****

***2018 MSRL Newsletter (2nd-Quarter Update)***

**NEW AND ON-GOING RESEARCH PROJECTS:**

**FACIES AND FACIES ARCHITECTURE:**

1. **Regional Austin Chalk study along the onshore Gulf Coast from the Texas-Mexico border to central Louisiana** – Bob Loucks
	1. Challenges and Questions
		1. Need to develop a better understanding of the regional stratigraphy lithofacies, mineralogy, depositional systems, source rock potential, and reservoir quality.
	2. Methods and Procedures
		1. Five cores have been described in Louisiana. A lithologic zone, commonly referred to as the “ash bed” is actually a regional anoxic event. The dark, unburrowed rock have up to 3% TOC.
		2. A series of cross sections are in progress in South Texas, west of the San Marcos Arch.
		3. The Getty Hurt core in northwest La Salle County will be fully analyzed to serve as the type Austin Chalk section for the area. The core contains the complete Austin Chalk section as well as parts of the upper Eagle Ford and lowermost Anacacho Formation
2. **Facies and facies architecture of the Wolfcamp in the southern Delaware Basin** – Stephen Ruppel, Scott Hamlin, Robin Dommisse, Rob Reed
	1. Challenges and Questions
		1. The Wolfcamp varies in complex ways both vertically and laterally across the basin
		2. Understanding and improving reservoir performance necessitates a better understanding of how facies and rock properties vary in 3D space
	2. Methods and Procedures
		1. Define facies based on integrated XRF/XRD and microscopy data
		2. Calibrate wireline logs based on core-log facies relationships
		3. Correlate facies and define their distribution and architecture using calibrated wireline logs

**HYDOCARBON MIGRATION AND PORE SYSTEMS:**

1. **Variations in oil generation potential and geochemical characteristics of solvent extracts and crude oils in Wolfcamp A and Wolfcamp B** – Tongwei Zhang, Lucy Ko, Xun Sun, Stephen Ruppel, Toti Larson
	1. Challenges and Questions
		1. Define key controls on variation in oil expulsion and retention
	2. Methods and Procedures
		1. Investigate organic matter type variations in Wolfcamp A to Wolfcamp B deposits by integrated geochemical and geological analysis including HAWK pyrolysis, carbon isotopes of OM, biomarkers, and gas chemistry
2. **Pore system and diagenesis of the Wolfcamp Formation, Delaware Basin, west Texas** – Rob Reed, Tongwei Zhang, Sheng Peng, Xun Sun
	1. Challenges and Questions
		1. Do pore systems in different Wolfcamp lithologies vary significantly and what influence does this have on fluid flow?
		2. Do different types of fine-grained carbonate rocks present in meter-scale cycles in the Wolfcamp act as reservoirs or seals to oil storage?
	2. Methods and Procedures
		1. Pore systems and diagenesis will be integrated with lithologies, XRF-based core logging, porosity and permeability measurements, N2 adsorption and organic geochemistry
		2. Relationship between pore development and timing of oil generation, migration and retention will be investigated by integrated pore characterization, oil saturation and mass balance calculation

**DIAGENESIS:**

1. **Biogenic silica and quartz cement in mudrocks** – Rob Reed
	1. Challenges and Questions
		1. Quartz cement plays an important role in enhancing “frac-ability” in many mudrocks and biogenic silica is a common source for quartz cement
		2. Defining quartz type and source is a major challenge
		3. Dissolution of radiolarians is one process by which biogenic silica is released. Diagenesis of radiolarians varies greatly from unit to unit, and it is in some cases difficult to even recognize the end product of this as having once been a radiolarian
	2. Methods and Procedures
		1. SEM-based cathodoluminescence will be used to identify diagenetic quartz cement in mudrocks
2. **Diagenesis of the Eagle Ford Group from shallow to deep burial** – Lucy Ko, Bob Loucks, Ahmed Alnahwi, Xun Sun
	1. Challenges and Questions
		1. Diagenesis affects reservoir quality, mechanical stratigraphy, and wettability in the Eagle Ford
		2. Are limestone beds reservoirs or seals during oil migration?
		3. How does diagenesis of major lithofacies vary across the Eagle Ford from shallow to deep burial and can the diagenesis be correlated across areas in the basin?
		4. How does burial history vary across the Gulf Coast Basin and does it relate to diagenesis?
	2. Methods and Procedures
		1. Focus will be on the lower Eagle Ford (LEF) marls, limestones, and ash beds but will include the OAE 2 interval
		2. Tentatively six cores (Brechtel, Cinco Saus, Hendershot, L1, L2, Leppard) from Wilson, Bee, Gonzales, La Salle, and Maverick County will be studied
		3. Burial history curves will be constructed for these wells and regions
		4. Biomarker thermal maturity parameters will be investigated and used to calibrate the thermal and burial history model

**PERMEABILITY AND MODELING:**

1. **Measurement and characterization of shale matrix permeability and permeability-porosity relationships and geological controls** – Sheng Peng
	1. Challenges and Questions
		1. Measurements of shale matrix permeability is still challenging because of the influence of fractures
		2. More accurate measurements of shale matrix permeability and porosity may constrain the permeability-porosity relationship
		3. How do different lithofacies, mineralogy, maturity affect permeability-porosity relationships?
	2. Methods and Procedures
		1. Apply a newly-developed pressure decay method to measure matrix porosity and permeability for shale samples representing a range of mineralogy, lithology, and maturity
		2. Explore the link between permeability, permeability-porosity relationship, and geological controls
2. **3D Boolean modeling of shale permeability** –Pejman Tahmasebi, Lucy Ko, Farzam Javadpour
	1. Challenges and Questions
		1. Previous computational models have been restricted to 2D and do not contain realistic textures and compositions of the rocks
	2. Methods and Procedures
		1. 3D stochastic Boolean model will be used to reconstruct the objects
		2. Objects in the 3D permeability model will be built based on detailed mineralogy, texture, and fabric characterization of the upper Eagle Ford marl facies
		3. Results will be compared with data from laboratory measurement (stress-dependent in-situ permeability) by GeoFluids Group at UT

**XRD AND XRF METHODS:**

1. **Developing an expanded carbonate calibration for X-ray fluorescence core characterization –** Toti Larson and Evan Sivil
	1. Challenges
		1. The mudrock calibration has proven invaluable for characterizing lithologies across Eagle Ford, Wolfcamp, Bakken, Barnett, and Marcellus rock units but has issues when applied to simpler limestone lithologies
	2. Methods and Developments
		1. We are working closely with Bruker to develop new peak integration techniques
		2. We have begun to develp new carbonate standards using external laboratories
		3. We are hosting conversations with Pioneer natural resources to identify calibration gaps
2. **Addition of X-ray diffraction to in-house analytical tools** – Toti Larson and Evan Sivil
	1. Challenges
		1. Relationships between XRF elemental data and mineralogy must be based ongood XRD data
	2. Methods
		1. Add XRF mudrock standards to XRD to better understand and characterize mineralogy
		2. Determine sample preparation methods that are pertinent to the unique traits of mudrocks

**OCEAN ANOXIC EVENTS (OAE’S):**

1. **Organic matter origins in early Albian OAE1a, b black shales in central Texas** – Xun Sun, Toti Larson
	1. Challenges and Questions
		1. OAE1b is a composite of several sub events, is not generally associated with substantial mudrock deposition and does not contain well developed carbon isotope excursions
		2. Understanding the different mechanisms which are responsible for organic matter carbon isotope excursion between OAE1a and OAE1b
	2. Methods and Procedures
		1. Define depositional environment change based on integrated XRF/XRD and carbon isotope measurements
		2. Using detailed organic geochemical analysis of biomarkers to determine the sources of soluble OM of OAE1a, b black shales from the Cow Creek Formation, and upper Bexar and lower Glen Rose Formations in central Texas

**New Students:**

**Esben Pedersen** accepted our offer to the JSG graduate school in April and was awarded a two-year fellowship through Equinor (Statoil). **Esben** will be supervised by **Toti Larson** and Charlie Kerans and will be conducting a study of the Cow Creek Limestone of the Pearsall Formation, Texas. **Esben** is interested in identifying mechanisms that are responsible for the onset of oceanic anoxic event (OAE-1a), and sequencing the relative timing of events through the crisis and into the recovery phase. This will allow for better characterization of reservoir rocks, and potentially the ability to predict carbonate facies in the Cretaceous Gulf of Mexico (GoM).

**RECENT INVITED TALKS:**

* **Farzam Javadpour** gave a talk titled “**Flow and Transport in Nanoscale Porous Media**” at *Houston Geological Society*, Houston, Texas, March 6th
* **Sheng Peng** gave a talk titled “**Multi-Phase Fluid Imbibition, Distribution, and Wettability in Shale through Synchrotron-Based Dynamic Micro-CT Imaging**” at *Houston Geological Society*, Houston, Texas, March 6th
* **Stephen Ruppel** gave a talk titled “**Can Sequence Stratigraphic Concepts Be Applied in Mudrock Systems?**” at *West Texas Geological Society* luncheon meeting, Midland, Texas, May 8th
* **Rob Reed** gave a talk titled “**Predepositional Organic-Matter Pores from Low-Maturity Mudrocks: A Terrestrail Thing?**” at *SEPM Siliciclastic Diagenesis Research Group Meeting*, Salt Lake City, Utah, May 21st
* **Tongwei Zhang** gave a talk titled “**Controls on variation in oil saturation, Wolfcamp A. Delaware and Midland Basins**” at *AAPG/EMD Unconventional Research Group Meeting*, Salt Lake City, Utah, May 22nd
* **Farzam Javadpour** will give a talk titled “**Flow and Transport in Nanoscale Porous Media**” at *Gordon Research Conference*, Newry, Maine, this coming July 8–13th
* **Toti Larson** has been invited to give a talk titled “**Stable isotope measurements and molecular modelling of gas-solid reactions in the Earth Sciences**” at the *Elizabeth and Frederick White Research Conference*, Canberra, Australia, in September

**COLLABORATION ACTIVITIES:**

* **Toti Larson** will visit Geoscience Australia (GA) to discuss some of the ongoing collaborations between the Gulf Coast Carbon Center (GCCC) at the BEG and the GA. The topic will be on characterization and reactive transport of hydrocarbons and CO2 in the subsurface.
* **Sheng Peng** will be part of a collaborative project with TACC (Texas Advanced Computing Center) for “Petrobras - Machine Learning Course 2018”. He will teach courses on multiscale image processing in mudrocks and develop potential application of machine learning in mudrock pore characterization in August 2018.
* **Stephen Ruppel** is collaborating with BEG researchers in two other BEG consortia to create a Petrel model displaying the distribution of facies, wells, and other reservoir and completion attributes to better understand reservoir architecture and heterogeneity and their relationship to production response
* **The MSRL and RCRL consortiums** have reached a collaborative agreement that focuses on development of calibrations, core scanning method development, and equipment demonstration. Results of this collaboration were highlighted at AAPG with high resolution core scanning demonstrations. These developments will allow us to better characterize lithologies at a scale that compliments portable XRF scanning and scanning electron microprobe, allowing us to begin to ‘bridge the imaging scale gap’. – **Toti Larson** and **Evan Sivil**

**MSRL AAPG ACE CONFERENCE PRESENTATIONS (available on MSRL website):**

* **Toti Larson** and **Evan Sivil** demonstrated new X-ray technologies applied to core scanning at the Bruker booth during AAPG

**RECENT PEER-REVIEWED JOURNAL PUBLICATIONS (available on MSRL website):**

1. **Ko, L. T., S. C. Ruppel, R. G. Loucks**, P. C. Hackley, **T. Zhang**, and D. Shao, 2018, Pore-types and pore-network evolution in Upper Devonian-Lower Mississippian Woodford and Barnett mudstones: Insights from laboratory thermal maturation and organic petrology, *International Journal of Coal Geology*, http://dx.doi.org/10.1016/j.coal.2017.10.001
2. Naraghi, M.E., **Javadpour, F., Ko, L.T.**, 2018, An object-based shale permeability model: Non-darcy gas flow, sorption, and surface diffusion effects, *Transport in Porous Media* https://doi.org/10.1007/s11242-017-0992-z.
3. Wang, S., Feng, Q., Zha, M. **Javadpour, F.**, Hu, Q., 2018, Supercritical methane diffusion in shale nanopores: Effects of pressure, mineral types, and moisture content, *Energy & Fuels*, DOI: 10.1021/acs.energyfuels.7b02892.
4. Tahmasebi, P., **Javadpour, F.,** Frebourg, G., 2018, Geologic modeling of Eagle Ford facies continuity based on outcrop images and depositional processes, *SPE Journal*.
5. Sheng, G., **Javadpour, F.,** Sua, Y., 2018, Effect of microscale media compressibility on apparent permeability and porosity in shale gas reservoirs, *International Journal of Heat and Mass Transfer*, <https://doi.org/10.1016/j.ijheatmasstransfer.2017.12.014>
6. Shao, D., G. S. Ellis, Y. Li, **T. Zhang**, 2018, Experimental investigation of the role of rock fabric in gas generation and expulsion during thermal maturation: Anhydrous closed-system pyrolysis of a bitumen-rich Eagle Ford Shale,

*Organic Geochemistry*, 119, 23-35, https://doi.org/10.1016/j.orggeochem.2018.01.012

**INSTRUMENT AND LABORATORY UPDATE**:

A second state-of-the-art Bruker Tracer 5i was obtained and added to our XRF analytical suite