CONSTRUCTION OF A DIAGENETIC HISTORY AND IDENTIFICATION WITH QUALITY RANKING OF RESERVOIR FLOW UNITS: GRAYSON FIELD, COLUMBIA COUNTY, ARKANSAS

A Thesis

by

KATHLEEN RENEE POOLE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2006

Major Subject: Geology

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Approved by:

Chair of Committee,	Wayne Ahr
Committee Memebers,	Robert Popp
	David Schechter
Head of Department,	John Spang

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ABSTRACT

Construction of a Diagenetic History and Identification with Quality Ranking of
Reservoir Flow Units: Grayson Field, Columbia County, Arkansas. (December 2006)
Kathleen Renee Poole, B.S., Centenary College of Louisiana
Chair of Advisory Committee: Dr. Wayne Ahr

The purpose of this study was to describe depositional and diagenetic characteristics of the (Jurassic) Smackover formation and subsequently identify and rank the quality of flow units within Grayson field, Columbia County, Arkansas. The field has production from the Smackover, a reservoir which consists mainly of highly altered peloidal grainstones.

This was a four part study including a lithological analysis of ten cores, a petrographical study of 97 thin sections, a petrophysical study of reservoir properties from core analyses and borehole logs, and predictive mapping of quality ranked flow units across the field. Examination of the cores and thin sections revealed H_{1a} as the main pore type in Grayson field, which was a hybrid of both depositional and diagenetic processes with dominantly interparticle pores. The lowest ranked reservoir quality corresponded to intraparticle and intercrystalline pore types, which occurred mainly in the wackestone/mudstone and packstone/wackestone facies. The highest ranked reservoir quality corresponded to the H_{1a} pore type which occurred mainly in the grainestone/packstone facies 1 and 2. The reservoir quality maps identified the spatial distribution of the facies within the field, which could be used to locate zones for possible in-fill drilling. These results should aid in the economical development of Grayson field and other similar fields.

To Minette and Albert Poole,
whom I lovingly call mom and dad.
And to Beth and Chris,
who kept me in line when mom and dad weren't looking.

ACKNOWLEDGMENTS

I would like to start by thanking Petro-Chem Operating, Inc. and Anderson Oil & Gas, Inc of Shreveport, Louisiana, for generously supplying the data and funding necessary for this project. More specifically, I would like to extend my thanks to Bill Anderson for taking a chance on a Centenary graduate with little experience; Bill Meaney for always offering advice and listening; and to Larry Hock and Mr. & Mrs. Hock for their help with storing, moving, and studying the Grayson field core.

I would also like to thank my advisor and friend, Dr. Wayne Ahr, for all of his guidance and help during my time at Texas A&M. Likewise, I would like to express my gratitude to Dr. Bryan Willis, Dr. David Schechter, and Dr. Bob Popp for serving on my committee.

Finally, I would like to thank Joseph Anthony Urbis, Danielle Ebnother, Khryste Wright, and Heather Miller for their unfailing support and friendship.

NOMENCLATURE AND ABBREVIATIONS

<u>Production</u>:
bbls = barrels
Mcf = million cubic feet

<u>Porosity and Permeability Data</u>:
k = permeability in μ^2 or md (1md = $9.871 * 10^{-4}$ μm^2
Φ = porosity as a fraction or percent = phi

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INTRODUCTION

Carbonates and siliciclastics differ in many ways, examples of which include but are not limited to mode of origin, mineralogical composition, dependence on biology, susceptibility to diagenesis, and the variety of genetically different pore categories that can exist in any reservoir (Ahr, 2003). Hence, carbonate rocks tend to be more heterogeneous while siliciclastics are more homogeneous. Due to this heterogeneity, carbonate rocks present a challenge in predicting and correlating variations in reservoir properties. Detailed reservoir characterizations require an understanding of both fundamental rock properties as well as dependent or secondary rock properties.

Primary or fundamental rock properties for carbonate rocks consist of sedimentary structures, particle type, fabric, texture (size, shape, and arrangement of grains), and mineralogical composition (Ahr, 2003). Diagenetic processes; pore types, sizes and shapes; and porosity origin (depositional, diagenetic, fracture, or hybrid) are visible from these basic properties. Fundamental rock properties are obtained using cores and thin sections, though such information is often excluded from reservoir descriptions and modeling due to lack of time, money, or data (Hopkins, 2002).

Secondary rock properties depend upon primary rock properties and include porosity, permeability, bulk density, and S_w (Ahr, 2003). This information can be obtained from well logs, seismic records, and core analyses. However, to understand how and why reservoir quality is related to porosity, lithology, structure and

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This thesis follows the style and format of the American Association of Petroleum Geologists Bulletin.

stratigraphy; secondary rock properties must be tied to primary rock properties (Morgan, 2003). This multi-disciplinary approach to reservoir characterization has been proven by previous studies at Texas A&M (Hammel, 1996; Layman, 2002; Morgan, 2003; Fisher, 2005) to be the most effective and accurate way to obtain reproducible results.

Definition of Problem

Grayson (Smackover) field in Columbia County, Arkansas, is in advanced development and secondary recovery. However, the spatial distribution and rank of flow units in the field have not been determined using both the fundamental and dependent rock properties. Also, a detailed diagenetic history has not been established for the field.

Purpose of Study

The purpose of this study is to first develop a detailed diagenetic history for Grayson Field. The second objective is to map and rank flow units in the Smackover formation throughout the field. This information will allow the operators to assess the practicality, desirability, and cost of infill drilling as compared to managing production from existing wells at wider spacing. The findings will also aid in assessing which wells are preferable for water or other fluid injection during improved recovery and which wells are best suited as producers. Finally, the results will greatly improve the geological understanding of the field, the reservoir, and ultimately the projected added value of any additional geological or engineering works.

Location of Study Area

Grayson field is located in Township 16 South, Range 21 West, Columbia County, Arkansas (Figure 1). The field occupies 800-900 acres situated within the established Smackover production trend of South Arkansas (Takach et al, 1998).

Modified from HomeTownLocator (2005).

Figure 1. Map showing location of Grayson field, Columbia County, Arkansas.

Previous Work

<u>Grayson Field</u>

A previous study by Schatzinger (1993) focused on determining a depositional model for the Smackover based on core descriptions. He described cores from the Reeves #1, Kitty Jean #1, and Alexander #1, along with 53 thin sections from those wells. Schatzinger used the thin section analysis to identify major allochems in addition to determining the origin of the porosity within the cored interval. He suggested that the cores contain facies deposited in inner and outer carbonate sand shoal and inner shelf environments. According to Schatzinger, the inner shoal depositional facies consists of grainstones while the outer shoal contains pellet wackestone/packstones, pellet wackestone, and oncolite wackstones. The inner shelf is composed of carbonate mudstone/wackestones and coralgal boundstone. Schatzinger also interpreted that the grainstone facies were the most porous and that those with more preserved interparticle porosity were the most permeable. The major limitation in his work, however, is that his data were based on the first three wells in the field, where only the top of the structure is represented.

Netherland, Sewell and Associates, Inc. (1996) preformed a reservoir simulation study for Grayson field to estimate oil-in-place and to evaluate oil recovery methods based on proposed development plans. They calculated an OOIP of 41.9 MMSTB and primary recovery of 8.2 MMSTB, 19.5% of OOIP. Reservoir pressure was below the oil bubblepoint pressure, allowing gas cap formation. The reservoir drive mechanism was suggested to be primarily solution gas drive with a small amount of aquifer influx. They also divided the Smackover into 3 major intervals: Smackover A, B, and C. A is massive and considered the best developed reservoir. B and C are predominantly wet intervals though layer C has been completed and produced in 2 wells. The 3 intervals were further subdivided into 15 layers based on core analyses. Though this model does include more wells than the previous study by Schatzinger, it does not take into account primary rock properties obtained from core descriptions and thin sections.

Other works include Takach et al. (1998) and Hill (2001). Takach et al. outline the discovery and development of Grayson field. Hill describes the seismic processing used to recognize the Smackover reservoir.

Nearby Fields

Previous work in close proximity to the field includes a case study on Magnolia field by Rosaire and Forgotson (1953). They focused on the tectonics that formed the Magnolia field structure. They found that the structure was accentuated by but not formed as a result of salt tectonics.

Bliefnick and Kaldi (1996) studied Walker Creek field in Columbia County. They examined samples from eleven wells and incorporated data from core analyses. Using both petrophysical and petrographic criteria, they identified lithologic units and their corresponding log responses. Texture, grain types, cement types, amount of compaction, and relative abundance and distribution of pore types were recorded from thin section analyses. Thin sections and pore casts were used to determine pore geometry. MICP and drainage-only mercury injection analyses were also used. The results from the investigation indicate that pore geometry controls reservoir quality and is determined by depositional and diagenetic processes. Methods used in this study served as a model for the research preformed on Grayson field.

Identification and Mapping of Flow Units in Carbonate Rocks

Hammel (1996), Layman (2002), Morgan (2003), and Fisher (2005) focused on characterizing reservoirs by predicting reservoir quality and flow unit spatial distribution. This was done by integrating stratigraphic and petrographic analyses using a slice mapping technique. This is the same slice mapping method employed in this study.

Production History of Grayson Field

Grayson field was discovered in Columbia County, southern Arkansas in March, 1993. The reservoir covers an area of 800-900 acres and has produced over 11.7 MMBO from the Jurassic Smackover limestone. Figure 2 shows the field production from 1993 to present. There have been 14 productive wells, 2 of which were converted to injection wells. The Westbrook #1 was converted to a saltwater disposal well in September 1995, and the Reeves #1 was converted to a gas injection well in May 1996. Also, the Alexander #1 and Genestet #1 have had uphole recompletions.

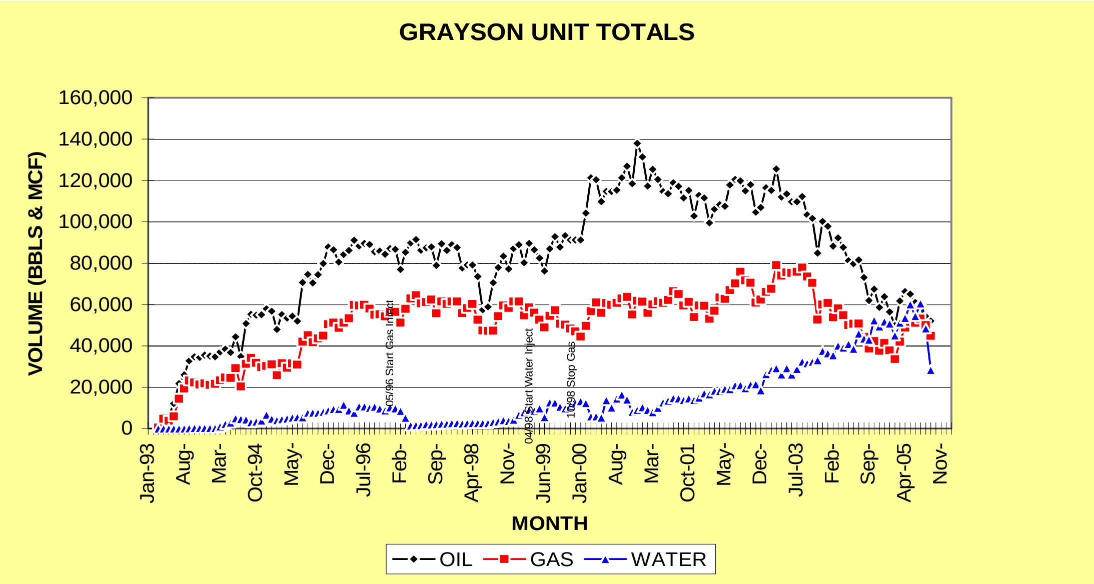


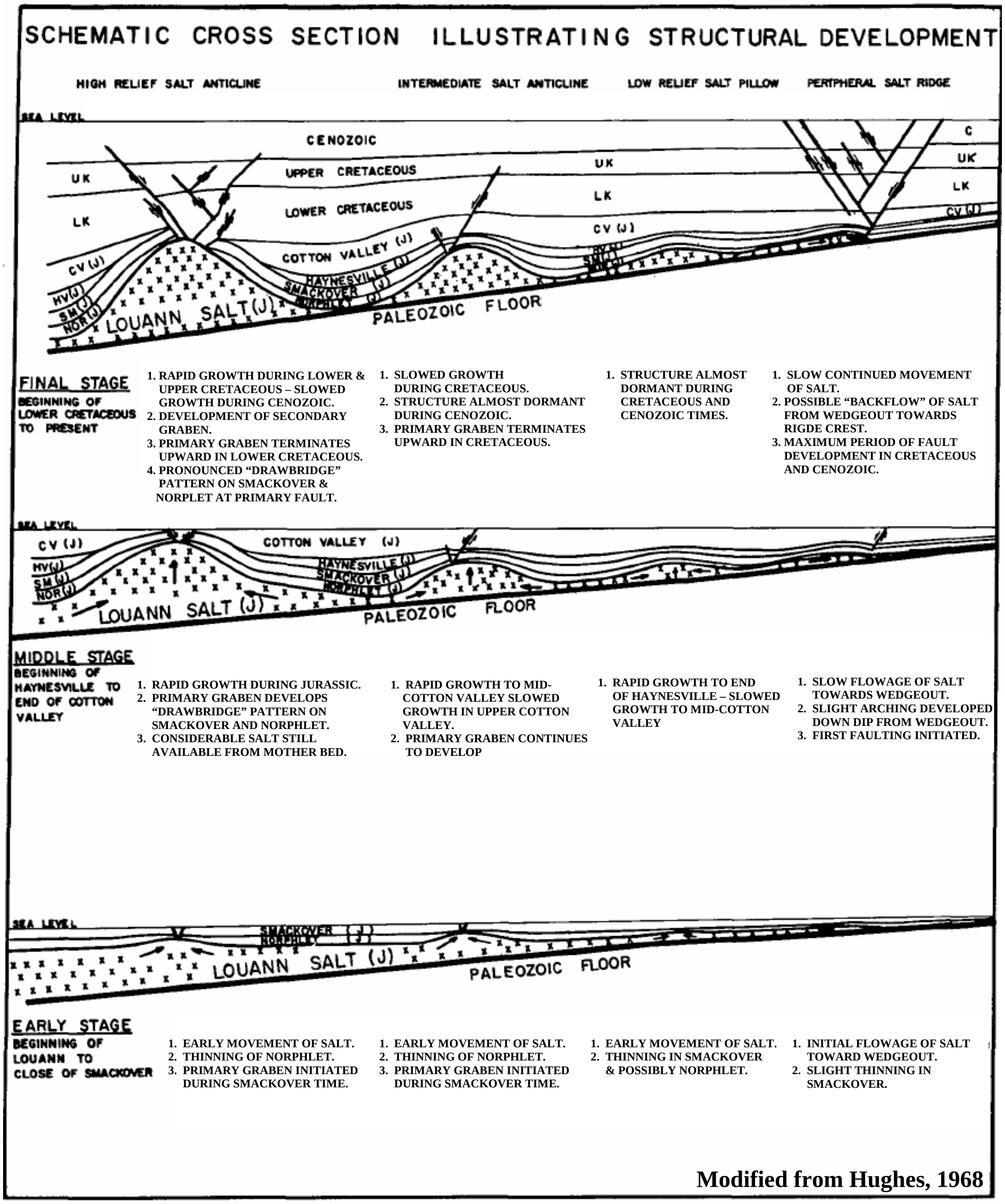
Figure 2. Graph of Grayson field production (Courtesy of Petro-Chem Operating, Inc. and Anderson Oil and Gas, Inc.).

REGIONAL GEOLOGIC SETTING

Structural Setting

The western Arkansas-Louisiana border was the site of active Triassic-Jurassic tectonism. This region is divided by an extensive rift system that was created as the Gulf of Mexico opened during this time (Kalbacher and Sartin, 1986). In the study area, the Smackover regionally dips to the southwest across South Arkansas. The majority of the Smackover production in this area is from salt-generated anticlines. Examples of such fields include McKamie-Patton, Dorcheat-Macedonia, Atlanta, and Magnolia (Troell and Robinson, 1987). As younger strata were deposited, the Louann Salt underwent gravity-flow folding that produced salt anticlines similar to the one underlying Grayson field. Gravity sliding of the salt was triggered by subsidence in the Gulfward direction (Troell and Robinson, 1987). Figure 3 shows a schematic cross section displaying this structural development due to salt movement according to Hughes (1968).

Grayson field is a combination structural-stratigraphic trap that consists of an elongated, east-west striking anticline south of a down-to-the-south normal fault. The structure has few internal faults although a small normal fault was identified on the southeast portion of the field (Netherland et al, 1996).



FINAL STAGE

1. RAPID GROWTH DURING LOWER & UPPER CRETACEOUS – SLOWED GROWTH DURING CENOZOIC.
2. DEVELOPMENT OF SECONDARY GRABEN.
3. PRIMARY GRABEN TERMINATES UPWARD IN LOWER CRETACEOUS.
4. PRONOUNCED “DRAWBRIDGE” PATTERN ON SMACKOVER & NORPLET AT PRIMARY FAULT.

1. SLOWED GROWTH DURING CRETACEOUS.
2. STRUCTURE ALMOST DORMANT DURING CENOZOIC.
3. PRIMARY GRABEN TERMINATES UPWARD IN CRETACEOUS.

1. STRUCTURE ALMOST DORMANT DURING CRETACEOUS AND CENOZOIC TIMES.

1. SLOW CONTINUED MOVEMENT OF SALT.
2. POSSIBLE “BACKFLOW” OF SALT FROM WEDGEOUT TOWARDS RIGDE CREST.
3. MAXIMUM PERIOD OF FAULT DEVELOPMENT IN CRETACEOUS AND CENOZOIC.

MIDDLE STAGE

1. RAPID GROWTH DURING JURASSIC.
2. PRIMARY GRABEN DEVELOPS “DRAWBRIDGE” PATTERN ON SMACKOVER AND NORPHLET.
3. CONSIDERABLE SALT STILL AVAILABLE FROM MOTHER BED.

1. RAPID GROWTH TO MID-COTTON VALLEY SLOWED GROWTH IN UPPER COTTON VALLEY.
2. PRIMARY GRABEN CONTINUES TO DEVELOP

1. RAPID GROWTH TO END OF HAYNESVILLE – SLOWED GROWTH TO MID-COTTON VALLEY

1. SLOW FLOWAGE OF SALT TOWARDS WEDGEOUT.
2. SLIGHT ARCHING DEVELOPED DOWN DIP FROM WEDGEOUT.
3. FIRST FAULTING INITIATED.

EARLY STAGE

1. EARLY MOVEMENT OF SALT.
2. THINNING OF NORPHLET.
3. PRIMARY GRABEN INITIATED DURING SMACKOVER TIME.

1. EARLY MOVEMENT OF SALT.
2. THINNING OF NORPHLET.
3. PRIMARY GRABEN INITIATED DURING SMACKOVER TIME.

1. EARLY MOVEMENT OF SALT.
2. THINNING IN SMACKOVER & POSSIBLY NORPHLET.

1. INITIAL FLOWAGE OF SALT TOWARD WEDGEOUT.
2. SLIGHT THINNING IN SMACKOVER.

Modified from Hughes, 1968

Figure 3. Schematic cross section showing evolution of structure due to salt movement.

Stratigraphic Setting

The Smackover Limestone of southern Arkansas formed in the Oxfordian stage of the Jurassic system and is typically underlain by the Norphlet Sandstone (Figure 4). However, the study area is north of the Norphlet pinchout. Hence, the Grayson field Smackover reservoir rests on top of the Louann Salt, a rock unit consisting of halite with some siliciclastics and anhydrite. The Buckner, composed of massive anhydrite and intercalated dolomite beds, overlies the Smackover and serves as the seal for the reservoir in the study area.

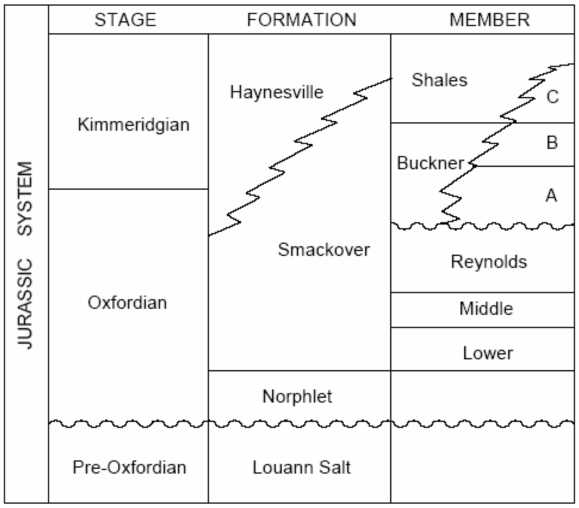
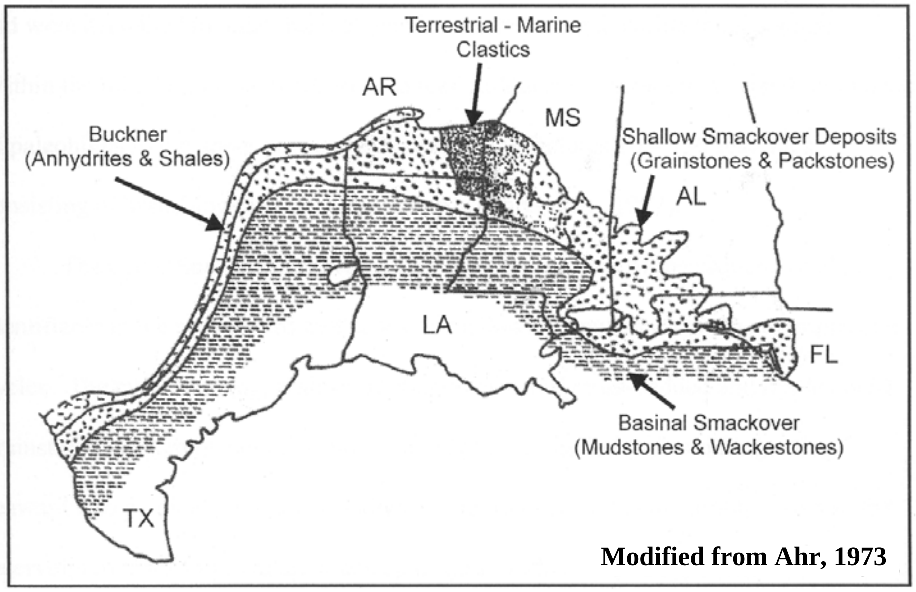


Figure 4. Simplified stratigraphy for Jurassic section in southern Arkansas (Bliefnick and Kaldi, 1996).

In Grayson field, the upper Smackover has been interpreted to be a prograding grainstone belt on a carbonate ramp with high energy deposits around paleo-highs and low energy deposits in bathometric lows (Ahr, 1973). Figure 5 illustrates the regional faces associated with the Smackover. A lower zone, consisting of mainly peloidal-oncoidal packstones and wackestones, was initially deposited in shallow embayment centers. As centers became restricted and water depths increased within the embayments, the middle member, laminated mudstones were deposited in shallower waters. Along the flanks and crests of paleo-highs, middle member algal laminations and microbial patch reefs began to develop. The upper member grainstone complexes formed around paleo-highs as sedimentation rates exceeded subsidence and sea level rise (Morgan, 2003).

The middle and lower mudstones are organic-rich and dark colored. They probably serve as the source rock for many of the Smackover fields in and around the study area though they could also be reservoirs in some cases. These mudstones formed in quiet, basinal marine, reducing waters during a marine transgression. The upper Smackover grainstones represent a regressive portion of the sequence. This upper section is identifiable in the rock record as a series of shoaling upward mudstone to grainstone cycles (Morgan, 2003).



Modified from Ahr, 1973

Figure 5. Extent of Smackover deposits in the United States.

METHODS

This study consists of four parts: 1) a lithological core study, 2) thin section petrography, 3) petrophysical interpretation of reservoir properties from core analyses and borehole logs, and 4) predictive mapping of quality ranked flow units across the field. Depositional facies were first identified and described by examining cores and thin sections selected from each lithogenetic unit and each significant diagenetic alteration zone within lithogenetic units. Subsequently, these depositional facies were subdivided based on diagenetic alteration and variations in visible as well as measured (from core analyses) porosity and permeability. Pore types were classified according to the genetic pore classification (as shown in the figure on page 21) of Ahr et al. (2005). The rock and pore types were then compared in order to identify key characteristics that determined reservoir quality.

Materials Used in the Study

Petro-Chem Operating, Inc. and Anderson Oil & Gas, Inc of Shreveport, La. supplied slabbed core, borehole logs, core analysis reports, thin sections, base maps, structure maps, production history reports, and previous geologic studies.

Core

25 wells exist in and within one mile of the boundaries of the field-wide unit for Grayson Field. Of those wells, 17 have been cored partially or completely through the reservoir interval, resulting in 1900 feet of slabbed core. Ten representative cores were

examined wet using a binocular microscope after being etched in dilute HCl to provide a fresh rock surface. Descriptive colors and symbols logged were based on the AAPG Sample Examination Manual. Detailed core descriptions included identification of particle type, depositional textures, sedimentary structures, lithology, visible porosity, and significant facies changes (Appendix A). A working depositional and diagenetic model was created using the core descriptions. The depositional facies identified from core descriptions were then compared with wireline log signatures to allow for field wide correlation.

Thin Sections

Petro-Chem Operating, Inc. and Anderson Oil & Gas, Inc provided thin sections from 53 samples collected in the first three field wells by Schatzinger (1993). They were examined to classify pore types genetically. From this information, 40 additional thin sections were made to ensure that all facies, porosity, and permeability types were represented. Billets were cut and then sent to National Petrographic Service, Inc. for impregnation with blue epoxy, thin sectioning, and staining with Alizarin Red S in order to identify calcite.

Thin section petrography was performed using a binocular microscope in plane and polarized light. Depositional texture, porosity, mineralogy, and diagenetic processes were described. Appendix B contains thin section descriptions and photomicrographs.

Borehole Logs

Of the 25 wells in the field area, logs were provided on 13 producing wells and 4 dry holes. Most of the logs include full suites of modern logs including photoelectric effect, spontaneous potential, gamma-ray, resistivity, dip meter, porosity and mud logs. The gamma-ray, spontaneous potential, porosity, and resistivity logs were used for correlating across the field where available.

Subsurface Mapping

Log and core analysis data were used to produce subsurface maps such as structure, Buckner isopach, porosity slice, permeability slice, and reservoir quality-ranked maps (Appendix C). Stratigraphic and structural cross sections were also produced using the fore mentioned data (Appendix D). An interval isopach map of the Smackover could not be produced due to a lack of wells that fully penetrated the Smackover.

Slice Mapping

Slice mapping was used to determine the 3-D distribution of quality ranked poroperm units in the study area. This style of mapping incorporates petrologic, petrographic, and petrophysical data in order to give a complete picture of the reservoir. Porosity and permeability were averaged from core analyses for consecutive, ten-foot interval slices field wide. The slices were then contoured. The top of the slices were taken from the top of the Smackover downward in 10-ft intervals, creating stratigraphic slices. Superimposing the corresponding porosity and permeability slice maps allowed identification of the spatial distribution of quality-ranked porous and permeable zones within the reservoir. Appendix C contains the porosity, permeability, and reservoir quality slice maps.

SMACKOVER FORMATION ROCK PROPERTIES

Depositional Facies Descriptions

Core descriptions from the ten Grayson wells show five dominant facies contained within the Smackover interval. These facies include two grainstone/ packstone facies, a packstone/wackestone facies, a wackestones/mudstone facies, and a microbial boundstone facies.

Grainstone/Packstone Facies 1

This grainstone/packstone facies comprises 67% of all rocks described in this study. Rocks in this facies range from light brown to gray in color though they may appear darker if stained by hydrocarbons. Ooids and peloids make up greater than 65% of the rock. The ooids range from 2mm to 0.25mm while the peloids range from 5mm to 0.1mm. These grainstones generally are moderately sorted. This facies is usually massive and often shows faint bedding structures. The porosity most commonly visible in the cores is oomoldic porosity.

Grainstone/Packstone Facies 2

This grainstone/packstone facies comprises 15% of all rocks described in this study. This facies is light brown to dark brown in color. Occasional pisoids, greater than 50% ooids and peloids, and greater than 2% oncoids make up this rock. The oncoids range from 10mm to 2mm in diameter while the peloids range from 7mm to 0.125mm. The ooids range from 2mm to 0.25. Grainstone/packstone facies 2 is commonly poorly sorted, exhibits little to no sedimentary structures, and frequently exhibits visible porosity. This grainstone/packstone is typically thinner than facies 1, usually ranging from 4 to 10 feet in thickness. Styolites are commonly found in this facies.

<u>Packstone/Wackestone Facies</u>

This facies comprises 3% of all rocks described in the study. The rocks are light brown to dark gray in color. Occasional pisoids and oncoids as well as less than 50% ooids and peloids make up this rock. The oncoids range from 11.5mm to 2mm in diameter while the peloids range from 5mm to 0.1mm. The ooids range from 0.5mm to 0.25mm. The packstone/ wackestone facies is commonly poorly sorted and exhibits few sedimentary structures. This facies usually ranges from 2 to 8 feet in thickness. Styolites are commonly found in this facies.

<u>Wackestones/Mudstone Facies</u>

This facies also comprises 3% of all rocks described in the study. The rocks are light gray to dark brown in color. Occasional pisoids and oncoids, less than 20% ooids and peloids, and less than 2% quartz grains make up this rock. The oncoids range from 8mm to 2mm in diameter while the peloids range from 0.25mm to 0.125mm. The ooids range from 0.5mm to 0.25mm. The quartz grains are silt size. The packstone/ wackestone facies is commonly poor to moderately sorted and exhibits little to no sedimentary structures. This facies usually ranges in thickness from 2 to 8 feet. Styolites are common.

Microbial Boundstone Facies

This microbial boundstone facies comprises 11% of all rocks described in the study and is light gray to dark brown in color. Occasional fossils such as gastropods, bryozoans, echinoderms, and various shell fragments as well as ooids and greater than 70% peloids make up this rock. The ooids range from 1mm to 0.5mm in diameter while the peloids range from 1mm to 0.1mm. The microbial boundstone facies commonly exhibits visible vuggy porosity and burrowing. Dolomite and anhydrite pore/vug filling and grain replacement is present to common. This facies usually ranges in thickness from 8 to 22 feet.

Diagenesis

The Smackover reservoir in Grayson field exhibits a variety of diagenetic features including micritization, cementation, leaching, compaction, grain replacement, pore filling, and solution compaction. 9 diagenetic episodes and their sequence were identified based on crosscutting relationships seen in thin section.

96 of 97 thin sections showed micritization of grains as the first diagenetic event occurring in the marine environment. Early isopachous rim cement formed in this environment also. As shown in Figure 6, leaching, compaction, and blocky cementation dominate the meteoric phreatic and mixing zone. Field wide, the meteoric phreatic

leaching event is generally the dominant porosity and permeability enhancement mechanism. The freshwater phreatic, blocky cements along with late stage anhydrite and dolomite pore filling are the greatest porosity reducing events in the study area.

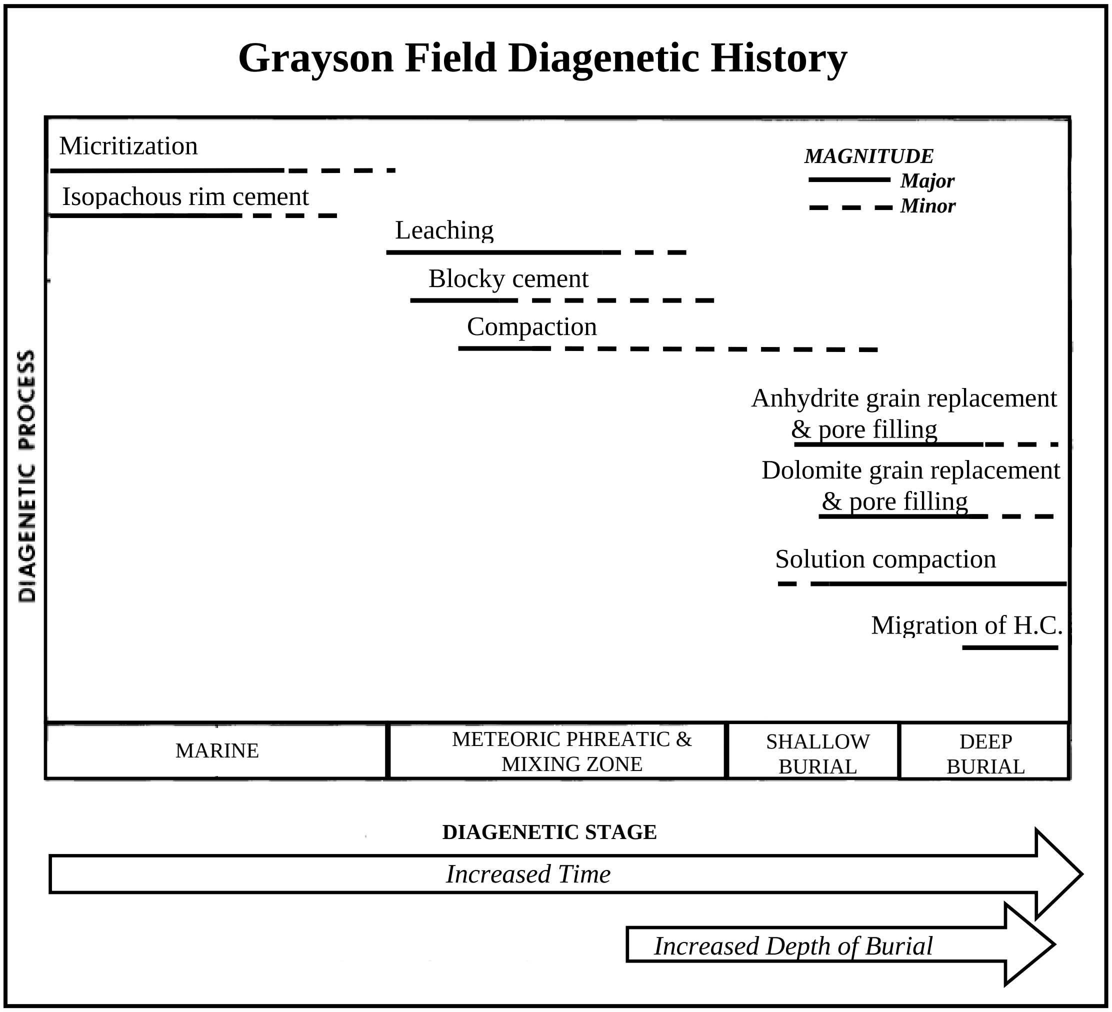
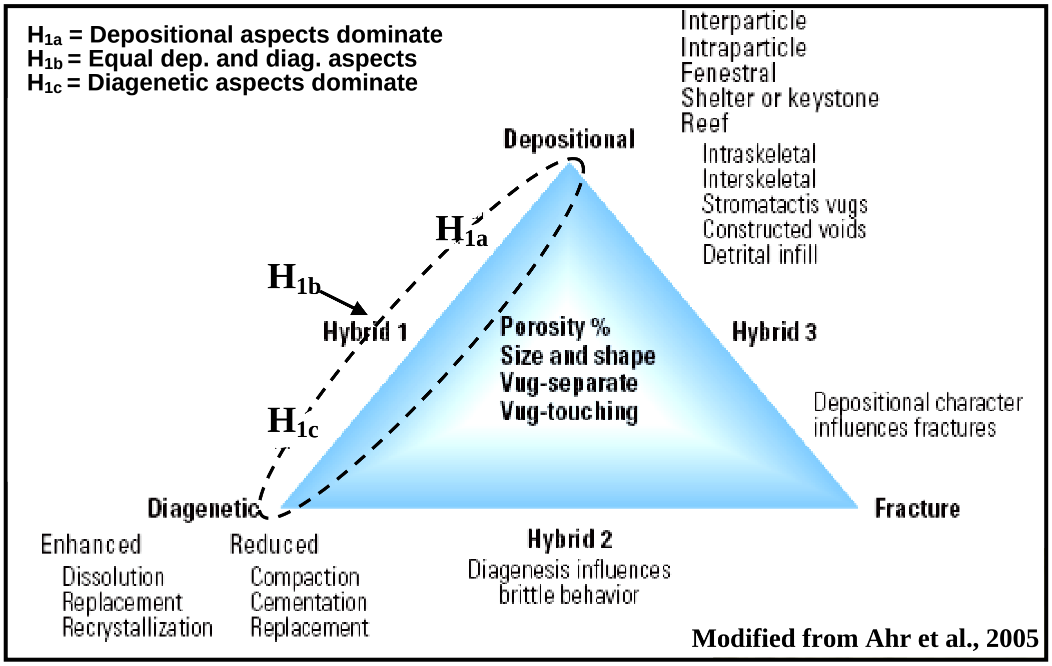


Figure 6. Summary of the diagenetic history in the study area. Modified from Ahr and Palko (1981).

Pore Types

When working in highly, diagenetically altered areas, classifying pore types using conventional schemes can be difficult. Figure 7 shows the genetic classification of carbonate porosity in Grayson field. This genetic approach to classification is beneficial because it links the geologic processes which created the pore type to pore geometry, allowing for the prediction of permeability and porosity at field scale (Morgan, 2003).



Modified from Ahr et al., 2005

Figure 7. Ahr's integrated triangle diagram of genetic porosity types. The majority of the porosity found in Grayson filed in located within the dashed ellipse.

Initially, 65% of the thin section samples were classified as having hybrid pore types. These hybrid pores were then subdivided based on depositional or diagenetic dominant aspects. The porosity and permeability graph in Figure 8 shows that the majority of the hybrid pore points plot in the interparticle porosity zone which supports the classification of H_{1a}, a hybrid of both depositional and diagenetic processes with dominantly interparticle pores. Upon further investigation, 63% of the hybrid pore samples are classified as H_{1a} and all are either grainstone/packstone facies 1 or 2.

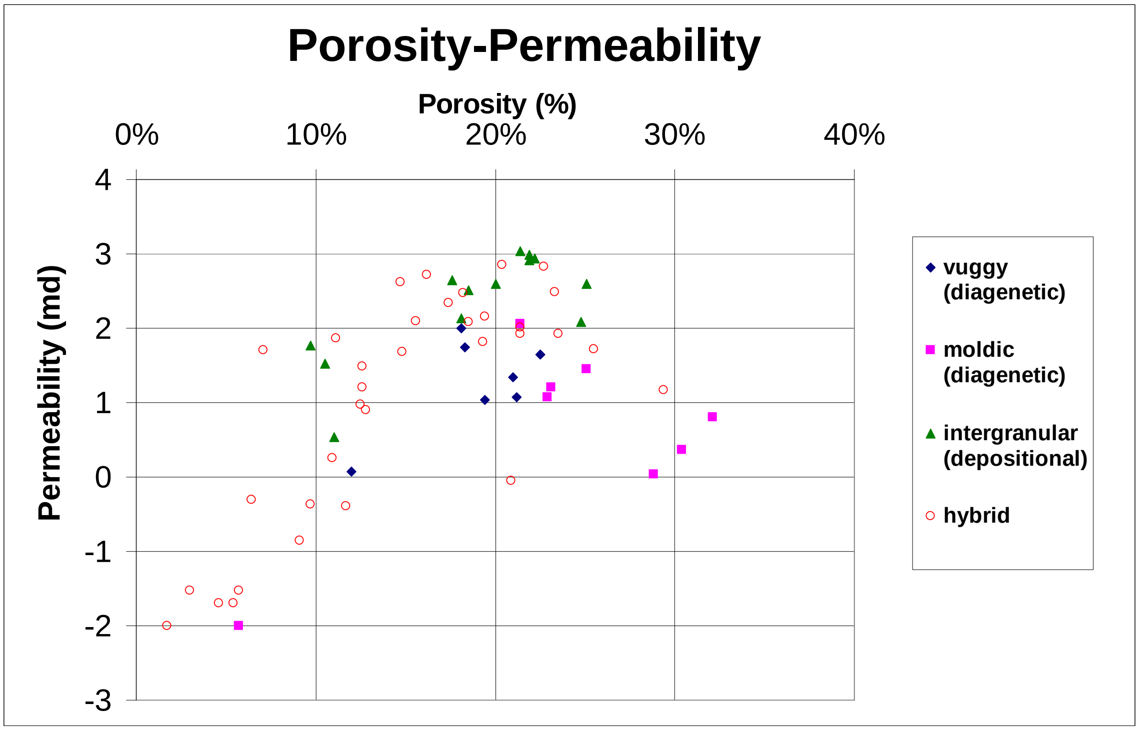


Figure 8. Semi-log plot showing porosity and permeability for the dominant pore types found in Grayson field.

It is important to remember that diagenesis can both increase and decrease pores/porosity. Marine isopachous rim and meteoric blocky cements reduce porosity in the grainstone/ packstone facies by 5 to 10% while a later episode of leaching aids in increasing porosity. Dolomitization is generally abundant in the packstone/ wackestone and wackestones/mudstone facies along with anhydrite pore filling and grain replacement which serves to decrease porosity. Anhydrite and dolomite pore filling and replacement are present to common in the microbial boundstone facies. The dominant pore types found in the wackestone/packstone facies are interparticle and moldic. The wackestone/mudstone facies contains dominantly intercrystalline porosity though the facies as a whole only has an average of 4% porosity in the samples examined. The grainstone/packstone facies 1 contains dominantly interparticle, solution enhanced interparticle, and moldic porosity. Interparticle, solution enhanced interparticle, and intraparticle porosity dominate the grainstone/packstone facies 2. The microbial boundstone facies contains mostly dissolution vugs, solution enhanced interparticle, and solution enhanced intraparticle porosity.

DISCUSSION AND INTERPRETATION

Spatial Distribution of Facies

After comparing the salt time-structure map, Buckner isopach map, and the Smackover structure map (Appendix C); it was noted that thick sections of the Buckner Formation corresponded to lows on both the salt time-map and the Smackover structure map. This means that the Smackover present day structure is similar in size and shape to the bathymetry of the Buckner-Smackover ocean at the time of Buckner deposition. Comparisons of the facies distributions with the salt time-structure map, Buckner isopach map, and the Smackover structure map (Appendix C) as well as the field wide Smackover cross sections (Appendix D), revealed that the Smackover facies boundaries correspond to both the present and paleo-structure. This indicates that salt movement occurred before the deposition of the Smackover and Buckner.

The grainstone/packstone facies 1 and 2 as well as the microbial boundstone facies are located on the top and flanks of salt highs, Buckner thins, and Smackover structural highs. These paleo-highs allowed for shallow, agitated waters to form grainstone shoals and microbialites. The packstone/wackestone and wackestone/ mudstone facies correspond to bathymetric lows, Buckner thicks, and Smackover structural lows. The paleo-structural lows allowed the accommodation space needed to provide quieter, deeper water environment than that found on and around the highs. Thus, off structure toward paleo-lows, packstone/wackestone facies were deposited while wackestone/mudstone facies were deposited directly in the paleo-lows.

Porosity, Permeability, and the Relationship to Depositional and Diagenetic History

The facies identified in Grayson field are listed in Table 1. The two grainstone/ packstone facies have the best combined porosity and permeability while the wackestone/mudstone facies has the worst combined porosity and permeability found in the study area. Since 82% of the samples studied in Grayson field are classified as grainstone/packstone facies and the majority of these samples has H_{1a} as the dominant pore type, it is important to understand how porosity and permeability relate to the depositional and diagenetic history of the facies.

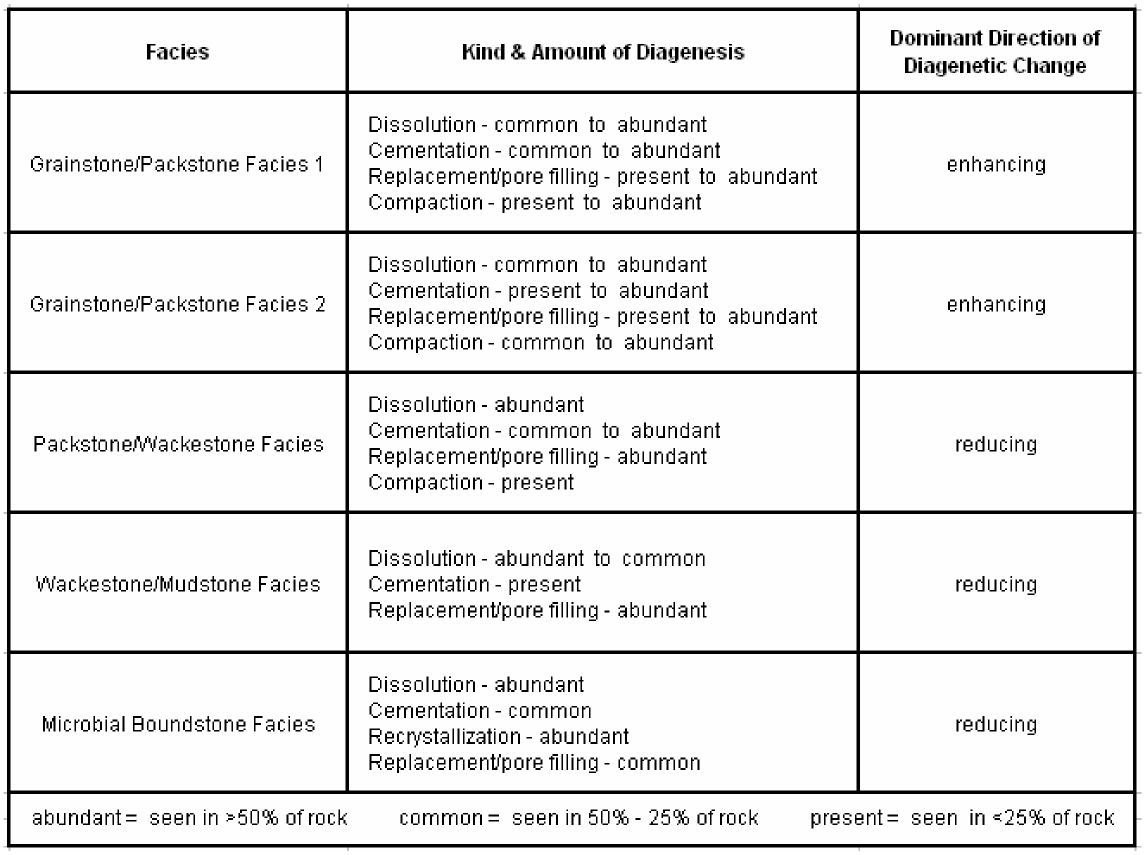
Table 1. Grayson field facies and their average porosities and permeabilities. Ranked from the top to bottom according to best to worst combined porosity and permeability.

Facies	Average Porosity	Average K	Porosity Range	K Range
Grainstone/packstone (facies 1 & 2)	16.3%	192.2	32.1 - 1.7%	< 0.01 - 2260 md
Microbial boundstone	18.3%	29.0	23.8 - 9.2%	0.32 - 100 md
Packstone/wackstone	6.1%	1.1	11.0 - 2.7%	0.01 - 3.4 md
Wackestone/mudstone	4.0%	0.1	10.5 - 0.7%	< 0.01 - 0.18 md

The rocks of grainstone/packstone facies 1 and 2 were deposited in the marine environment where early isopachous, marine rim cement served as both a porosity reducer and a porosity protector. Rocks with early marine cement better withstood compaction, were later extensively leached, and became the principle reservoir rocks in

Grayson field (H_{1a}). However, in zones that did not undergo sufficient leaching, the cement remained as a porosity reducer which created H_{1b} and H_{1c} pore types. Blocky, meteoric phreatic cements along with late stage pore filling dolomite and anhydrite also act as porosity reducers. Zones with little to no cement suffered porosity reduction from compaction and late stage pore filling. As shown in Table 2, the dominant direction of diagenetic change is positive or enhancing for these rocks. This is because the diagenetic event that caused the greatest change in both of the grainstone/packstone facies is medium to late stage dissolution/leaching.

Table 2. The kind and amount of diagenesis found in each facies within Grayson field.



Facies	Kind & Amount of Diagenesis	Dominant Direction of Diagenetic Change
Grainstone/Packstone Facies 1	Dissolution - common to abundant Cementation - common to abundant Replacement/pore filling - present to abundant Compaction - present to abundant	enhancing
Grainstone/Packstone Facies 2	Dissolution - common to abundant Cementation - present to abundant Replacement/pore filling - present to abundant Compaction - common to abundant	enhancing
Packstone/Wackestone Facies	Dissolution - abundant Cementation - common to abundant Replacement/pore filling - abundant Compaction - present	reducing
Wackestone/Mudstone Facies	Dissolution - abundant to common Cementation - present Replacement/pore filling - abundant	reducing
Microbial Boundstone Facies	Dissolution - abundant Cementation - common Recrystallization - abundant Replacement/pore filling - common	reducing
abundant = seen in >50% of rock	common = seen in 50% - 25% of rock	present = seen in <25% of rock

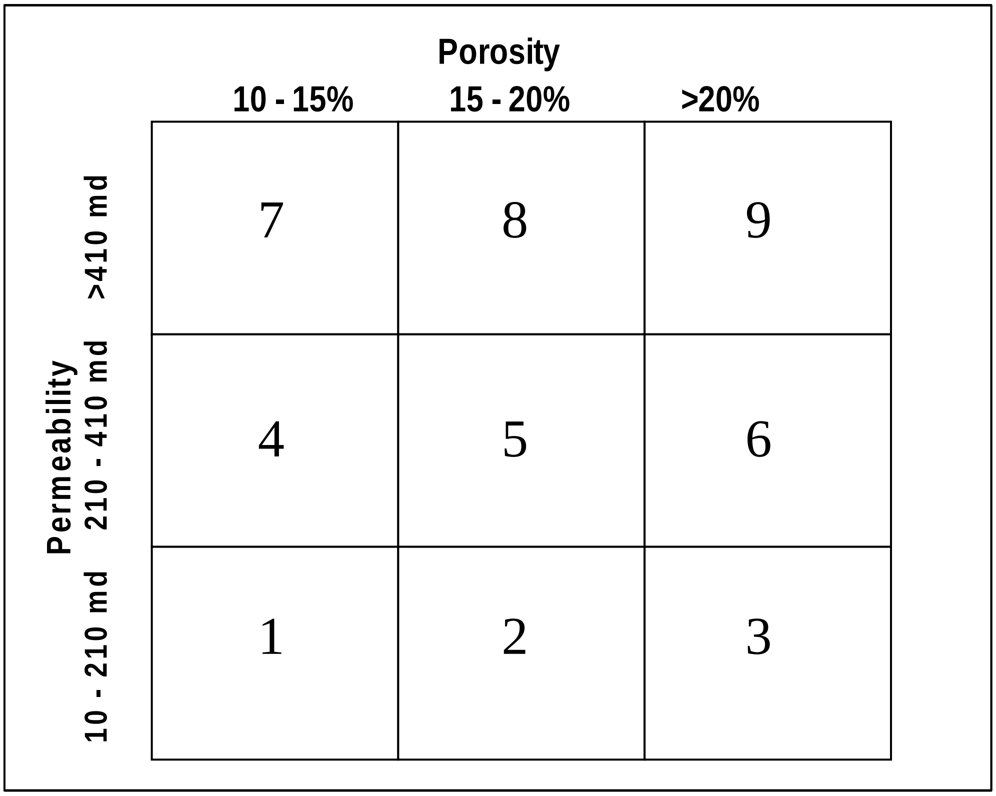
The majority of the diagenesis found in the packstone/wackstone, wackestone/ mudstone, and microbial boundstone facies is porosity reducing. Though dissolution is present to abundant in most samples, early cementation and compaction as well as late stage dolomite and anhydrite pore filling and grain replacement caused the greatest changes in these rock types. Also, variations in the microbial boundstone facies can be seen across the field. Pore filling, grain replacement, and cement increase from West to East as seen in individual core and thin section descriptions (Appendix A & B).

Flow Units and Quality Ranking

Flow units mapped using the slice map technique can be found in Appendix C. These units are zones of high porosity and permeability within the reservoir. Flow unit quality was ranked according to the divisions found in Figure 9 such that 1 is the worst flow unit and 9 is the best.

The wackestone/mudstone facies lacks sufficient porosity and permeability to be classified as a flow unit and instead serves as both baffles and barriers. The packstone/ wackestone facies ranks in the lowest tier of permeability, falling into the 1, 2, and 3's on the map. The microbial boundstone facies ranks as 2's and 3's only.

However, both grainstone/packstone facies 1 and 2, which comprise 82% of the rocks studied, span the entire spectrum, ranking in all of the categories 1-9. This means that the majority of the rocks in Grayson field have been diagenetically altered such that porosity and permeability is highly variable within the dominant facies. Hence, the



Permeability \ Porosity	10 - 15%	15 - 20%	>20%
>410 md	7	8	9
210 - 410 md	4	5	6
10 - 210 md	1	2	3

Figure 9. Chart showing divisions of porosity and permeability used to rank the Grayson field flow units.

quality ranking reflects the type and degree of diagenetic alteration within grainstone/ packstone facies 1 and 2. Zones with the lowest quality ranking correspond to areas with extensive cementation, grain replacement, and pore filling. Zones with the highest quality ranking correspond to areas with cementation followed by extensive leaching.

Distribution of Ranked Flow Units

The distribution of ranked flow units can be seen on the reservoir quality maps located in Appendix C. As expected, the lowest ranking facies, the wackestone/

mudstones, lies off of the structure and outside of the reservoir quality areas. The next lowest ranked flow units (1, 2, & 3's) consist of the packstone/wackestone facies as well as those grainstone/packstone facies that are tightly cemented and/or contain a large amount of pore filling dolomite and anhydrite (H_{1c}). The packstone/wackestone facies tend to rest on the lower portions of the structure flanks. The low ranking grainstone/packstones tend to be on the outer edges of the structure; however, this is not always the case. The next tier up in permeability (4, 5, & 6) is found to be grainstone/packstone facies that only had partial leaching or encountered minor amounts of blocky meteoric cement (H_{1b}). In general, these rocks are located around the paleo-highs. The highest permeability tier (7, 8, & 9) consists of grainstone/packstone facies in which ispachous, rimmed cement preserves the original porosity followed by extensive leaching of the cement (H_{1a}). These zones typically are found on the top of the structure and generally have interparticle, solution enhanced interparticle, moldic and vuggy porosity.

CONCLUSIONS

- Interval isopach maps of the Buckner Formation reveal paleo-highs and lows in the underlying Smackover Formation. This indicates that salt movement occurred before the deposition of the Smackover and is responsible for the paleo-structure.
- The shape and form of the present structure map of the Smackover Formation closely resemble Buckner Formation isopach maps, indicating that present structure and paleo-structure coincide. This suggests that highs and lows in the bathymetry of the Smackover sea can be identified as Buckner thins and thicks, respectively.
- Buckner isopach maps help predict facies boundaries across the field. Thinner Buckner zones correlate to paleo-highs on which grainstone/packstone and microbial boundstone facies formed while thicker areas correlate to wackestone/mudstone and packstone/wackestone facies.
- Average Smackover porosity is higher on present structural highs and lower off present structure.
- The main pore type in Grayson field is H_{1a}, a hybrid of both depositional and diagenetic processes with dominantly interparticle pores. The greatest amount is found within both grainstone/packstone facies 1 and 2.
- The lowest reservoir porosity corresponds to intraparticle and intercrystalline pore types, which occur mainly in the wackestone/mudstone and packstone/ wackestone facies. This is due to diagenetic porosity reduction associated with

dolomitization, anhydrite grain replacement, and both dolomite and anhydrite pore filling.

- The highest reservoir porosity corresponds to the H_{1a} pore type which occur mainly in the grainestone/packstone facies 1 and 2. This is due to early cementation protecting the rock against porosity reduction due to compaction. Subsequent leaching then restored and enhanced the original depositional porosity.

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APPENDIX A

CORE DESCRIPTIONS AND PHOTOGRAPHS

Core Description
Alice Sydney
Crone #1
Grayson Field
Columbia County, Arkansas
Core Interval 8296.0' - 8326.0'

Depth (ft.)	Thickness (ft.)	Description
8296.0	2.3	Limestone. Gray to brown, very fine to coarse microbial boundstone, poorly sorted, peloids, ooids, gastropods, bivalves, abundant dolomite, abundant anhydrite, burrows present, visible porosity present, dissolution features common.
8298.3	1.4	Limestone. Gray to brown, very fine to coarse grained grainstone/packstone, poorly sorted, peloids, ooids, abundant dolomite, abundant anhydrite, burrows present, visible porosity present, dissolution features common.
8299.7	3.8	Limestone. Gray to brown, very fine to coarse microbial boundstone, poorly sorted, peloids, ooids, gastropods, bivalves, abundant dolomite, abundant anhydrite, burrows present, visible porosity present, dissolution features common.
8303.5	4.1	Limestone. Gray to brown, very fine to coarse grained grainstone/packstone, poorly sorted, peloids, ooids, abundant dolomite, abundant anhydrite, burrows present, visible porosity present, dissolution features common.
8307.6	5.2	Limestone. Gray to brown, very fine to coarse microbial boundstone, poorly sorted, peloids, ooids, gastropods, bivalves, abundant dolomite, abundant anhydrite, burrows present, visible porosity present, dissolution features common.

8312.8	5.0	Limestone. Gray to brown, very fine to coarse grained grainstone/packstone, poorly sorted, peloids, ooids, abundant dolomite, abundant anhydrite, burrows present, visible porosity present, dissolution features common.
8317.8	8.2	Limestone. Gray to brown, very fine to coarse microbial boundstone, poorly sorted, peloids, ooids, gastropods, bivalves, abundant dolomite, abundant anhydrite, burrows present, visible porosity present, dissolution features common.
8326.0	------	END OF CORE

Core Description
Petro-Chem Operating Inc.
Dodson #1
Grayson Field
Columbia County, Arkansas
Core Interval 8186.0' - 8247.0'

Depth (ft.)	Thickness (ft.)	Description
8186.0	4.4	Limestone. Light gray to brown, very fine to fine grained grainstone, moderate to well sorted, ooids, dolomite, anhydrite present, abundant oomoldic porosity, laminations present.
8190.4	2.8	Limestone. Light gray to brown, very fine to fine grained grainstone, moderate to well sorted, ooids, peloids, dolomite and anhydrite present, oomoldic porosity common, sucrosic texture, mottled.
8193.2	5.8	Limestone. Light gray to brown, very fine to fine grained grainstone, moderate to well sorted, ooids, peloids, dolomite and anhydrite present, oomoldic porosity present, sucrosic texture.
8199.0	5.0	Limestone. Light gray to brown, very fine to fine grained grainstone, moderate to well sorted, ooids, peloids, anhydrite present, well cemented, styolites present.
8204.0	15.0	Limestone. Light gray to brown, very fine to medium grained grainstone, moderately to poorly sorted, ooids, dolomite and anhydrite present, well cemented, styolites common filled with hydrocarbon residue and anhydrite.
8219.0	2.5	Limestone. Dark gray to brown, very fine to coarse grained grainstone/packstone, poorly sorted, ooids, peloids, oncoids, dolomite and anhydrite present, visible porosity common, styolites common filled with hydrocarbon residue and anhydrite, occasional dolomite grain replacement.

8221.5	12.7	Limestone. Light gray to brown, very fine to medium grained grainstone, moderately to poorly sorted, ooids, anhydrite present, cement present, dissolution of cement and grains common, styolites common filled with hydrocarbon residue and anhydrite.
8234.2	12.8	Limestone. Dark gray to brown, very fine to coarse grained grainstone/packstone, poorly sorted, ooids, peloids, pellets (?), oncoids, bivalves, anhydrite present, visible porosity common, dissolution of cement and grains common, styolites common filled with hydrocarbon residue and anhydrite.
8247.0	-----	END OF CORE

Core Description
Petro-Chem Operating Inc.
Genestet Farms #1
Grayson Field
Columbia County, Arkansas
Core Interval 8100.7’ – 8222.0’

Depth (ft.)	Thickness (ft.)	Description
8100.7	38.3	Limestone. Light tan to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, anhydrite present, cross stratification present, compaction apparent, styolites common filled with hydrocarbon residue and anhydrite.
8139.0	2.8	Limestone. Light tan to gray, very fine to coarse grained packstone/wackestone, poorly sorted, ooids, peloids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8141.8	9.2	Limestone. Light tan to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8151.0	7.0	Limestone. Dark gray to brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, visible porosity common, styolites common filled with hydrocarbon residue and anhydrite.
8158.0	20.0	Limestone. Dark gray to brown, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), fossils (?) present, anhydrite present, visible porosity common, styolites common filled with hydrocarbon residue and anhydrite.

8178.0	8.0	Limestone. Dark gray to brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8186.0	7.0	Limestone. Dark gray to brown, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8193.0	5.0	Limestone. Dark gray to brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, dolomite present, styolites common filled with hydrocarbon residue and anhydrite.
8198.0	22.0	Limestone. Dark gray to brown, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8220.0	2.0	Limestone. Dark gray to brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, pellets (?), anhydrite present, dolomite present, styolites common filled with hydrocarbon residue and anhydrite.
8222.0	-----	END OF CORE

Core Description
Petro-Chem Operating Inc.
Kemmerer #3
Grayson Field
Columbia County, Arkansas
Core Interval 8023.0’ – 8196.0’

Depth (ft.)	Thickness (ft.)	Description
8023.0	3.0	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8026.0	22.0	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8048.0	8.0	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, cross stratification present, styolites common filled with hydrocarbon residue and anhydrite.
8056.0	20.0	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8076.0	18.0	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.

8094.0	10.0	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8104.0	35.5	Limestone. Light gray to brown, fine to medium grained packstone/ wackestone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8139.5	18.5	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8158.0	26.0	Limestone. Light gray to brown, fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, highly altered by diagenesis, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8184.0	12.0	Dolostone. Dark gray to brown, fine to medium grained packstone/wackestone altered to dolostone(?), poorly to moderately sorted, peloids, anhydrite present, styolites common filled with hydrocarbon residue and anhydrite.
8196.0	-----	END OF CORE

Core Description
Petro-Chem Operating Inc.
Kitchens #1
Grayson Field
Columbia County, Arkansas
Core Interval 8075.0' - 8196.0'

Depth (ft.)	Thickness (ft.)	Description
8075.0	1.0	Anhydrite. Bluish gray.
8076.0	3.3	Dolostone. Bluish gray, sucrosic texture, abundant anhydrite, algal laminations (?).
8079.3	6.0	Limestone. Dark brown, mudstone/ wackestone, poorly sorted, ooids, peloids, sucrosic texture, abundant anhydrite.
8082.0	28.0	Limestone. Tan to light brown, fine to medium grained grainstone, moderately to well sorted, ooids, occasional peloids, anhydrite common to abundant, cross stratification common.
8110.0	12.0	Limestone. Gray, very fine to fine grained grainstone, moderately to well sorted, ooids, occasional peloids, abundant anhydrite nodules, abundant dolomite, occasional fractures filled with dolomite.
8122.0	10.0	Limestone. Gray to dark brown, very fine to medium grained grainstone, moderately to well sorted, ooids, peloids, abundant anhydrite, dolomite common.
8132.0	2.0	Limestone. Brown, fine to medium grained packstone/grainstone, anhydrite present, dolomite present.
8134.0	4.0	Limestone. Gray to dark brown, very fine to medium grained grainstone, moderately to well sorted, ooids, peloids, abundant anhydrite, dolomite common.

8138.0	8.7	Limestone. Dark brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids, oncoids present, anhydrite present, abundant visible porosity, abundant hydrocarbon residue.
8146.7	4.0	Limestone. Dark brown, very fine to fine grained packstone/grainstone, moderately sorted, ooids, peloids, anhydrite present, visible porosity common, abundant hydrocarbon residue.
8150.7	1.6	Limestone. Dark brown, very fine to fine grained grainstone, moderately to well sorted, ooids, peloids, anhydrite present.
8152.3	1.2	Limestone. Brown, very fine to fine grained packstone/grainstone, moderately sorted, ooids, peloids, anhydrite present.
8153.5	7.5	Limestone. Brown, very fine to fine grained grainstone, moderately to well sorted, ooids, peloids, anhydrite present, abundant visible porosity.
8161.0	35.0	Limestone. Gray to brown, very fine to coarse grained grainstone, poorly sorted, ooids, peloids, oncoids, gastropods present, anhydrite present, abundant visible porosity, abundant hydrocarbon residue, styolites common filled with anhydrite and hydrocarbon residue.
8196.0	-----	END OF CORE

Core Description
Petro-Chem Operating Inc.
Kitty Jean #1
Grayson Field
Columbia County, Arkansas
Core Interval 8028.0' - 8134.7'

Depth (ft.)	Thickness (ft.)	Description
8028.0	30.0	Limestone. Brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids, anhydrite present, oomoldic porosity present, dissolution of cement present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8058.0	14.0	Limestone. Brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids, occasional oncoids, abundant visible porosity, anhydrite present, dissolution of cement present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8072.0	10.0	Limestone. Light brown to dark brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids, occasional oncoids, occasional gastropods, occasional bivalves, anhydrite present, dissolution of cement present, styolites present filled with anhydrite and hydrocarbon residue.
8082.0	17.0	Limestone. Light brown to dark brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids, oncoids present, anhydrite present, visible porosity abundant.
8099.0	7.0	Limestone. Light brown to dark brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids,

		anhydrite present, occasional sucrosic texture, styolites present filled with anhydrite and hydrocarbon residue.
8106.0	5.0	Limestone. Light brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids, oncoids present, anhydrite present, dissolution of cement present, styolites present filled with anhydrite and hydrocarbon residue.
8111.0	6.0	Limestone. Light brown to dark brown, very fine to coarse grained grainstone, moderately sorted, ooids, peloids, oncoids present, anhydrite present, visible porosity abundant, dissolution of cement present.
8117.0	17.8	Limestone. Light brown to dark brown, very fine to coarse grained grainstone, poorly to moderately sorted, ooids, peloids, oncoids, occasional bivalves, occasional gastropods, anhydrite present, dissolution of cement present, styolites common filled with anhydrite and hydrocarbon residue.
8134.7	------	END OF CORE

Core Description
Petro-Chem Operating Inc.
Lizzy Grayson #2
Grayson Field
Columbia County, Arkansas
Core Interval 8077.0’ – 8197.5’

Depth (ft.)	Thickness (ft.)	Description
8077.0	76.0	Limestone. Brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), anhydrite present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8091.0	5.0	Limestone. Brown, very fine to fine grained packstone/wackestone, well to moderately sorted, ooids, peloids, pellets(?), anhydrite present, bounded by styolites filled with anhydrite and hydrocarbon residue.
8096.0	16.0	Limestone. Brown, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), anhydrite present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8112.0	26.0	Limestone. Brown, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, pellets(?), anhydrite present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8138.0	12.0	Limestone. Brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), anhydrite present, visible porosity common.

8150.0	6.0	Limestone. Brown, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, oncoids, pellets(?), anhydrite present, visible porosity abundant.
8156.0	15.8	Limestone. Brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), occasional oncoids, anhydrite present, dolomite present, styolites present filled with anhydrite and hydrocarbon residue.
8171.8	3.2	Limestone. Brown to gray, very fine to fine grained wackestone/mudstone(?), well to moderately sorted, ooids, peloids, pellets(?), occasional oncoids, anhydrite present, styolites present and filled with anhydrite and hydrocarbon residue.
8175.0	22.3	Limestone. Brown, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), abundant oncoids, anhydrite nodules, styolites present filled with anhydrite and hydrocarbon residue.
8197.3	------	END OF CORE

Core Description
Petro-Chem Operating Inc.
Nina Grayson Warnock #1
Grayson Field
Columbia County, Arkansas
Core Interval 8038.0’ – 8159.0’

Depth (ft.)	Thickness (ft.)	Description
8038.0	4.0	Limestone. Brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), oncoids, anhydrite present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8042.0	30.0	Limestone. Light brown, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), anhydrite present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8072.0	30.0	Limestone. Brown to gray, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), oncoids, anhydrite present, cross stratification present, styolites present filled with anhydrite and hydrocarbon residue.
8102.0	32.0	Limestone. Brown to gray, very fine to medium grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), anhydrite present, styolites present filled with anhydrite and hydrocarbon residue.
8134.0	2.5	Limestone. Brown to gray, very fine to medium grained wackestone/mudstone(?), poorly to moderately sorted, ooids, peloids, pellets(?), occasional oncoids, anhydrite present, bounded by styolites filled with anhydrite and hydrocarbon residue.

8136.5	22.5	Limestone. Brown to gray, very fine to coarse grained grainstone/packstone, poorly to moderately sorted, ooids, peloids, pellets(?), oncoids, anhydrite present, styolites present filled with anhydrite and hydrocarbon residue.
8159.0	------	END OF CORE

Core Description
Petro-Chem Operating Inc.
Strong #1
Grayson Field
Columbia County, Arkansas
Core Interval 8167.0' - 8221.0'

Depth (ft.)	Thickness (ft.)	Description
8167.0	1.6	Anhydrite. Gray, nodules present within the more massive anhydrite.
8168.6	1.5	Dolostone. Gray to brown, dolomite and anhydrite abundant, appears laminated, styolites present.
8170.1	40.9	Limestone. Brown, fine to coarse grained grainstone, poorly sorted, ooids, peloids, oomoldic porosity present to common, occasional nodules of micrite, cement dissolution present, styolites common filled with hydrocarbon residue and anhydrite.
8211.0	10.0	Limestone. Gray to brown, fine to coarse grain grainstone, poorly sorted, ooids, peloids, pellets, gastropods, bivalves, occasional nodules of micrite, visible porosity common, cement dissolution present, styolites common filled with hydrocarbon residue and anhydrite.
8221.0	------	END OF CORE

Core Description
Petro-Chem Operating Inc.
Westbrook #1
Grayson Field
Columbia County, Arkansas
Core Interval 8110.0' - 8169.6'

Depth (ft.)	Thickness (ft.)	Description
8110.0	5.5	Limestone. Gray, very fine to fine grained grainstone, moderately sorted, ooids, highly altered such that it appears to be mudstone/wackestone in core sample, nodules of anhydrite present.
8115.5	1.0	Anhydrite. Gray.
8116.5	1.5	Limestone. Dark gray, very fine grainstone, ooids, highly altered such that it appears to be mudstone/ wackestone in core sample.
8118.0	30.0	Limestone. Tan to dark brown, medium to coarse grained grainstone, moderately to well sorted, ooids, parallel to inclined laminations present.
8148.0	10.0	Limestone. Dark brown, medium to coarse grained grainstone, moderately to well sorted, ooids, styolites common filled with hydrocarbon residue and anhydrite.
8158.0	7.2	Limestone. Dark brown, fine to very coarse grained grainstone, poorly sorted, ooids and oncoids with occasional pisoids, styolites present filled with hydrocarbon residue and anhydrite.
8165.2	4.4	Limestone. Dark brown, fine to very coarse grained grainstone, poorly sorted, ooids, pisoids, oncoids, bivalves, styolites present filled with hydrocarbon residue and anhydrite, visible porosity, hydrocarbon residue abundant throughout sample.
8169.6	-----	END OF CORE

Figure A-1. A) Core photo taken from Reeves # 1 @ 8024' representing the Microbial Boundstone Facies as well as abundant replacement. B) Core photo taken from Reeves # 1 @ 8027.5' representing microbial boundstone facies exhibiting a thombolitic texture.

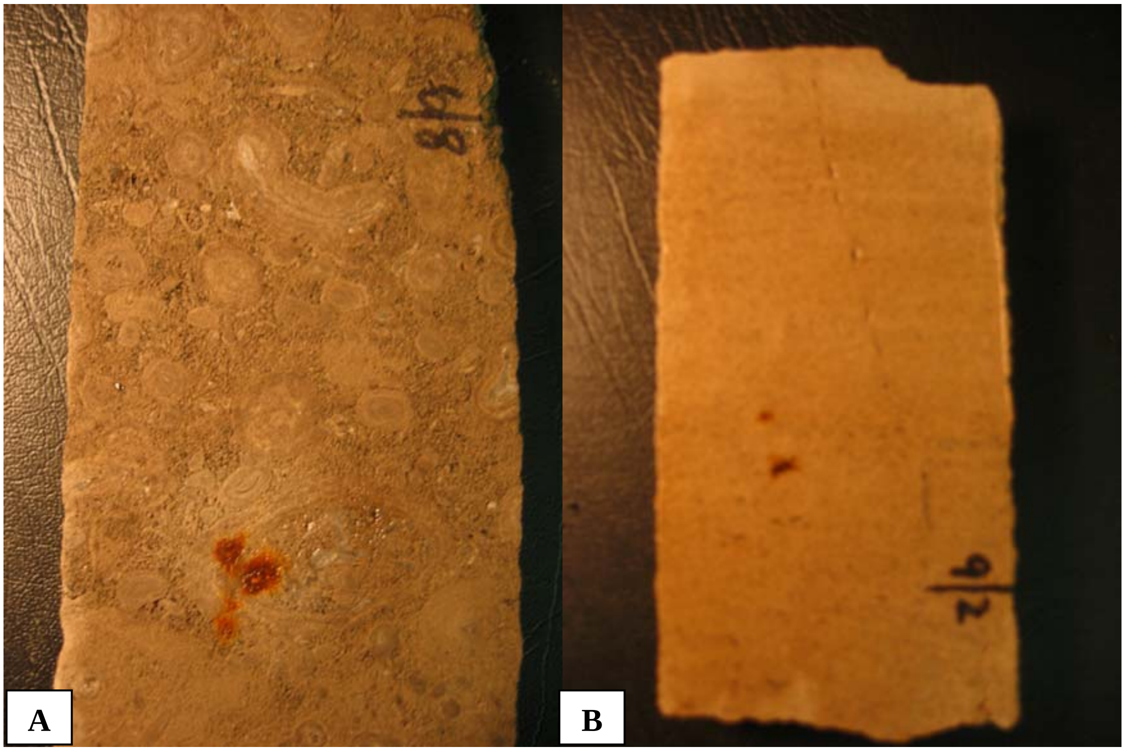

Figure A-2. A) Core photo taken from Westbrook # 1 @ 8168 representing grainstone facies 2. B) Core photo taken from Kitchens # 1 @ 8092 representing grainstone facies 1.

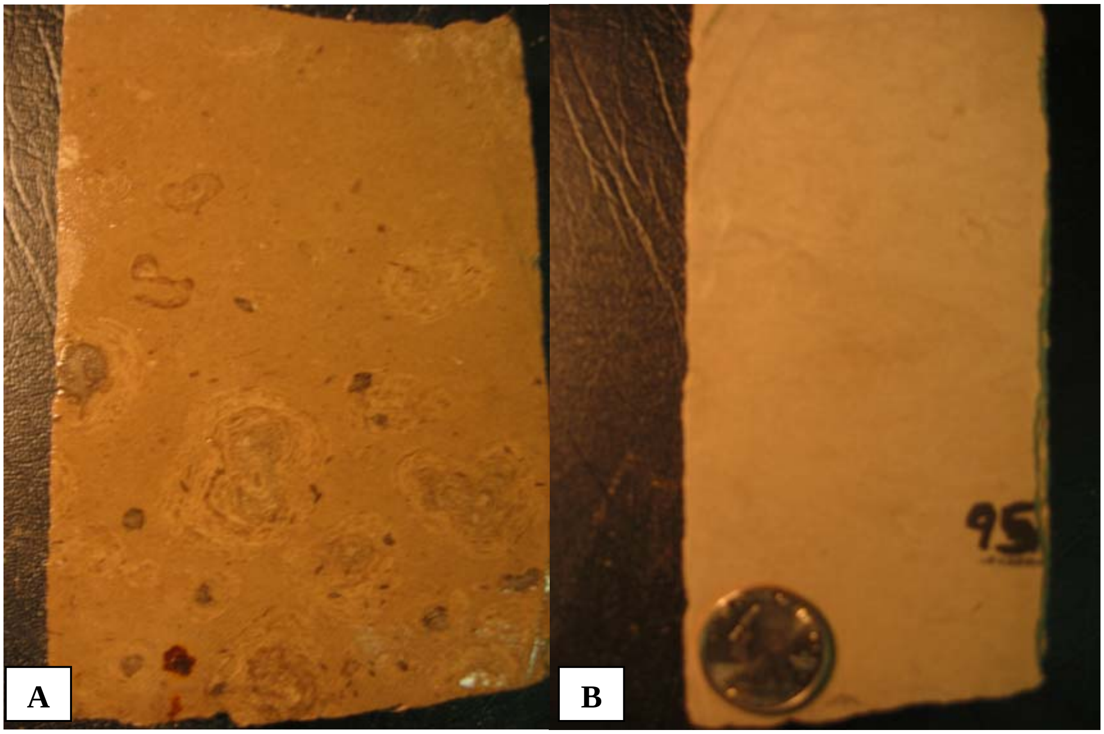

Figure A-3. A) Core photo taken from Reeves # 1 @ 8103.5 representing packstone facies. B) Core photo taken from Dodson # 1 @ 8195 representing wackestone facies.

APPENDIX B

THIN SECTION DESCRIPTIONS AND PHOTOMICROGRAPHS

Thin Section Description
Petro-Chem Operating Inc.
Alexander #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8020 - 8020.5 (Plug 3)	Limestone. Tan, peloidal grainstone, moderately sorted, peloids and ooids range from mU to fL, minor amount of dolomite and anhydrite present, estimated 20% porosity.
	Interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Calcite blocky, meteoric cement (could be altered isopachous, bladed marine). 3. Leaching/ dissolution of grains. 4. Minor anhydrite and dolomite grain replacement and pore filling.
8022 - 8022.5 (Plug 7)	Limestone. Brown, peloidal grainstone, moderately sorted, peloids and ooids range from mU to fL, minor amount of dolomite and anhydrite present, estimated 20% porosity.
	Interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Calcite blocky, meteoric cement (could be altered isopachous, bladed marine). 3. Leaching/ dissolution of grains. 4. Minor anhydrite and dolomite grain replacement and pore filling.
8024 - 8024.5 (Plug 11)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids and ooids range from fL to crsU, minor amount of anhydrite present, shell fragments and algae present, estimated 13% porosity.
	Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Compaction. 4. Minor leaching/dissolution. 5. Minor blocky, meteoric cement. 6. Minor anhydrite grain replacement and pore filling.

8028.5 - 8029 (Plug 20)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids and ooids range from fU to fU, minor amount of anhydrite present, algae present, estimated 12% porosity. Solution enhanced intraparticle, solution enhanced moldic, and interparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Compaction. 4. Leaching/ dissolution. 5. Minor anhydrite grain replacement and pore filling.
8030.5 - 8031 (Plug 24)	Limestone. Brown, oolitic/peloidal grainstone, moderately sorted, peloids and ooids range from fU to crs, minor amount of anhydrite present, estimated 20% porosity. Solution enhanced moldic, solution enhanced intraparticle, interparticle, and solution enhanced interparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Compaction. 4. Leaching/ dissolution. 5. Minor anhydrite grain replacement and pore filling.
8038 - 8038.5 (Plug 39)	Limestone. Brown, oolitic/peloidal grainstone, moderately sorted, peloids and ooids range from fU to crs, < 3% anhydrite and dolomite present, estimated 22% porosity. Solution enhanced moldic, solution enhanced intraparticle, solution enhanced interparticle, and interparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Extensive blocky, meteoric cement. 3. Minor compaction. 4. Leaching/ dissolution. 5. Minor anhydrite and dolomite grain replacement and pore filling.
8048.5 - 8049 (Plug 59)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fL to 5mm, < 2% anhydrite and dolomite present, estimated 15% porosity. Interparticle porosity. Two or more stages of diagenesis possible. 1. Extensive micritization of grains. 2. Minor anhydrite and dolomite grain replacement and pore filling.

8054 - 8054.5 (Plug 70)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from fU to crs, ooids range from crs to fL, estimated 25% porosity. Solution enhanced interparticle and solution enhanced intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Early isopachous marine, fibrous to bladed cement. 3. Compaction. 4. Leaching/ dissolution. 5. Possible minor meteoric, blocky cement. 6. Leaching/dissolution?
8055.5 - 8056 (Plug 73)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from fL to mL, ooids range from mU to fL, < 3% anhydrite present, estimated 10% porosity. Solution enhanced interparticle and solution enhanced intraparticle porosity (in order of abundance). Three or more stages of diagenesis possible. 1. Extensive micritization. 2. Compaction. 3. Leaching/ dissolution.
8056.5 - 8057 (Plug 75)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from fL to crs, ooids range from crs to fU, crinoids, gastropods, shell fragments, < 3% anhydrite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Extensive micritization. 2. Compaction. 3. Leaching/ dissolution. 4. Meteoric, blocky cement. 5. Leaching/ dissolution. 6. Minor anhydrite grain replacement and pore filling.
8057 - 8057.5 (Plug 76)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fL to crs, < 5% anhydrite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Extensive micritization. 2. Compaction. 3. Leaching/ dissolution. 4. Meteoric, blocky cement. 5. Leaching/ dissolution. 6. Minor anhydrite grain replacement and pore filling.

8061 (Plug 84)	Limestone. Dark brown, oolitic/peloidal grainstone, poorly sorted, peloids range from fU to crs, ooids range from crs to mL, < 2% anhydrite and dolomite present, estimated 30% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Extensive micritization. 2. Fibrous to bladed marine cement. 3. Compaction. 4. Leaching/ dissolution. 5. Meteoric, blocky cement. 6. Leaching/ dissolution. 7. Minor anhydrite and dolomite grain replacement and pore filling.

Thin Section Description
Alice Sydney
Crone #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8299	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from f̲L to fL, ooids range from fL to fU, < 2% dolomite and anhydrite present, estimated 10% porosity. Fracture and interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Compaction. 3. Blocky, meteoric cement. 4. Fractures. 5. Blocky, meteoric cement. 6. Minor leaching/dissolution. 7. Anhydrite and dolomite grain replacement and pore filling. 8. Fractures and stylolites. 9. Hydrocarbon migration.
8305.5	Limestone. Brown, oolitic/peloidal grainstone/packstone, poorly sorted, peloids range from f̲L to 2mm, ooids range from fL to 2mm, 70% calcite, 10% dolomite, 20% anhydrite, estimated 35% porosity. Moldic, interparticle, and vuggy porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Leaching/dissolution. 4. Anhydrite and dolomite grain replacement and pore filling.
8313.5	Limestone. Brown, oolitic/peloidal grainstone/packstone, poorly sorted, peloids range from f̲L to 2mm, ooids range from fL to 2mm, 68% calcite, 30% dolomite, 2% anhydrite, estimated 10% porosity. Interparticle and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution. 5. Anhydrite grain replacement and pore filling. 6. Dolomite grain replacement and pore filling.

Thin Section Description
Petro-Chem Operating Inc.
Genestet Farms #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8209 (Plug 111)	Limestone. Gray, oolitic/peloidal grainstone, poorly sorted, peloids range from 2mm to fL, ooids range from 2mm to mL, echinoderms present, shell fragments present, 10% dolomite present, < 4% anhydrite present, estimated 7% porosity. Interparticle and intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Compaction. 3. Leaching/dissolution. 4. Blocky, meteoric cement. 5. Leaching/dissolution. 6. Anhydrite grain replacement and pore filling. 7. Dolomite grain replacement and pore filling.
8213 (Plug 115)	Limestone. Gray, oolitic/peloidal grainstone, poorly sorted, peloids range from mL to fL, ooids range from 2mm to fU, 79% calcite present, 20% dolomite present, 1% anhydrite present, estimated 20% porosity. Interparticle, solution enhanced interparticle, and intraparticle porosity (in order of abundance). Eight or more stages of diagenesis possible. 1. Micritization. 2. Early blocky, meteoric cement. 3. Compaction. 4. Leaching/dissolution. 5. 2nd phase of blocky, meteoric cement (can be seen inside grains). 6. Anhydrite grain replacement. 7. Leaching/dissolution. 8. Dolomite grain replacement and pore filling.
8220.5 (Plug 122)	Limestone. Gray, oolitic grainstone, poorly sorted, ooids range from 2mm to fL, < 4% dolomite and anhydrite present, estimated 10% porosity. Moldic and intercrystalline porosity (in order of abundance). Four or more stages of diagenesis possible. 1 Early blocky, meteoric cement (vadose diagenesis?) completely fills original interparticle porosity. 2. Ooids extensively leached to produce oomoldic porosity.

3. Compaction. 4. Minor Anhydrite grain replacement and pore filling (& small amt of dolo).

Thin Section Description
Petro-Chem Operating Inc.
Kemmerer #2
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8070.6 (Plug 18)	Limestone. Brown, oolitic/ peloidal grainstone, poorly sorted, ooids range from fU to 2mm, peloids range from crs to fU, < 2% dolomite and anhydrite, estimated 35% porosity. Interparticle and intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Early blocky, meteoric cement. 4. Compaction (deformation of grains and cement popped off of grains). 5. Leaching/dissolution. 6. Minor anhydrite and dolomite grain replacement and pore filling.
8127.5 (Plug 75)	Limestone. Gray, oolitic/ peloidal grainstone, poorly sorted, ooids range from 2mm to mL, peloids range from 3mm to fL, 3% dolomite, 10% anhydrite, estimated 20% porosity. Solution enhanced interparticle, solution enhanced intraparticle, vuggy, and moldic porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early fibrous to bladed cement (marine). 3. Leaching/dissolution. 4. Blocky, meteoric cement. 5. Leaching/dissolution. 6. Anhydrite pore filling and grain replacement. 7. Minor dolomite grain replacement and pore filling.
8146.5 (Plug 94)	Limestone. Gray, peloidal grainstone/ packstone , poorly sorted, peloids range from mU to fL, 5% dolomite, 1% anhydrite, estimated 25% porosity. Interparticle, intraparticle, vuggy, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution.

	5. Anhydrite grain replacement and pore filling. 6. Dolomite grain replacement and pore filling.
8166.8 (Plug 115)	Limestone. Brown, oncolitic/ peloidal grainstone, poorly sorted, oncoids range from 5mm to 2mm, peloids range from crs to fU, 20% dolomite, 3% anhydrite, estimated 10% porosity. Solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Marine bladed to fibrous cement. 3. Leaching/ dissolution. 4. Blocky, meteoric cement. 5. Dissolution? 6. Anhydrite and dolomite grain replacement and pore filling.
8167.5 (Plug 116)	Limestone. Gray, oolitic/ peloidal/ oncolitic grainstone, poorly sorted, ooids range from 2mm to fU, peloids range from mU to fL, oncoids range from 3mm to 2mm, echinoderm present, 10% dolomite, 2% anhydrite, estimated 4% porosity. Intraparticle, interparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution. 5. Anhydrite grain replacement and pore filling. 6. Dolomite grain replacement and pore filling.
8172.5 (Plug 120)	Limestone. Gray, oolitic/ peloidal/ oncolitic grainstone, poorly sorted, ooids range from 2mm to fU, peloids range from 3mm to fL, oncoids range from 2mm to 4mm, 20% dolomite, 10% anhydrite, estimated 5% porosity. Intraparticle, interparticle, vuggy, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution. 5. Anhydrite grain replacement and pore filling. 6. Dolomite grain replacement and pore filling.

Thin Section Description
Petro-Chem Operating Inc.
Kemmerer #3
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8124 (Plug 102)	Limestone. Tan, peloidal packstone/ wackestone, poorly sorted, oncoids average 8mm, peloids range from f̲L to fU, 5% dolomite, 2% anhydrite, estimated 25% porosity. Interparticle, moldic, solution enhanced interparticle, intraparticle, vuggy porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Leaching/dissolution. 4. Blocky, meteoric cement. 5. Anhydrite replaces grains. 6. Dolomite grain replacement and pore filling. 7. Leaching/dissolution.
8143 (Plug 121)	Limestone. Brown, peloidal/ oolitic grainstone, poorly sorted, ooids range from crs to Vf, oncoids range from 2mm to 7mm, peloids range from f̲L to f̲U, 5% dolomite, < 1% anhydrite, estimated 20% porosity. Interparticle, solution enhanced interparticle, and intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Anhydrite grain replacement and pore filling. 5. Leaching/dissolution. 6. Pore filling dolomite (small amt of grain replacement).
8155 (Plug 134)	Limestone. Tan, peloidal/ oncolitic grainstone, poorly sorted, ooids range from crs to Vf, oncoids range from 3mm to 5mm, peloids range from f̲L to f̲U, pellets present, pisoids present, 59% calcite, 40% dolomite, < 1% anhydrite, estimated 2% porosity. Interparticle and intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Minor leaching/ dissolution. 4. Minor anhydrite grain replacement and pore filling. 5. Dolomite

	replaces calcite cement and some parts of grains (some pore filling where no cement is present).
8159 (Plug 138)	Limestone. Gray, peloidal/ oolitic grainstone, poorly sorted, ooids range from fU to f̲L, peloids range from f̲L to f̲U, 74% calcite, 25% dolomite, < 1% anhydrite, estimated 15% porosity. Interparticle, solution enhanced interparticle, and intraparticle porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Minor leaching/ dissolution. 4. Blocky, meteoric cement. 5. Major leaching/ dissolution. 6. Anhydrite and dolomite grain replacement and pore filling. 7. Migration of hydrocarbon.
8167 (Plug 146)	Limestone. Gray, peloidal/ oolitic grainstone, poorly sorted, ooids range from 2mm to 0.25mm, peloids range from f̲L to f̲U, pisoids range from 2mm to 4.5mm, shell fragments present, echinoderm present, gastropods present, 78% calcite, 20% dolomite, 2% anhydrite, estimated 3% porosity. Interparticle, intraparticle, moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Minor leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution. 5. Anhydrite and dolomite grain replacement and pore filling.
8193 (Plug 172)	Dolostone. Tan, crystalline?, poorly sorted, remnant ooids range from fU to f̲U, remnant peloids range from f̲L to fL, 25% calcite, 74% dolomite, < 1% anhydrite, estimated 3% porosity. Intercrystalline and vuggy porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Anhydrite grain replacement and pore filling. 4. Dolomite micrite/grain replacement.

Thin Section Description
Petro-Chem Operating Inc.
Kitchens #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8081 (Plug 3)	Limestone. Gray, peloidal mudstone/wackestone, poorly sorted, peloids range from fL to f̲L, 50% calcite, 40% dolomite, 10% anhydrite, estimated 0% porosity. Three or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Anhydrite and dolomite grain replacement and pore filling.
8088 (Plug 10)	Limestone. Gray, oolitic grainstone, mod. sorted, ooids range from 2mm to fL, < 2% dolomite and anhydrite present, estimated 22% porosity. Interparticle and intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Dissolution/ leaching of grains. 4. Blocky, meteoric cement (or old cement is recrystallized). 5. Minor anhydrite and dolomite pore filling.
8181 (Plug 98)	Limestone. Gray, oolitic grainstone/packstone, poorly sorted, ooids range from mU to fL, peloids range from f̲L to fU, shell fragments present, 62% calcite, 35% dolomite, 3% anhydrite, estimated 12% porosity. Interparticle, intraparticle, and moldic porosity (in order of abundance). Three or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Anhydrite and dolomite grain replacement and pore filling.
8184 (Plug 101)	Limestone. Gray, oolitic/ peloidal/ oncolitic grainstone/ packstone, poorly sorted, ooids range from 2mm fL, oncoids range from 2mm to 6mm, peloids range from f̲L to crs, shell fragments present, echinoderm present, bryozoan present, algae? present, 75% calcite, 15% dolomite, 10% anhydrite, estimated 15% porosity.

	Intraparticle, interparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution. 5. Anhydrite grain replacement and pore filling. 6. Dolomite grain replacement and pore filling.
8189 (Plug 106)	Limestone. Gray, oolitic/ peloidal/ oncolitic grainstone, poorly sorted, ooids range from 2mm mL, oncoids range from 2mm to 6mm, peloids range from fL to 2mm, < 2% dolomite, < 6% anhydrite, estimated 20% porosity. Solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution. 5. Dolomite and Anhydrite grain replacement and pore filling.
8195 (Plug 112)	Limestone. Gray, oolitic/ peloidal/ oncolitic grainstone, poorly sorted, ooids range from 2mm fL, oncoids range from 2mm to 10mm, peloids range from fU to 3.5mm, < 2% dolomite, < 6% anhydrite, estimated 22% porosity. Solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Early isopachous, fibrous to bladed marine cement. 3. Leaching/ dissolution. 4. Blocky, meteoric cement. 5. Leaching/dissolution. 6. Anhydrite and dolomite grain replacement and pore filling.

Thin Section Description
Petro-Chem Operating Inc.
Kitty Jean #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8028.5 - 8029 (Plug 2)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fL to crsU, minor amount of anhydrite present, algae? present, estimated 25% porosity. Interparticle, intraparticle, solution enhanced moldic, and solution enhanced vuggy porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Isopachous marine, fibrous to bladed cement (changed from bladed to blocky? Or could be meteoric phreatic blocky cement). 4. Compaction. 5. Leaching/dissolution. 6. Minor Anhydrite grain replacement and pore filling.
8030 - 8030.5 (Plug 5)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fU to crs, ooids range from mL to crs, < 10% anhydrite present, algae? and coral present, estimated 30% porosity. Solution enhanced interparticle, intraparticle, vuggy, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Isopachous marine, fibrous to bladed cement (changed from bladed to blocky? Or could be meteoric phreatic blocky cement). 4. Compaction. 5. Leaching/dissolution. 6. Anhydrite grain replacement and pore filling.
8032.2 (Plug 9)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fU to crsU, ooids range from 2mm to fL, < 12% dolomite and anhydrite present, algae present, estimated 25% porosity. Solution enhanced moldic and Solution enhanced interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization.

	2. Marine, bladed to blocky cement. 3. Leaching/ dissolution of grains (oomoldic porosity created). 4. Minor anhydrite and dolomite grain replacement and pore filling.
8034 - 8034.5 (Plug 13)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fU to crs, ooids range from crs to fU, < 4% dolomite and anhydrite present, estimated 20% porosity. Solution enhanced intraparticle, interparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Extensive early marine, bladed cement. 3. Compaction. 4. Leaching/ dissolution. 5. Anhydrite and dolomite grain replacement and pore filling.
8035.5 - 8036 (Plug 16)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fU to crs, ooids range from crs to fU, < 4% dolomite and anhydrite present, estimated 20% porosity. Solution enhanced intraparticle, interparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Compaction. 4. Leaching/ dissolution. 5. Minor anhydrite and dolomite grain replacement and pore filling.
8037.5 - 8038 (Plug 20)	Limestone. Light brown, peloidal grainstone, poorly sorted, peloids and ooids range from mU to mL, < 3% dolomite and anhydrite present, estimated 30% porosity. Solution enhanced moldic and intraparticle and interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Isopachous, marine bladed to fibrous cement (almost complete pore filling). 3. Leaching/dissolution of grains. 4. Anhydrite and dolomite replacing grains w/ minor pore filling.
8042 - 8042.5 (Plug 29)	Limestone. Brown, peloidal grainstone, poorly sorted grains range from crsU to fU, minor amounts of dolomite and anhydrite, estimated 10% porosity.

	Solution enhanced moldic, intraparticle, and interparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Extensive micritization. 2. Compaction. 3. Marine blocky/bladed cement. 4. Leaching/ dissolution. 5. Minor anhydrite and dolomite grain replacement and pore filling.
8052 - 8052.5 (Plug 49)	Limestone. Light brown, peloidal grainstone, poorly sorted, grains range from 3mm to fU, minor amounts of dolomite and anhydrite, estimated 10% porosity.
	Solution enhanced intraparticle, interparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization of grains. 2. Marine blocky to bladed cement. 3. Compaction. 4. Leaching/ dissolution. 5. Minor anhydrite and dolomite grain replacement and pore filling.
8057 - 8057.5 (Plug 59)	Limestone. Brown, peloidal grainstone, poorly sorted peloids and ooids, peloids and ooids range from crsU to fL, minor amounts of dolomite and anhydrite, estimated 20% porosity.
	Solution enhanced interparticle, intraparticle, and moldic porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early bladed marine cement. 3. Compaction. 4. Leaching/dissolution. 5. Minor blocky, meteoric cement. 6. Leaching/ dissolution. 7. Minor anhydrite and dolomite grain replacement and pore filling.
8071 - 8071.5 (Plug 74)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fL to 3mm, ooids range from mU to fL, minor amounts of dolomite and anhydrite, estimated 20% porosity.
	Interparticle porosity, solution enhanced intraparticle, and solution enhanced interparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Marine bladed cement. 3. Compaction. 4. Leaching/dissolution. 5. Minor anhydrite and dolomite grain replacement and pore filling.

8078 - 8078.5 (Plug 81)	Limestone. Light brown, peloidal grainstone, poorly sorted, peloids range from fL to crsU, minor amounts of dolomite and anhydrite, estimated 20% porosity. Solution enhanced moldic, intraparticle, and interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Marine, bladed to blocky cement. 3. Leaching/dissolution. 4. Minor anhydrite and dolomite grain replacement and pore filling.
8087 (Plug 90)	Limestone. Brown, oolitic/ peloidal/ oncolitic grainstone, poorly sorted, ooids range from 2mm fL, oncoids range from 3mm to 5mm, peloids range from fU to 2mm, < 1% dolomite, 1% anhydrite, estimated 30% porosity. Interparticle, Intraparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Minor compaction. 3. Leaching/ dissolution. 4. Blocky, meteoric cement. 5. Leaching/ dissolution. 6. Minor anhydrite and dolomite grain replacement and pore filling.
8088 - 8088.5 (Plug 91)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from fL to 4mm, ooids range from 2mm to fU, minor amounts of dolomite and anhydrite, gastropod fossils present, estimated 15% porosity. Solution enhanced interparticle, intraparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Marine, bladed to blocky cement. 3. Leaching/dissolution. 4. Minor meteoric cement. 5. Minor anhydrite and dolomite grain replacement and pore filling.
8123.5 (Plug 127)	Limestone. Brown, peloidal grainstone/packstone, moderately sorted, peloids range from fL to fL, mud present (from alteration?), 85% calcite, 10% dolomite, 5% anhydrite, estimated 15% porosity. Solution enhanced interparticle, solution enhanced intraparticle, moldic, and vuggy porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early fibrous to bladed cement (marine). 3. Leaching/dissolution. 4. Blocky, meteoric

	cement. 5. Leaching/dissolution. 6. Anhydrite pore filling and grain replacement. 7. Dolomite grain replacement and pore filling.
8135.5 (Plug 139)	Limestone. Gray, peloidal packstone/wackestone, poorly sorted, peloids range from fL to fL, mud present (from alteration?), 49% calcite, 50% dolomite, 1% anhydrite, estimated < 2% porosity. Intraparticle and fracture porosity (in order of abundance). Three or more stages of diagenesis possible. 1. Extensive micritization of grains. 2. Leaching/dissolution. 3. Anhydrite and dolomite grain replacement and pore filling.
8140.5 (Plug 144)	Limestone. Brown, oolitic/ peloidal/ oncolitic grainstone, moderately sorted, ooids range from fU to 2mm, peloids range from fL to fL, oncoids range from 3mm to 7mm, near reef material present, echinoderm present, 2% dolomite, 5% anhydrite, estimated 20% porosity. Interparticle and intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Compaction (suture contacts). 3. Leaching/dissolution. 4. Blocky, meteoric cement. 5. Dolomite and anhydrite grain replacement and pore filling.

Thin Section Description
Petro-Chem Operating Inc.
Lizzy Grayson #2
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8135 (Plug 59)	Limestone. Brown, oolitic/ peloidal grainstone/ packstone, poorly sorted, ooids range from crsL to fL, peloids average fL, 64% calcite, 35% dolomite, < 1% anhydrite, < 1% quartz silt, estimated 10% porosity. Interparticle porosity. Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Anhydrite grain replacement and pore filling. 4. Late stage dolomite pore filling.
8167 (Plug 91)	Limestone. Brown, oolitic/ peloidal grainstone/ packstone, poorly sorted, ooids range from crsL to fU, peloids average fL, 88% calcite, 10% dolomite, < 1% anhydrite, < 1% quartz silt, estimated 10% porosity. Interparticle porosity. Six or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Anhydrite replacement. 4. Extensive leaching/dissolution. 5. Blocky, meteoric cement. 6. Pore filling dolomite.
8174 (Plug 98)	Limestone. Gray/brown, peloidal packstone/ mudstone?, poorly sorted, ooids range from crsL to fU, peloids average fL, 59% calcite, 40% dolomite, < 1% anhydrite, < 1% quartz silt, gastropods present, estimated 2% porosity. Interparticle porosity. Seven or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Anhydrite replacement. 4. Minor leaching/dissolution. 5. Blocky, meteoric cement. 6. Late stage pore filling dolomite. 7. Minor leaching/dissolution
8190 (Plug 114)	Limestone. Dark brown, oolitic grainstone, poorly sorted, ooids range from 2mm to fU, peloids average <fU, oncoids

average 5mm, 5% dolomite, 1% anhydrite, < 1% quartz silt, estimated 20% porosity.

Solution enhanced interparticle porosity. Six or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Leaching/dissolution. 3. Anhydrite replacing grains. 4. Late stage pore filling dolomite.
5. Leaching/dissolution. 6. Hydrocarbon migration.

Thin Section Description
Petro-Chem Operating Inc.
Nina Grayson Warnock #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8141 (Plug 104)	Limestone. Gray, oolitic/ peloidal grainstone, poorly sorted, ooids range from 2mm to f̲U, peloids range from f̲L to fU, oncoids range from 2mm to 6mm, minor amount of pellets present, 74% calcite, 25% dolomite, < 1% anhydrite, estimated 20% porosity. Interparticle, intraparticle, and moldic porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Leaching/ dissolution. 4. Blocky, meteoric cement. 5. Leaching/dissolution. 6. Anhydrite pore filling and grain replacement. 7. Dolomite grain replacement and pore filling.
8145 (Plug 108)	Limestone. Gray, peloidal grainstone, poorly sorted, ooids range from 2mm to fU, peloids average <f̲L to fU, minor amount of pellets present, 15% dolomite, 3% anhydrite, < 1% quartz silt, shell fragments present, estimated 15% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Eight or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Compaction. 4. Cement and grain leaching/ dissolution. 5. Anhydrite grain replacement. 6. Blocky, meteoric cement. 7. Pore filling dolomite (small amt of replacement also). 8. Leaching/ dissolution.
8152.5 (Plug 115)	Limestone. Gray, peloidal/ oolitic grainstone/packstone, poorly sorted, ooids range from 2mm to fL, peloids range from <f̲L to fU, oncoids range from 2mm to fL, echinoderm present, 3% dolomite, 2% anhydrite, estimated 20% porosity.

	Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Isopachous, fibrous to bladed marine cement. 3. Leaching/ dissolution. 4. Anhydrite and dolomite grain replacement and pore filling. 5. Leaching/ dissolution (minor).
8155.5 (Plug 118)	Limestone. Gray, peloidal/ oolitic grainstone, poorly sorted, ooids range from 2mm to 0.75mm, peloids range from fL to fU, oncoids range from 2mm to 3mm, pisoids present, 3% dolomite, 2% anhydrite, estimated 16% porosity.
	Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Compaction. 3. Leaching/dissolution. 4. Blocky, meteoric cement. 5. Leaching/dissolution. 6. Anhydrite and dolomite grain replacement and pore filling. 7. Leaching/dissolution?

Thin Section Description
Petro-Chem Operating Inc.
Reeves #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8023 - 8024 (Plug 1)	Limestone. Brown, microbial bounstone, poorly sorted, peloids range from fL to crs, ooids range from mU to crs, < 4% dolomite and anhydrite present, estimated 15% porosity. Solution enhanced intraparticle, moldic, and vuggy porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Leaching/ dissolution. 4. Anhydrite and dolomite grain replacement and pore filling.
8025 - 8026 (Plug 3)	Limestone. Brown, microbial bounstone, poorly sorted, peloids range from silt to crs, abundant shell fragments, dolomite and anhydrite common, estimated 12% porosity. Vuggy, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Leaching/dissolution. 4. Anhydrite and dolomite grain replacement and pore filling.
8026.5 (Plug 4)	Limestone. Brown, microbial boundstone, poorly sorted, peloids range from silt to crs, < 3% anhydrite and dolomite present, estimated 30% porosity. Vuggy, solution enhanced intraparticle, solution enhanced interparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization 2. Leaching/dissolution. 3. Recrystallization. 4. Blocky, meteoric cement. 5. Anhydrite and dolomite grain replacement and pore filling.

8029 - 8030 (Plug 7)	Limestone. Brown, microbial bounstone, poorly sorted, peloids range from silt to crs, < 6% anhydrite present, estimated 10% porosity. Vuggy and solution enhanced interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Leaching/ dissolution. 3. Blocky, meteoric cement. 4. Anhydrite grain replacement and pore filling.
8031 - 8032 (Plug 9)	Limestone. Brown, microbial bounstone, poorly sorted, peloids range from fU to crs, ooids range from fU to mU, < 6% anhydrite and dolomite present, estimated 10% porosity. Vuggy and solution enhanced interparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Recrystallization. 4. Blocky, meteoric cement. 5. Anhydrite and dolomite grain replacement and pore filling.
8035.1 (Plug 13)	Limestone. Brown, highly altered microbial bounstone, poorly sorted, peloids range from fL to mL, < 2% dolomite and anhydrite present, estimated 10% porosity. Intercrystalline, vuggy, and moldic porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Leaching/ dissolution. 3. Major recrystallization. 4. Leaching/ dissolution?
8038 - 8039 (Plug 16)	Limestone. Brown, highly altered microbial boundstone?, poorly sorted, peloids range from fU to crs, < 4% anhydrite and dolomite present, estimated 10% porosity. Vuggy and solution enhanced interparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Marine bladed to fibrous cement. 4. Recrystallization. 5. Possible minor meteoric, blocky cement. 6. Anhydrite and dolomite grain replacement and pore filling.

8041 - 8042 (Plug 19)	Limestone. Brown, highly altered microbial boundstone?, poorly sorted, peloids range from mU to crs, < 3% anhydrite and dolomite present, estimated 10% porosity. Vuggy and solution enhanced interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Recrystallization. 4. Anhydrite and dolomite grain replacement and pore filling.
8044 - 8045 (Plug 22)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from mU to 3mm, < 4% anhydrite and dolomite present, estimated 15% porosity. Solution enhanced interparticle and intraparticle porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early isopachous marine, bladed cement. 3. Compaction. 4. Leaching/ dissolution. 5. Blocky, meteoric cement. 6. Leaching/ dissolution? 7. Anhydrite and dolomite grain replacement and pore filling.
8049 - 8050 (Plug 27)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from mL to crs, ooids range from crs to mU, < 2% anhydrite and dolomite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early isopachous marine, bladed cement. 3. Compaction. 4. Leaching/dissolution. 5. Blocky, meteoric cement. 6. Leaching/dissolution? 7. Anhydrite and dolomite grain replacement and pore filling.
8054 - 8055 (Plug 32)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from mL to 3mm, < 4% anhydrite and dolomite present, estimated 30% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization.

	2. Early isopachous marine, bladed cement. 3. Compaction. 4. Leaching/dissolution. 5. Blocky, meteoric cement. 6. Anhydrite and dolomite grain replacement and pore filling.
8061 - 8062 (Plug 39)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from fL to 3mm, ooids ranges from crs to mL, crynoids present, algae present?, < 5% anhydrite and dolomite present, estimated 20% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Compaction. 4. Leaching/dissolution. 5. Blocky, meteoric cement. 6. Anhydrite and dolomite grain replacement and pore filling.
8069 - 8070 (Plug 47)	Limestone. Brown, highly altered microbial boundstone, mostly mud remaining, < 6% anhydrite and dolomite present, estimated 20% porosity. Moldic? porosity. Three or more stages of diagenesis possible. 1. Extensive micritization. 2. Leaching/ dissolution. 3. Anhydrite and dolomite grain replacement and pore filling.
8071 - 8072 (Plug 49)	Limestone. Brown, highly altered peloidal grainstone, poorly sorted, peloids range from mU to fL, < 4% anhydrite and dolomite present, estimated 5% porosity. Solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Extensive micritization. 2. Early isopachous marine, bladed to fibrous cement? 3. Compaction. 4. Alteration by leaching/ dissolution and maybe recrystallization. 5. Anhydrite and dolomite grain replacement and pore filling.
8072 - 8073 (Plug 50)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from mL to fL, ooids range from mU to fL, < 2% anhydrite and dolomite present, estimated 25% porosity.

	Interparticle, solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Leaching/ dissolution. 4. Anhydrite and dolomite grain replacement and pore filling.
8077 - 8078 (Plug 55)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from mL to fL, ooids range from mU to fL, < 3% anhydrite and dolomite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3.Leaching/ dissolution. 4. Anhydrite and dolomite grain replacement and pore filling.
8080 - 8081 (Plug 58)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from 5mm to fL, ooids range from 2mm to mL, < 4% anhydrite and dolomite present, estimated 35% porosity. Interparticle, solution enhanced interparticle, solution enhanced intraparticle, vuggy, and moldic porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement? 3. Leaching/dissolution. 4. Anhydrite and dolomite grain replacement and pore filling.
8084 - 8085 (Plug 62)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from crs to fU, ooids range from mU to fL, < 6% anhydrite and dolomite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Compaction. 4. Leaching/dissolution. 5. Anhydrite and dolomite grain replacement and pore filling.

8085 - 8086 (Plug 63)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from crs to fU, ooids range from mU to fL, < 4% anhydrite and dolomite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Compaction. 4. Leaching/dissolution. 5. Anhydrite and dolomite grain replacement and pore filling.
8087 - 8088 (Plug 65)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from crs to fU, ooids range from mU to fL, crynoids present, < 3% anhydrite and dolomite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Compaction. 3. Leaching/ dissolution. 4. Blocky, meteoric cement. 5. Anhydrite and dolomite grain replacement and pore filling.
8091 - 8092 (Plug 69)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from crs to fU, ooids range from mU to fU, < 4% anhydrite and dolomite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/ dissolution. 3. Blocky, meteoric cement. 4. Compaction. 5. Leaching/ dissolution. 6. Anhydrite and dolomite grain replacement and pore filling.
8093 - 8094 (Plug 71)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from crs to fU, ooids range from mU to fU, < 4% anhydrite and dolomite present, estimated 25% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Seven or more stages of diagenesis possible.

	1. Micritization. 2. Early isopachous marine, bladed to fibrous cement. 3. Compaction. 4. Leaching/dissolution. 5. Blocky, meteoric cement. 6. Leaching/dissolution? 7. Anhydrite and dolomite grain replacement and pore filling.
8098 - 8099 (Plug 76)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from 3mm to fL, ooids range from mU to crs, < 3% anhydrite and dolomite present, estimated 20% porosity. Interparticle, solution enhanced interparticle, and solution enhanced intraparticle porosity (in order of abundance). Seven or more stages of diagenesis possible. 1. Micritization. 2. Early isopachous marine, bladed to fibrous cement. 3. Compaction. 4. Leaching/dissolution. 5. Blocky, meteoric cement (minor). 6. Leaching/dissolution? 7. Anhydrite and dolomite grain replacement and pore filling.
8109.5 (Plug 87)	Limestone. Brown, highly altered microbial boundstone?, poorly sorted, peloids range from crs to fL, <6% dolomite present, < 2% anhydrite present, estimated 20% porosity. Vuggy, solution enhanced intraparticle, and solution enhanced interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Leaching/ dissolution. 3. Blocky, meteoric cement. 4. Anhydrite and dolomite grain replacement and pore filling.
8115 - 8116 (Plug 93)	Limestone. Brown, highly altered peloidal grainstone?, poorly sorted, peloids range from fU to fL, ~30% dolomite crystals present, < 3% anhydrite present, estimated 6% porosity. Solution enhanced interparticle and solution enhanced intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Extensive micritization. 2. Early isopachous marine, bladed to fibrous cement. 3. Leaching/dissolution. 4. Blocky, meteoric cement. 5. Extensive dolomite grain replacement and pore filling. 6. Minor anhydrite grain replacement and pore filling.

8120 - 8121 (Plug 98)	Limestone. Brown, highly altered microbial boundstone?, poorly sorted, peloids range from mU to fL, ~10% dolomite present, < 3% anhydrite present, estimated 10% porosity. Vuggy, solution enhanced intraparticle, and solution enhanced interparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Anhydrite and dolomite grain replacement and pore filling.
8128 - 8129 (Plug 106)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from crs to fL, ooids range from crs to mL, ~12% dolomite present, < 3% anhydrite present, estimated 4% porosity. Solution enhanced interparticle and solution enhanced intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Early marine, fibrous to bladed cement. 3. Leaching/ dissolution. 4. Blocky, meteoric cement. 5. Anhydrite and dolomite grain replacement and pore filling.
8130 - 8131 (Plug 108)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from crs to fL, ~12% dolomite present, < 5% anhydrite present, estimated 10% porosity. Solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Leaching/dissolution. 4. Anhydrite and dolomite grain replacement and pore filling.
8135 - 8136 (Plug 113)	Limestone. Brown, oncolitic/ oolitic/ peloidal grainstone, poorly sorted, peloids range from 4mm to fL, ooids range from 2mm to mU, oncoids range from 5mm to 2mm, ~12% dolomite present, < 3% anhydrite present, estimated 7% porosity. Solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky,

	meteoric cement. 4. Compaction. 5. Anhydrite and dolomite grain replacement and pore filling.
8136 - 8137 (Plug 114)	Limestone. Brown, oncolitic/ oolitic/ peloidal grainstone, poorly sorted, peloids range from 4mm to fL, ooids range from 2mm to mU, oncoids range from 5mm to 2mm, ~12% dolomite present, < 3% anhydrite present, estimated 10% porosity. Solution enhanced interparticle, solution enhanced intraparticle, and moldic porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Blocky, meteoric cement. 3. Compaction. 4. Leaching/ dissolution. 5. Stylolites. 6. Anhydrite and dolomite grain replacement and pore filling.
8139 - 8140 (Plug 117)	Limestone. Brown, peloidal grainstone, poorly sorted, peloids range from mU to fL, ~10% dolomite present, < 3% anhydrite present, estimated 10% porosity. Vuggy, solution enhanced interparticle, moldic, and solution enhanced intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Compaction. 3. Leaching/ dissolution. 4. Blocky, meteoric cement. 5. Anhydrite and dolomite grain replacement and pore filling.
8141 - 8142 (Plug 119)	Limestone. Gray, highly altered peloidal grainstone?, poorly sorted, peloids range from mL to fL, ~12% dolomite present, < 3% anhydrite present, estimated 10% porosity. Solution enhanced interparticle and solution enhanced intraparticle porosity (in order of abundance). Four or more stages of diagenesis possible. 1. Micritization. 2. Leaching/ dissolution. 3. Blocky, meteoric cement. 4. Anhydrite and dolomite grain replacement and pore filling.

Thin Section Description
Petro-Chem Operating Inc.
Strong #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8205.2 (Plug 66)	Limestone. Brown, oolitic/peloidal grainstone, poorly sorted, peloids range from crsL to fU, ooids range from crsL to mL, < 2% anhydrite present, estimated 15% porosity. Solution enhanced interparticle, interparticle, and intraparticle porosity (in order of abundance). Six or more stages of diagenesis possible. 1. Micritization. 2. Leaching/ dissolution. 3. Blocky, meteoric cement. 4. Compaction. 5. Leaching/ dissolution. 6. Minor Anhydrite grain replacement and pore filling.
8218.6 (Plug 82)	Limestone. Gray, oolitic/peloidal grainstone, poorly sorted, peloids range from mL to fL, ooids range from 2mm to fU, < 2% anhydrite present, estimated 18% porosity. Solution enhanced interparticle, interparticle, and intraparticle porosity (in order of abundance). Five or more stages of diagenesis possible. 1. Micritization. 2. Leaching/dissolution. 3. Blocky, meteoric cement. 4. Leaching/dissolution. 5. Anhydrite grain replacement and pore filling.

Thin Section Description
Petro-Chem Operating Inc.
Westbrook #1
Grayson Field
Columbia County, Arkansas

Depth (ft.)	Description
8114 - 8115 (Plug 2)	Limestone. Gray, highly altered mudstone/wackestone, poorly sorted, ooids ~ fL, 25% calcite, 45% dolomite, 30% anhydrite present, estimated 0% porosity. Five or more stages of diagenesis possible. 1. Extensive micritization of grains. 2. Leaching/ dissolution. 3. Blocky, meteoric cement. 4. Calcite/micrite replaced by anhydrite. 5. Calcite/micrite and some anhydrite replaced by dolomite.

Figure B-1. Thin section photo from Alexander #1 @ 8056.0'. Extensive micritization and leaching visible.

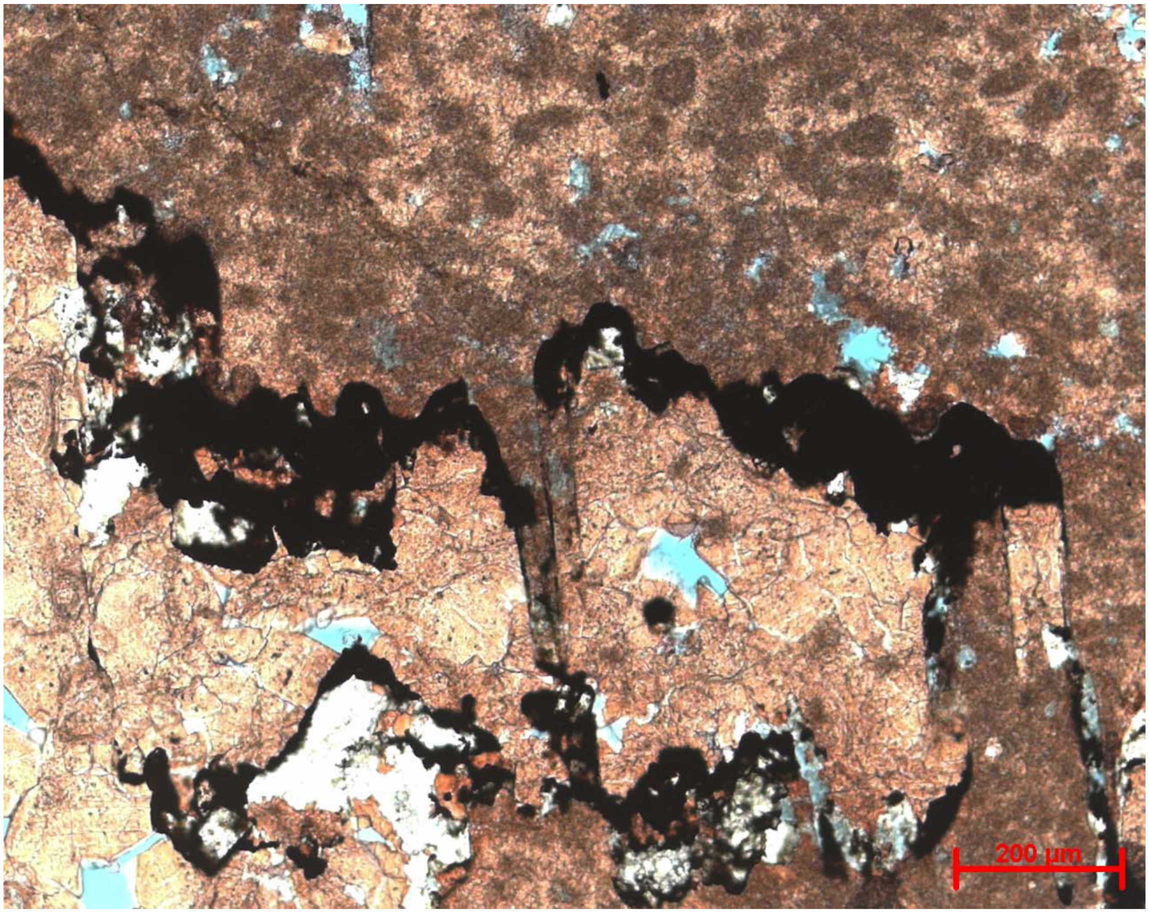

Figure B-2. Thin section photo from Alice Sydney Crone #1 @ 8299.0'. Peloids, micritization, and styolite filled with hydrocarbon visible in sample.

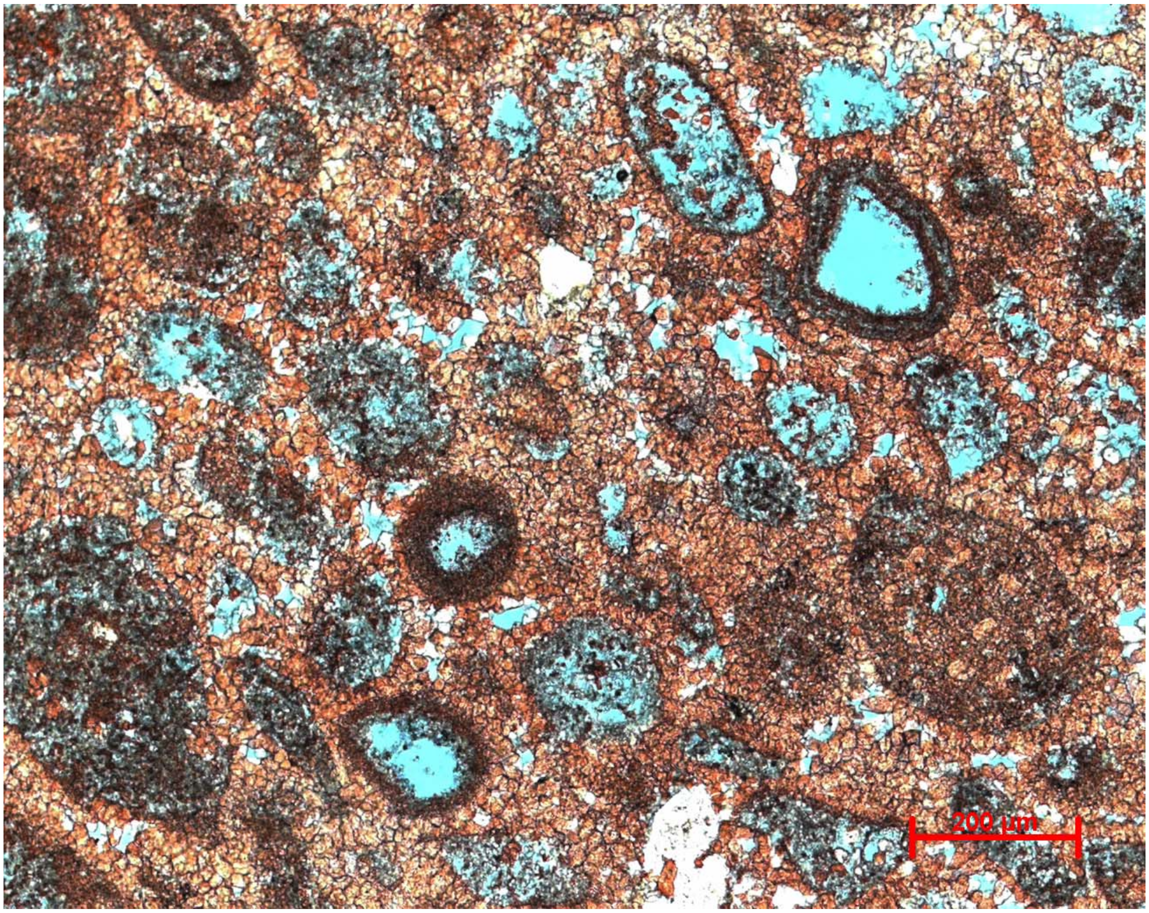

Figure B-3. Thin section photo from Genestet Farms #1 @ 8220.0'. Abundant calcite cement and leaching of grains visible.

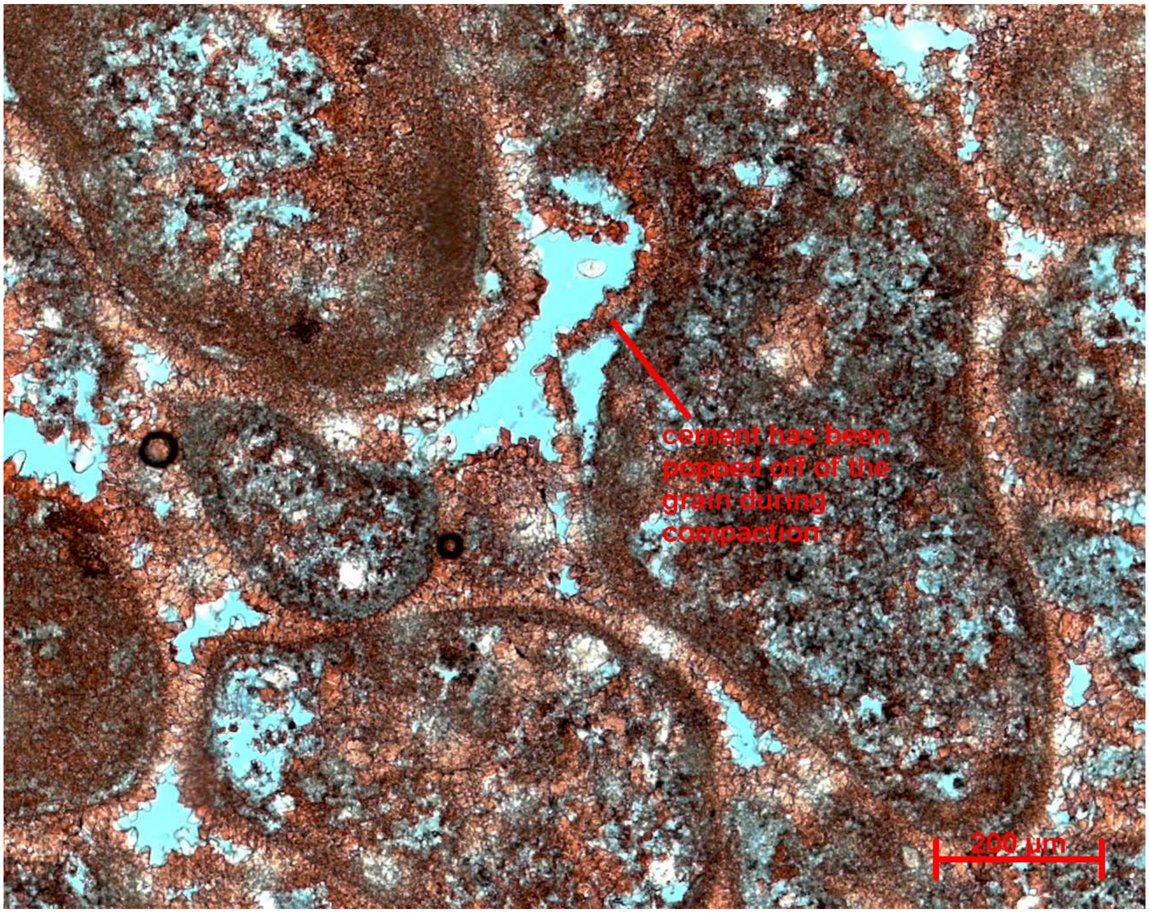

Figure B-4. Thin section photo from Kemmerer #2 @ 8070.6'. Cement has been popped off of the grain during compaction.

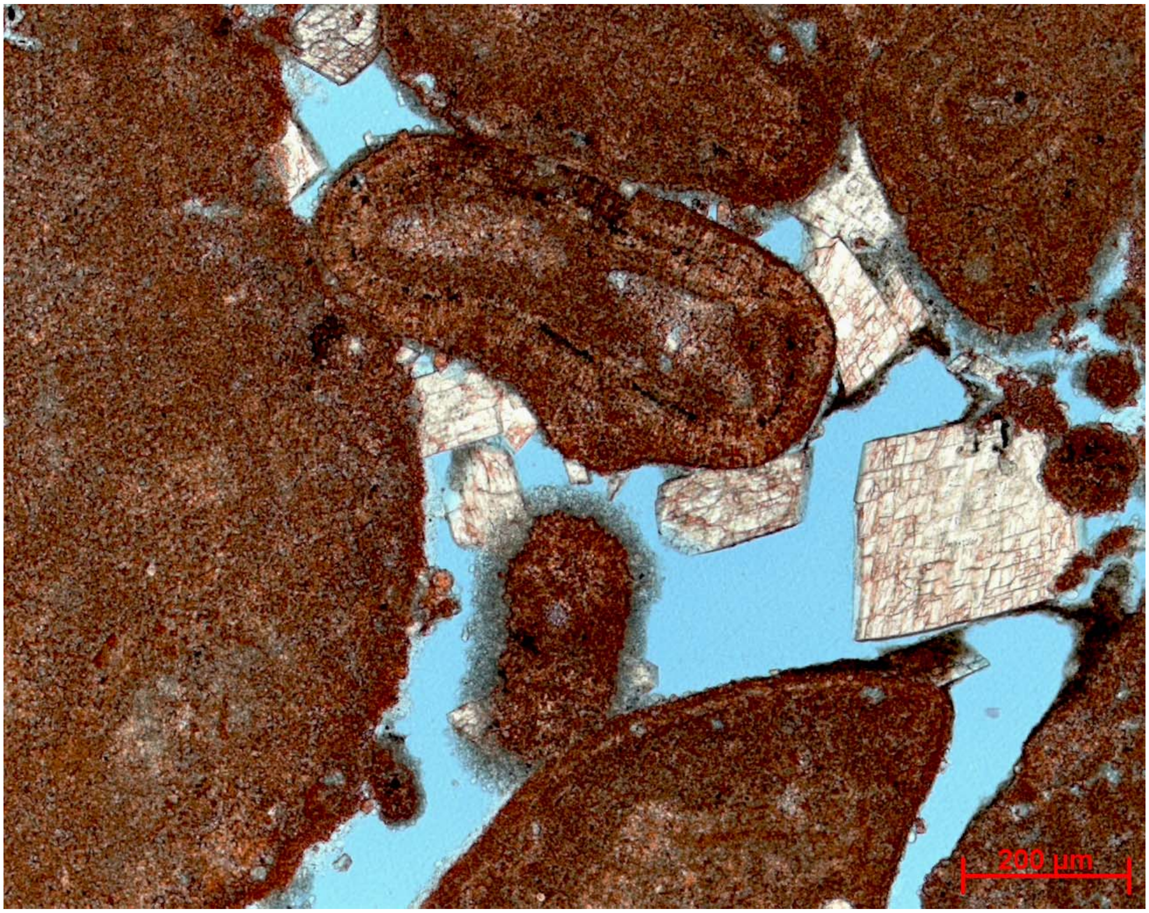

Figure B-5. Thin section photo from Kemmerer #3 @ 8143.0'. Pore filling dolomite around ooids and peloids. Blocky, meteoric cement has been leached/dissolved before the formation of the dolomite.

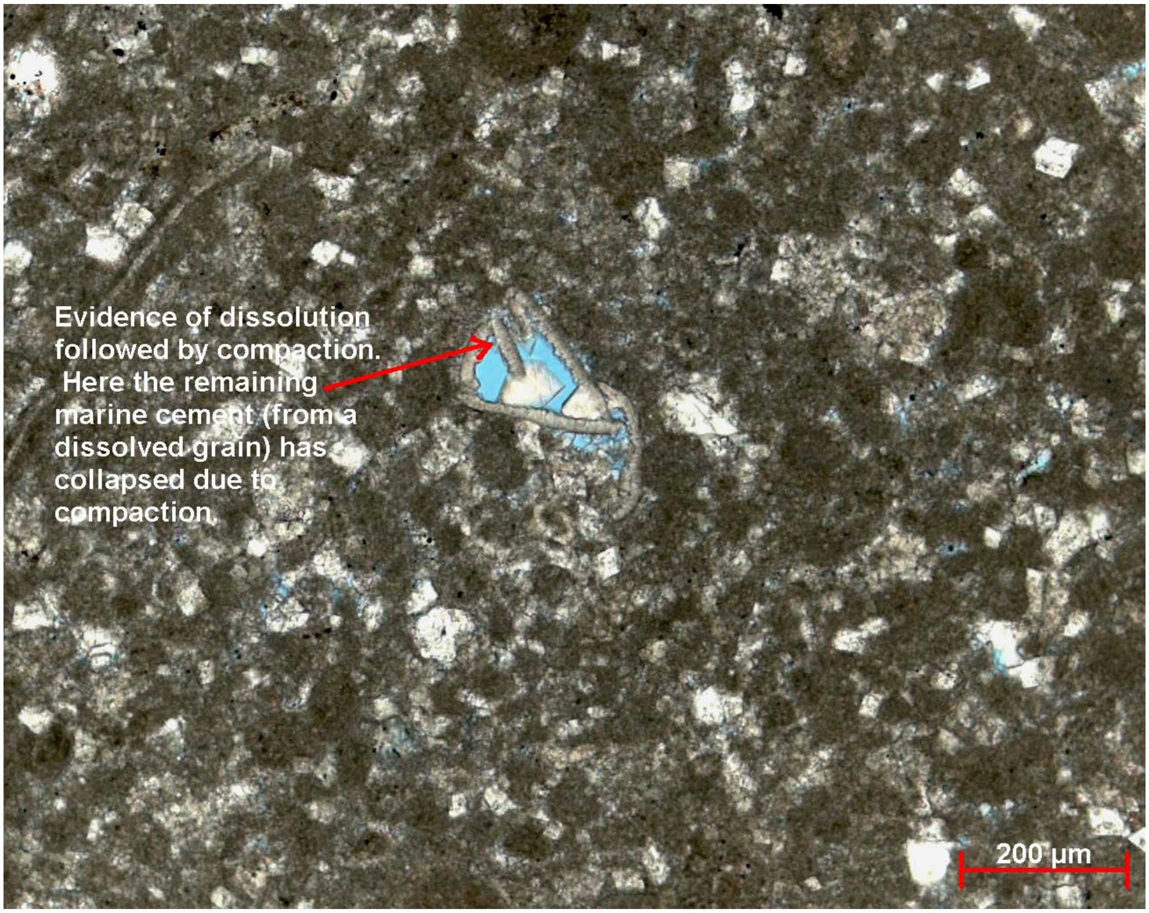

Figure B-6. Thin section photo from Kemmerer #3 @ 8167.0'. Evidence for dissolution followed by compaction. This marine, fibrous to bladed cement is all that remains from a dissolved grain. It is collapsing upon itself because of subsequent compaction.

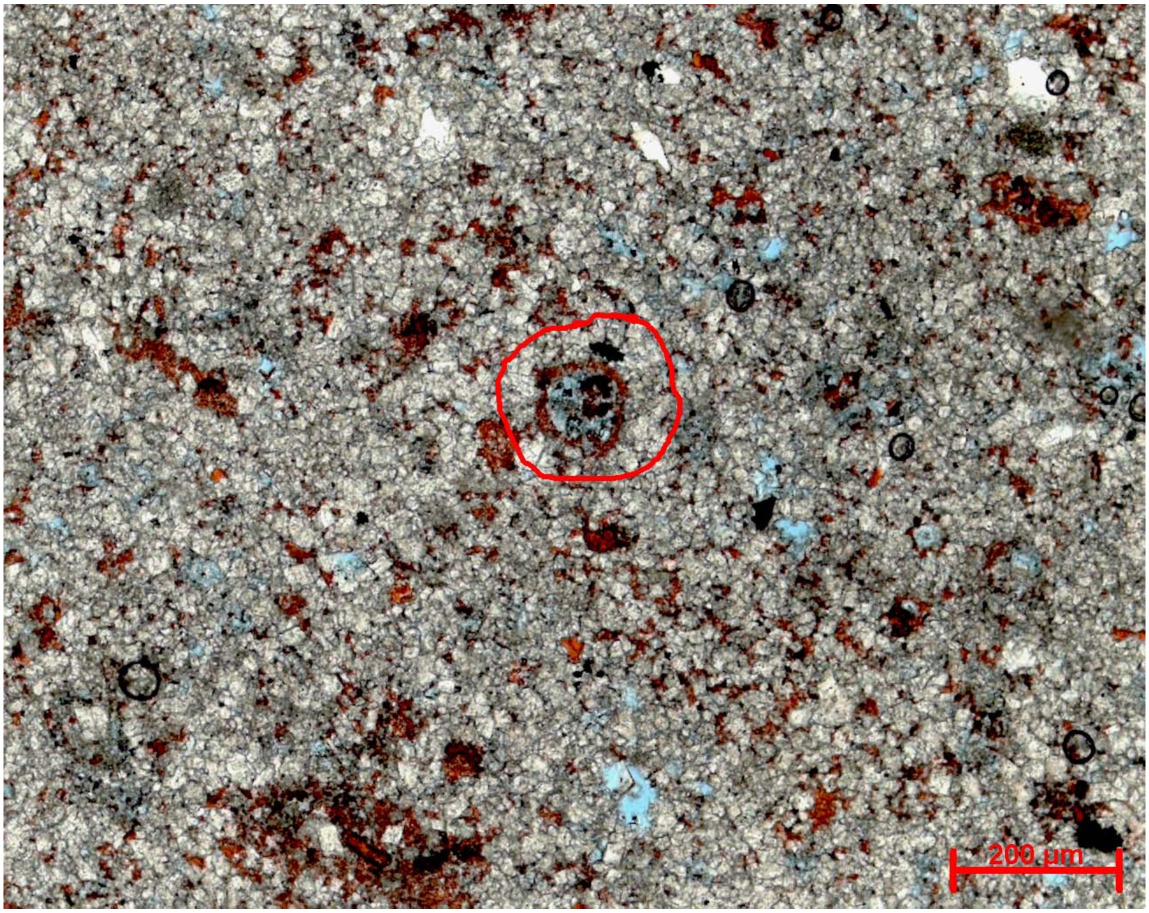

Figure B-7. Thin section photo from Kemmerer #3 @ 8193.0'. Dominantly dolomite crystals present. Remnant grain circled in red. This section possibly contained very fine grained ooids to peloids. However, the grains were extensively altered/micritized. Very little currently remains as evidence of these grains.

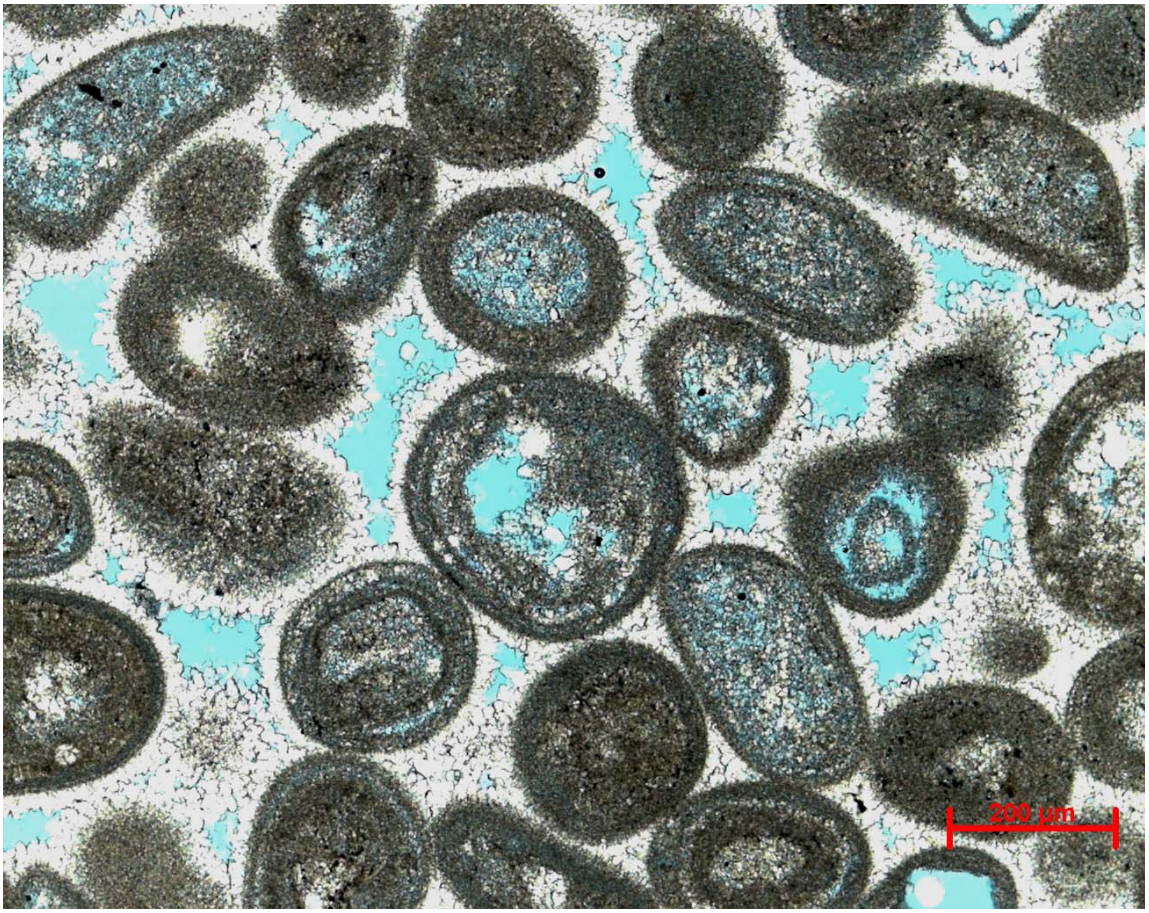

Figure B-8. Thin section photo from Kitchens #1 @ 8088.0'. Probably isopachous bladed to fibrous cement followed by leaching of the ooids and peloids. Subsequent recrystalization of the cement/new blocky, meteoric cement.

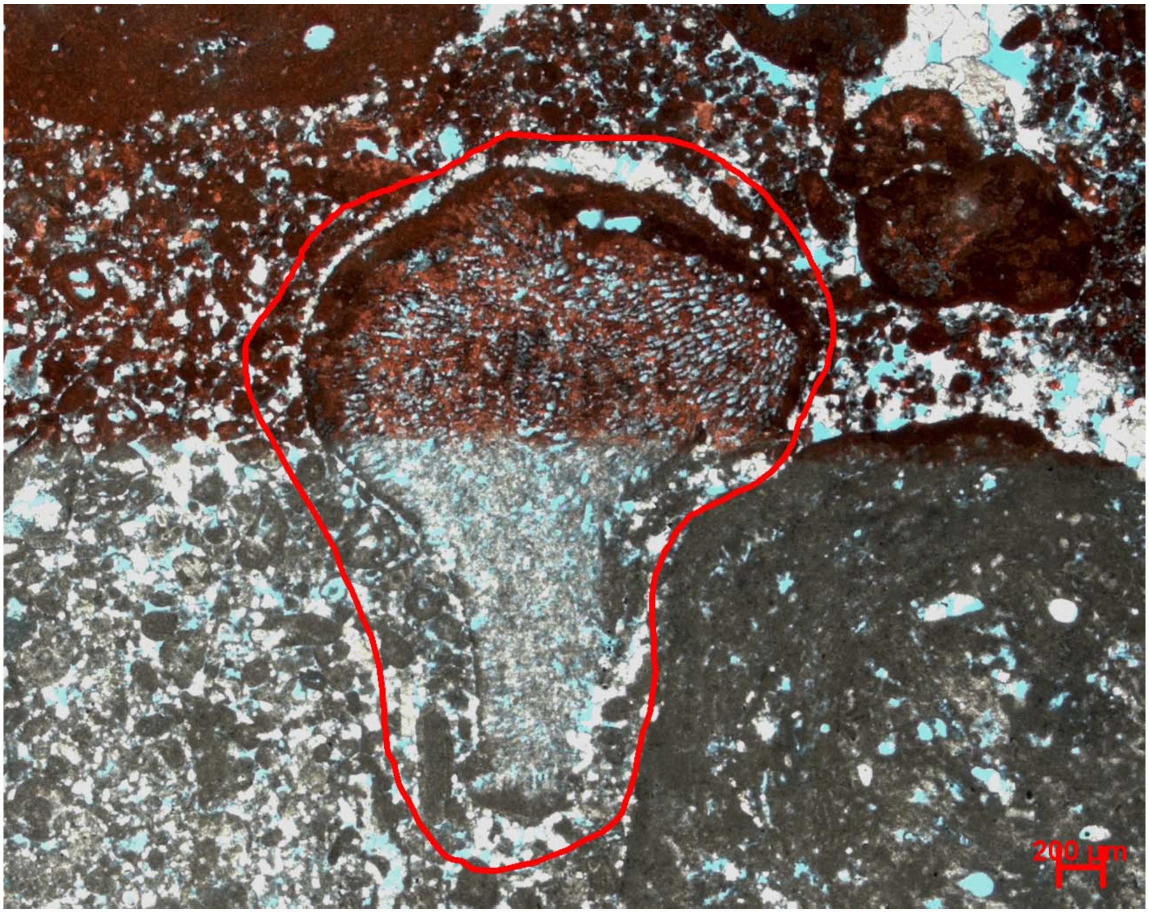

Figure B-9. Thin section photo from Kitchens #1 @ 8184.0'. Peloids, micritization, and Bryozoan (circled in red) visible. The dark, top half of the thin section is due to the calcite identification stain.

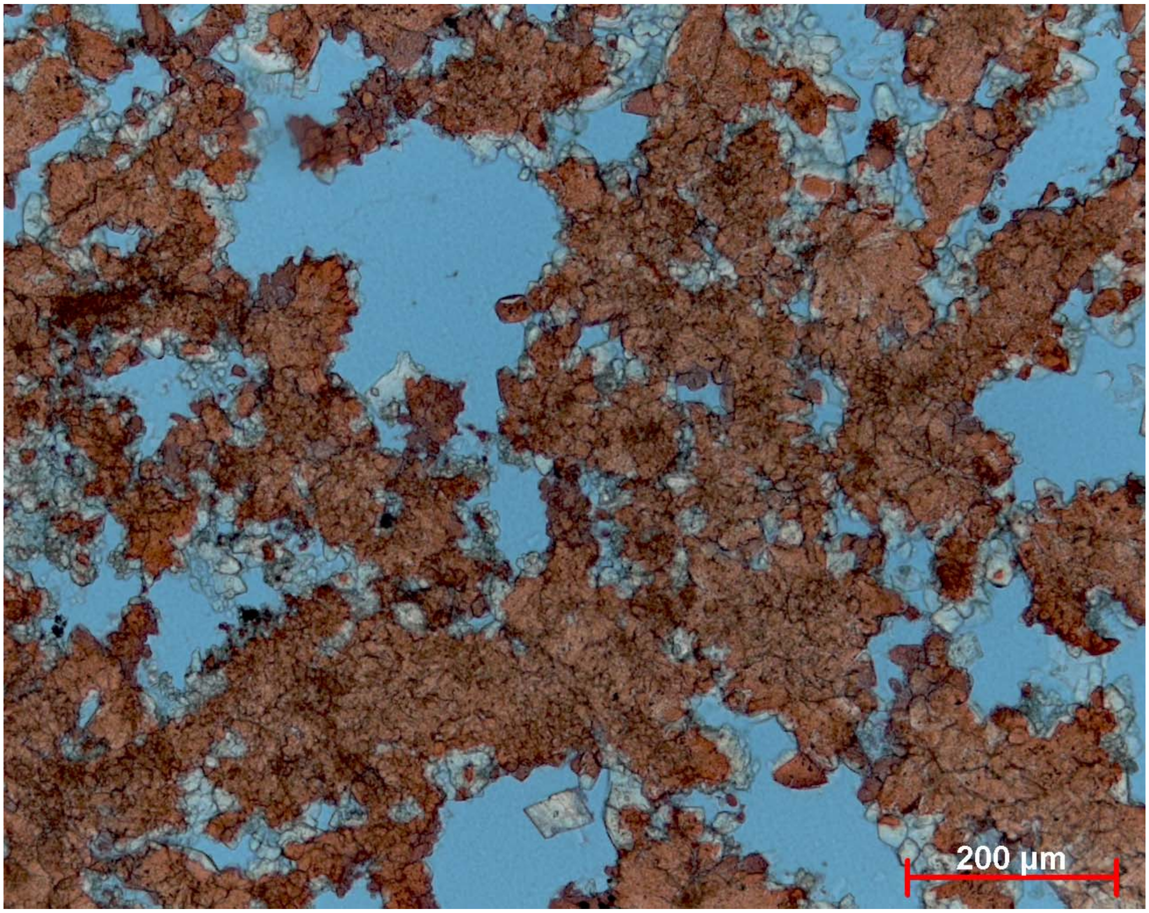

Figure B-10. Thin section photo from Lizzy Grayson #2 @ 8167.0’. Extensive cementation (or replacement?) followed by extensive dissolution/leaching.

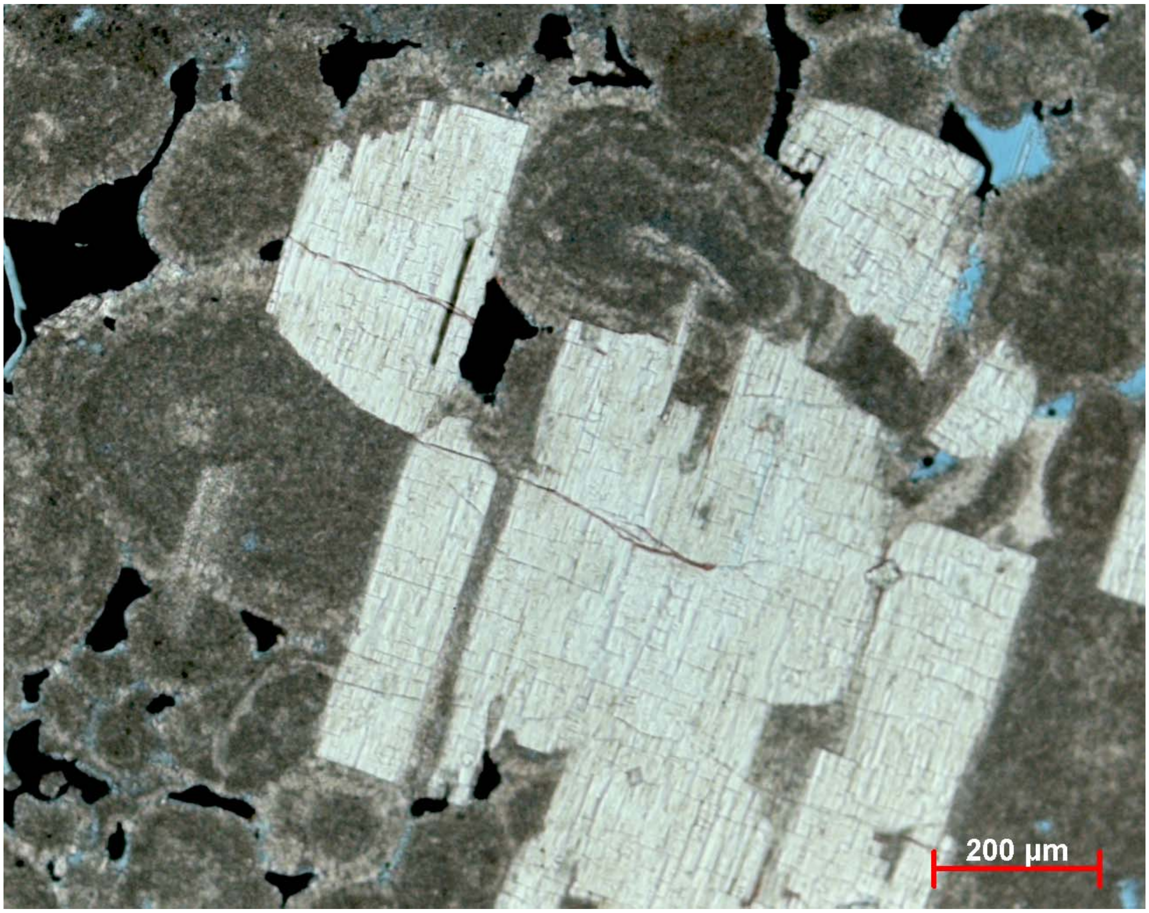

Figure B-11. Thin section photo from Lizzy Grayson #2 @ 8190.0'. Micritization, grain replacement, and hydrocarbon visible in sample.

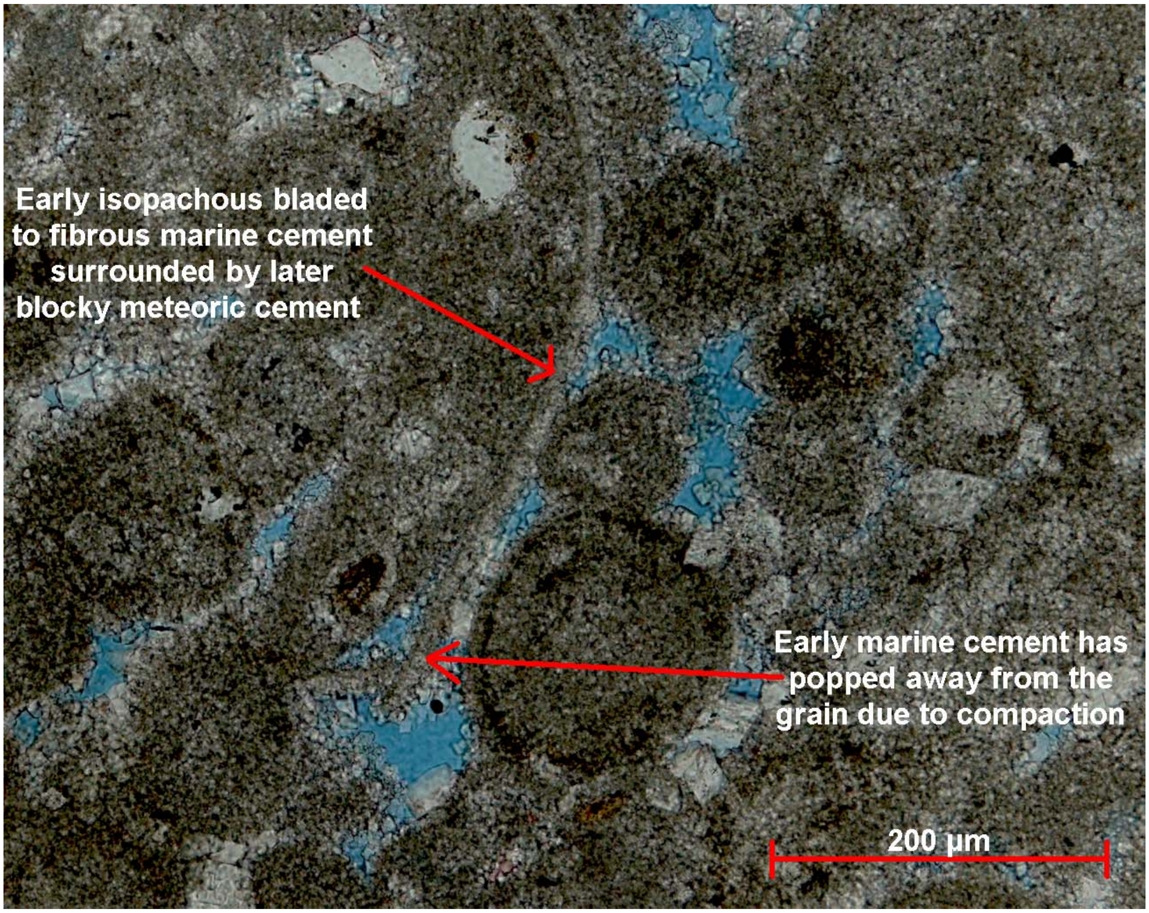

Figure B-12. Thin section photo from Nina Grayson Warnock #1 @ 8145.0'.

APPENDIX C

STRUCTURE, ISOPACH, POROSITY, PERMEABILITY, AND FLOW UNIT MAPS

Appendix C contains a salt-time structure map, a Buckner isopach map, a top of Smackover structure map, and slice maps for Grayson field. There are three kinds of slice maps including porosity, permeability, and reservoir quality. For the porosity and permeability maps, the Smackover was divided into 10ft intervals and the values were averaged. The reservoir quality maps were created by overlaying the corresponding porosity and permeability slice maps, locating and identifying zones from Figure 9, and labeling the facies present (A PDF file accompanies this thesis as a file available for downloading).

APPENDIX D

STRUCTURAL AND STRATIGRAPHIC CROSS SECTIONS

Appendix D contains two structure and two stratigraphic cross sections for Grayson field. The structural cross sections run North to South and West to East and show the present day structure in the field. The North to South and West to East stratigraphic cross sections contain facies based on thin sections and core descriptions (A PDF file accompanies this thesis as a file available for downloading).

VITA

Kathleen Renee Poole graduated from Caddo Parish Magnet High School in 1998. She went on to college at Texas Christian University for two years, majoring in Advertising and Public Relations. In 2000, she transferred to Centenary College of Louisiana in Shreveport and switched her major to Geology. She completed a Bachelor of Science in geology in 2003.

In the fall of 2003, Kathleen joined the graduate program at Texas A&M University, College Station, Texas, to pursue a Master of Science in geology. Upon completion of her graduate degree, she began work with BP in Houston, Texas. She can be reached at 200 Westlake Park Blvd., Houston, Texas, 77079. Her email address is Kathleen.Poole@bp.com.