian Mixed Slope Outcrop Analogue Characterization, Sierra Diablo Mountains (3+ year project)

This year, we plan to continue our study of the shelf-to-slope strata transition exposed in the Sierra Diablo Mountains, focusing on the Upper Wolfcampian and Leonardian intervals (equivalent to the Wolfcamp B/2nd Bone Spring Formation). These strata reveal complex interfingering of carbonate and siliciclastic slope deposits, offering valuable insights. This outcrop analogue work aims to elucidate the detailed architecture and stratigraphy of this significant producing interval in the subsurface. Additionally, it will enhance our understanding of how the complexities observed on the slope may influence interpretations of basinal deposits further down-dip.

Mississippian Toe-of-Slope to Basinal Deposits in Outcrop and Subsurface Wells, Orogrande Basin (2+ year project)

In 2025, we will continue our study of Mississippian strata exposed in the Sacramento Mountains, Bishop Cap, and Franklin Mountains. Our primary objective is to characterize the temporal and spatial transitions from outer ramp deposits to basinal gravity flows, current deposits, and the organic-rich shales that form the Barnett Formation. We plan to extend our investigation further down-dip to better assess the nature of basinal Mississippian deposits in the northern Franklin Mountains and potentially the Hueco Mountains. Additionally, we aim to refine our understanding of current influences on deposits in the more proximal slope, where deep-water mounds developed. This research will provide valuable insights into the distribution, alternation, and mixing of various distal deposits (e.g., gravity flows vs. contourites) and their implications for the unconventional development of Mississippian-age organic-rich pelagic deposits in the Permian Basin and similar resources globally.

Petrophysical and 3D Facies Analysis of Dagger Draw 3D seismic survey, Northwest Shelf-to-Basin Delaware Basin area, Eddy County, New Mexico

The Dagger Draw Field is a significant oil and gas producing area located in Eddy County, southeastern New Mexico. Using a unique shelf-to-basin 3D seismic survey donated by Spur Energy, we will create a 3D reservoir characterization study and integrate it with our RCRL Permian Basin regional stratigraphic and petrophysical 3D model. This seismic dataset also covers the area where some of the Bone Spring contourites were identified by well log mapping by Buddy Price. This is a good opportunity to better characterize these potential contourites with a more integrated dataset.

Integrated Structure, Stratigraphy, Fractures and Karst Studies

Geomechanical Modeling of Pennsylvanian-Wolfcampian Structures for Improved Understanding of Syntectonic Sedimentation of the Orogrande and Permian Basins

To unravel the complex geological history of Texas during the Paleozoic, particularly the Atokan-Wolfcampian period, we will develop geomechanical models to better understand fault timing and uplift mechanisms during periods of significant sedimentation near active tectonic elements. Integrating geomechanically derived fault attributes into these models will enable a more accurate representation of sedimentation conditions and provide deeper insights

into fault timing, uplift processes, sedimentation dynamics, and the overall geological evolution of the Delaware Basin and Central Basin Platform.

Building on previous RCRL research, we will continue refining the Late Pennsylvanian to Early Permian syntectonic interpretation and model for the Dry Canyon area, with plans to extend the study southward toward Alamo Canyon. The analogous structures and timing observed in these areas offer valuable insights into faulting and tectonic activity along the western Central Basin Platform and transpressional zones within the Delaware and southern Midland Basins. By integrating outcrop data with subsurface models, we aim to improve understanding of small-scale reservoir structures and better elucidate syntectonic stratigraphic relationships.

Cretaceous (Albian-Santonian) Fault-Related Fracture Age Dating to Delineate the Influence of Cenozoic Tectonics on the Maverick and Permian Basins

Studying the age of fault-related fractures in Texas offers valuable insights into the region's geologic history, petroleum systems, and reservoir characterization. These fractures are critical for understanding the formation and evolution of features that influence reservoir rock permeability and porosity, ultimately affecting fluid flow and hydrocarbon migration. By employing U-Pb dating to determine the timing of fracture cementation, we can constrain the ages of key diagenetic events and establish a chronological framework that links fracture development to regional geological processes, such as tectonic activity and changes in fluid composition. Integrating U-Pb dating with fluid inclusion analyses provides a more comprehensive understanding of the dynamic geological history of the South Texas Basins. This approach is essential for improving reservoir characterization and optimizing resource assessment in the oil and gas industry.

Recent and Modern Carbonates Studies

Geomorphology and depositional history of Pleistocene-Quaternary lacustrine sediment in Lake Winnemucca, Nevada (2+ year project)

This study aims to investigate the Pleistocene to Quaternary lacustrine deposits within Lake Winnemucca, with a primary focus on enhancing our understanding of sedimentary dynamics in a fluvial-lacustrine environment. While significant research has focused on the carbonate tufa mounds surrounding Lake Pyramids and Lake Winnemucca, these formations represent only a small portion of the broader sedimentary record of Lake Lahontan and Lake Winnemucca during the Pleistocene-Quaternary period. Key geomorphic features such as spits, alluvial fans, and shoreline deposits are also present. This research will integrate remote sensing data with ground-based observations to map, classify, and interpret the various depositional environments within Lake Winnemucca. Our goal is to reconstruct how wind and currents have influenced sediment deposition in the lake over the past 18,000 years.

Comparison of Pleistocene Carbonate Depositional Systems, Cozumel, Bahamas, and Turks and Caicos Islands

To increase our developing atlas of modern and Pleistocene analogs of different carbonate depositional systems, we plan to visit and further map and document the wave-dominated atoll setting of the Last Interglacial deposits on the island of Cozumel. Cozumel has many similarities and many differences to the Turks and Caicos and Bahamas settings we have documented previously and has the potential to add significantly to our understanding of coupled barrier-lagoon environments and linked early diagenesis. Cozumel is also an ideal and

easy access point for field excursions to observe fossil reefs, shoreface deposits, barrier standplain systems, and lagoonal facies. Several karst-enhanced unconformities can also be accessed in quarries across the island and active research on the karst networks is ongoing by research collaborators from the National Autonomous University of Mexico. Products of the research will include lidar enhanced facies maps, 3D renderings of beach-barrier, reef, spit, and lagoon deposits, and petrographic documentation of facies.

Mixed Carbonate-Siliciclastic Routing Systems of the Red Sea Rifted Margin

As the world's youngest rifted margin, the mixed system of the northern Red Sea has potential to serve as an important analogue for sedimentary processes that controlled distribution of play elements, especially reservoir presence, during the formation of the proto-Atlantic conjugate margins. Initial work by collaborators at the University of Potsdam on integrated carbonate-siliciclastic sediment routing from the western rift shoulder (Egypt) and Gulf of Aqaba (Saudi Arabia) has revealed striking similarities to steep carbonate escarpments that developed along segments of West Africa during the rift-to-drift phase of Mesozoic extension. Of particular interest is the transition from the southern Gulf of Suez rift basin to the northern Red Sea nascent passive margin which offers a unique opportunity to study controls and feedbacks related to mixed carbonate-siliciclastic sedimentation and the relative influence of structural elements that characterize the rift-to-drift transition. This study plans to leverage field, remote sensing, and subsurface data from the northern Red Sea as well as 3D seismic from the West African Atlantic margin to evaluate traditional paradigms in mixed systems and develop new process-based predictive concepts for nascent passive margin facies distribution.

Virtual Reality Outcrop Models, Virtual Field Trips, and Digital Analogues

Digital outcrop models (DOMs) play a crucial role in enhancing the understanding of stratigraphic, structural, and non-matrix elements that are common to the carbonate reservoir environment. Geoscientists can utilize DOMs to simulate different geological scenarios, improving their ability to interpret subsurface conditions and make informed decisions regarding exploration and production strategies. The value of digital outcrop models lies in their ability to bridge the gap between field observations and application to reservoir development scenarios.

The RCRL team will continue our efforts to develop and optimize virtual reality field trips, digital outcrop models, and other analogue models for our sponsors. Our plan is to make key areas available as digital models (OBJ or LAS files), interpreted 3D models (VRGS©), and Virtual Reality sessions (Craytive Technologies BaselineZ© and VRGS).

Our goal is to continue to generate 3D virtual-reality fieldtrips, integrating digital outcrop models with geological interpretations, core descriptions, subsurface models, and documentary materials from RCRL's database of key analogues.

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Sponsor Activities in 2025

2025 Spring Core Work Session, May 19-21, 2025: A core workshop highlighting cores from key integrated datasets will be featured, illustrating various carbonate reservoir ages, style, and setting to be determined. This workshop will focus on Paleozoic reservoir systems and will contain timely and relevant cores from current RCRL research initiatives.

Sponsor Field Trip, November 2-8, 2025: The fall field trip will visit spectacular exposures of Pennsylvanian and Permian basinal and slope depositional systems in the 2022 Keeler/Darwin Basin (Death Valley NP area). These exposures are among the best outcrop analogues of the Wolfcampian and Bone Spring rocks in the Permian Basin. We will visit exposure of numerous depositional elements including channelized and non-channelized slope, MTCs, unconfined basin floor fan in both carbonates, siliciclastic and mixed carbonate siliciclastic lithologies.

The trip will discuss the stratigraphic relationships, platform to basin correlations, and basinal depositional architecture for Pennsylvanian and Permian intervals in the Keeler/Darwin Basin, east central California. We will view a variety of carbonate, siliciclastic, and mixed sediment gravity flow deposits, and discuss stacking and architecture, sourcing mechanisms, continuity, variations, and relationships to possible eustatic and tectonic drivers of deposition and highlight the analog to the Permian basin unconventional plays.

RCRL Database Updates

- Searchable Catalog of RCRL Presentations and Extended Abstracts
- RCRL Core Workshop Database
- Austin Chalk Core Properties Database
- Reservoir Properties Database of Gulf of Mexico Carbonates

Carbonate Reservoir Characterization Research Laboratory (RCRL)

Research Group

Principal Staff

Dr. Xavier Janson, Research Professor, Principal Investigator
Dr. Charles Kerans, Goldhammer, Professor and Chair of Carbonate Geology
Dr. Robert (Bob) Loucks, Research Professor
Dr. Benjamin Rendall, Assistant Research Professor
Dr. Christopher Zahm, Research Scientist Associate
Mr. Robin Dommisse, Research Scientist Associate
Mr. Josh Lambert, Research Scientist Associate

Associated Staff

Ms. Kelly Hattori, Research Scientist Associate, Stratigrapher
Dr. Tingwei ("Lucy") Ko, Research Associate, Geochemist
Dr. Hongliu Zeng, Senior Research Scientist, Seismic Analysis

RCRL collaborates closely with the Quantitative Clastics Laboratory (QCL) at the Bureau of Economic Geology (BEG) in the characterization of mixed carbonate/siliciclastic slope to deep-water systems in the Permian Basin and in Australia. We also collaborate with BEG's STARR-CCUS consortium on reservoir characterization projects and with the Center for Injection and Seismicity Research (CISR) and the Texas Seismological Network and Seismology Research (TexNet) for improved structural characterization in the Permian Basin.

Graduate Students

RCRL is proud of the research accomplishments of our past and current graduate students. Most of our graduated students are now working in industry research, production, and exploration. Our recent or current students and their research projects include:

Shawn Fullmer (Ph.D., May 2024)– Quaternary (Mid-Late Pleistocene–-Holocene) Carbonate Geomorphology of the Bahamas-Caicos Archipelago: Carbonate Factory Response to Sea-level and Climate Change. ExxonMobil and DGS-Goldhammer Chair of Geology funding, RCRL contributor

Kyle Fouke (Ph.D., May 2024) – Architecture and climatic record of the Last Interglacial Coral-algal Reef Complexes, Bahamas-Caribbean region. DGS and Goldhammer Chair of Geology funding, RCRL contributor

Colton Hayden (MSc, May 2025) – Stratigraphic architecture of the Smackover Fm. NE Texas and Arkansas, RCRL funded.

Taufik Al Amin (MSc, May 2025) – Mechanical properties of carbonate fans (Wolfcamp) and the potential for natural and induced fracture heterogeneity related to differential compaction, DEPS Fellowship

Josh Malone (Ph.D., May 2026) – Pennsylvanian Shelf-to-Basin Architecture, Darwin Basin, Nevada, California, and Permian Basin, TX, RCRL funded and contributor

Invitation

Staff and students of the Reservoir Characterization Research Laboratory cordially invite you and your colleagues to contact the Principal Researchers to join us in these and other important research activities.

Carbonate Reservoir Characterization Research Laboratory (RCRL)

Industrial Sponsors

The RCRL program has functioned continuously since 1987, maintaining strong company sponsorship each year. In 2024, these 19 companies supported our research initiatives:

2024 Contributor Members

Software and Data Contributors