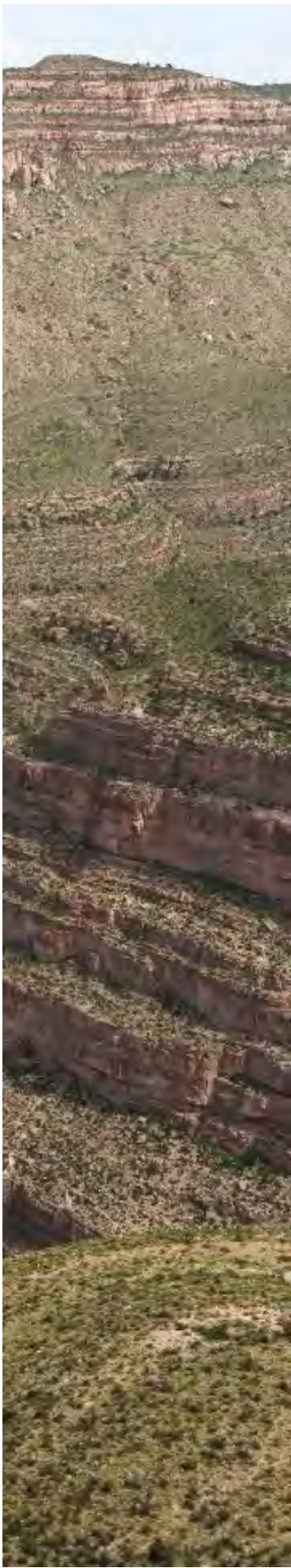


2026 RCRL Research Prospectus

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



Cover: Albian grainstone along the Pecos River



Mission

The Carbonate Reservoir Characterization Research Laboratory (RCRL) mission is to use outcrop and subsurface data from carbonate reservoir strata as the basis for developing integrated methodologies and concepts to describe 3D-reservoir properties, and to improve discovery, production, and storage of subsurface fluids in carbonate rocks. 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 and Training Goals

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

Our training philosophy for carbonate reservoir characterization emphasizes hands-on, integrated, multidisciplinary learning that blends lectures and exercises with real-world data including core, well-log, seismic and field experiences. We strive to combine basic foundational knowledge with cutting-edge research in our training to reach all levels of experience in the industry.

Membership and Funding

We invite your company to participate in the continuation of the RCRL Carbonate Reservoirs Research Program. In 2026, 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 (2026 and 2027) 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 an annual review meeting, a yearly short course or core workshop, and on the continually updated, members only RCRL website knowledgebase (<http://www.beg.utexas.edu/rcrl/members/>). Our searchable website contains more than 25 years of digital presentations, video, core workshops, and fieldtrip guidebooks. Supplemental data (maps, core photos, porosity and permeability data, and digital outcrop reservoir models) are available through our password-protected database for RCRL members. This year we will be adding training modules that can be completed virtually or asynchronously.

RCRL website: <https://www.beg.utexas.edu/rcrl>



Regional Stratigraphic Studies

Problems to be addressed: Regional stratigraphic studies provide context for understanding controls on reservoir development through space and time, improving predictions at various scales in the subsurface.

Regional studies currently underway are centered around the tectonostratigraphic evolution of the Permian Basin, differential aggradation of the Lower Cretaceous strata of the Maverick intrashelf basin and surrounding shelf/margins, the evolution of the northern Red Sea rifted margin and affiliated mixed carbonate-siliciclastic sediment routing systems, and fundamental controls on grainstone development and distribution throughout the Bahamas-Caicos archipelago.

Regional Synthesis of Pennsylvanian Strata in the Permian Basin

- Understand the complex influence of coupled tectonism and icehouse eustatic signals in sediment dispersal and accumulation in pure carbonate and mixed carbonate siliciclastic systems across depositional environments
- Characterize the tectonic drivers responsible for regional spatial differences in stratigraphic stacking, reservoir architecture, and reservoir rock types
- Build high-fidelity cross sections that address the complex Pennsylvanian stratigraphy across the Greater Permian Basin region

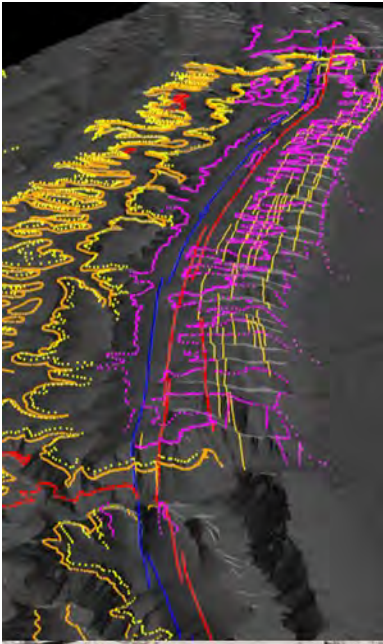
Duration and Sharing: Year 2 of 3-year project. In 2026, we will focus on the Central Basin Platform and Midland Basin (excluding Eastern Shelf) as well as updating the stratigraphic framework in the Delaware Basin. Results include development of a regional cross section illustrating the variability of stacking patterns and depositional environments as well as updated paleogeographic maps.

Interplay of Ancestral Rocky Mountains Orogenesis and Late Paleozoic Ice Age Eustasy on Pennsylvanian Mixed Systems in the Greater Permian Basin and Sacramento Mountains

- Relative influence of eustasy and orogenesis on accommodation and facies partitioning in Pennsylvanian/icehouse reservoir analogs
- Evolving mechanisms for carbonate and siliciclastic sedimentation driven by orogenesis (source terrain unroofing and regional subsidence), local structure kinematics, and icehouse eustasy
- Implications for predictive conceptual models and reservoir compartmentalization

Duration and Sharing: Multi-year project building on extensive RCRL outcrop datasets. Intended Sharing includes digital outcrop models and dimensions of phylloid buildups as well as process-based predictive models for subsurface equivalents (Strawn, Canyon, Cisco reservoirs).





Basin-wide to Reservoir-Scale Synthesis of Mixed Carbonate-Siliciclastic Permian Composite Sequences Highlighting Stratigraphic Traps and High-Grading Saltwater Disposal Targets (San Andres-Grayburg-Avalon-Bone Spring Lime-Brushy Canyon-Cherry Canyon Midland Basin)

- Modernization of the Midland Basin sequence framework to synchronize with the Delaware Basin
- Developed regional stratigraphic framework by integrating well logs, depth-converted 2D and 3D seismic datasets, and strategically located cores with high-resolution outcrop analog model
- Improved porosity and lithology model as well as preliminary facies will be built within the larger RCRL geocellular model to assist in saltwater disposal (SWD) and identifying and hydrocarbon targets

Duration and Sharing: Year 2 of 3-year project. The seismic and well knowledgebase has been assembled, and key surfaces have been picked through all wells and some seismic.



Mixed Contourites, Turbidites, Carbonate Mounds and Organic Shale in Toe-of-Slope to Basinal Deposits in Outcrop and Subsurface (Mississippian, Orogrande Basin, NM)

- Characterize the temporal and spatial transitions of complex outer ramp-to-basin deposits formed by gravity flows and modified by deep water currents
- Understand the impact of mixed turbidite-contourite processes on accumulation of organic-rich shales in basinal deposits (e.g., Barnett Shale)
- Refine our understanding of current influences on deposits associated with irregular slope topography (e.g., deep-water mounds)

Duration and Sharing: Year 2 of 3-year project. Sharing will include detailed measured sections and cross sections combined with digital outcrop models (DOMs) to characterize stratal architecture, shape, and dimensions of contourite and mixed contourite-turbidite deposits in this system.



Shelf- to Intrashelf-Basin Exposures and Facies Patterns (Albian, South Texas)

- Seismic-scale insights into the subtle Maverick intrashelf basin framework to serve as a valuable analogue for Lower Cretaceous reservoirs in South Texas and the Arabian Gulf
- Spatiotemporal distribution and of large rudist reef complexes, prograding grainstone margins, and shelf interior facies tracts
- Models and examples of facies-controlled permeability pathways and capillary barriers

Duration and Sharing: Year 2 of 3-year project. Intent for 2026 is to apply the well-constrained stratigraphic framework from the Pecos River Canyon to coeval deposits in the region. We plan to map systems-tract specific facies distributions along both depositional strike and dip. By comparison with fields in south Texas and the Middle East, we aim to provide improved conceptual models for reservoir facies architecture and capillary seal potential.

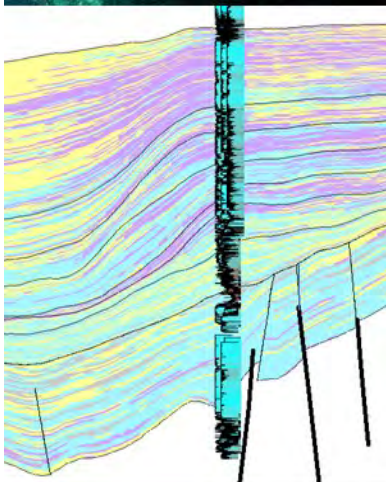




Permian Basin Regional Supermodel

- Integration of 360,000 wells, 38 3D seismic surveys, more than 2500 2D seismic lines, 2.2 million well tops, 41,000 horizontal wells with landing zones into a 55,000 square mile, 2.4 billion cell geologic model
- Developed robust stratigraphic framework in 3-dimensions over the entire Permian Basin
- Incorporate detailed facies and petrophysical distribution based on extensive RCRL studies including 16,000 quad combo wells with mineral inversion
- Regional distribution of petrophysical and velocity data in the entire model, calibrated with multiple datasets
- Integration of historical injection and production data for future pore-pressure and fluid flow reservoir simulation
- Potential regional simulation test using UT's Texas Advanced Computing Center (TACC) high-performance computing cluster systems (e.g., Longhorn6)

Duration and Sharing: The Permian Super Model is an evergreen internal regional model in which we incorporate new results and understanding of the tectono-stratigraphy of the greater Permian Basin and test ideas and workflows to populate subsurface geology in both sector 3D geomodel and a large 3D geomodel. Ideas and workflows are part of the knowledge transfer to our sponsors. We cannot share our Permian model due to data agreement and confidentiality issues.



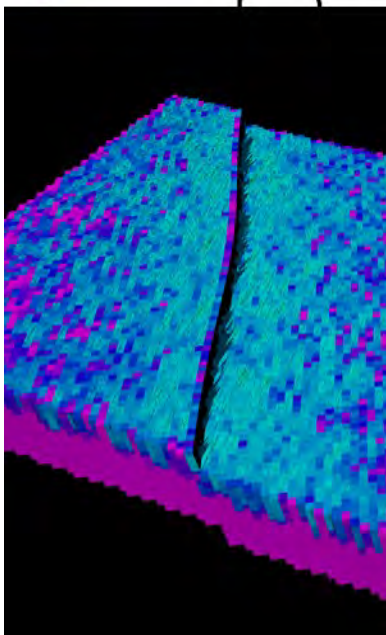
Reservoir Scale Studies

Problems to be addressed: RCRL has decades of experience proving the role of a robust stratigraphic framework and spatiotemporal facies distribution in reservoir characterization. We continue to improve our understanding of heterogeneities in carbonate facies distribution and stacking patterns, rock property distribution and pore systems architecture at the reservoir scale in many settings. We are striving to integrate the newest subsurface technologies and enhance integration with our outcrop/core-based foundation to improved reservoir characterization approaches and workflows.

Upper Jurassic (Smackover Fm.) Ooid Grainstone Reservoir Heterogeneities

- Acquire direct core measurement of permeability, UCS, Vp, and XRF to better characterize small-scale heterogeneities of ooid grainstones
- Assess external regional controls on depositional environments and paragenesis on distribution of reservoir rocks and properties
- Evaluate geological controls on differences in pore types and networks in ooid grainstones

Duration and Sharing: Year 2 of 3-year project. Sharing will consist of detailed core descriptions and high-resolution rock property analyses combined with basic paragenesis and petrography. This pore system scale effort supports an updated understanding of the regional geology and permeability architecture of the Smackover Formation in East Texas and Arkansas.





Characterization of a Mixed Carbonate-Siliciclastic Karst Modified Shelf Edge Conventional Field (San Andres/Grayburg Reservoir, North Monument Field)

- Combine detailed core characterization with well log and high-quality 3D seismic to characterize the reservoir quality variation around the Monument structure
- Integrate new ML/AI approach in well log correlation and seismic facies extraction to detect sub-seismic karst and other reservoir heterogeneities
- Evaluate external geological controls (i.e., eustasy, structure, fracture, Si vs CaCO₃) on reservoir quality distribution

Duration and Sharing: Year 2 of 3-year project. The sharing of this project will be detailed core descriptions of 18 cores, construction of a robust stratigraphic framework for the Monument field combined with detailed reservoir rock typing. In addition, we will evaluate using ML/AI log correlation and seismic extraction techniques in building 3D reservoir models in Permian Basin conventional reservoir settings. Three MSc. students will be working on complimentary aspects of this project.

Mixed Carbonate-Siliciclastic Slope to Toe-of-Slope Characterization and Modeling (Early Permian, Delaware Basin)

- Use high quality 3D seismic data to map detailed slope architecture
- Use outcrop analogues in the Sierra Diablo Mountains to improve models for stratigraphic architecture, stacking patterns, and geobody dimensions at a sub-seismic scale
- Assess slope petrophysics variability using high-density well log spacing and 3D seismic datasets
- Evaluate existing geostatistical modeling techniques to populate facies and rock properties in slope and toe-of-slope environments

Duration and Sharing: Year 2 of 3-year project. The research outcome of this project will be improved understanding of detailed mixed carbonate-siliciclastic slope and toe-of-slope settings, quantification of size and distribution of various geobodies, rock properties distribution and assessment of best practices for building 3D reservoir models in mixed slope settings.

Icehouse Isolated Platform Facies and Permeability Distribution Modeling (Carboniferous, Horseshoe Atoll Midland Basin)

- Refine 200 million cell geocellular model based on 300 seismic horizons
- Refine the seismically guided geobody framework using deep learning-based facies prediction for the 3D distribution of the porous grainstone units
- Assess petrophysics variability using high density well log spacing and 3D seismic
- Evaluate existing geostatistical modeling technics to populate facies and rock properties in an isolated platform setting, integrating learning from a well-constrained Pleistocene-modern analogue
- ML facies-conditioned permeability distributions and ML analysis of production data for reservoir connectivity/compartimentalization

Duration and Sharing: 2-year project. The main result will include sharing best practices and workflows for building robust, stratigraphically-constrained 3D reservoir models in this setting that can be applied to other isolated platform-top reservoirs.





Using ML/AI Image Segmentation to Extract Seismic Facies and Geobodies from 3D Seismic

- Use ML/AI technique developed for GIS to segment 3D horizon stacks on high quality offshore 3D seismic survey into consistent seismic facies/geobodies using various seismic attributes
- Build full 3D model from segmented horizon stack
- Combine the segmented seismic facies and/or geobodies with direct ML/AI (SOM-based) approach that incorporate well constraints
- Adapt technique to older and/or lower resolution onshore 3D seismic surveys in the Permian basin

Duration and Sharing: 2-year project. Sharing will be a documented workflow to extract seismic facies and geobodies from 3D seismic using ML/AI segmentation and SOM-based extraction of seismic facies and rock properties. This is a student project.

Integrated Structure, Stratigraphy, & Fracture Studies

Problem to address: The complex interplay between brittle carbonate rocks and structural deformation results in mechanically stratified fault and fracture zones. These features are significant because they act as heterogeneous permeability elements within subsurface reservoirs.

Furthermore, the volumetric development of these zones can increase fracture porosity, impacting exploration and development strategies. However, this enhanced connectivity also presents a significant risk for projects involving Carbon Capture and Storage (CCS) or Saltwater Disposal (SWD), as it can lead to unexpected fluid pathways.

Fracture Porosity and Permeability Modeling in, Oblique-Slip Fault-Related Fracture Zones, (Albian, Pecos River South Texas)

- Albian-age carbonates that are deformed by oblique-slip faults during Laramide compression provide a catalog of small-offset faults and the resultant fault-related fractures in carbonates of differing facies and mechanical properties
- The Lewis Canyon model will be progressed to a state where members will be able to download the digital dataset and Petrel model for in-depth interrogation
- Additional digital outcrop models (DOMs) are being developed for the Sanderson exposure and two other excellent exposures along the Pecos River

Duration and Sharing: Multi-year project utilizing numerous DOMs with yearly presentations, workshops, and models available for download.





Fault-Related Fracture Characterization in Mixed Carbonate-Siliciclastic Zones (San Andres, Grayburg and Cherry Canyon Formations, Brokeoff Mountains, NM)

- Characterize the fault-related fracture development in key mixed carbonate-siliciclastic intervals that are targets for SWD, including orientation, intensity and extent
- Units are exposed within significant extensional faults associated with the Rio Grande Rift exposed in the Brokeoff Mountains
- Project will be the subject of Carly Johnson's MSc thesis and will be integrated with mechanical property characterization of similar units at Monument Field

Duration and Sharing: Multi-year project that will include presentations and core studies. DOMs will be developed, and the Petrel outcrop model will be available at the end of the project.

Deformation and Syntectonic Sedimentation at the Pennsylvanian-Permian Transition (Sacramento Mountains and Central Basin Platform)

- Characterize the Late Pennsylvanian-Early Permian tectonostratigraphy of the Sacramento Mountains, as it provides insight into the influence of subtle changes on the shelf and basin
- Model fault-timing, uplift, and syntectonic sedimentation during Atokan–Wolfcampian in the Orogrande and Permian Basins
- Extend Dry Canyon studies south to Alamo Canyon and combine with work in the southern range to refine Late Pennsylvanian–Early Permian deformation models
- Integrate outcrop and subsurface data to better characterize small-scale reservoir structures and stratigraphic responses
- Develop geomechanical models of syntectonic development based on outcrop characterization work

Duration and Sharing: Multi-year projects that will include presentations and field trips to essential outcrop exposures.



Analog Studies

Problem to be addressed: RCRL uses analog studies to address themes and processes that are key in carbonate characterization. These include regional source-to-sink approaches in mixed carbonate-siliciclastic systems and sub-Milankovitch forcing on development and preservation of stratigraphic signals, as well as detailed characterization of timing and distribution of carbonate grainstones using Pleistocene and modern deposits.

Northern Red Sea as an Analog for Rifted Margin Exploration Concepts

- Integrated field/remote sensing study from distinct tectonic provinces of the northern Red Sea that exemplify mixed carbonate-siliciclastic sedimentation across the rift-to-drift transition
- Evolving margin geometry and feedbacks in mixed carbonate-siliciclastic depositional systems
- Cross-shelf siliciclastic sediment transfer from hyperarid source terrains to the deep basin
- Seismic characterization of early continental margin development and influence of extensional tectonics on analogous mixed carbonate-siliciclastic reservoir facies distribution

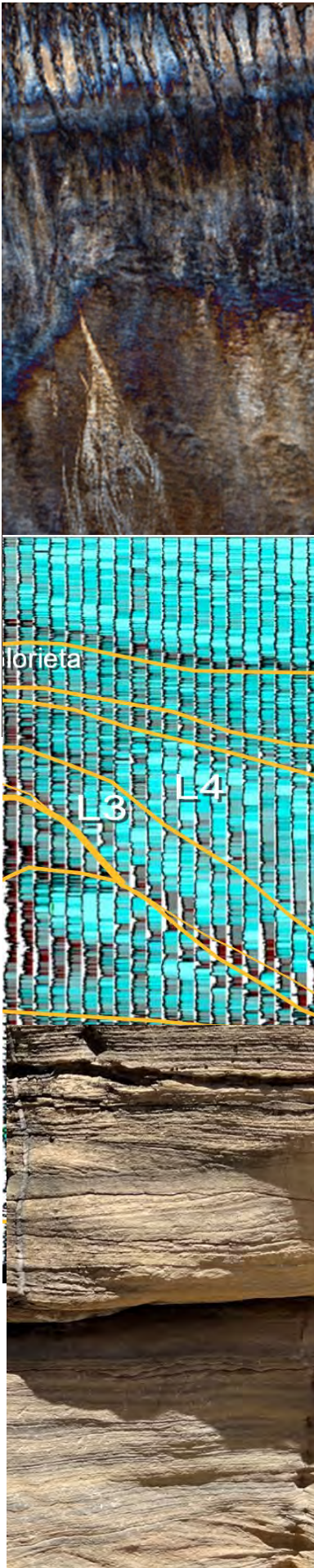
Duration and Sharing: Multi-year project. Intended sharing includes presentations at international and annual sponsor meetings, along with series of publications highlighting the relevance for predictive concepts related to Atlantic conjugate margin construction (exploration scale) and fundamental controls on depositional processes in arid mixed systems (development/production scale).

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

- New depositional models for carbonate systems are now being generated from the high-resolution airborne lidar/photogrammetry based DEM's combined with detailed outcrop measurements and petrography from Turks and Caicos platform, Bahamian islands, and the Yucatan/Cozumel settings.
- Most of the data available is from shallow reef, shoreline, and aeolian/lacustrine facies associated with Marine Isotope Stage 5e.
- Different arrangements of tide, wave, and longshore processes have combined to create a diverse suite of analog deposits that are important for subsurface modeling and interpretation.

Duration and Sharing: This is an ongoing 5-year program that is now in the interpretation phase, with most field work complete. Synthesis presentations and publications will be targeted at developing paired outcrop-subsurface analog datasets that show the importance of understanding depositional and diagenetic processes at a high resolution spatial and temporal scale, as is unique to Quaternary systems.





Geomorphology and Depositional History of Pleistocene-Quaternary Lacustrine Sedimentary Systems (Pleistocene to Quaternary, Nevada)

- Understand sedimentary dynamics in a mixed fluvial-lacustrine-carbonate environment
- Map spatiotemporal distribution of preserved lacustrine geomorphic features (e.g., spits, beaches, alluvial fans, mounds, springs, etc)
- Understand intrinsic vs. extrinsic controls on grain-dominated sediment distribution
- Interpret processes that influence accumulation of grain-dominated carbonates in lacustrine settings

Duration and Sharing: This is a 3-year project. Output will include maps of various geomorphic features in the paleolake conceptual model to demonstrate how such features become reservoirs in the subsurface.

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 that influence 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 how these systems can be applied in reservoir development scenarios.

The RCRL team will continue our efforts to develop and optimize virtual reality field trips, digital outcrop models, and other analog models for our sponsors. Our plan is to make key areas available digitally (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 that integrate digital outcrop models with geological interpretations, core descriptions, subsurface models, and documentary materials from RCRL's knowledgebase of key analogs.



Training Opportunities

RCRL has a large catalog of field trips and workshops. For additional cost, RCRL can provide private or in-house training for individual companies. Contact us to discuss tailored field trips or workshops (or a combination) that fit your training needs. Below is a list of potential workshops and field trips based on events from recent years.

Workshops

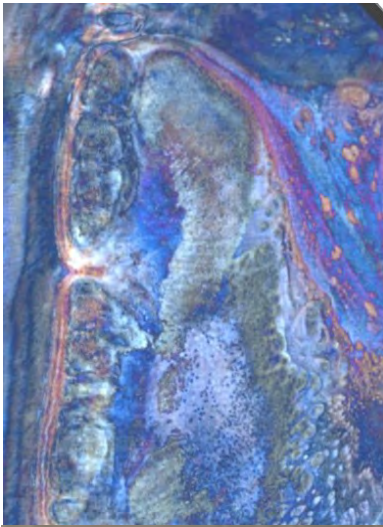
- Fundamentals of Carbonate Reservoirs: Settings, Styles, Seismic Expression and Case Studies
- Introduction to Interpreting Carbonate Deposits in Core
- Introduction to Subsurface Mapping
- Principles of Sequence Stratigraphy and Predictive Concepts for Mixed Depositional Systems
- Carbonate Reservoir Geology for Engineers
- Seismic Characterization of Carbonates: Techniques, Interpretation, and Application
- Integrated Geologic, Seismic, and Geomechanical Characterization of Fractured Carbonate Reservoirs
- Well Log and Seismic Interpretation Workflows for Regional Sequence Stratigraphy in Unconventional Slope and Basinal Systems
- Challenges and Potential for Characterization of, and Enhanced Recovery from, Conventional Carbonate Reservoirs (Permian Basin)
- Tight Cretaceous Carbonate Reservoirs
- Principles of Carbonate Karst and Associated Reservoirs: Core Workshop
- Mesozoic Reservoirs of the Gulf of Mexico Basin: Core Workshop
- Permian Unconventional and Conventional Reservoirs: Core Workshop
- Spectrum of Gravity Flow Deposits in Carbonate and Mixed Carbonate-Siliciclastic Slope and Basinal Deposits: Core Workshop

Field Trips

Paleozoic

- Mississippian Outer Ramp, Waulsortian Mounds and Basinal Turbidites and Contourites, Sacramento Mountains, NM, USA
- Carboniferous Mixed Carbonate-Siliciclastic Shelf Evolution, Sacramento Mountains, NM, USA
- Icehouse Reciprocal Sedimentation and Carbonate Algal Mounds, Sacramento Mountains, NM, USA
- San Andres Reservoir Analogues (Algerita escarpment, Last Chance Canyon)
- Foreland Basin Sedimentary Fill (Marathon Fold Belt and Glass Mountains) USA
- Evaporite Paleokarst and Brecciation Within the Upper Mississippian Madison Group of Wyoming and Montana, USA
- Classic Exposures of Wolfcampian to Guadalupian Shelf-to-Basin Carbonate Systems in the Permian Basin, NM and TX, USA
- Deepwater Mixed Carbonate-Siliciclastic Deposits, Carboniferous/Permian, Death Valley, CA, USA



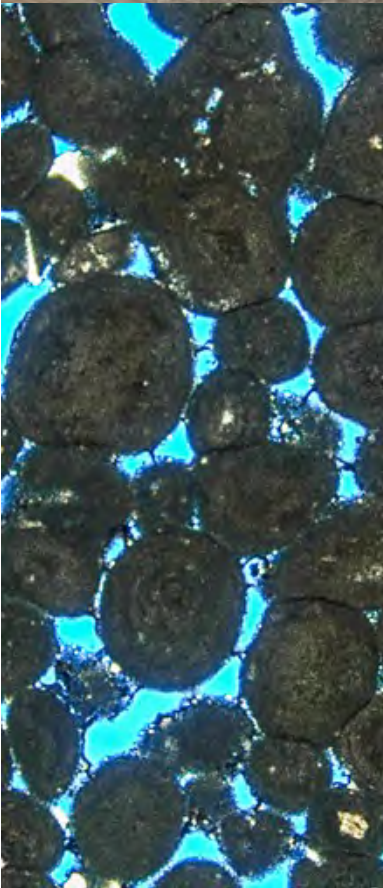


Cretaceous Texas

- Albian shelf to intrashelf basin sequence stratigraphy of the Pecos and Devil's Rivers, TX, USA
- The Aptian composite sequence in Texas: shoreline to deep shelf profile of OAE 1A, TX, USA
- Stratigraphic architecture and facies variability in Albian shelf interior, TX, USA
- Evaporite paleokarst and deformation within Albian-age carbonates, TX, USA
- Albian rudist buildups and complex vuggy pore networks, TX, USA

Cenozoic and Modern

- Miocene carbonate platform and reefs in the Mut Basin, Turkey
- Tectonic and oceanographic drivers of grain-dominated shallow-water carbonate contourite deposits of the Maltese Archipelago: Miocene and Modern, Italy
- Modern and Ancient depositional patterns and reservoir analogs, Caicos Platform, BWI
- Tectonics and Sedimentation of the Northern Red Sea: Birth of a Continental Margin, Saudi Arabia





Research Group

Principal Staff

Dr. Xavier Janson, Research Professor, Principal Investigator
 Dr. Charles Kerans, Emeritus Professor
 Dr. Ben Rendall, Assistant Research Professor
 Dr. Christopher Zahm, Research Scientist Associate
 Mr. Robin Dommissie, Research Scientist Associate
 Mr. Josh Lambert, Research Scientist Associate

Associated Staff

Dr. Robert (Bob) Loucks, Research Professor

Current Graduate Students

Josh Malone, PhD 2026, Pennsylvanian shelf-to-basin architecture, Darwin Basin
 Ali Albulushi, MSc 2027, ML/AI geobody extraction from seismic
 Ali Al Subait, MSc 2027, San Andres-Grayburg reservoir characterization
 Carly Johnson, MSc 2027, Fault-related fracture damage zones, Brokeoff Mts.
 Jimmy Vercoe, MSc 2027, Mississippian mixed contourite/turbidite deposits

Industrial Associates

The RCRL program has functioned continuously since 1987, maintaining strong company sponsorship each year. In 2025, these companies supported our research initiatives.

2025 Contributor Members



Software and Data Contributors



Contact

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