Facies and Stratigraphic Framework of the Eagle Ford Shale in South Texas

A Thesis Presented to

the Faculty of the Department of Earth and Atmospheric Science

University of Houston

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

By

Heather Anne McGarity

May 2013

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Abstract

The Upper Cretaceous Eagle Ford Shale, in South and East Texas, consists of organic matter-rich fossiliferous marine shale. It is one of the most actively drilled targets for oil and gas in the United States, due to new technologies in drilling and completions. These low porosity and permeability reservoirs are now significant hydrocarbon producers, and therefore, it is crucial to understand the architectural elements and reservoir properties to maximize hydrocarbon production. Zones of higher clay content, variable lithology, total organic content variations, and changes in porosity and permeability can affect hydrocarbon recovery. This study focuses on building a detailed stratigraphic framework of the Eagle Ford Shale.

Six wells with whole core through the Eagle Ford Formation were analyzed and interpreted to determine lithology, sedimentary structures, and parasequences. Eight separate facies along with their depositional environment were interpreted to have been deposited above storm wave base along the inner and outer shelf in a moderate energy environment episodically interrupted by higher energy events, as opposed to a deeper-water setting. Gently inclined lamina and ripple cross laminations provide evidence of significant bedload transport, probably as floccule ripples. Bioturbated horizons mark flooding surfaces that cap upward-coarsening facies successions, interpreted as parasequences.

These surfaces, along with bentonites seen in core were then correlated to the corresponding wireline logs. These surfaces along with other distinct gamma ray markers were then correlated across the South Texas region using a dataset of 735 gamma ray logs. Several units show onlap and truncation that were used to document onlap and thinning adjacent to structural highs. The upper Eagle Ford Shale shows onlap and thinning of units towards the San Marcos Arch as opposed to the Maverick Basin region where the upper Eagle Ford Shale thickens significantly. The lower Eagle Ford Shale remains relatively constant throughout the South Texas region, showing only minimal areas of thickened sections. Thus, indicating deposition of this lower unit prior to subsidence of the Maverick Basin.

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Introduction

Shales were originally regarded as primarily serving as the source rock or seal of a petroleum system (Magoon, 1994). The Eagle Ford Shale was traditionally known as a source rock in South and East Texas for the Austin Chalk, which produced both oil and gas (Liro, 1994). However, recently, shales have become increasingly important hydrocarbon-producing plays due to the advancement of drilling and particularly completion technologies. Shale plays can have low porosity and permeability compared to their conventional counterparts. Consequently, it is crucial to understand the architectural elements and reservoir properties to maximize hydrocarbon production (Magara, 1980). Some of the most actively drilled plays currently in the United States are shale reservoirs including the Bakken Shale Formation of North Dakota, the Marcellus Formation of Pennsylvania, the Barnett Formation of North Texas, and the Eagle Ford Shale Formation of South Texas (U.S. Energy Information Administration).

According to the Railroad Commission of Texas (2011), the Eagle Ford Shale in South and Central Texas is arguably one of the best shale plays within the United States due to: 1) its relatively shallow depths in the oil window, 2) high percentage of carbonate, which makes it easier to fracture, and 3) large lateral extent and thickness. The Eagle Ford Shale was first studied and named by Hill (1887) in an outcrop around Dallas, Texas. Since then, there have been numerous studies, which have taken place primarily on outcrop (Stephenson and Reeside, 1938, Adkins and Lozo, 1951, and Lock et al., 2010). However, due to drilling activity, more studies have been done on the subsurface extent of the Eagle Ford Shale utilizing well logs and core (Donovan and Staerker, 2010, Hentz and Ruppel 2010, Dawson and Almon, 2010, and Harbor, 2011).

The Austin Chalk Formation overlies the Eagle Ford Formation in South Texas and has been a known producer of oil and gas since the 1920s (Oil Shale Gas 2012). However, in 2006, two wells, operated by Conoco and Apache, were drilled and perforated within both the Austin Chalk and Eagle Ford Shale (DrillingInfo, 2012). The first true Eagle Ford Shale well was drilled in 2008 by Petrohawk in the Hawkville Field in LaSalle County, Texas. The play was originally regarded as a dry gas play; however, wet-gas and oil were discovered farther up-dip. The northwestern part of the play is the up-dip oil window with lower pressure and higher oil volumes, the southeastern part of the play is the down-dip dry gas window, and the middle is the wet-gas or condensate window (DrillingInfo, 2012). The Eagle Ford Shale play has been growing rapidly. According to the Texas Railroad Commission, there were 1262 producing oil leases on schedule in 2012; 368 producing oil leases on schedule in 2011; 72 producing oil leases in 2010; and 40 producing oil leases in 2009.

Shale composition can be quite variable; however, clay is typically a major component. The term shale has been applied to many classes of materials, which can be generally described as fine-grained, clastic sedimentary rocks (Chapman et al., 1976). Historically shales were thought to be deposited in quiet water settings, typically in basins, shelves, deltas, floodplains, or meandering rivers. However, more recent work indicates that these fine-grained rocks can be deposited in more energetic environments

(Schieber, 1999). There have been multiple proposed methods to classify shale: slakability (Chapman et al., 1976), grain size (Spears, 1980), grain type (Dickinson 1970; Valloni and Maynard, 1981), and geochemistry (Herron, 1988) to name a few. Fine-grained clastic sedimentary rocks form a very broad category; as a result, it is necessary to improve and specify this definition. Shale is composed of grain sizes less than $\frac{1}{256}$mm (8ϕ) and is fissile or laminated (Wentworth, 1922; Krumbein, 1934). Mudstones, siltstones, and claystones may also fall into this category, however, mudstones require 33%-66% silt particles, claystones need less than 33% silt, and siltstones require greater than 66% silt (Blatt and Tracy, 1996). The defining characteristic between shales and mudstones is that shale must be fissile or laminated, whereas a mudstone is neither fissile nor laminated (Spears, 1980).

The color of shale can be a valuable source of information; however, it does have its limitations. Gray to dark gray shales form under open-marine, oxic conditions and pose two different fabric types depending on the intensity of bioturbation (O'Brien, 1987). Extensively bioturbated shales consist of randomly oriented particles and are similar to unbioturbated, flocculated clay. Shales with less bioturbation show laminations or bedding, and their microfabric is parallel to sub-parallel, indicating a minor amount of sediment mixing or little to no organism activity (O'Brien, 1987). Black shales commonly reflect high organic matter content. The type of organic matter, percentage, and distribution all play key factors in creating black shale (Spears, 1988). These black shales are thought to be deposited in anoxic, reducing conditions, and are typically finelylaminated due to little to no biogenic activity. This has been disputed by Schieber (1999) and Schieber et al., (2000) who suggest instead high surface productivity as the cause of abundant organic accumulation. Their primary fabric consists of parallel clay flakes (O'Brien, 1987). Black shales likely show preferred orientation because of slow deposition in a dispersed state (O'Brien, 1981). Red and green colors indicate that organic matter was of minor importance during diagenesis due to low original organics or destruction caused by oxygen (Spears, 1980).

The mineralogy of medium to coarse siltstone can be determined with a petrographic microscope (Folk, 1960 and1962; Picard, 1966; Miller, 1966) and XRD. Quartz and feldspar are the main components of siltstone (Krynine, 1940). Other components may include chert, rock fragments, mica, opaque minerals, calcite, and dolomite. The Eagle Ford Shale is more of a carbonate marlstone than shale; however, shale is the term most commonly used in industry. The Eagle Ford Shale formation's carbonate content can be as high as 70%. The higher carbonate content and subsequently lower clay content make the Eagle Ford Shale more brittle and easier to stimulate through hydraulic fracturing or "fracking." Claystone is much more difficult to interpret petrographically due to small grain sizes. However, XRD can be useful in interpreting origin and composition (Picard, 1971). There have been numerous classification systems for fine-grained sedimentary rocks, and numerous debates on the best classification method (Spears, 1980).

Petrophysical techniques are now more commonly utilized to identify shale mineralogy and composition. Determining shale mineralogy can easily be accomplished using geochemical tools or conventional well logs (photo-electric absorption for pyrite volume, bulk density for limestone volume, neutron porosity for pay volume, and porosity and resistivity for water saturation) (Mullen, 2010).

Mineralogy is not the only rock property obtainable from well logs; effective porosity, water saturation, and total organic content can also be calculated. Through the integration of petrophysical characteristics and core, it is possible to build a locally calibrated petrophysical model (shale log) that can be applied to future wells to grade the reservoir and learn about the lateral variation across an entire shale formation (Mullen, 2010).

The traditional model for the deposition of shales has been suspension settling from hypopycnal flows. However, this depositional model is being challenged by numerous studies, such as Einsele and Mosebach (1955), Ettensohn et al. (1988), Lineback (1970), Sutton et al. (1970), Eugster and Hardie (1975), Stow and Piper (1984), Lash (1987), Cluff (1987), Wignall (1989), O'Brien and Slatt (1990), Schieber (1989, 1990a, 1994b), and Macquaker and Gawthrope (1993). Schieber (1998) notes that because observable features vary between shale sequences, there may be an emphasis on compositional parameters in some studies, and on sedimentary features in others. If the shale contains few sedimentary features, a detailed composition-based approach to identify depositional environments is ideal. However, if there are recognizable and varied sedimentary features within the shale, a careful study usually allows more detailed and direct conclusions about sedimentary conditions (Schieber, 1998).

Laminations are the most typically observed feature within shale. They can represent quiet settling, sculpting of the sediment surface by bottom currents, and growth of microbial mats (Schieber, 1986). Internal lamina features (Schieber, 1998) can also be indicative of depositional environment, e.g., grading can be indicative of event sedimentation (e.g. floods, storms, and turbidites). Random clay orientation may be due to flocculation or sediment trapping by microbial mats, preferred clay orientation is deposited due to settling from dilute suspension, sharp basal contacts indicate current deposition, and sharp top contacts represent current flow and erosion/reworking after deposition. Schieber et al. (2007) showed that clay beds can accrete from migrating floccule ripples under swift current conditions. In the rock record the things to look for that are indicative of this lateral accretion and ripple migration are subtle non-parallel laminae geometry, basal downlap and top truncation of laminae, and low amplitude bedforms. Post-depositional compaction in muddy strata can lead to the interpretation of planar-parallel laminations, however upon further investigation, signs of floccule ripple bedding should be retained in the form of low-angle foresets and mud beds (Schieber et al., 2007). Therefore, to interpret if deposition is through suspension settling or high energy processes, it is necessary to observe small scale sedimentary structures.

This study evaluates the stratigraphic framework of the Eagle Ford Shale in South Texas, which will be calibrated to core data. Previous sequence stratigraphic studies of the Eagle Ford Shale from BP have focused on an outcrop in Lozier Canyon, west of Langtry, Texas. BP's study of this outcrop lead by Donovan et al. (2011), has identified four sequence boundaries and three maximum flooding surfaces within the Eagle Ford Shale. BP has interpreted 5 facies within the Eagle Ford Shale, all of which are interpreted as being higher energy deposits, above storm wave base. Core Laboratories also have studied the Eagle Ford Shale in core samples from operator wells that are part of the Core Lab Core Consortium. Core Laboratories interpretation of the Eagle Ford Shale is similar to BP’s suggesting that the majority of deposition occurred above storm wave base. Dawson (1997, 2000) interpreted 6 separate microfacies within the Eagle Ford Shale. The majority of these facies were interpreted by Dawson (1997, 2000) as being low energy deposits below storm wave base, in anoxic conditions. There have also been studies on the condensed section within the Eagle Ford Shale (Liro et al., 1994) in the East Texas Basin.

Geologic Setting

During the mid-late Cretaceous, the Western Interior Cretaceous Seaway (Fig. 1) split North America into two land masses, Laramidia and Appalachia. The Western Interior Seaway extended 4800 km from the present-day Arctic Ocean to the Gulf of Mexico at its maximum, with a width of approximately 1600 km (Kauffman, 1984). Depths of this sea reached a maximum depth of 250-300 m based on facies and faunal assemblages (Kaufmann, 1977). Within this seaway, the Eagle Ford Shale was deposited from the present day Texas-Mexican

Figure 1. Shows the extent of the Western Interior Cretaceous Seaway during the Cenomanian-Turonian. (Figure taken from Sampson et al. 2010; modified from Blakey et al. 1996).

border in South Texas into East Texas (Fig. 2). The Eagle Ford trend forms a roughly 80 km (50 mi) wide and approximately 650 km (400 mi) long, shale formation buried 1200 m (4000 ft) to 3600 m (12,000 ft) below the surface.

The Eagle Ford Shale overlies the Buda Limestone within the South Texas region. This contact marks a distinct shift from bioturbated gray wackestone of the Buda, to more organic-rich mudrocks of the lower Eagle Ford. This contact between the Buda and Eagle Ford Shale is interpreted as a widespread depositional hiatus recording the mid-Cenomanian Unconformity (Addy and Buffler, 1984). This unconformity has been tied to a lowering of global sea level and subaerial exposure of the shallow Buda platform beyond the shelf margin, while intrashelf basins such as the Maverick Basin and East Texas Basin experienced continued deposition (Salvador, 1991). The Buda Formation is interpreted to pinch out as it approaches the Stuart City reef margin. In this area, the Eagle Ford Shale directly overlies the rudist reefs of the Stuart City Formation (Phelps, 2011).

The Eagle Ford Shale is overlain by the Austin Chalk (Fig. 2). This contact has been interpreted by Montgomery (1991) to be a clear unconformity around the San Marcos Arch, but a gradational contact in the Maverick Basin/Rio Grande Embayment area. The Austin Chalk consists of heavily bioturbated coccolith-rich limestone with abundant echinoid, bryozoan, and foraminiferal microfossil remnants. The Austin Chalk is also interbedded with organic-rich shales and ash beds (Montgomery, 1990).

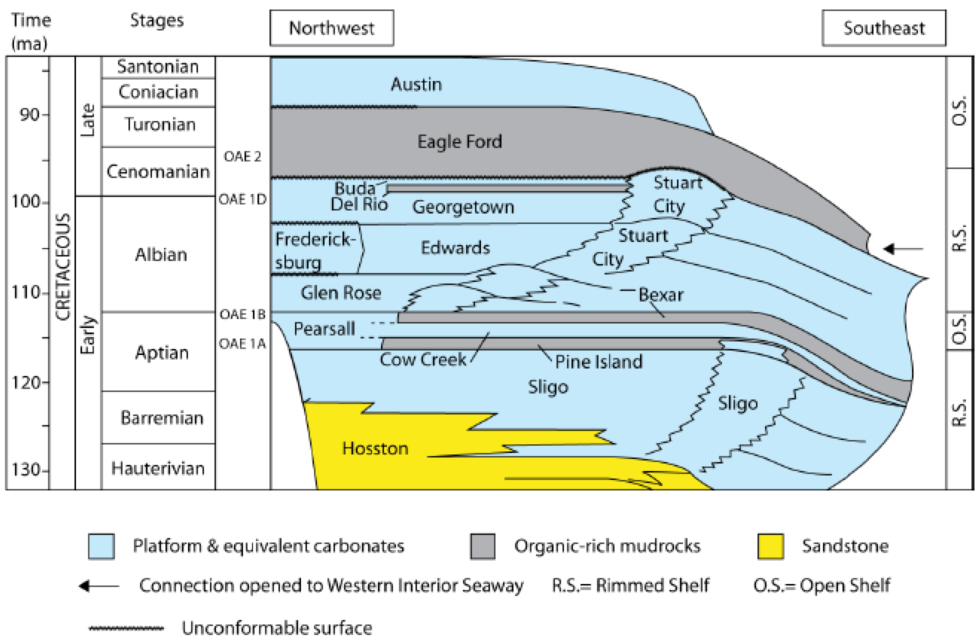

Figure 2.Stratigraphic column and architecture of Gulf Coast depositional systems (Figure Modified after Galloway (2008) and Salvador and Muñeton (1989)).

In the Northern Gulf of Mexico area, a quiet tectonic environment existed and shelf-edge reefs were able to form (Fig. 3) in the early Cretaceous (Condon et al., 2006). The Comanche Shelf (Fig. 4), developed as a thick, prograding carbonate succession that was deposited during multiple transgressive events (Salvador and Muñeton, 1989). These reefs formed where the continental shelf met the Gulf of Mexico basin and only diverged at the Western edge. The southern portion of the reef formed much earlier than the northern (Condon et al. 2006). Two dominant end-member shelfal depositional processes formed at this time; reef-rimmed platforms, which were dominant during low-order regressive events, and storm-dominated ramp profiles, which were produced by transgressive and early highstand deposits (Salvador and Muñeton, 1989). Following formation of the reef, back-stepping of the platform resulted in deposition of organic-rich lime mudstone and shale on top of the platform. This resulted in deposition of units such as the Eagle Ford Shale Formation, Pearsall Formation, and Del Rio Formation (Mullen, 2010).

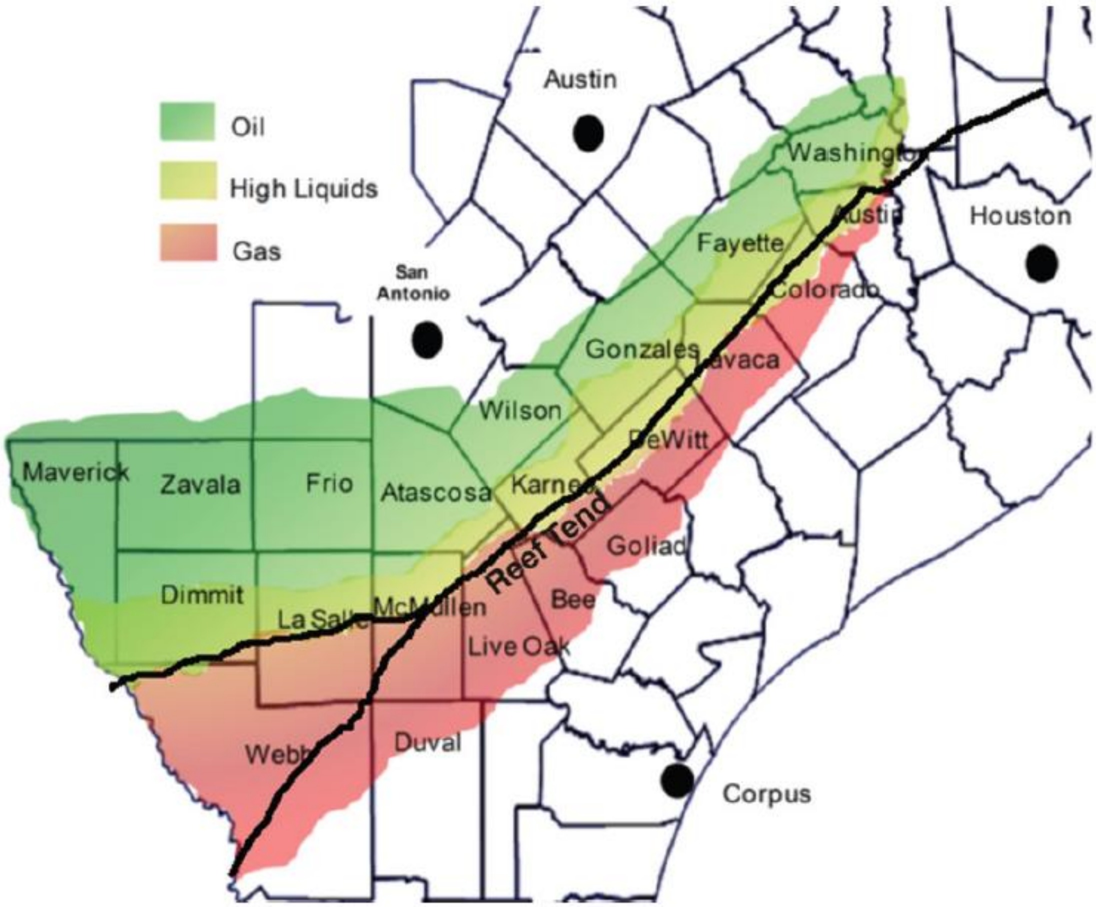

Figure 3. Lateral extent of Eagle Ford showing hydrocarbon type dependent on region. Black lines approximate the reef trend of this area. (Figure taken from Mullen 2010).

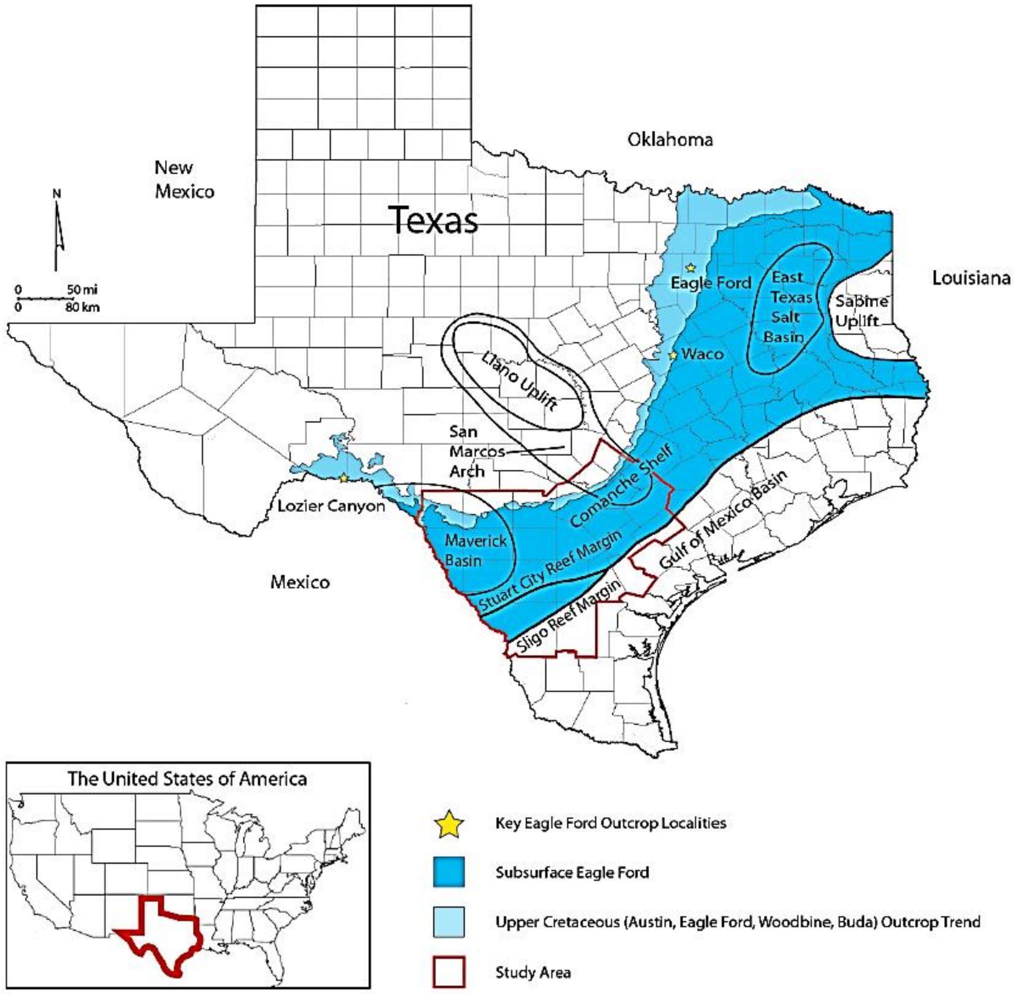

Figure 4. Map showing the distribution of the Eagle Ford Shale and the key structural features affecting distribution and thickness (San Marcos Arch and Sabine Uplift). Figure adapted from Geology of Texas Map (1992), Montgomery (1991), and Phelps (2011).

The thickness and lateral distribution of the Eagle Ford Shale was controlled by pre-existing platform rimming biologic build-ups and structural features such as the San Marcos Arch (Dravis, 1980). The San Marcos Arch is an extension of the Paleozoic Llano Uplift that trends southeast-northwest and separates the Maverick Basin/Rio Grande Embayment area and the East Texas Basin (Fig. 5) (Dravis, 1980). A series of southwest-northeast trending fault systems developed during the Ouachita Orogeny (Montgomery, 1990) (Fig. 6). The Charlotte Fault Zone, Balcones Fault Zone, Luling Fault Zone, and Fashing Fault Zone are the major faults zones throughout the South Texas area. The Charlotte, Luling, and Fashing Fault zones formed as a result of basinward movement of Triassic and Jurassic salt (Montgomery, 1990). The Balcones Fault Zone consists of discontinuous individual faults (Muehlberger and Kurie, 1956). This fault zone ranges from Del Rio to Central Texas (Reaser, 1961). Balcones faulting is a series of normal, downthrown faults that form an arcuate pattern that is concave to the Llano Uplift (Zink, 1957). The Luling Fault Zone is a series of normal landward dipping faults that parallel the Balcones Fault Zone, creating grabens that range from Luling, Texas, to the Balcones Fault Zone (Zink, 1957). The Charlotte Fault Zone, also known as the Atascosa Trough, lies along the southern portion of the San Marcos Arch in Atascosa and Frio counties. This fault system is a complex system of basinward and landward dipping normal faults that created grabens (Zink, 1957). The Fashing Fault Zone, which is also known as the Karnes Trough, is similar to the Atascosa Trough in that it is a complex series of basinward and landward dipping faults that lead to graben formation (Zink, 1957). These fault systems remained active during deposition of the Eagle Ford

Shale and led to formation of depocenters; these locally thickened sections within the depocenters are ideal locations for hydrocarbon exploration (Eaton, 1956; Corbett, 2010).

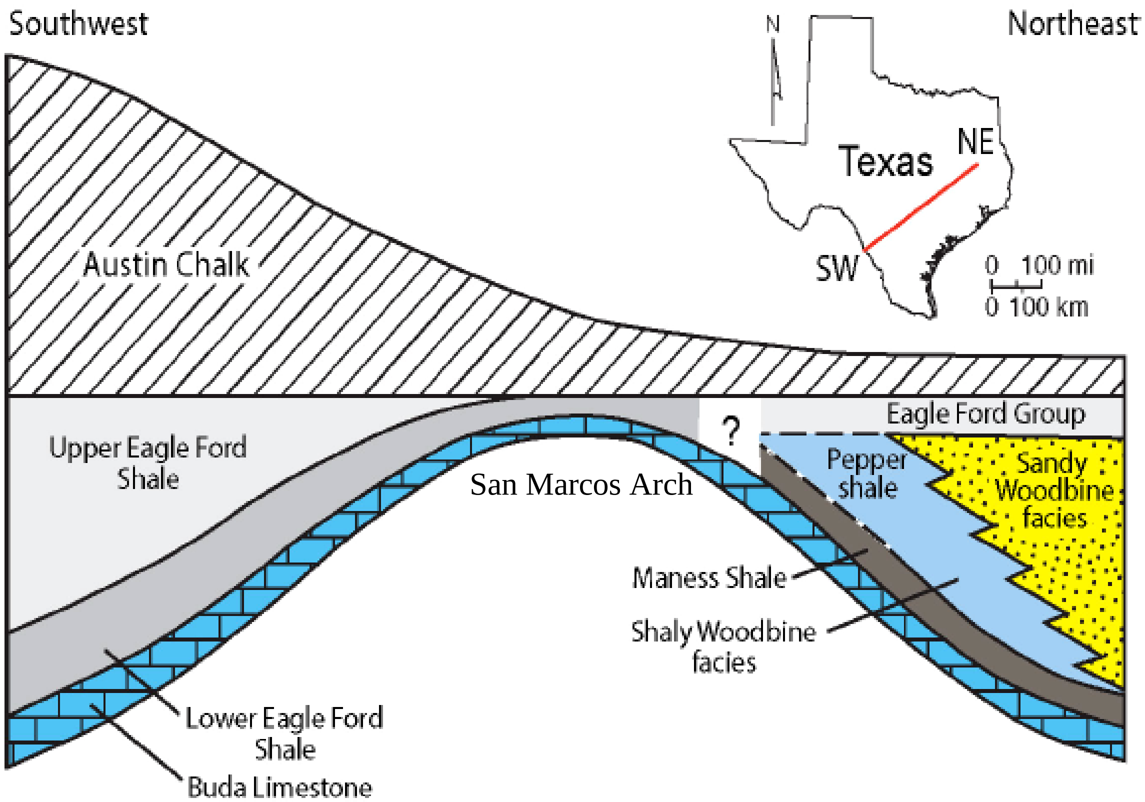

Figure 5. Southwest-northeast schematic cross-section showing thinning of the Eagle Ford Shale over the San Marcos Arch. This figure shows the Eagle Ford, which is subdivided into upper and lower Eagle Ford equivalents by Hentz and Ruppel (2010), thins significantly, and the upper Eagle Ford pinches out over the San Marcos Arch. Figure also shows stratigraphic equivalents of the Eagle Ford Shale within the East Texas Basin. Figure taken from Hentz and Ruppel (2010).

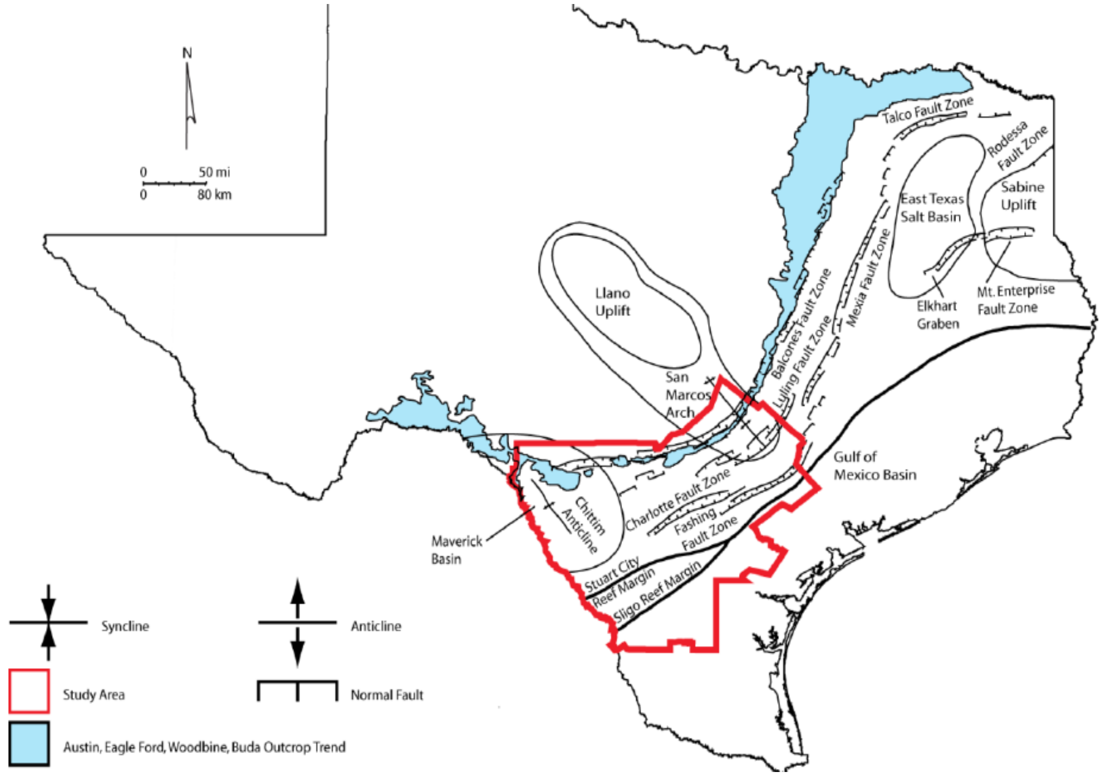

Figure 6. Map showing the structural features affecting the South Texas area. These fault systems affected deposition of the Eagle Ford Shale. Figure modified after Montgomery (1990) and Phelps (2011).

Depocenters also formed through tectonic activity of basement structures developed during the Rio Grande Rift (Rose, 1972; Donovan and Staerker, 2010). The failed rifting led to active salt withdrawal and the development of accommodation such as the Maverick Basin (Donovan and Staerker, 2010). These depocenters contain higher concentrations of sandy sediment compared to other deposits outside of the depocenters. This led to vertical and lateral variations within the Eagle Ford Shale, ultimately affecting reservoir quality (Mullen, 2010). The up-dip regions (Fig. 7) have variable organic richness due to these reef margin controlled depocenters, whereas the down-dip portion of the reef margin is characterized by lateral reservoir variability and primary permeability controlled by the location of distal turbidite and tempestite deposition (Corbett, 2010).

The condensed interval of the Eagle Ford Shale represents one of the greatest and most rapid sea-level rises in Earth's history and is associated with the Cenomanian-Turonian (92 ma) boundary (Dawson, 2000). Other prolific source rocks, such as the Mowry and Pierre Shales, were deposited during this same period, which is known as having high organic richness. These organic-rich shales are presumed to be correlative with Cretaceous oceanic anoxic events (Jenkyns, 1980), however, based on organic geochemical data there is little evidence of the Eagle Ford Shale being deposited under anoxic conditions (Liro et al., 1994).

The upper section of the Eagle Ford represents a highstand/regressive facies with thin limestones, shales, siltstones, bentonites, and local dolomites (Dawson, 2000). It consists of thinly interstratified (high frequency cycles) shales, limestones, and carbonaceous quartzose siltstones (Dawson, 2000). Dawson (2000) has divided the Eagle Ford Shale into six different microfacies and interpreted an environment of deposition based on an outcrop near Dallas, Texas. There is debate if the entire Eagle Ford section, subsurface and outcrop, contains this uppermost highstand system or if it has been locally eroded.

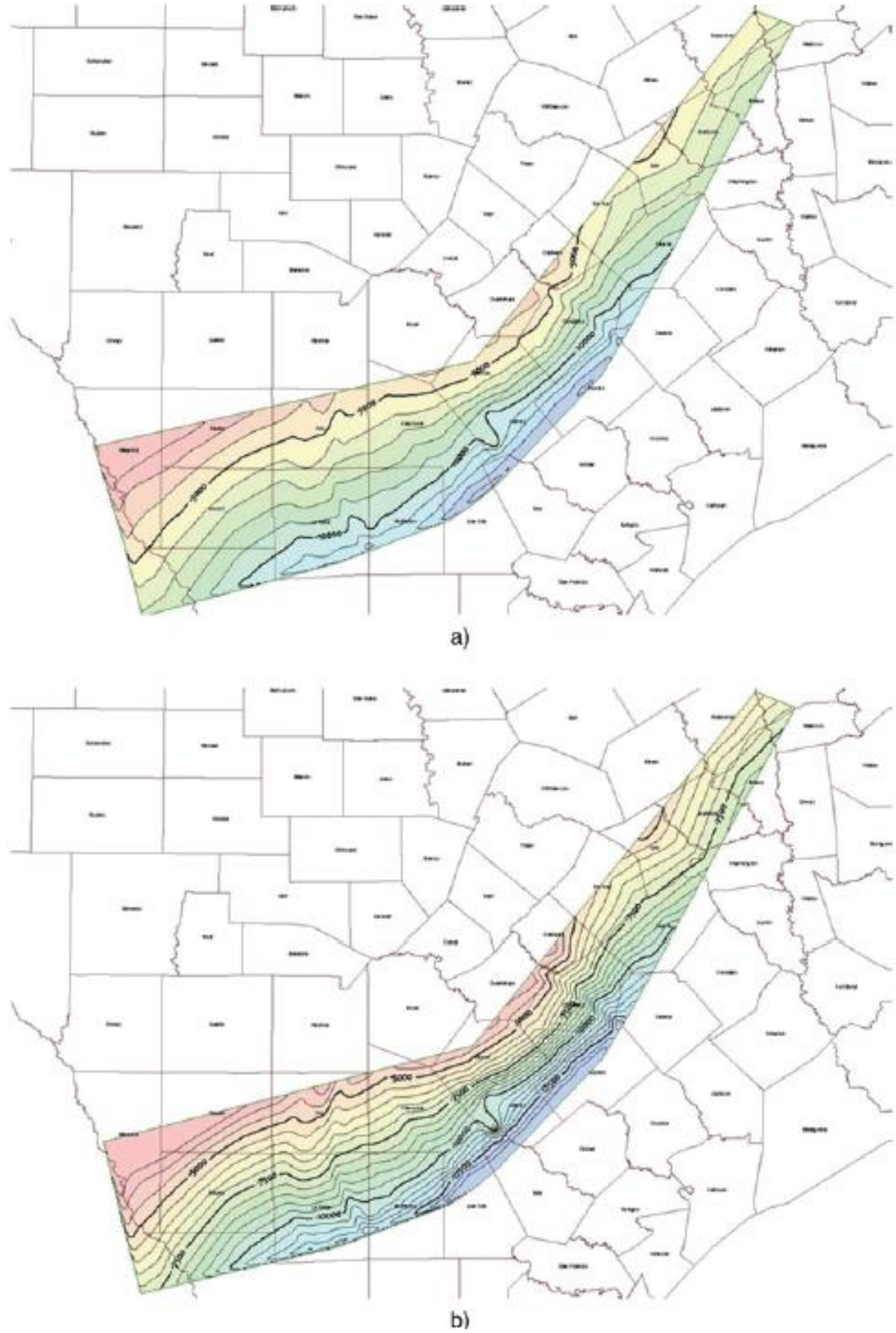

Figure 7. Structure map of the Eagle Ford Shale. (a) map of the top of the Eagle Ford; (b) map of the base of the Eagle Ford (Figure taken from Mullen 2010).

Methodology

Data for this study includes whole core from six wells and well logs from several hundred wells within the South Texas Eagle Ford Shale trend. The six cored wells utilized in this study are the Murphy Jog Unit 1 located within Karnes Country, Pioneer Long Gas Unit 1 #1 in Karnes Country, Murphy George Miles in McMullen Country, Peregrine Petroleum Briscoe Ranch in Maverick County, Hilcorp Mauch #1H which is now owned by Marathon Oil, and an undisclosed well located within LaSalle County (Fig. 8). Sedimentary structures and lithofacies were described using the Dunham classification system. Facies stacking patterns were analyzed and helped aid in the identification of stratigraphic surfaces. These stratigraphic surfaces were then correlated to well logs. Bentonites were also key beds within this study because they can easily be correlated to well logs where they show up as a distinct gamma ray spike.

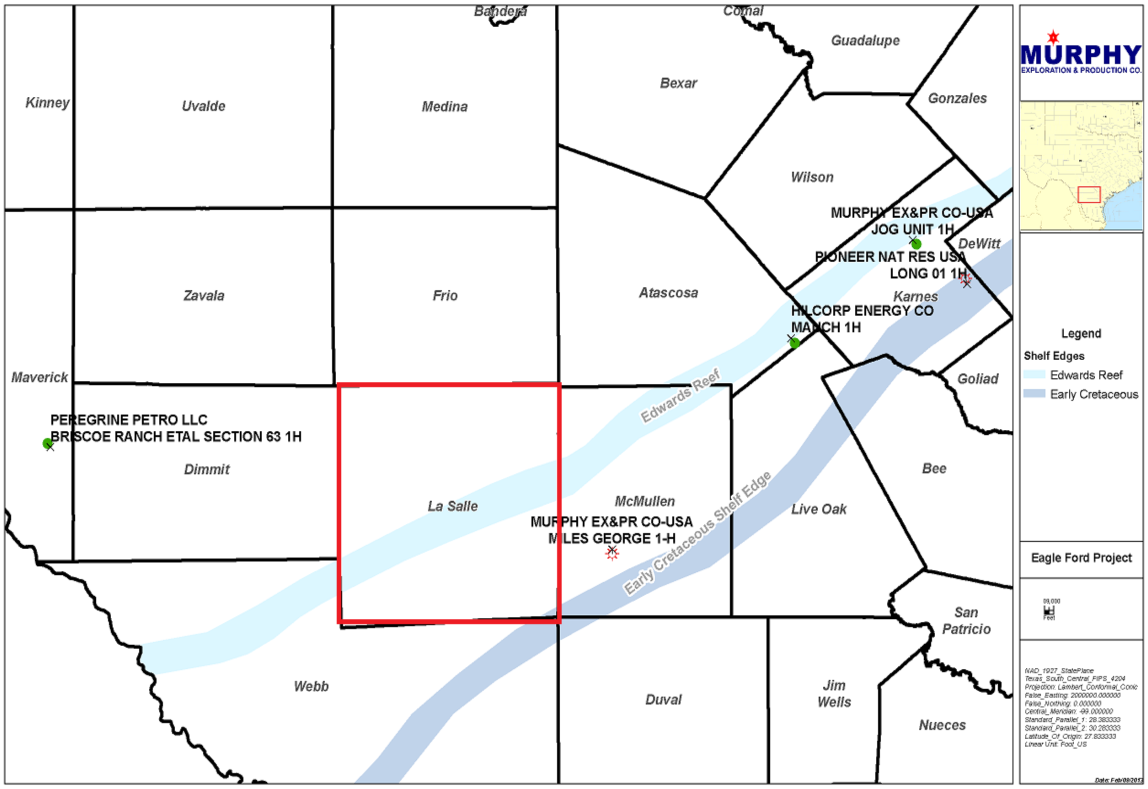

Figure 8. Map showing the well location of all the cores described for this study. The red box symbolizes the location of the undisclosed well.

Originally a set of over 10,000 well logs was collected and analyzed to find suitable well logs for this study. Suitable wells logs include gamma ray logs, which penetrate the entire section of the Eagle Ford Shale and have high enough quality to correlate flooding surfaces. Seven hundred thirty five well logs from this original set met the criteria listed. However, a smaller set of 500 wells was used for this study. Stratigraphic surfaces identified from core were correlated to well logs then correlated across the Eagle Ford Shale trend of South Texas. Following the correlation of surfaces, stacking patterns and lapout patterns were interpreted resulting in the identification of sequence stratigraphic surfaces and ultimately a sequence stratigraphic framework was constructed.

Subsurface Eagle Ford Shale Facies

Analysis of six cored wells within the Eagle Ford Shale led to the identification of eight major facies within the formation. Facies were identified through grain type, grain size, grain abundance, sedimentary structures, and color. The identification of facies led to the interpretation of environment of deposition, ultimately aiding in the building of a sequence stratigraphic framework. The facies identified within the six studied core samples were:

1. Laminated Marl
2. Bioturbated Marl
3. Laminated Wackestone
4. Laminated Packstone
5. Bioturbated Wackestone
6. Bioturbated Packstone
7. Fossiliferous Grainstone
8. Bentonite

Facies 1: Laminated Marl

The laminated Marl facies within the Eagle Ford Shale ranges from almost black to a light gray. The laminae are on millimeter scale and are planar to gently inclined.

Ripple cross-laminations are visible within this facies, however are very intermittent (Fig. 9). In addition, top truncation of laminations is frequently seen throughout this facies (Fig. 9d). Often these marls have very faint laminae that are not easily distinguishable. Typically within this facies, the marl grades from parallel to gently inclined laminations and then sometimes grading to ripple cross-laminations (Fig. 9). Inoceramid fragments that are bedding parallel and foraminifera-rich layers are common throughout this facies along with limestone concretions, phosphate nodules, and authigenic pyrite nodules. Laminations that are above and below grains and nodules exhibit differential compaction. There are fractures within this facies of the Eagle Ford Shale (Fig. 9c). These natural fractures are parallel to bedding and have radiating halite crystals (Fig. 9c). The source of halite is unknown. This is the most common facies throughout the Eagle Ford Shale, existing as beds that range from 10 centimeters to several meters.

This facies is interpreted as being the second most distally deposited facies within the Eagle Ford Shale. Gently inclined laminations suggest this facies was deposited above storm wave base (Schieber, 2000), likely in an outer shelf environment. The lack of bioturbation and high preservation of organic matter within this facies suggests deposition in an anoxic or oxygen deficient environment. Harbor (2011) noted thin, isolated zones with nearly horizontal *Chondrites* burrows 1-2 centimeters thick that were interpreted to be associated with short lived oxygenation events, which are well documented during OAEs (Schlanger et al., 1987), however, no burrows were visible within this facies in the six cored wells described for this study.

Hemipelagic and pelagic sedimentation of marine carbonate, terrigenous clay, and silt-sized quartz were common sediment delivery mechanisms for this facies, however, deposition from turbidity flows, storm-entrained sediments, and fair-weather current transport may have aided in the primary sedimentation and resedimentation of the fine-grained matrix (Kreisa, 1981). Traction deposits and scour into underlying facies led to the interpretation of deposition due to turbidity flows, however complete Bouma Sequences were not visible. Current transport that initiated in more proximal environments led to the formation of millimeter scale foraminifera-rich laminations. Due to the presence of gently inclined laminations, top truncation of laminations, starved ripples, and ripple cross laminations, deposition is interpreted to have occurred from accretion of migrating floccule ripples under swift currents (Schieber et al., 2007), indicating that deposition occurred above storm wave base.

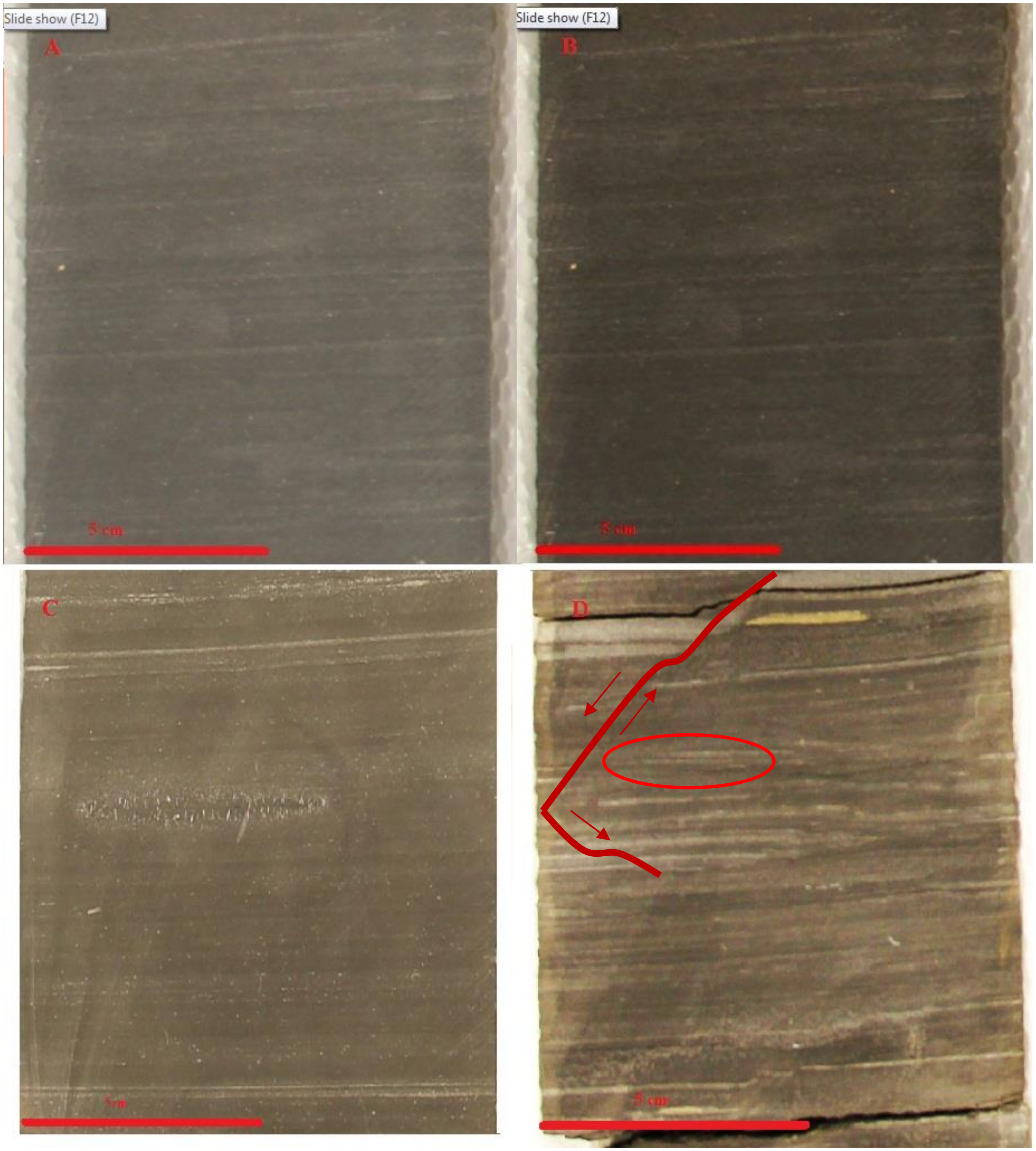

Figure 9. (a) and (b) are both the same photo of a faintly laminated marl with gently inclined lamina. (a) Laminations within the marl are barely visible, (b) contrast adjusted to see sedimentary structures more clearly. (c) Picture of a fracture within this facies. Fractures have halite precipitating around them. (d) Ripple laminated marl. Laminations are gently inclined, and show onlapping geometry, where lamina pinch out on top of one another. Within the red circle, top truncation of lamina can be seen. A microfault has also been labeled within this photo.

Facies 2: Bioturbated Marl

The bioturbated marl facies is seen in core as a dark gray to black mudstone. It has no visible laminations, and sometimes exhibits a fissile texture. There are some interspersed foraminifera tests and ostracods. Pyrite nodules and pyrite replacement of foraminifera is common throughout this facies (Fig. 10). This facies predominantly exists within the lower portion of the Eagle Ford Shale, directly overlying the Buda Formation with a sharp contact. In well logs this facies has the highest gamma ray API values. This can be attributed to high total organic content, pyrite, and clay. The average thickness of this facies is 0.5 meters.

This facies is interpreted to be deposited in very low energy conditions above storm wave base. The high total organic matter content, extensive burrowing, and lack of sedimentary structures indicates oxic conditions that were low energy. According to Harbor (2011), there is an increase in detrital quartz and an increase in grain size approaching the San Marcos Arch, representing more terrigenous input as opposed to more calcareous, less siliciclastic-rich sources like within other facies of the Eagle Ford Shale.

This bioturbated marl facies suggests episodic increases in siliciclastic input and sedimentation in low-energy conditions (Harbor, 2011). This is further suggested by Oliver (1971) who showed the rejuvenation of sediment source areas in Oklahoma and Arkansas occurred periodically, producing multiple events of increased terrigenous shedding into the East Texas Basin, ultimately leading to increased terrigenous influx towards the San Marcos Arch and occasional transport beyond the arch itself.

Figure: 10. Both (a) and (b) are the same photo: (a) is a regular exposure, whereas, (b) has an enhanced contrast. This core shows cryptic stratification due to extensive burrowing.

Facies 3: Laminated Wackestone

The laminated wackestone facies within the Eagle Ford Shale is a light gray to brown package with millimeter scale laminations (Fig 11). Laminations are parallel to gently inclined, sometimes exhibiting asymmetric ripple cross-lamination (Fig. 12). The laminations consist of foraminifera, and exhibit small fining-upward couplets (Fig. 11). As explained by Harbor (2011) these laminations are laterally continuous, yet show variable vertical thickness and concentrations throughout the facies. One pattern seen within this facies is that the foraminifera concentrations typically become more abundant farther up within the individual bed, however, this is not always the case. Inoceramid fragments that are oriented bedding parallel are present within this facies. This facies is typically 5-15 centimeters thick overall with the individual couplets ranging from 1-2 cm. This facies generally overlies the laminated or bioturbated marl facies.

The bedding couplets that exhibit normal grading have sharply defined bases and weakly defined upper contacts, indicating event sedimentation (Flügel, 2009). Graded couplets form when storm-generated turbulence weakens and sediment begins to drop out of suspension clouds (Kreisa, 1981). The marl matrix of this facies likely represents mud accretion from migrating floccule ripples, and/or settling from slow-moving or still suspension, indicating an environment above storm wave base, likely on the outer shelf. The lack of bioturbation and preservation of organic matter indicates that this was an oxygen depleted environment.

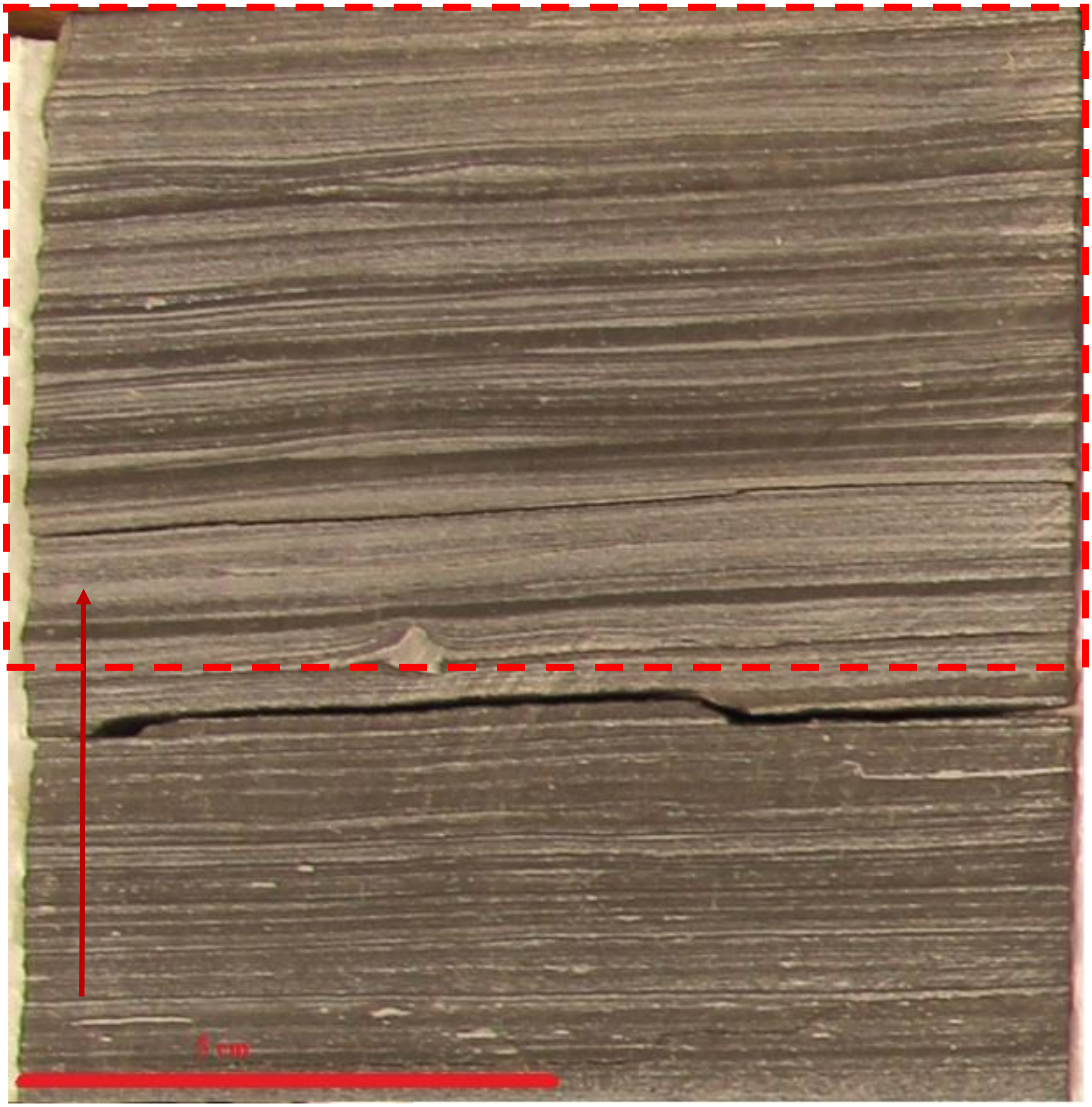

Figure: 11. Facies shows pinching and swelling of lamina due to ripples. Laminae are composed of foraminifera, coccoliths, and Inoceramid fragments. Ripples indicate higher energy environment above storm wave base. Arrow indicates direction of increasing abundance of foraminifera. Box shows area in bedding diagram (Fig. 12).

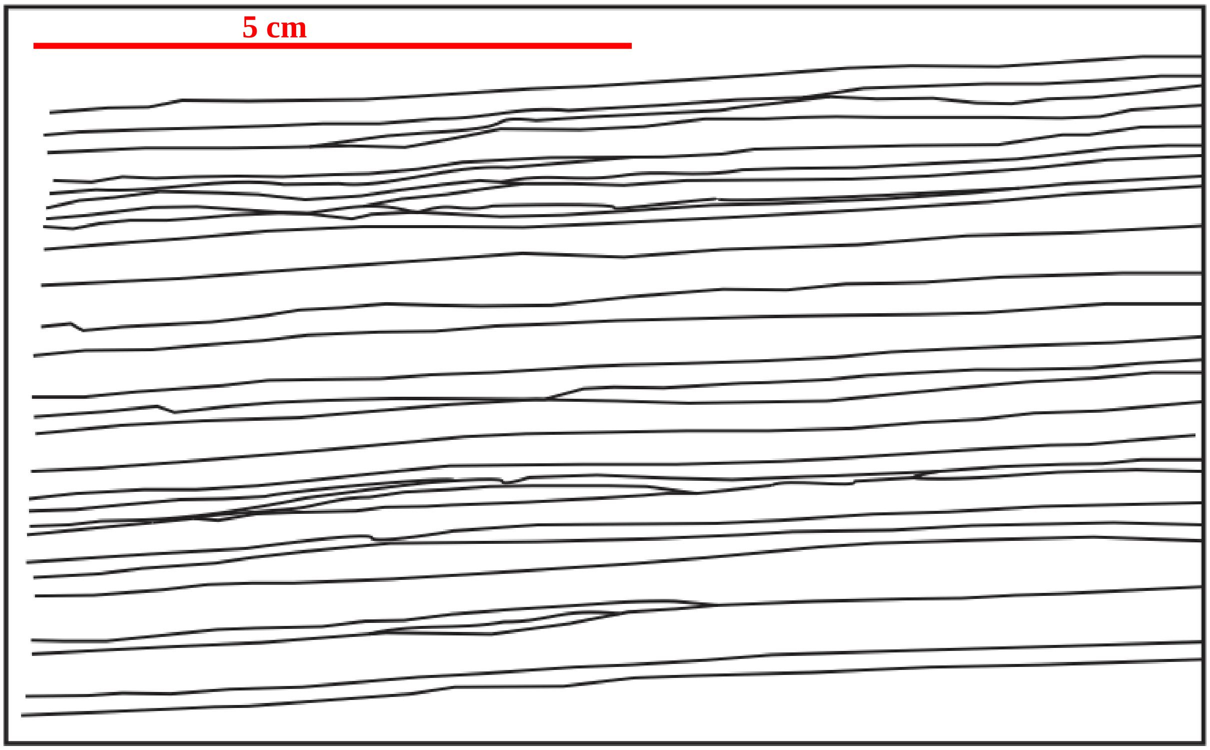

Figure 12. Bedding diagram showing ripple forms of the laminated wackestone facies. Individual laminations truncate, showing onlapping geometries and ripple bedforms. This indicates a depositional environment above storm wave base.

Faces 4: Laminated Packstone

The laminated packstone facies within the Eagle Ford Shale is a gray unit with millimeter scale laminations composed of foraminifera, Inoceramid fragments, and coccoliths interbedded with organic-rich clay. Inoceramid fragments are not always bedding parallel, and are sometimes oriented randomly. Small fining-upward couplets are also present within this facies. Laminations are typically parallel, however, they can also exhibit gentle inclination or differential compaction surrounding limestone concretions or fossil fragments. This facies also exhibits some starved ripples and ripple cross-laminations primarily composed of skeletal fragments and mud matrix (Fig. 13). This facies averages 5-20 centimeters thick. As noted by Harbor (2011) there are small fining upward couplets within this facies. These individual couplets are typically less than 3 centimeters thick.

Similar to the laminated wackestone, this facies represents event sedimentation due to the presence of small fining-upward bedding couplets (Flügel, 2009). The higher concentration of carbonate grains and fossil fragments indicates an environment more proximal than the laminated wackestone facies. However, energy conditions likely waxed and waned which is demonstrated by the inoceramid fragments appearing in both bedding parallel and random orientations. In addition, starved ripples and ripple cross-lamination indicates an environment above storm wave base, likely on the inner shelf.

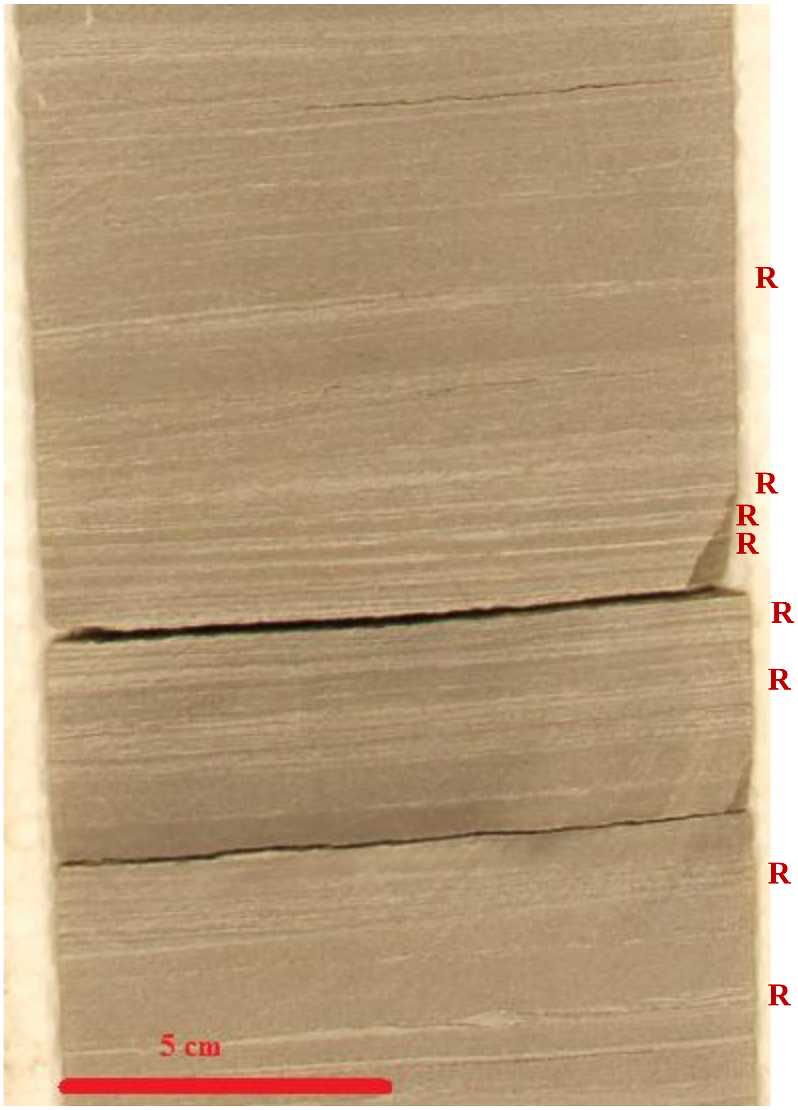

Figure: 13. Image is of packstone facies with obvious laminations. Dipping geometries of laminae along with gentle lapout indicate higher energy, above storm wave base conditions. "R" indicates individual ripples.

Facies 5: Bioturbated Wackestone

The bioturbated wackestone facies is composed of heavily bioturbated marl with foraminifera and inoceramid fragments. Accessory minerals seen within this facies are phosphatic bioclasts, ostracods, and pyrite nodules. Intense burrowing and compaction commonly masks individual burrows, yet as described by Harbor (2011) *Zoophycos, Thalassinoides, Planolites,* and *Chondrites* traces are apparent. The core analyzed for this study however, does not exhibit any of the trace fossils identified by Harbor (2011).This facies typically ranges from 4-16 centimeters thick (Fig. 14). This facies is typically overlain by the laminated wackestone facies or laminated marl facies.

The carbonate grains and fossil fragments were likely deposited by a combination of event sedimentation and pelagic settling. Event sedimentary structures are not present due to intense bioturbation, which can quickly erase storm-generated sedimentary structures in shelf environments (Sepkoski and Bambach, 1979). The mud matrix is interpreted to be deposited by current ripple flocculation, however, due to bioturbation, sedimentary structures are no longer visible. The increase in bioturbation in this facies indicates an oxygenated environment above storm wave base and below fair-weather wave base.

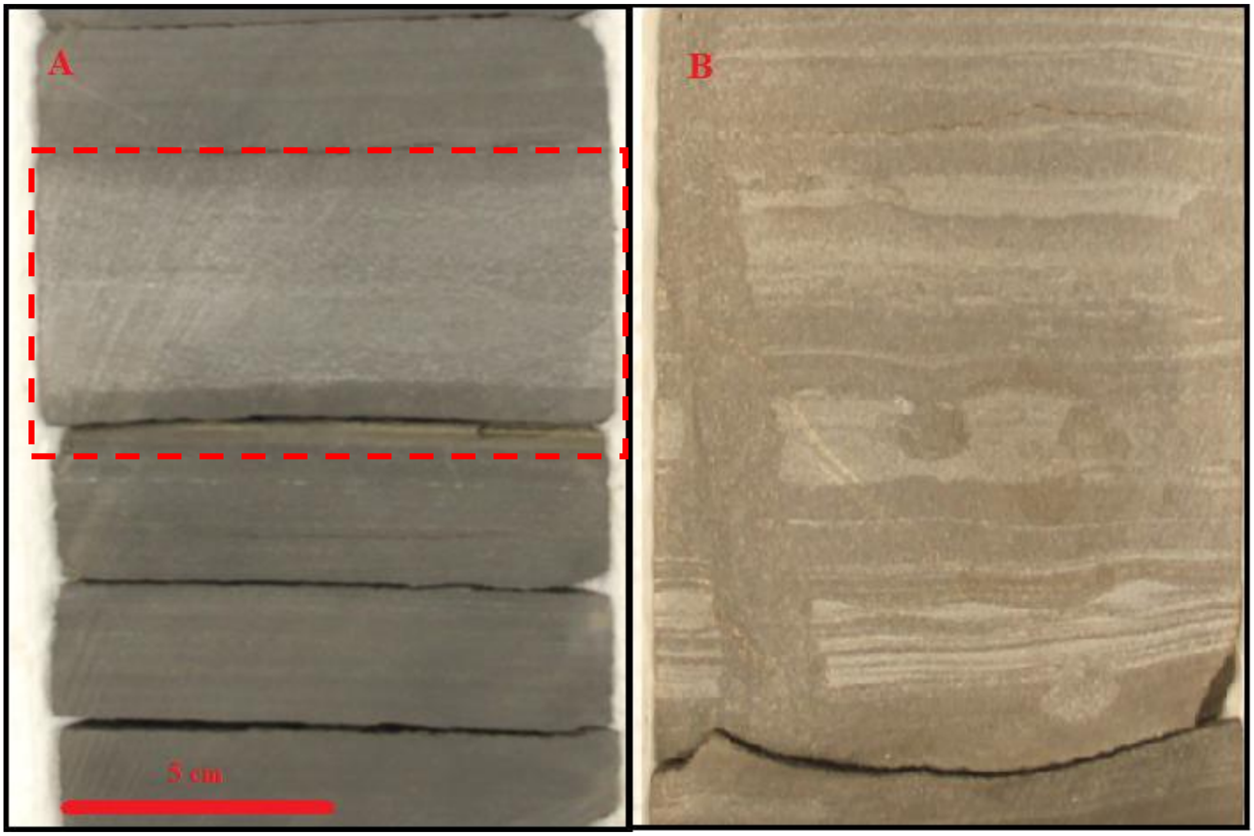

Figure: 14. (a) shows a laminated marl that grades into an extensively bioturbated wackestone which is in the red dashed box. There are no apparent sedimentary structures within the bioturbated wackestone facies. (b) shows lots of ripple laminations with burrows cutting through lamina. If not for the burrows present, this facies would be interpreted as one of the laminated facies. Trace fossils could be from *Teichichnus*, *Diplocraterion*, and/or *Planolites*.

Facies 6: Bioturbated Packstone

The bioturbated packstone facies is characterized by light gray, disrupted, centimeter scale bedding. Disruption of bedding is due to bioturbation. Large inoceramid fragments are common throughout this facies, and are typically bedding parallel; however, around areas of more intense bioturbation they are oriented randomly. Accessory grains within this facies include phosphatic bioclasts, pyrite nodules, and echinoid fragments. This facies ranges from 15-30 centimeters thick (fig. 15), and is typically overlain by the laminated marl facies.

Similar to the bioturbated wackestone facies, the carbonate grains and fossil fragments were deposited by a combination of event sedimentation and pelagic setting. However, due to the increase in carbonate concentration, this facies is more proximal in comparison to the bioturbated wackestone facies. Intense bioturbation of this facies indicates an oxygenated environment above storm wave base, in a subtidal environment.

Figure: 15. Above the red line, some sedimentary structures are visible, however due to extensive bioturbation, laminae are disrupted and/or not visible. Overlying the bioturbated packstone is a laminated packstone.

Facies 7: Fossiliferous Grainstone

The fossiliferous grainstone facies within the Eagle Ford Shale is characterized by brown, massively bedded, coarse-grained fossil debris. The most common grains within this facies are inoceramid fragments. Accessory grains include phosphate bioclasts, foraminifera, and echinoid fragments. Fossils are commonly calcite or pyrite filled. Some beds exhibit partial dolomitization and early diagenesis, which is apparent due to the fossils well-preserved shape. The base of this facies exhibits scour into the underlying facies, which is normally the laminated marl facies (Fig. 16). This facies is present within the upper portion of the Eagle Ford Shale.

Due to the scour into underlying facies, geometry of bedding, and random orientation of grains, this facies is interpreted to be a cohesive density flow (Mulder and Alexander, 2001). Flows likely originated in proximal settings and traveled to more distal environments due to gravity driven sedimentary failure. Partial dolomitization is probably due to shallow-burial of sediments where compaction modified seawater formed dolomite as discussed by Reinhold (1997).

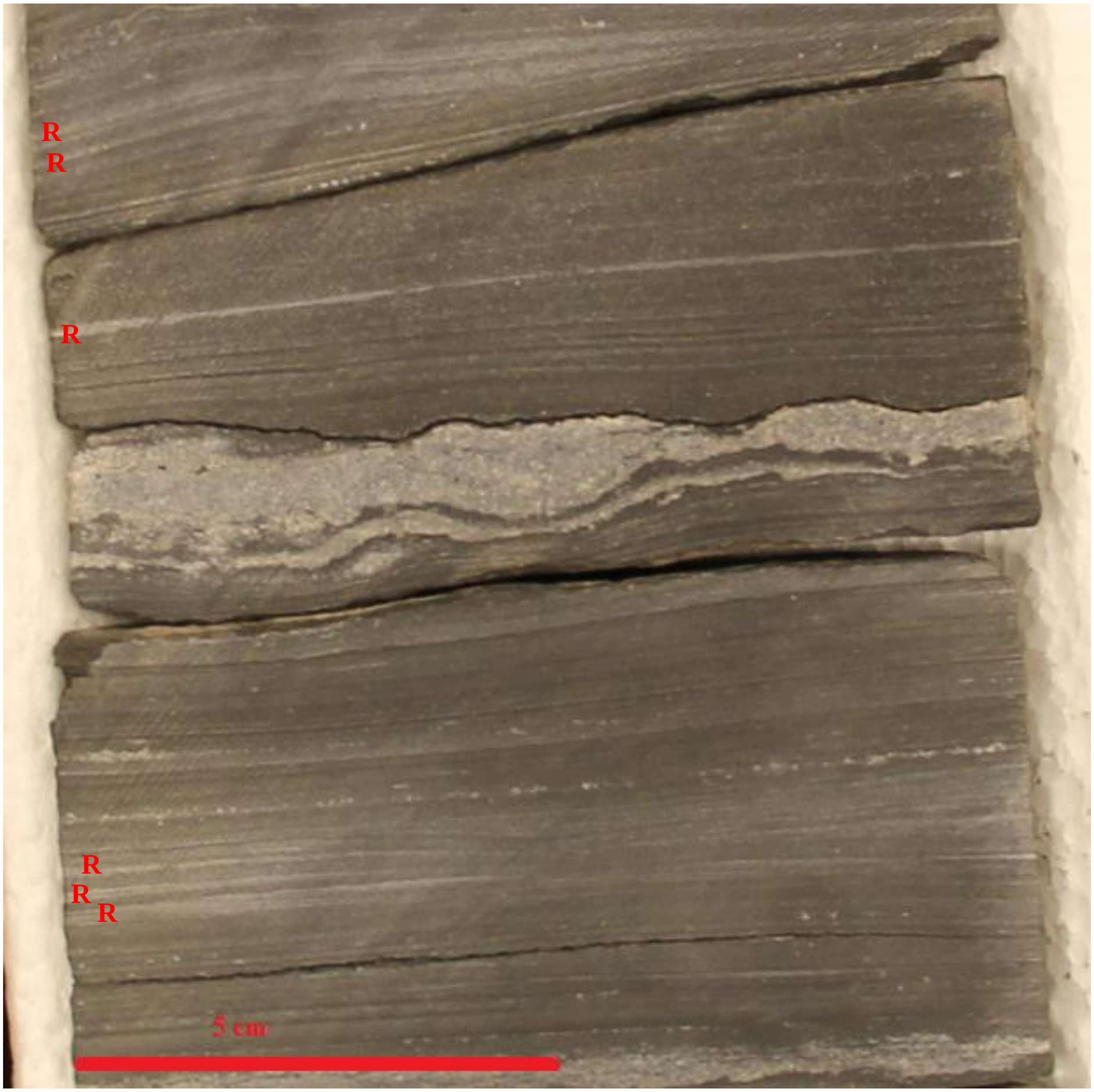

Figure 16. This facies is present in the center of this photo. The grainstone is composed of inoceramid fragments and foraminifera. The base of this grainstone scours into the underlying laminated marl facies. The depositional process responsible for this is likely a cohesive gravity flow. Overlying the fossiliferous grainstone is also the laminated marl facies. The red letter "R" indicates individual ripples.

Facies 8: Bentonite

The bentonite facies within the Eagle Ford Shale is quite significant. Beds range from tenths of a centimeter to the largest one seen in the core being 15 centimeters thick. The bentonites are present within all facies of the Eagle Ford Shale. Pyrite replacement of the bentonites is visible within some core, and is only seen within the smaller bentonites beds (Fig. 17). These beds fluoresce bright yellow-orange under black light. It is common within the upper Eagle Ford Shale to see these bentonite beds bioturbated with limestone to make them appear to be one large bentonite bed, however, upon closer inspection, foraminifera are distinguishable.

The bentonites within the Eagle Ford Shale have a distinct mineralogy due to deposition within an open marine system. Potter et al. (2005) described these bentonites as mixed smectite-illite clay mineralogy due to the reaction of volcanic ash with saline solutions high in potassium. The bentonites present in the laminated marl, wackestone, and packstone facies show little to no reworking, indicating an outer shelf environment where only storm waves will affect deposition. The bentonites in the bioturbated wackestone and packstone facies are mixed throughout the facies due to bioturbation, indicating a more oxygenated, proximal environment, as opposed to the bentonites within the laminated facies of the Eagle Ford Shale.

Figure: 17. This bentonite is a brownish-green under white light, and fluoresces a yellow-orange under black light. The bentonite facies show some current reworking and bioturbation. Underlying the bentonite is the laminated marl facies, which grades into a laminated wackestone facies. Large inoceramid fragments are parallel to bedding. Above the bentonite is the laminated wackestone facies grading into the bioturbated packstone facies. Large, bedding parallel inoceramid fragments are also abundant above the bentonite.

Electric Log Stratigraphy

In this study, gamma ray wireline logs supplemented with core descriptions were utilized to build a stratigraphic framework based on lapout patterns. The contact between the Buda and Eagle Ford Shale is very distinct in electric logs as a sharp increase to high gamma ray API values (Fig. 18). The contact between the Eagle Ford Shale and Austin Chalk proves to be more difficult to pick in both core and wireline logs. In the core described, the contact is gradational. However in electric logs, there is a slight gamma ray spike that corresponds to the shift from Austin Chalk to Eagle Ford Shale (Fig. 18).

Dawson (2000) interpreted the Eagle Ford Shale to have two major depositional sequences; the lower Eagle Ford being a transgressive systems tract, bounded above by a second-order maximum flooding surface, and the upper Eagle Ford being a high stand systems tract. The contact between the lower and upper Eagle Ford Shale can easily be seen in electric logs as a shift from higher gamma ray API values in the lower section to lower API values in the upper section. However, this contact is difficult to distinguish in core as there is no obvious change in lithology. This contact was picked within the logs due to it being a distinct gamma ray marker (Fig. 18).

A bentonite layer within the lower Eagle Ford Shale (Fig. 18) was visible within the Murphy Jog well, Hilcorp Energy (Marathon Oil) Mauch #1H, Peregrine Petroleum Briscoe Ranch et al. Section 63-1H, and an undisclosed well within LaSalle County. The bentonite layer was not visible in the Murphy George Miles and Pioneer Long Gas core. However, there is a distinct gamma ray spike that correlates to the ash bed in the other wells. The absence of the bentonite in the George Miles and Long Gas cores can be attributed to the deposition of these cores in a more distal environment (Fig. 19).

Another key surface correlated throughout the Eagle Ford Shale is a shift in lithology from laminated marl to bioturbated packstones and fossiliferous grainstones. This limestone package sits at the top of the Eagle Ford and is known as the Kamp Ranch Member (Jacobs et al., 2005). In electric logs, the Kamp Ranch shows up as a spike in gamma ray API (Fig. 18). In more proximal settings this limestone bed is extremely thin, however, it thickens in more distal settings.

To build a detailed stratigraphic framework of the Eagle Ford Shale, surfaces not seen in core were also utilized. These surfaces are distinct gamma ray shifts (Fig. 18).

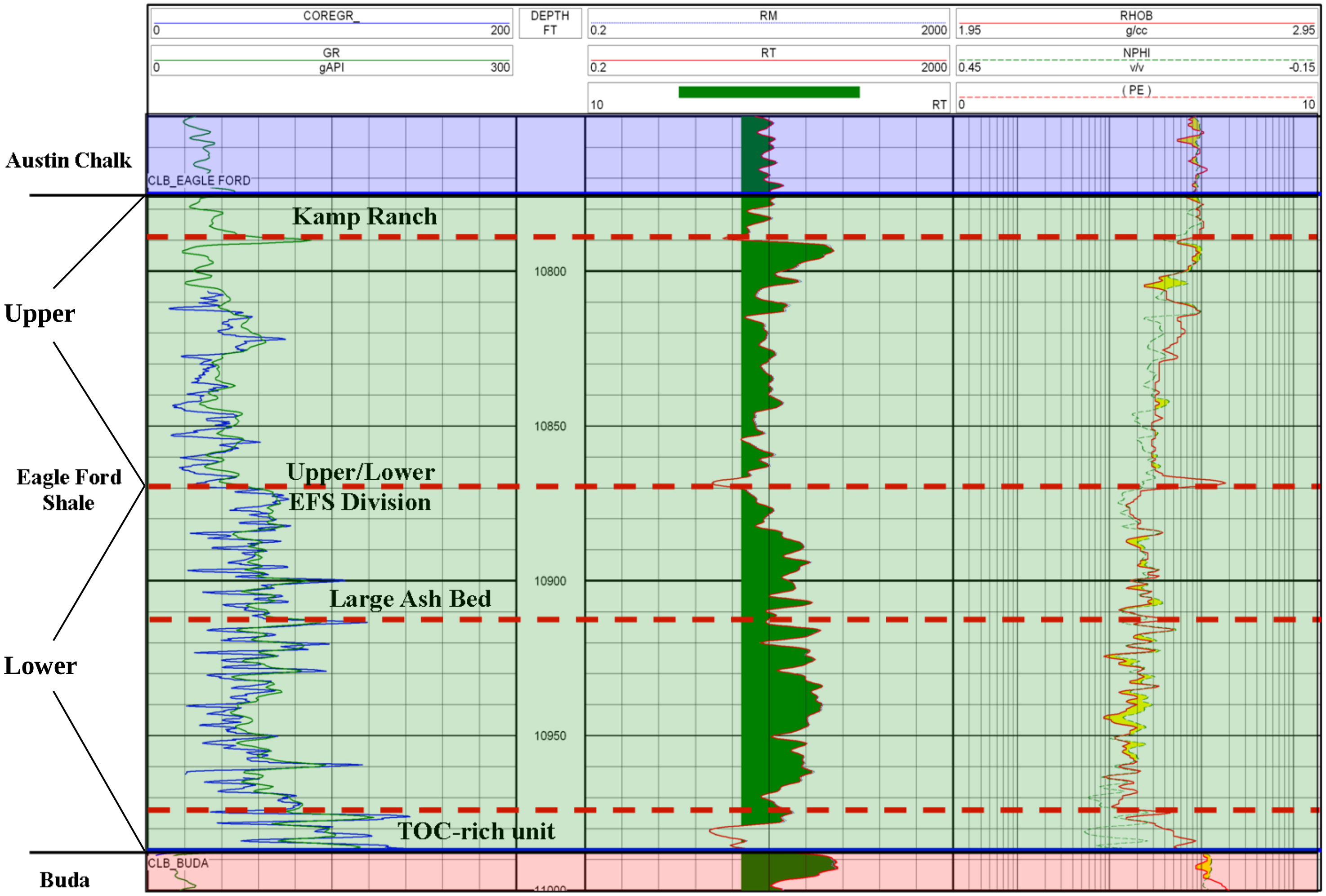

Figure: 18. This is the log for the Murphy Jog well in Karnes County. It shows markers that are seen in core that were able to be correlated to well logs to correlate across the region. Other well log markers were used for correlation purposes. These other markers can be seen in cross sections.

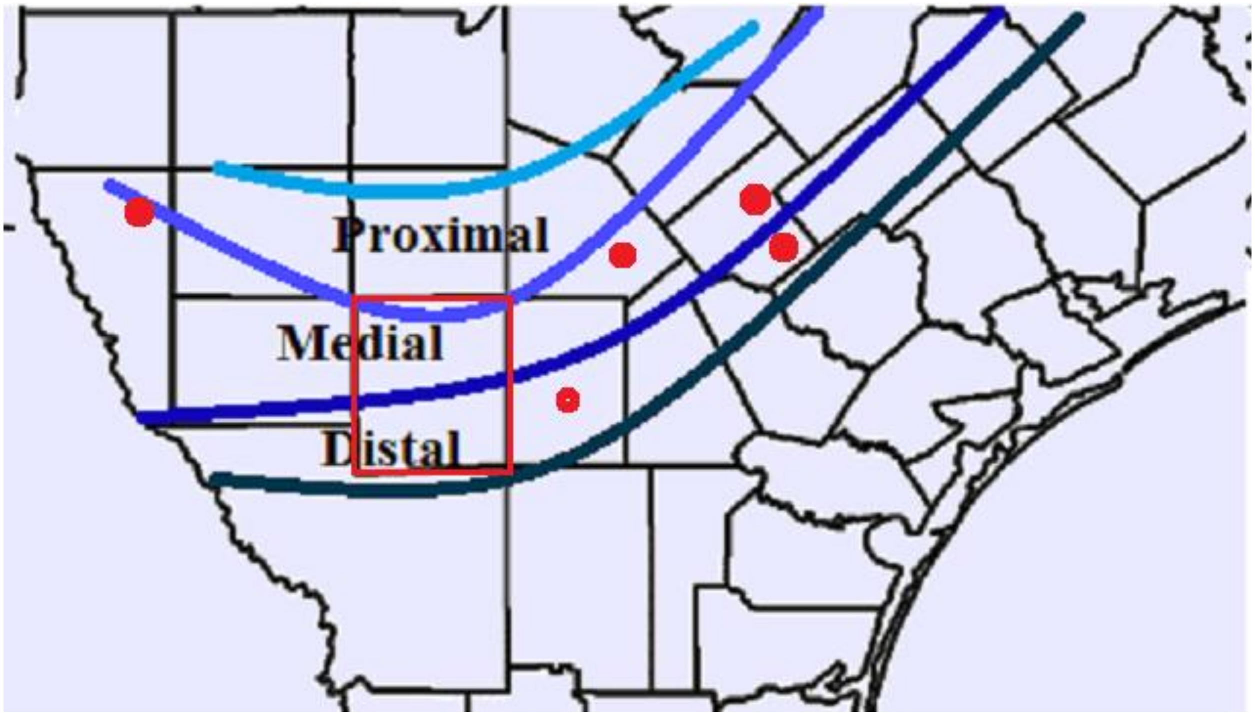

Figure: 19. This map shows the interpretation of distal and proximal deposition interpreted through core analysis. Figure modified after Core Laboratories interpretation. Red circles symbolize locations of core described for this study. Red box outlines LaSalle County where the undisclosed well is located.

Stratigraphic Trends

Measured sections created through core description aid in the interpretation of distal and proximal depositional environments. Parasequences are identified by relatively conformable successions of genetically related beds or bedsets bounded by marine flooding surfaces and their correlative surfaces (Van Wagoner, 1990), meaning Walther's Law holds true within a parasequence, however, the law is violated by the flooding surface contact with the underlying facies. It is challenging to identify surfaces that violate Walther's Law within these core, due to deposition within a marine environment; facies may appear conformable, however, with the identification of stacking patterns of beds (as seen in measured sections) parasequences can be identified. In the core described for this study, parasequences are identified on the basis of flooding surfaces (laminated or bioturbated marl) overlying a facies that was deposited within a more energetic environment (thickened sections of wackestones, packstones, and grainstones).

The Murphy Jog, Peregrine Petroleum Briscoe Ranch et al. 63-1H, Hilcorp Mauch, and undisclosed well within LaSalle County contain facies that are interpreted to be deposited in more energetic environments (Fig. 20-23). The presence of these more energetic facies indicates deposition in a proximal environment. Parasequences within these core are subtidal, showing no evidence of episodic exposure or tidal influence. The basal portion of these parasequences is composed of laminated or bioturbated marl. The marl is capped by a burrowed or laminated wackestone or packstone, indicating a slight shallowing of sea level. The parasequences within these 4 wells are thinner, indicating a more proximal environment of deposition where there is less accommodation.

The Murphy George Miles and Pioneer Natural Resources Long Gas Unit 1 contain a greater number of facies that were deposited in lower energy environments such as the outer shelf (Fig. 24-25). The presence of these less energetic facies indicates deposition in a more distal environment. Parasequences within these cores are much thicker than their proximal counterparts and contain a greater percentage of marl than limestone.

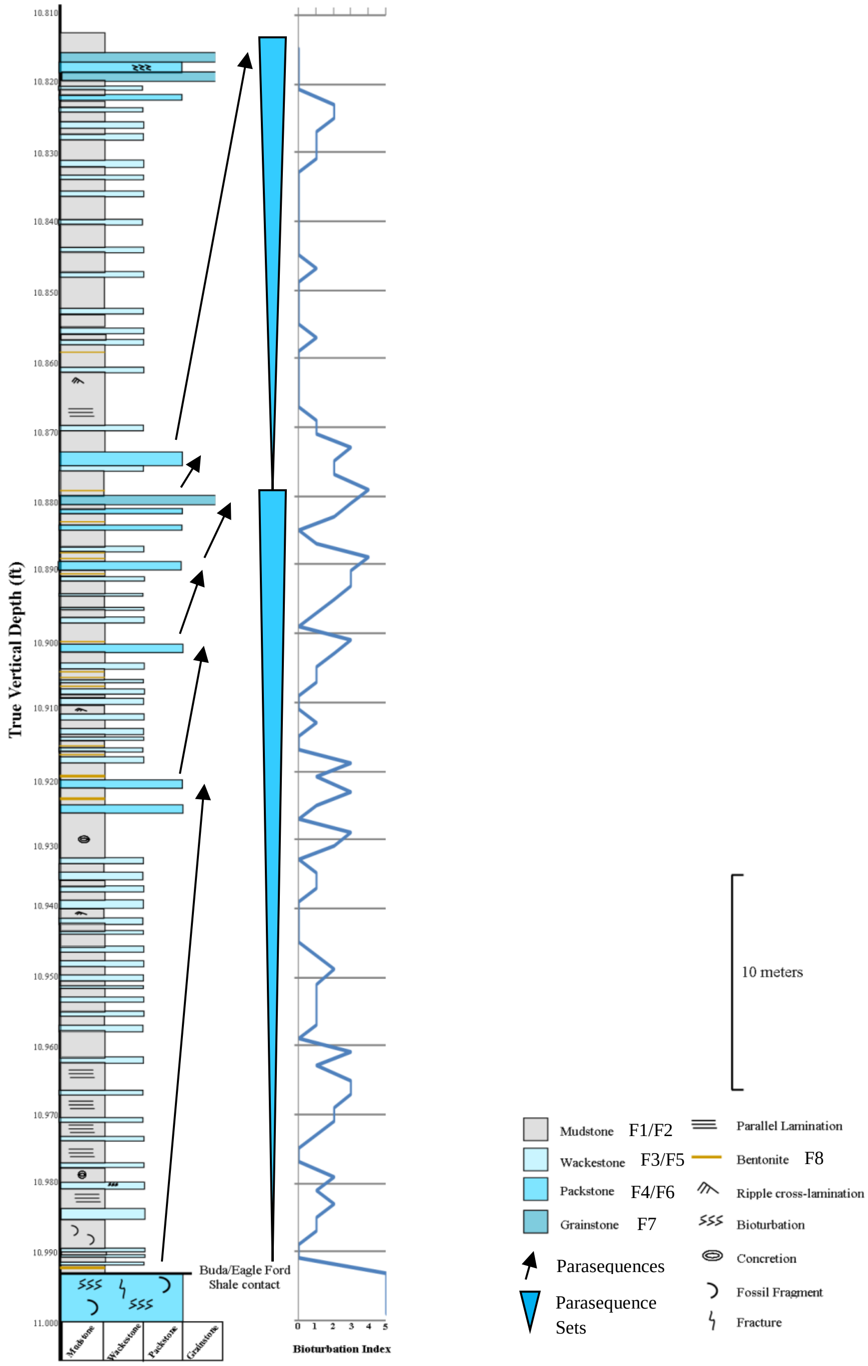

Figure: 20. Measured section of Murphy Jog #1 H well. Arrows indicate parasequences.

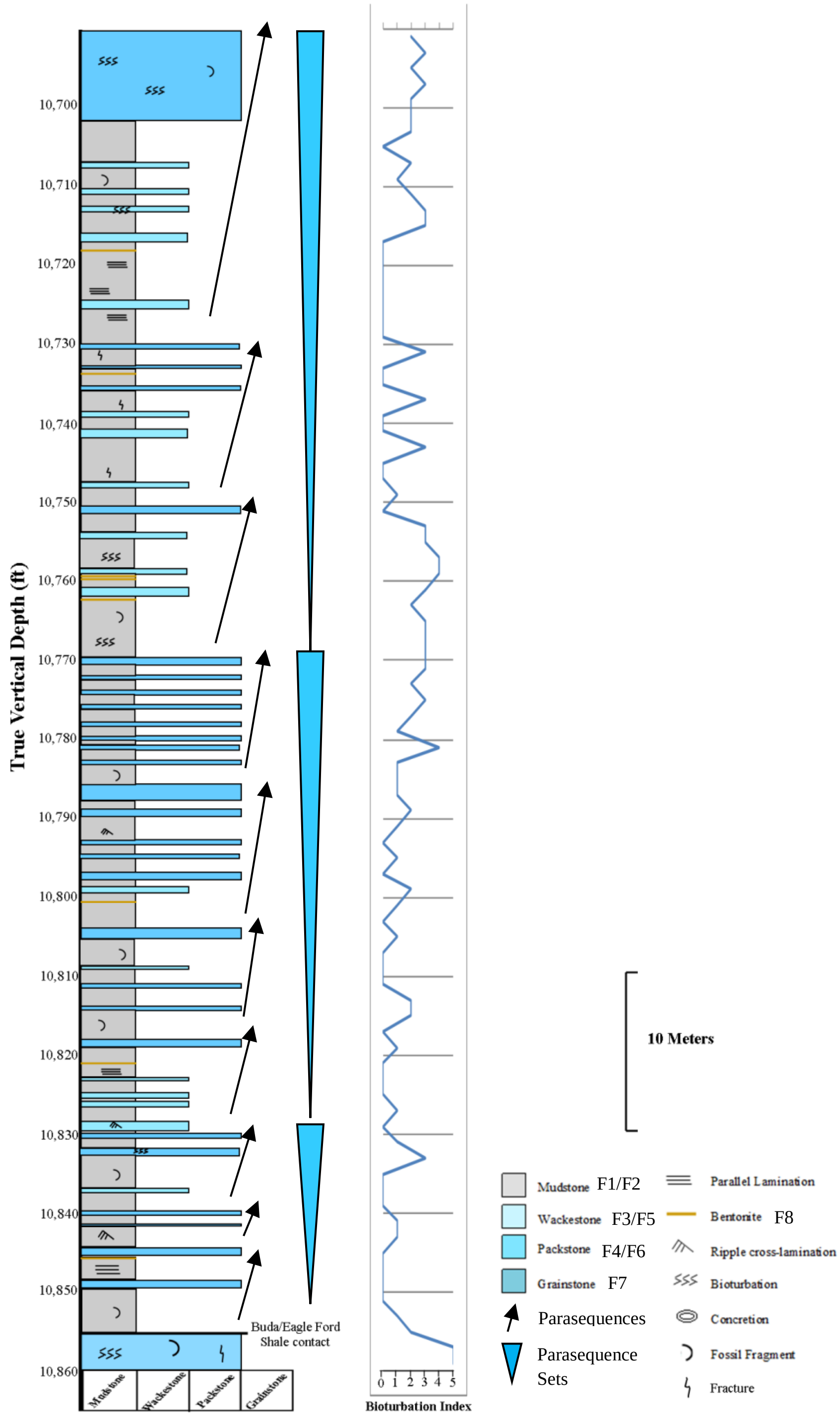

Figure 21.Hilcorp (Marathon) Mauch #1 H measured section. Arrows indicate parasequences.

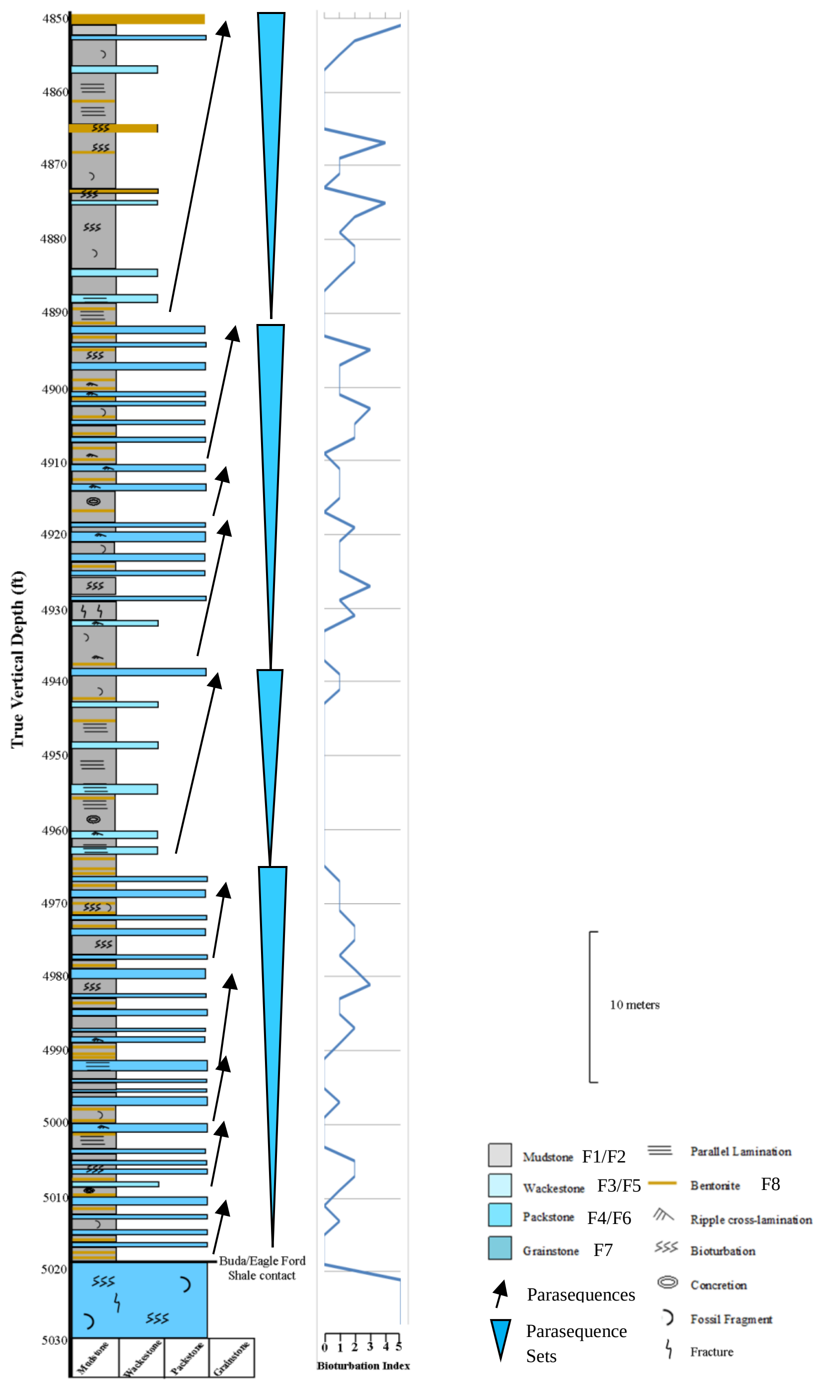

Figure 22. Peregrine Petroleum Briscoe Ranch measured section. Arrows indicate parasequences.

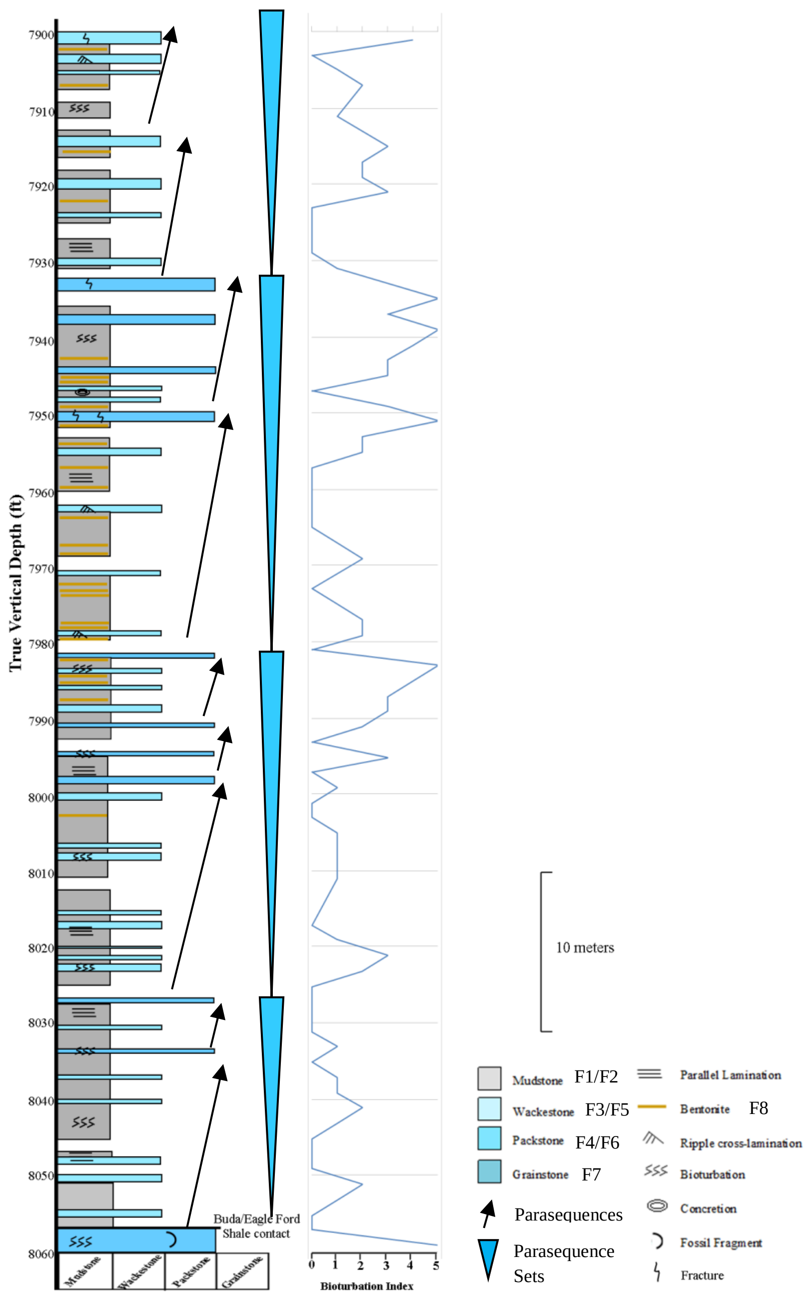

Figure 23.Measured section of undisclosed well within LaSalle County. Arrows indicate parasequences.

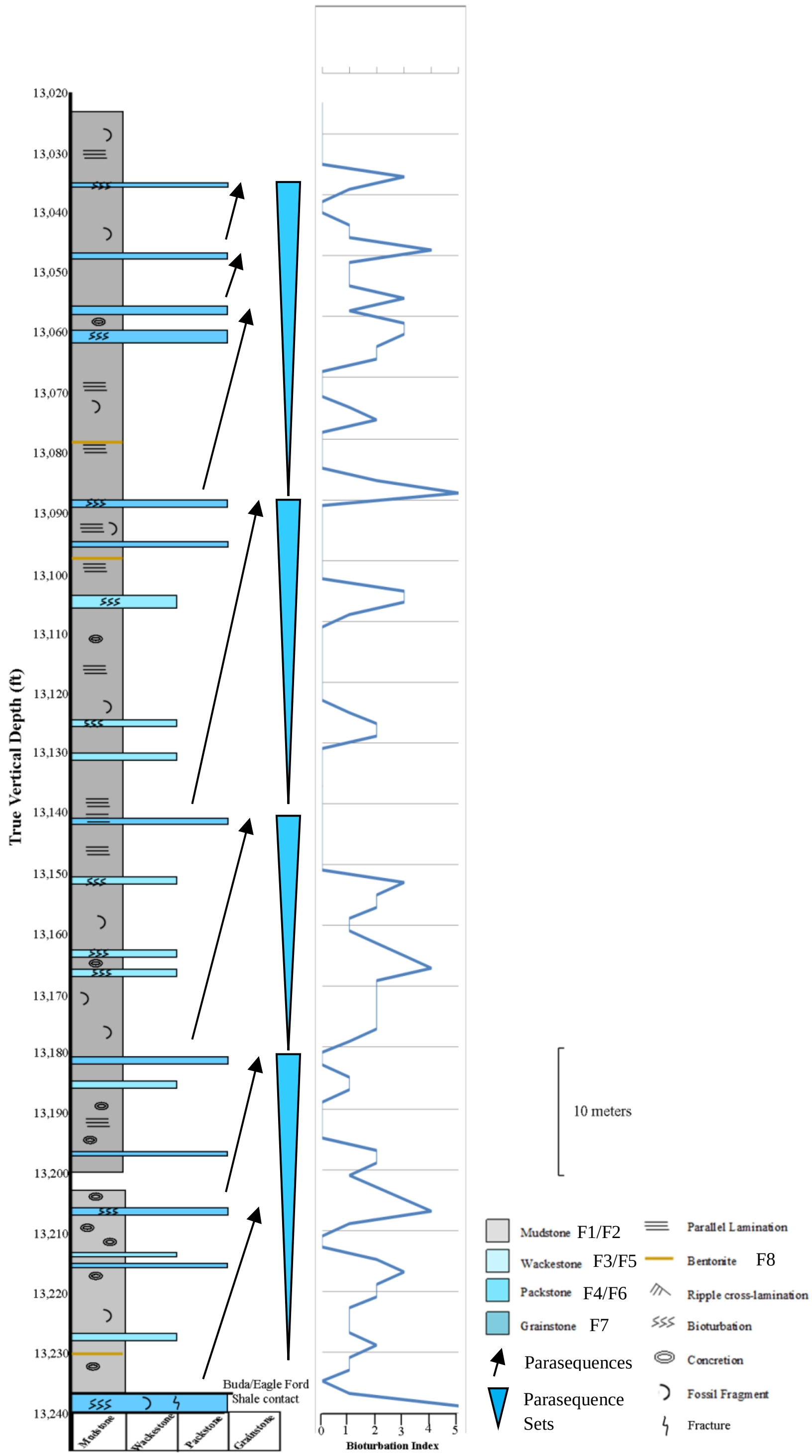

Figure 24. Murphy George Miles measured section. Arrows indicate parasequences.

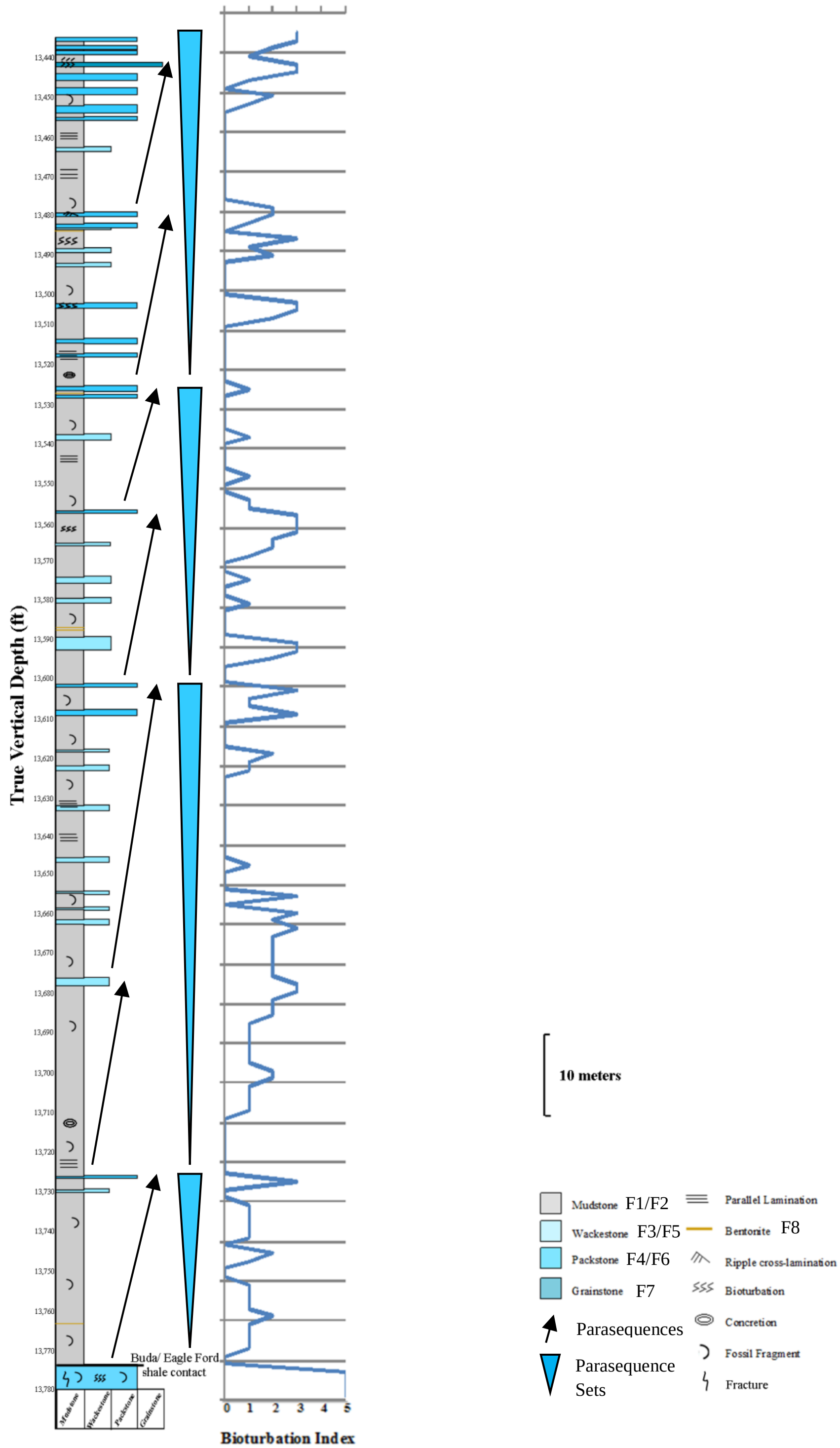

Figure 25.Pioneer Natural Resources Long Gas Unit 1. Arrows indicate parasequences.

The relationship of these surfaces and facies can be seen through cross-sections where lapout patterns can be determined and a stratigraphic framework can be built. Parasequence surfaces seen in core were calibrated to wireline logs to see if there were observable gamma ray patterns (Fig. 26). Other significant markers seen in the gamma ray logs were also picked to aid in a more detailed mapping of Eagle Ford Shale trends. These surfaces seen in core and logs were then correlated across the South Texas region to build a stratigraphic framework.

Three different cross-sections throughout the South Texas region (Fig. 27) demonstrate onlap of the Eagle Ford Shale onto the underlying Buda Formation. Cross-sections A-A' and B-B' (Fig. 28-31) do not show abundant onlap relationships, however, units thin in more proximal locations due to less accommodation. The regional cross section C-C' (Fig. 32-33) shows onlap of units within the upper Eagle Ford Shale. The Maverick Basin is drastically thicker than the other portions of the upper Eagle Ford Shale, however, the lower units have remained relatively constant throughout the entire region. This could suggest that deposition of the lower Eagle Ford Shale occurred prior to subsidence of the Maverick Basin. The upper Eagle Ford Shale in the Maverick Basin shows obvious onlapping geometries (Fig. 32-33) suggesting that it was deposited during and/or after subsidence of the Maverick Basin. The upper units of this formation thin significantly over the San Marcos Arch supporting the observations of Hentz and Ruppel (2010).

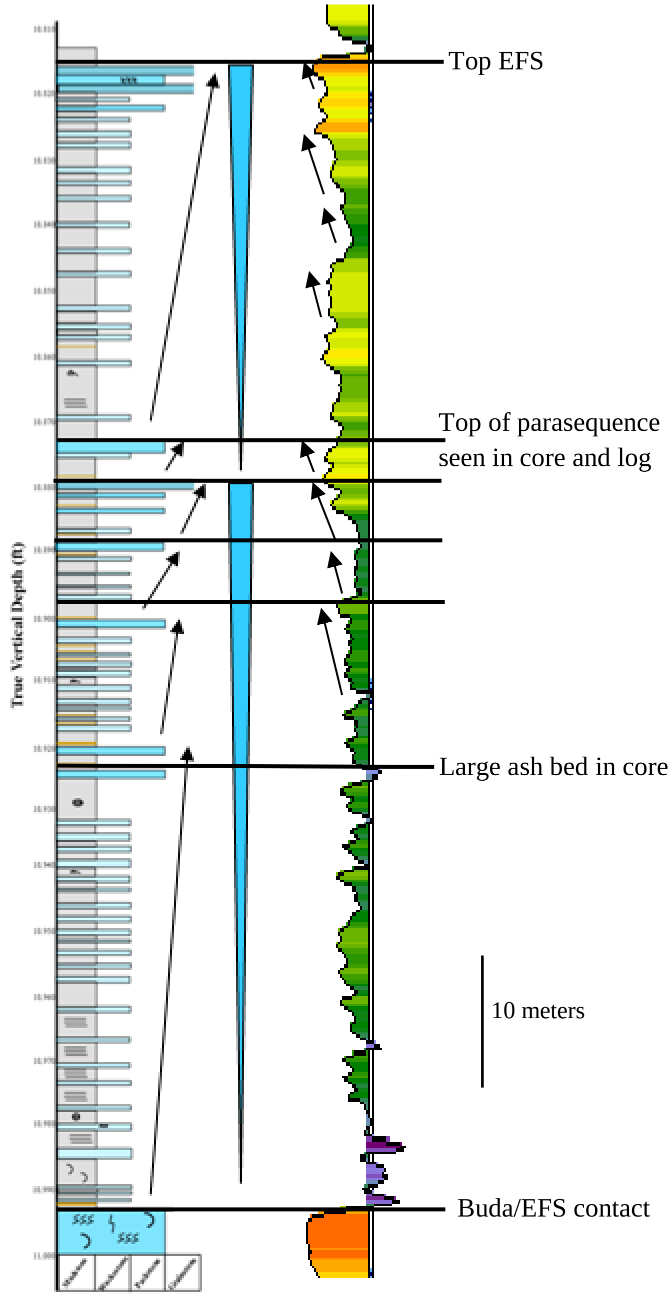

Figure 26. Measured section and gamma ray log of Murphy Jog Unit 1. Surfaces seen in core were calibrated to gamma ray logs to build a detailed stratigraphic framework. Some of the significant surfaces seen in both core and logs are shown here. In addition to these surfaces, distinct gamma ray shifts, not seen in core (not marked in this figure) were used to build a more detailed stratigraphic framework.

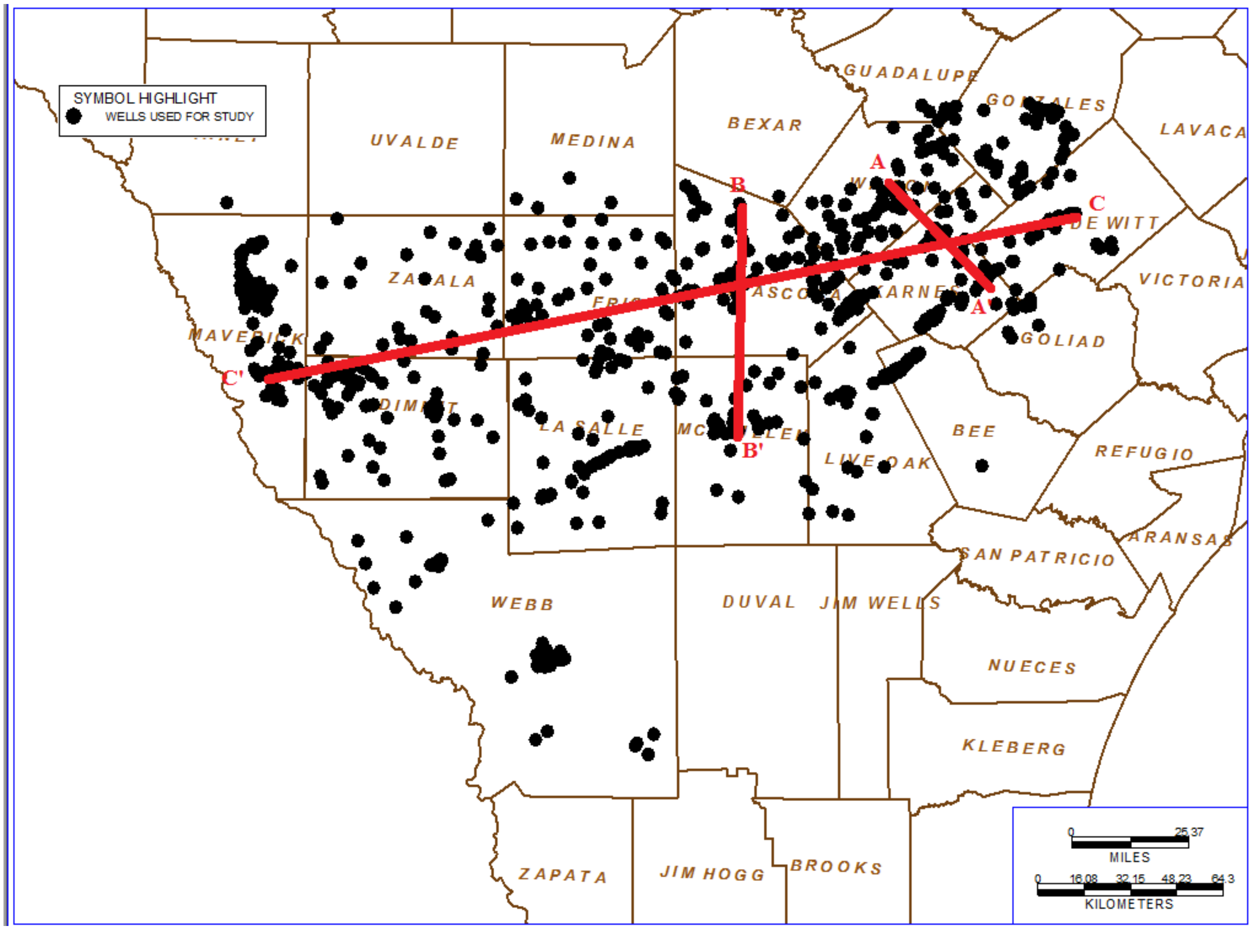

Figure: 27. Map of South Texas showing the locations of 735 wells used for correlations and locations of cross sections.

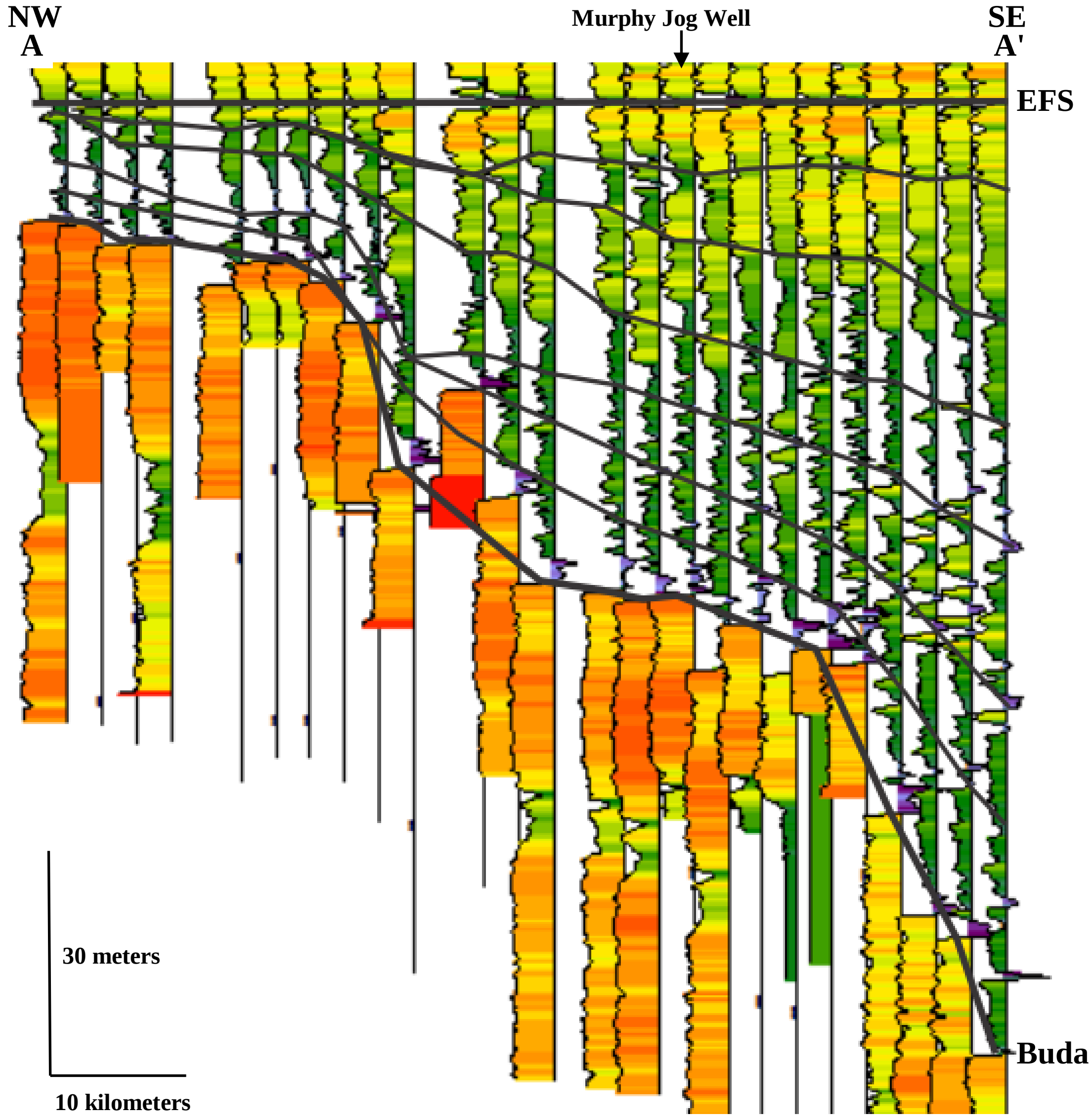

Figure: 28. Stratigraphic cross-section A-A’, hung from the Eagle Ford Shale datum, goes from northwest Wilson County to the southeast into Karnes County. This cross-section establishes the fact that more proximal depositional environments have a thinner stratigraphic equivalent compared to their distal counterparts.

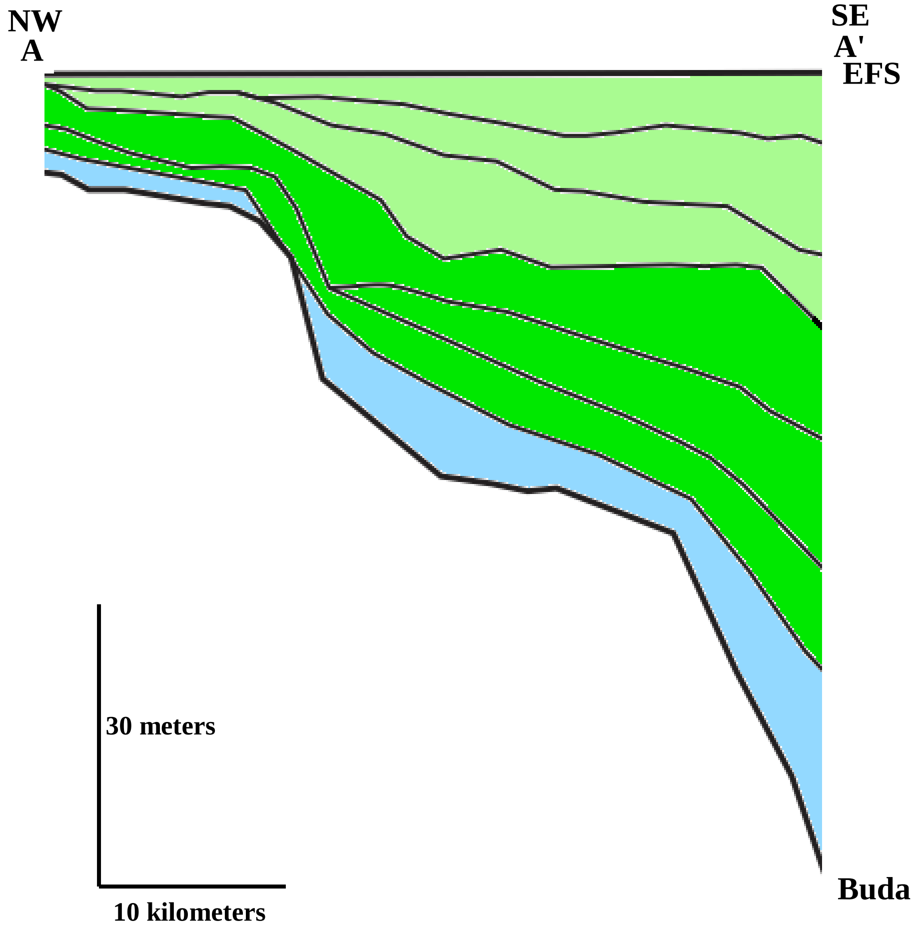

Figure: 29. Cross-section A-A' diagram going from northwest Wilson County to the southeast into Karnes County. This cross-section shows onlap of clinoforms onto underlying clinoforms and the Buda Formation. Based on geometry of units, blue unit represents a transgressive systems tract and green units represent highstand systems tracts.

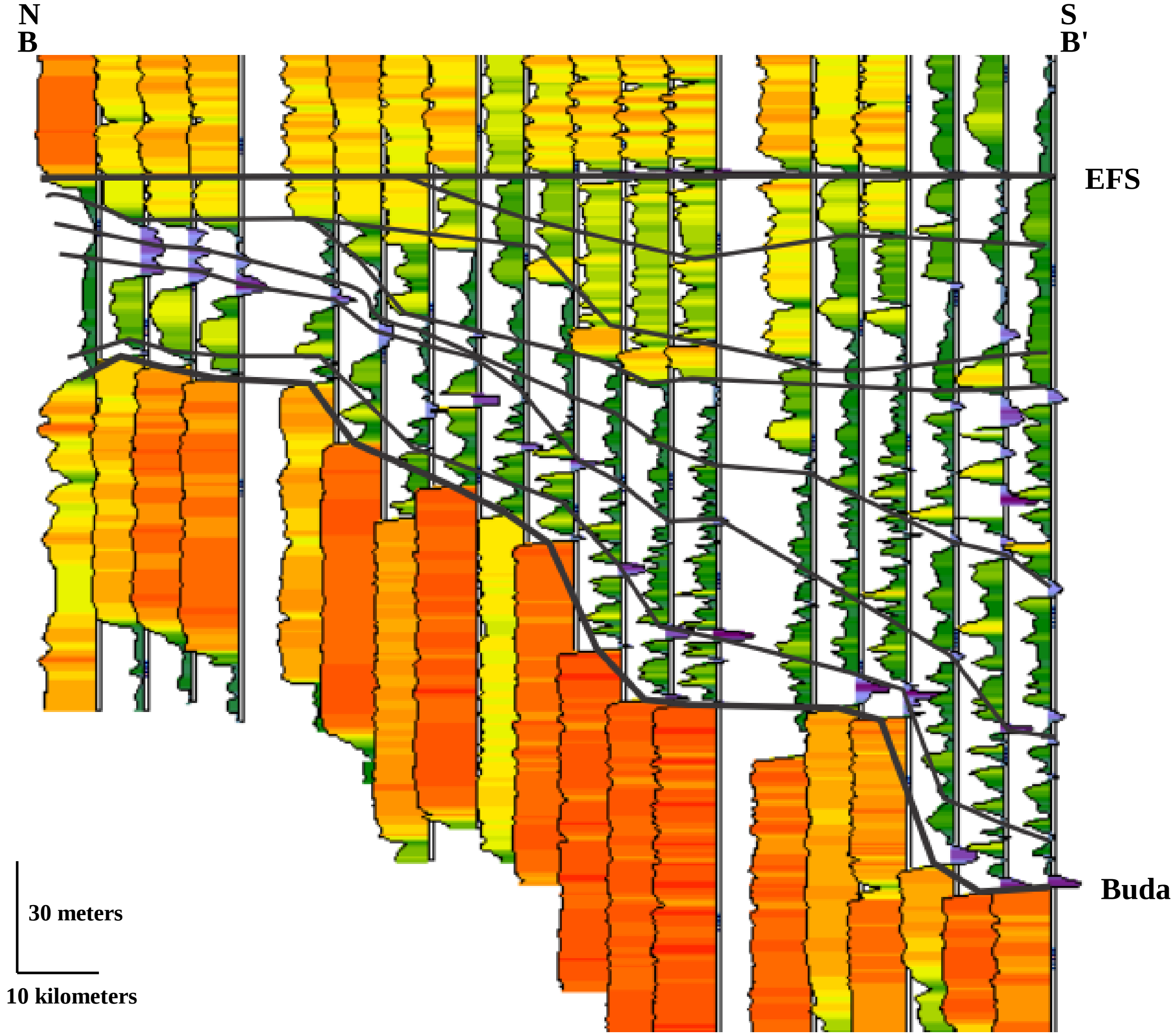

Figure: 30. Cross-section showing B to B' going from northern Atascosa County to southern McMullen County. This cross-section further demonstrates more proximal depositional environments having thinner stratigraphic equivalents of the Eagle Ford Shale compared to their more distal counterparts.

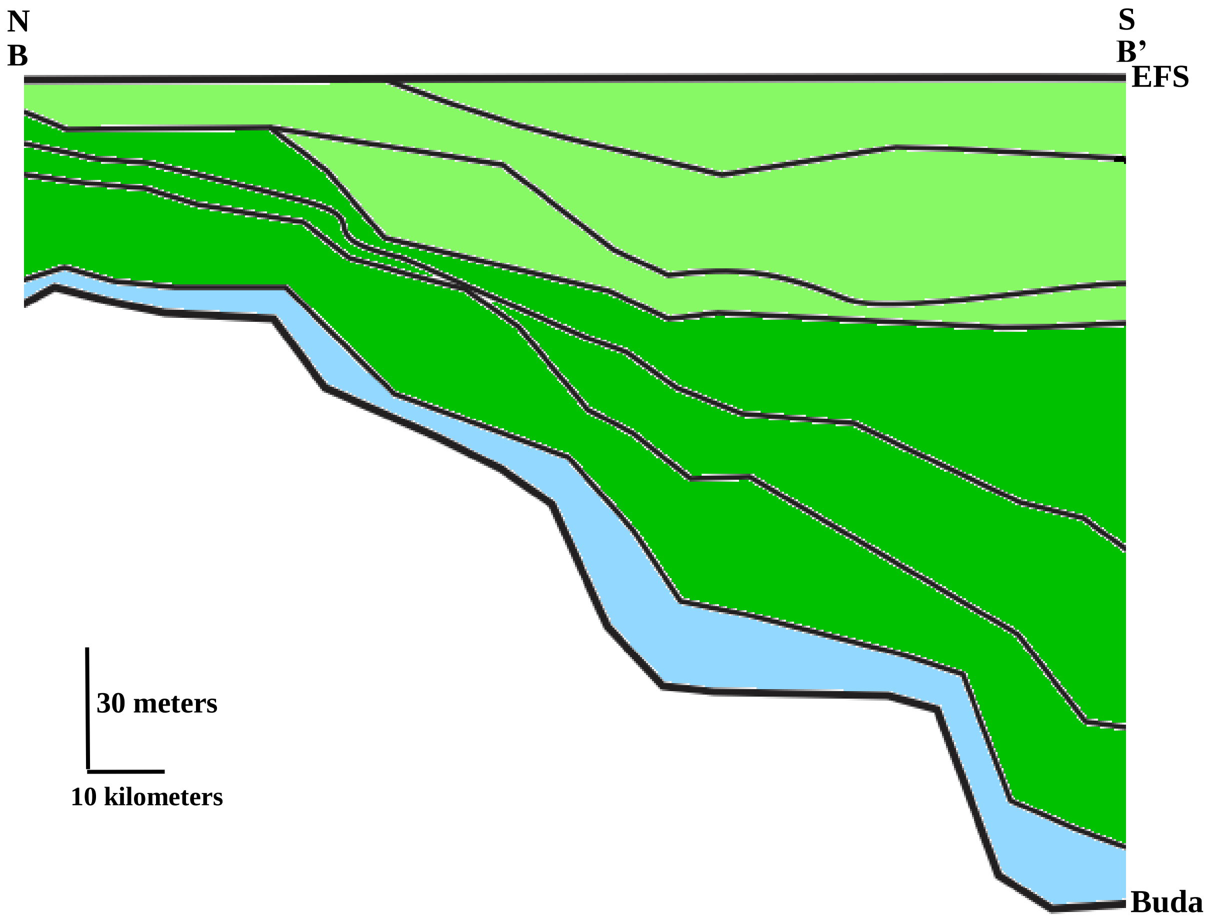

Figure: 31. Cross-section showing B to B' diagram going from northern Atascosa County to southern McMullen County. This cross-section shows onlap of clinoforms onto the Buda Formation and underlying clinoforms. The upper Eagle Ford in this interpretation shows truncation and a slight angular unconformity with the overlying Austin Chalk. This indicates erosion over the more proximal areas of deposition occurred. Therefore, the contact between the Austin Chalk and Eagle Ford shale is likely to be gradational in some areas and erosional in others. Based on geometry of units, blue unit represents a transgressive systems tract and green units represent highstand systems tracts.

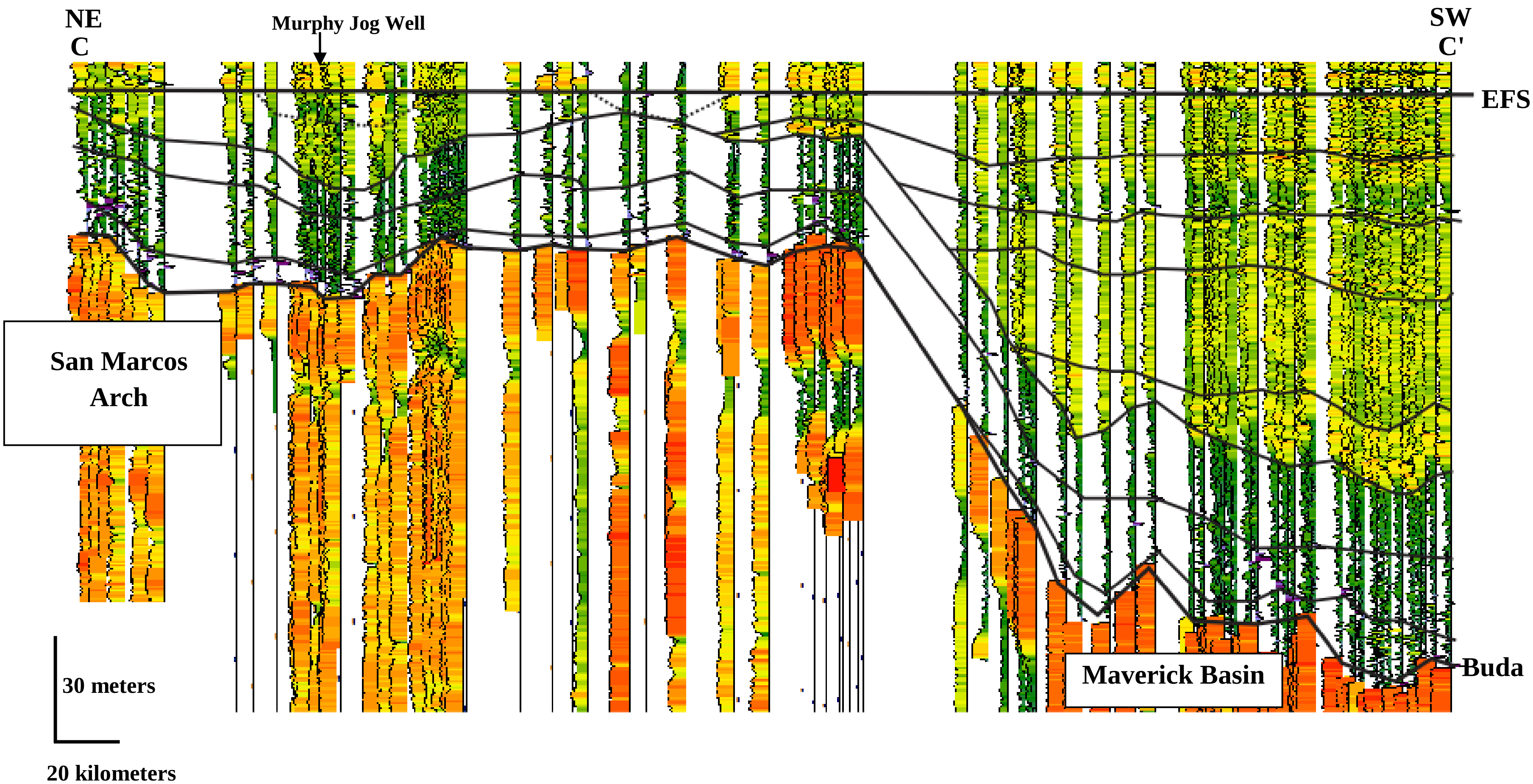

Figure: 32. Cross-section C to C' is a regional cross-section going from northeast DeWitt County to southwestern Maverick County. This cross-section shows the thickness changes and onlap of the Eagle Ford Shale onto the Buda Formation due to the San Marcos Arch. The Eagle Ford Shale thickens away from the San Marcos Arch, and reaches its maximum thickness within the Maverick Basin.

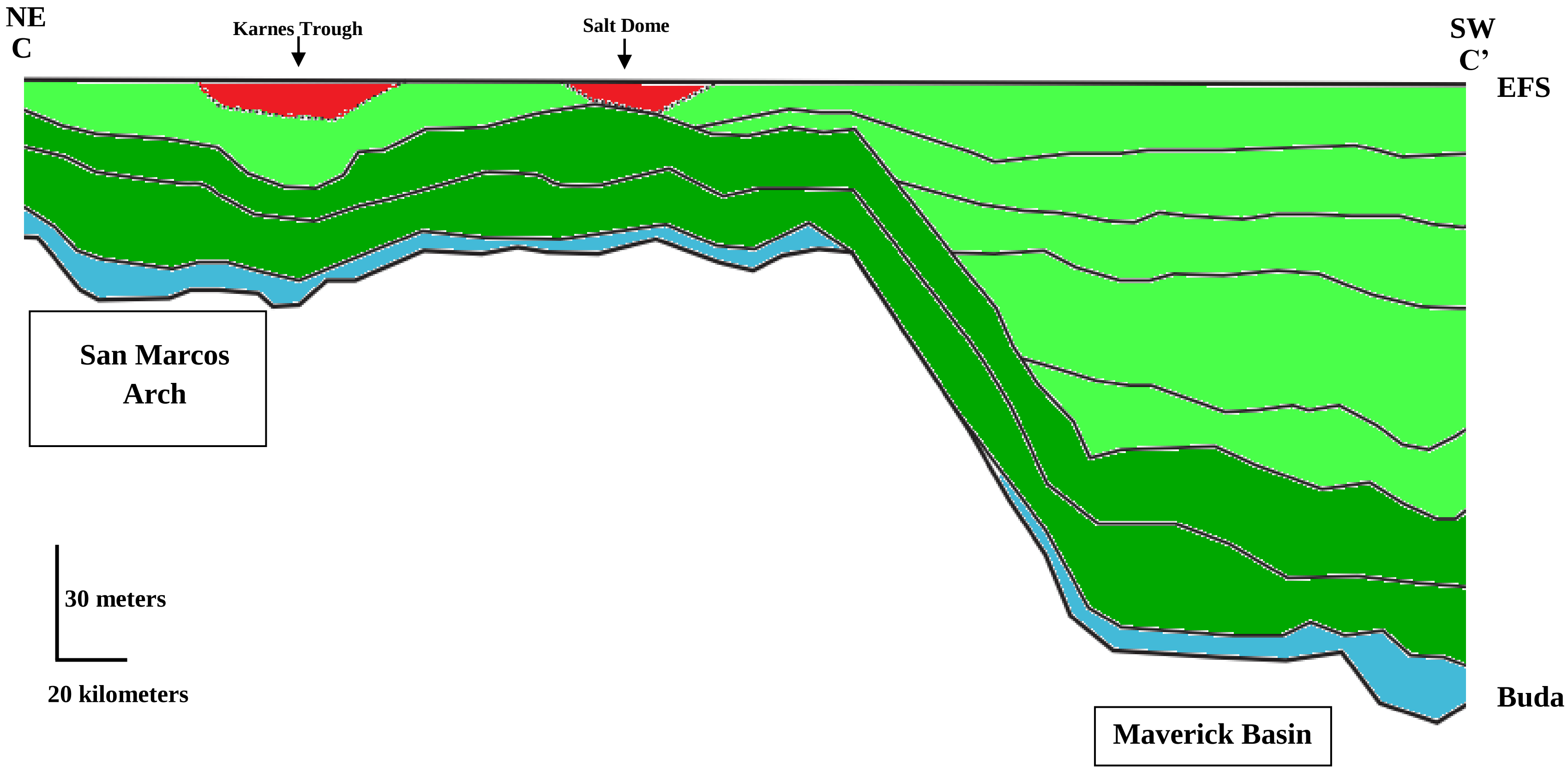

Figure: 33. This cross-section C to C' diagram is a regional cross-section going from northeast DeWitt County to southwestern Maverick County. This cross-section shows the thickness changes and onlap of the Eagle Ford Shale onto the Buda Formation due to the San Marcos Arch. The lowest portion of the Eagle Ford Shale exhibits a geometry similar to that of a transgressive systems tract (shown in blue). In addition, the Maverick Basin shows significantly thicker sections of the Eagle Ford Shale with units that onlap onto the Lower Eagle Ford Shale units. This indicates the lower Eagle Ford Shale (dark green) was deposited prior to subsidence of the Maverick Basin. Following subsidence of the Maverick Basin, the upper Eagle Ford Shale (light green) deposited with a geometry onlapping the lower EFS. Based on geometry of units, blue unit represents a transgressive systems tract and green units represent highstand systems tracts.

Discussion

The presence of parallel laminae in shale is indicative of settling of clay particles from slow-moving or still suspension. This theory has been the most common depositional model for shales. However, the presence of subtle, non-parallel laminae geometry, basal downlap and top truncation of laminae, and/or low amplitude bedforms indicate deposition of clay particles through mud accretion from migrating floccule ripples (Schieber, 2007). Distinguishing between these sedimentary structures is difficult, however, careful observation of small scale sedimentary features is the most important aspect of accurately interpreting environment of deposition for shale.

Accurately interpreting depositional processes aids in the understanding of how mudstones can act as barriers to fluid migration, which is critically important in formations such as the Eagle Ford Shale. If mud accumulated from current transported floccules, one might expect a network of larger pores, poorer sealing capacity, and easier release of liquid and gaseous hydrocarbons (Schieber, 2007). If accumulation of mud is from still water suspension, one can anticipate lower permeability and potential generation of an oil shale that clings tightly to its generated hydrocarbons (Schieber, 2007).

Core analyzed for this study exhibited parallel laminae, non-parallel laminae, truncation and downlap of laminae, and low amplitude bedforms such as ripple cross-laminae and starved ripples, indicating variable methods of deposition. Differentiation of traction transport sedimentary structures proved to be difficult in some beds due to varying degrees of bioturbation. Intense bioturbation of beds led to uncertainty of determining depositional processes. However, due to reworking of clay particles, fluid migration patterns become even more challenging to predict. Further investigation of bioturbation and its effect on mudstone permeability and fluid migration is needed to accurately understand their relationship. Understanding this relationship will aid in future exploitation of hydrocarbons from shale or mudstone.

This study also investigated the regional stratigraphy utilizing well logs calibrated to core to build a stratigraphic framework. Surfaces from the core that were correlative to the well logs proved to be difficult to distinguish. However, a few key surfaces (i.e., the large bentonite within the lower Eagle Ford Shale, the Eagle Ford Shale/Buda contact, the Kamp Ranch Limestone, and a few other parasequences boundaries) were easily distinguishable within the core and well logs. These surfaces, along with distinct gamma ray markers (Fig. 18), when correlated across the field exhibited onlap of the Eagle Ford Shale onto the underlying Buda Formation, particularly within the Maverick Basin. Truncation of units in the upper Eagle Ford Shale into the Austin Chalk was present in cross-section B-B' (Fig. 30 and 31) and absent in the other cross-sections, indicating that the Eagle Ford Shale/Austin Chalk contact is gradational in some areas and erosional in others. Sequence stratigraphic surfaces within the Eagle Ford Shale have been interpreted to be second and third order (Donovan and Staerker, 2011). Donovan and Staerker (2011) interpreted two separate sequence boundaries and two maximum flooding surfaces within the Eagle Ford Shale from outcrops in South Texas. While this study utilized several hundred well logs, more core description and outcrop analysis is needed to compare and further identify these significant sequence stratigraphic surfaces. Further investigation beyond this study is needed to accurately identify sequence stratigraphic surfaces in the subsurface. A study utilizing an even more fine-scaled correlation approach than this study would be best to identify these surfaces accurately.

Conclusions

The Eagle Ford Shale within South Texas contains 8 distinct facies that illustrate variable depositional processes depending on their proximity to the San Marcos Arch. These facies are:

1. Laminated Marl
2. Bioturbated Marl
3. Laminated Wackestone
4. Laminated Packstone
5. Bioturbated Wackestone
6. Bioturbated Packstone
7. Fossiliferous Packstone
8. Bentonite

Differentiation between facies and observations of small scale sedimentary structures led to the interpretation of depositional environment. The laminated marl facies, which was the most common throughout the cores described, is interpreted as being deposited on the outer shelf, above storm wave base in an oxygen depleted environment. The laminated wackestone and packstone facies represent event sedimentation on the inner shelf with the packstone facies being more proximal than the wackestone facies. Bioturbated marls were deposited in low energy, oxic environments. The bioturbated wackestone and packstone facies may have potentially been deposited in more energetic environments, but the sedimentary structures to demonstrate this are no longer apparent due to extensive bioturbation. The fossiliferous grainstone facies is interpreted as being a cohesive gravity flow due to scour into underlying facies. These gravity flows likely originated in more proximal locations then traveled distally due to gravitational forces. The last facies distinguished in this study was the bentonite facies. Bentonites are very common throughout the Eagle Ford Shale, originating from high volcanic activity in surrounding areas.

Electric well log correlations of key surfaces show thinning and onlap of the Eagle Ford Shale in proximal locations and along the San Marcos Arch. These thinned areas show more frequent, cyclic parasequences that have higher energy facies associated with them. The Eagle Ford Shale thickens in more distal locations and within the Maverick Basin. Thickened sections exhibit less energetic facies with thicker parasequences.

References

Addy, S.K., and Buffler, R.T., 1984, Seismic stratigraphy of shelf and slope, northeastern Gulf of Mexico: AAPG Bulletin, v. 68, p. 1782-1789.

Adkins, W.S., and Lozo, F.E., 1948. Stratigraphy of the Woodbine and Eagle Ford, Waco Area, Texas: Fondren Science Series, p. 100-161

Adkins, W.S., 1949. Eagle Ford condensed zone in Travis County, Texas. Shreveport Geological Society Guidebook 17th Annual Field Trip, pp 95-97.

Adkins, W.S., and F.E. Lozo, 1951. Stratigraphy of the Woodbine and Eagle Ford, Waco area, Texas, in F.E. Lozo ed., The Woodbine and adjacent strata of the Waco area of Central Texas, a symposium: Southern Methodist University Press Fondren Science Series 4, Dallas, Texas, p. 105-164.

Ambrose, W. A., Hentz, T. F., Bonnaffee, F., Loucks, R. G., Brown, F. J., Wang, F. P., Potter, E. C., 2009. Sequence-stratigraphic controls on complex reservoir architecture of highstand fluvial-dominated deltaic and lowstand valley-fill deposits in the Upper Cretaceous (Cenomanian) Woodbine Group, East Texas field: Regional and local perspectives: AAPG Bulletin, v. 93, no. 2, p. 231-269.

Asquith, G.B., 1990. Log Evaluation of Shaly Sandstones Reservoirs: A Practical Guide: American Association of Petroleum Geologists, p.15-26

Alling, H.L., 1945. Use of microlithologies as illustrated by some New York sedimentary rocks: Geological Society of America Bullten, v. 56, p. 737-755.

Bhattacharya, J. P., MacEachern, J. A., 2009. Hyperpycnal rivers and prodeltaic shelves in the Cretaceous seaway of North America: Journal of Sedimentary Research, v. 79, p. 184-209.

Blatt, Harvey, 1970. Determination of mean sediment thickness in the crust: A sedimentologic method: Geological Society of America Bulletin, v. 81, p. 255-262.

Blatt, H., and Tracy, R.J., 1996. Petrology. Igeneous, Sedimentary, and Metamorphic 2nd ed. 529 p.

Campbell, C.V. 1967. Lamina, laminaset, bed, and bedset: Sedimentology, v. 8, p. 7-26.

Chapman, D.R., Wood, L.E., Lovell, C.W., 1976. Comparative study of shale classification tests and systems: Bulletin of the Association of Engineering Geology, v. 13, n. 4, p. 247-266.

Cluff, R.M., 1980. Paleoenvironment of the New Albany Shale group (Devonian-Mississippian) of Illinois: Journal of Sedimentary Petrology, v. 50, p. 767-780.

Condon, S.M. and Dyman, T.S., 2006. 2003 Geologic Assessment of Undiscovered Conventional Oil and Gas Resources in the Upper Cretaceous Navarro and Taylor Groups, Western Gulf Province, Texas: U.S. Geological Survey Digital Data Series DDS-69-H, Chapter 2 42 p. http://pubs.usgs.gov/dds/dds-069/dds-069-h/.

Corbett, K., 2010, Eagleford Shale Exploration Models: Depositional Controls on Reservoir Properties: Search and Discovery Article #10242.

Corbett, H., Geiger, S., Borges, L., Garayev, M., and Valdez, C., 2012. The third porosity system: understanding the role of hidden pore systems in well-test interpretation in carbonates: Petroleum Geoscience, v. 18, p. 73-81.

Davies, S., Elliot, T., 1996. Spectral gamma ray high resolution sequence stratigraphy: examples from Upper Carboniferous fluvio-deltaic systems, County Clare, Ireland: Geological Society, London, Special Publications, v. 104, p. 25-35.

Dawson, W.C., 1997, Limestone microfacies and sequence stratigraphy: Eagle Ford Group (Cenomanian-Turonian) north-central Texas outcrops: Gulf Coast Association of Geological Societies Transactions, v. 47, p. 99-105.

Dawson, W. C., 2000. Shale Microfacies: Eagle Ford Group (Cenomanian-Turonian) North- Central Texas Outcrops and Subsurface Equivalents: Gulf Coast Association of Geological Societies Transactions, vol. L, p. 607-622.

Dawson, W.C., and Almon, W.R., 2010, Eagle Ford Shale Variability: Sedimentologic influences on source and reservoir character in an unconventional resource unit: Gulf Coast Association of Geological Societies Transactions, v. 60, p. 181-190.

Dickinson, W. R., 1970. Interpreting detrital modes of graywacke and arkose: Journal of Sedimentary Petrology, v. 40, p. 695-707.

Donovan, A., Staerker, S., Pradmudito, A., 2011. Sequence stratigraphy, facies, and depositional environments of the Eagle Ford Shale in West Texas, USA: An example of using integrated outcrop studies in characterizing "boring-looking" shales. GSA Annual Meeting in Minneapolis, MN.

Dravis, J.J., 1980, Sedimentology and diagenesis of the Upper Cretaceous Austin Chalk Formation, South Texas and northern Mexico: PhD Dissertation, Rice University, Houston, Texas, 532 p.

DrillingInfo, 2012. Eagle Ford Shale Overview: Ramona Hovey, DrillingInfo, Inc.

Eaton, R.W., 1956, Resume of subsurface geology of Northeast Texas with emphasis on salt structures: Gulf Coast Association of Geological Societies Transactions, p. 79-84.

Einsele, G., and Mosebach, R., 1955. Zur Peetrographie, Fossilhaltung und Entstehung der Gesteine des Psidonienschifersimscwabischen Jura. NeuesJarbuch fur Geologie und Palaontologie Abhandlungen, v. 101: p. 319-427.

Ettensohn, F.R., Miller, M.L., Dillman, S.B., Elam, T.D., Geller, K.L., Swager, D.R., Markowitz, G., Woock, R.D., and Barron, L.S., 1988. Characterization and implications of the Devonian-Mississippian black shale sequence, eastern and central Kentucky, U.S.A.: Pycnolcines, transgression, regression, and tectonism. In: NJ McMillan, A.F. Embry and D.J. Glass (Editors), Devonian of the World, vol. 2, Canadian Society of Petroleum Geology, Calgary, p. 323-345.

Eugster, H.P., and Hardie, L.A. 1975. Sedimentation in an ancient playa lake complex: the Wilkins Peak Member of the Green River Formation of Wyoming: Geological Society of America Bulletin, v. 86, p. 319-334.

Fang, J.H., Chen, H.C., Shultz, A.W., Mahmoud, W. 1992. Computer-aided well log correlation: The American Association of Petroleum Geologists Bulletin, v. 76, no. 3, p. 307-317.

Flügel, E., 2009, Microfacies of Carbonate Rocks: New York, Springer, 921 p.

Folk, R.L., 1960. Petrography and origin of the Tuscaroro, Rose Hill, and Keefer formations, Lower and Middle Silurian of eastern West Virginia: Journal of Sedimentary Petrology, v. 30, p. 1-58.

Folk, R.L., 1962. Petrography and origin of the Silurian Rochester and McKenzie Shales, Morgan County, West Virginia: Journal of Sedimentary Petrology, v. 32, p. 539-578.

Folk, R.L., 1968. Petrology of Sedimentary Rocks: Hemphills' Austin, 170 p.

Grabowski G.J. Jr. 1984.Generation and Migration of Hydrocarbons in Upper Cretaceous Austin Chalk, South-central Texas. Source Rock Potential of Carbonate Rocks– AAPG Studies in Geology 18, American Association of Petroleum Geologists, P. 97-115.

Hentz, T.F., and Ruppel, S.C., 2010, Regional lithostratigraphy of the Eagle Ford Shale: Maverick Basin to East Texas Basin: Gulf Coast Association of Geological Societies Transactions, v. 60, p. 325-337.

Harbor, R., 2011, Facies Characterization and Stratigraphic Architechture of Organic-Rich Mudrocks, Upper Cretaceous Eagle Ford Formation, South Texas: Master's Thesis, University of Texas at Austin, 195 p.

Herron, M.M., 1988. Geochemical classification of terrigenous sands and shales from core or log data: Journal of Sedimentary Petrology, vol. 58, no. 5, p. 820-829.

Hill, R.T., 1887a, The topography and geology of the Cross Timbers and surrounding regions in northern Texas: American Journal of Science, 3rd series, v. 33, p. 291-303.

Hill, R.T., 1887b, The Texas section of the American Cretaceous: American Journal of Science, 3rd series, v. 34, p. 287-309.

Hill, R.J., Zhang, E., Katz, B.J., Tang, Y., 2007. Modeling of gas generation from the Barnett Shale, Fort Worth Basin, Texas: American Association of Petroleum Geologists Bulletin, v. 91, p. 501-521.

Jenkyns, H.C., 1980. Cretaceous anoxic events: from continents to oceans: Journal of Geological Society London, v. 137, p. 171-188.

Kauffman, E.G., 1977. Upper Cretaceous cyclothems, biotas and environments, Rock Canyon, Anticline, Pueblo, Colorado, Cretaceous Facies, Faunas and Paleoenvironments across the Western Interior Basin, Mountain Geologist, v. 14, p. 129-152.

Kauffman, E.G., 1984. Paleobiogeography and evolutionary response dynamic in the Cretaceous Western Interior Seaway of North America, Jurassic-Cretaceous Biochronology and Biogeography of North America: Geological Assoication of Canada, Special Paper 27, p. 273-306.

Kreisa, R.D., 1981, Storm-generated sedimentary structures in subtidal marine facies with examples from the middle and upper Ordovician of Southwest Virginia: Journal of Sedimentary Petrology, v. 51, p. 823-848.

Kreisa, R.D., and Bambach, R.K., 1982, The role of storm processes in generating shell beds in Paleozoic shelf environments, in Einsele, G., and Seilacher, A., eds., Cyclic and Event Stratification: New York, Springer-Verlag, 536 p.

Krynine, P.D. 1940. Petrology and Genesis of the Third Bradford Sand: Pennsylvania State College Bulletin 29, 134 p.

Kumbrein, W.C., 1934. Size frequency distribution of sediments: Journal of Sedimentary Petrology, v. 4, p. 65-77.

Kumbrein, W.C., 1947. Shales and their environmental significance: Journal of Sedimentary Petrology, v. 17, p. 101-108.

Kumbrein, W.C. and Sloss, L.L., 1951. Stratigraphy and Sedimentation: W. H. Freeman and Company, San Francisco, 497 p.

Liro, L.M., Dawson, W.C., Katz, B.J., Robinson, V.D., 1994. Sequence stratigraphic elements and geochemical variability within a "condensed section:" Eagle Ford Group, east-central Texas: Gulf Coast Association of Geological Societies Transactions, v. 44, p. 393-402.

Lineback, J.A., 1970. Stratigraphy of the New Albany Shale in Indiana: Indiana Geological Survey Bulletin, v. 44, pp. 73.

Lock, B. E., L. Peschier, and N. Whitcomb, 2010. The Eagle Ford (Boquillas Formation) of Val Verde County, Texas—A window on the South Texas play: Gulf Coast Association of Geological Societies Transactions, v. 60, p. 419-434.

MacQuaker, J.H.S., and Gawthorpe, R.L., 1993. Mudstone lithofacies in the Kimmeridge Clay Formation, Wessex Basin, southern England: implications for the origin and controls of the distribution of mudstones: Journal of Sedimentary Petrology, v. 63, p. 1129-1143.

Magara, K., 1980. Comparison of porosity-depth relationships of shale and sandstone: Journal of Petroleum Geology, v. 3, no. 2, p. 175-185.

McKee, E.D., and Weir, G.W., 1953. Terminology for stratification and cross-stratification in sedimentary rocks: Geological Society of America Bulletin, v. 64, p. 381-389.

Mitchum, R.M., Van Wagoner, J.C., 1991. High-frequency sequences and their stacking patterns: sequence-stratigraphic evidence of high-frequency eustatic cycles: Journal of Sedimentary Geology, v. 70, p. 131-160.

Montgomery, S.L., ed., 1990, Horizontal drilling in the Austin Chalk; Part 1, Geology, drilling history and field rules: Petroleum Frontiers, v. 7, no. 3, 44 p.

Montgomery, S.L. 1991, Horizontal drilling in the Austin Chalk; Part 2, Patterns of production: Petroleum Frontiers, v. 7, no. 4, 58 p.

Muehlberger, W.R., and Kurie, A.E., 1956, Fracture study of central Travis county, Texas, a preliminary statement: Gulf Coast Association of Geological Societies Transactions, v. 6, p. 43-49.

Mulder, T., and Alexander, J., 2001, The physical character of subaqueous sedimentary density flows and their deposits: Sedimentology, v. 48, p. 269-299.

Mullen, M., and Roundtree, R. 2007. A composite determination of mechanical rock properties for stimulation design (What to do when you don't have a sonic log): Paper SPE 123992 presented at the Annual Technical Conference and Exhibition, New Orleans, Louisiana, 4-7 October. doi: 10.2118/108139-MS.

Mullen, J., 2010. Petrophysical characterization of the Eagle Ford Shale in South Texas: Paper presented at Canadian Unconventional Resources and International Petroleum Conference in Calgary, Alberta, Canada, 19-21 October 2010. CSUG/SPE 138145.

Nitsche, F.O., Jacobs, S.S., Larter, R.D., 2007. Bathymetry of the Amundsen Sea continental shelf: implications for geology, oceanography, and glaciology: Geochemisty, Geophysics, and Geosystems, v. 8, issue 10,

O'Brien N.R. 1981. SEM Study of Shale Fabric- A Review: Scanning Electron Microscopy. SEM I, Inc., p. 569-575.

O'Brien N.R. 1987. The effects of bioturbation on the fabric of shale. Journal of Sedimentary Petrology, Vol. 57, No. 3, P. 449-455.

OilShaleGas. 2012. Eagle Ford Shale – South Texas – Natural Gas and Oil Field. http://oilshalegas.com

Picard, M.D., 1966. Petrography of Red Peak Member, ChugwaterFromation (Triassic), west-central Wyoming: Journal of Sedimentary Petrology, v. 36, p. 904-926.

Picard, M.D., 1971. Classification of fine-grained sedimentary rocks. Journal of Sedimentary Petrology, v. 41, no. 1, p. 179-195.

Potter, P.E., Maynard, J.B., and Depetris, P.J., 2005, Mud and Mudstones: Springer-Verlag, New York, 297 p.

Railroad Commission of Texas, 2011, Eagle Ford Information, <http://www.rrc.state.tx.us/eagleford/index.php#general>, accessed January 15, 2013.

Reaser, D.F., 1961, Balcones Fault System: its northeast extent: Bulletin of the American Association of Petroleum Geologists, v. 45, p. 1759-1762.

Reinhold, C., 1997. Total-reflection X-ray fluorescence analysis: Wiley Publishing, v. 140, 245 p.

Rickman, R., Mullen, M. Petre, E., Grieser, B., and Kundert, D., 2008. A practical use of shale petrophysics for stimulation design optimization: all ahale plays are not clones of the Barnett Shale: Paper SPE 115258 presented at the Annual Technical Conference and Exhibition, Denver, Colorado, 21-24 September doi: 10.2118/115258-MS.

Rose, P.R., 1972, Edwards Group, surface and subsurface, Central Texas: University of Texas at Austin, Bureau of Economic Geology Report of Investigations No. 74, 198 p.

Salvador, A., 1991, Origin and development of the Gulf of Mexico Basin, in Salvador, A., ed., The Gulf of Mexico Basin: Boulder, Colorado, Geological Society of America, The Geology of North America, v. J., p. 389-444.

Salvador, A. and Muñeton, J.M. Q., 1989, Stratigraphic Correlation Chart Gulf of Mexico Basin, in Salvador, A., ed., The Gulf of Mexico Basin: Boulder Colorado, Geological Society of America, The Geology of North America, v. J., plate 5.

Schieber, J. 1986. The possible role of benthic microbial mats during the formation of carbonaceous shales in shallow Proterozoic basins: Sedimentology, v. 33, p. 521-536.

Schieber, J., 1989. Facies and origin of shales from the Mid-Proterozoic Newland Formation, Belt Basin, Montana, U.S.A.: Sedimentology, v. 36, p. 203-219.

Schieber, J., 1990(a). Sedimentary structures, textures, and depositional settings of shales from the Lower Belt Supergroup, Mid-Proterozoic, Montana, U.S.A. In Bennett, R.H., Bryant, W.R., and M.H. Hulbert (eds.), Microstructure of fine-grained sediments, New York, Springer Verlag. p. 101-108.

Schieber, J., 1990(b). Significance of styles of epicontinental shale sedimentation in the Belt Basin, Mid-Proterozoic of Montana, U.S.A.: Sedimentary Geology, v. 69, p. 297-312.

Schieber, J., 1994. Evidence for episodic high energy events and shallow water deposition in the Chattanooga Shale, Devonian, central Tennessee, U.S.A.: Sedimentary Geology, v. 993, p. 193-208.

Schieber, J., 1998. in Shales and Mudstones Vol. 1 (edsSchieber, J., Zimmerle, W., and Sethi, P.) 187-215 (Schweizerbart, Stuttgart, 1998).

Schieber, J., 1999.Distribution and deposition of mudstone facies in the Upper Devonian Sonyea Group of New York. Journal of Sedimentary Research v 69, p. 909-925.

Schieber, J., Krinsley, D., Riciputi, L., 2000. Diagenetic origin of quartz silt in mudstones and implications of silica cycling: Nature, vol. 406, p. 981-985.

Schieber, J., Southard, J.B., and Thaisen, K., 2007. Accretion of mudstone beds from migrating floccule ripples: Science, v. 318, p. 1760-1763

Schlanger, S.O., and Jenkyns, H.C., 1976, Cretaceous oceanic anoxic events: causes and consequences: Geologie en Mijnbouw, v. 55, p. 179-184.

Schlanger, S.O., Arthur, M.A., Jenkyns, H.C., and Scholle, P.A., Brooks, J., and

Fleet, A.J., 1987. Marine Petroleum Source Rocks: Geological Society Special Publication No. 26, p. 371-399.

Sepkoski, J.J., Jr., and Bambach, R.K., 1979, The temporal restriction of flat-pebble conglomerates: an example of co-evolution of organisms and sediments: Geological Society of America Abstracts with Programs, v. 11, p. 256.

Spears, D.A., 1976. The fissility of some carboniferous shales: Sedimentology v. 23, p. 721-725.

Spears, D.A. 1980. Towards a classification of shales: Journal of the Geological Society, v. 137, p. 125-129.

Stephenson, L.W., Reeside, J.B., 1938. Comparison of Upper Cretaceous deposits of Gulf region and Western Interior Region: American Association of Petroleum Geology Bulletin, v. 22, p. 1629-1638.

Stow, D.A.V, and Piper, D.J.W., 1984. Deep-water fine-grained sediments: Facies models: In: D.A.V. Stow and D.J.W. Piper (eds.), Fine-grained sediments: Deep-water processes and facies. Geological Society of London Special Publication, p. 611-645.

Sutton, R.G., Bowen, Z.P., and McAlester, A., 1970. Marine shelf environments of the Upper Devonian Sonyea Group of New York: Geological Society of America Bulletin, v. 81, p. 2975-2992.

U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI. Updated: May 9, 201. http://www.eia.gov.

Vail, P.R., Todd, R. G., Sangree, J. B., 1977. Seismic Stratigraphic and global changes of sea level, part 5: chronostratigraphic significance of seismic reflections: Exxon Production Research Co.

Valloni, R., and Maynard, J.B., 1981. Detrital modes of recent deep-sea sands and their relation to tectonic setting: a first approximation: Sedimentology, v. 28, p. 75-83.

Wentworth, C.K. 1922. A scale of grade and class terms for clastic sediments: Journal of Geology, v. 30, p. 377-392.

Wignall, P.B., 1989. Sedimentary dynamics of Kimmeridge Clay: Tempestites and earthquakes: Journal of the Geological Society of London, v. 146, p. 273-284.

Zink, E.R., 1957, Resume of the Lower Cretaceous of South Texas: Gulf Coast Association of Geological Societies Transactions, v. 7, p. 13-22.

Appendix

Well API number	Operator	Well Name
42029366150000	DORRIS PETROLEUM INC	BROWN JACK TRACT C-B
42271302310000	MJM OIL & GAS INC	PETRUCHA `A`
42325317020000	TENROC CORP	HARDIE RANCH
42325319730000	DALLAS SUNBELT O&G	CAROLINE D
42325321400000	VAUGHN BEN F	MECHLER EDWARD A
42325330480000	ATKINSON CLIFFORD 3	MCDONOUGH
42025303990000	SHELL OIL CO	S E TURNER GAS UNIT
42025304910000	SHELL OIL CO	ALBERT GORDON GU
42025305380000	SHELL OIL CO	W H FORD GAS UNIT
42025326380000	PARKER&PARSLEY DEV	ONEAL GAS UNIT
42025326390000	PARKER&PARSLEY DEV	BUES HENRY GAS UNIT
42025326490000	PARKER&PARSLEY DEV	BUES HENRY GAS UNIT
42025326560000	PARKER&PARSLEY DEV	BUES HENRY GAS UNIT
42025326580000	PARKER&PARSLEY DEV	OVERBY CHARLIE C GAS
42025328420000	PIONEER NAT RES USA	OVERBY CHARLIE C
42025328940000	PIONEER NAT RES USA	OLSON AMANDA G UN
42025331140000	PIONEER NAT RES USA	BUES HENRY GAS UNIT
42025331600000	PIONEER NAT RES USA	GORDON ALBERT GAS UN
42025331690000	PIONEER NAT RES USA	OLSON AMANDA GAS UNI
42025331710000	PIONEER NAT RES USA	TURNER GAS UNIT
42025331880000	PIONEER NAT RES USA	OLSON AMANDA GAS UN
42025331930000	PIONEER NAT RES USA	TURNER GAS UNIT
42025332460000	PIONEER NAT RES USA	TURNER GAS UNIT
42025332630000	PIONEER NAT RES USA	MANSKER RANCH GAS UN
42025332700000	PIONEER NAT RES USA	TURNER GAS UNIT
42025332720000	PIONEER NAT RES USA	BUES HENRY GAS UNIT
42025332730000	PIONEER NAT RES USA	ONEAL GAS UNIT
42025332800000	PIONEER NAT RES USA	SCHROEDER GAS UNIT
42025332810000	PIONEER NAT RES USA	MANSKER RANCH GAS UN
42025332950000	PIONEER NAT RES USA	GOING WINNIE MADGE G
42025333170000	PIONEER NAT RES USA	BUES GAS UNIT
42025333360000	PIONEER NAT RES USA	MANSKER RANCH GAS

API	Operator	Well Name
42025333380000	PIONEER NAT RES USA	TURNER GAS UNIT
42025333450000	PIONEER NAT RES USA	TOMASEK GAS UNIT
42025333540000	PIONEER NAT RES USA	SCHROEDER GAS UNIT
42025333590000	PIONEER NAT RES USA	TURNER GAS UNIT
42025333600000	PIONEER NAT RES USA	BUES HENRY GAS UNIT
42025333610000	PIONEER NAT RES USA	BUES HENRY GAS UNIT
42123302930000	SHELL OIL CO	FT WORTH NATL BANK
42123304050000	SHELL OIL CO	MW WAGNER ETALGSUNT
42123309050000	SHELL OIL CO	A WIELAND GAS UNIT
42123310100000	GETTY OIL COMPANY	SMITH RANCH
42123310510000	SUPERIOR OIL CO ETAL	WARLING-MEYER UNIT
42123311040000	NEUMIN PRODUCTION CO	DUESER MARIE UN
42123311620000	LA SALLE ENERGY CORP	MILLER
42123311980000	TOWNER PETROLEUM CO	KRAUSE
42123313070000	PEND OREILLE O&G CO	HUTCHINSON E B
42123314480000	TXO PROD CORP	BADE
42123314750000	APACHE CORP	BLAIN LOVEL A III G
42123315610000	HANSON MINERALS CO	HARTMAN
42123316890000	WEEKS EXPL CO	GOEHRING ALMA J
42123317130000	PARKER&PARSLEY DEV	FORT WORTH NATIONAL
42123317930000	EDCO ENERGY INC	RED CREST TRUST
42123318130000	CHESAPEAKE OPERG INC	BLACKWELL
42123319070000	PRIZE OPR CO	GOHMERT GAS UNIT
42123320140000	ABRAXAS PETRLM CORP	WAGNER GAS UNIT
42123320900000	PIONEER NAT RES USA	COSTLOW GAS UNIT
42175315910000	DAVIS OIL CO	SMITH JANICE
42175316160000	DAVIS OIL CO	MAYFLD PLES ETAL UN
42175316820000	L TEXAS PETROLEUM	CHAMBERS-JAKEMAN
42175318990000	ARCO OIL & GAS CORP	ALBRECHT ARCO V
42175323310000	SUN EXPL & PROD CO	BORCHERS C & M K
42175326110000	ORYX ENERGY CO	MUECKE E W UNIT
42175327850000	SANCHEZ-OBRIEN O & G	LUKER B J
42175331080000	HANSON PRODUCTION CO	BORCHERS
42175335500000	CARRIZO O&G INC	HORSE THIEF HOLLOW
42255001330000	AMERADA HESS CORP	MARY MIKA
42255007620000	BRIGHT & SCHIFF	PHILIP ROHAN EST

API	Operator	Well Name
42255302190000	GENERAL CRUDE OIL CO	ROLF ESTELLE
42255302220000	GENERAL CRUDE OIL CO	GRUNEWALD-BOWEN
42255302800000	DAVIS OIL CO	F L GAWLIK ET#1
42255305980000	SHELL OIL CO	BEN A PAWELEK A
42255306200000	GENERAL CRUDE OIL CO	LYONS GORDON ETAL
42255306300000	SHELL OIL CO	ELSIE TIPS
42255306570000	HUNT OIL CO	IDA P CARROLL
42255307930000	HENRY PETROLEUM INC	KORTH
42255308500000	HENRY PETROLEUM INC	MZYK UNIT
42255310430000	PRIMARY FUELS	RIEDEL
42255310740000	GETTY OIL COMPANY	GREEN HIX
42255310790000	NUGGET OIL COMPANY	KOTZUR
42255310810000	NUGGET OIL COMPANY	JOHNSON E
42255310820000	NUGGET OIL COMPANY	RUHMANN
42255310910000	NUGGET OIL COMPANY	RICHTER V GU 1-E
42255310940000	NUGGET OIL COMPANY	RUHMANN R GU 2-E
42255311120000	GIERHART B J INC	ROBERTS
42255311320000	MOBIL PRDUCNG TX&NM	ROLF ESTELLE GAS UN
42255311380000	NUGGET OIL COMPANY	URBANCZYK
42255311400000	EP OPERATING CO	KELLNER ETTA L
42255311420000	TEXSTAR N AMER INC	GUTIERREZ C
42255311430000	MOBIL PRDUCNG TX&NM	ROLF ESTELLE GAS UN
42255311550000	CHEVRON U S A INC	POLLOCK C T
42255311560000	NUGGET OIL COMPANY	BROCKMAN
42255311700000	TEXSTAR N AMER INC	JOHNSON HARDING
42255311750000	NUGGET OIL COMPANY	URBANCZYK /A/
42255311760000	NUGGET OIL COMPANY	MCMULLEN OIL & ROYAL
42255311770000	NUGGET OIL COMPANY	WIATREK
42255311790000	MOBIL PRDUCNG TX&NM	WERNLI ALBERT GAS U
42255311820000	CHEVRON U S A INC	YANTA GUSSIE
42255311950000	TEXSTAR N AMER INC	CARROLL IDA P
42255311960000	TEXSTAR N AMER INC	BERRY GAS UNIT
42255311980000	TEXSTAR N AMER INC	CARROLL IDA P
42255312090000	CHRISTICO PETR CO	PUSTJOVSKY
42255312140000	TEXSTAR N AMER INC	NEWBERRY
42255312440000	TEXSTAR N AMER INC	HOMEYER ANNIE P
42255312470000	TEXSTAR N AMER INC	HOMEYER ANNIE P

API	Operator	Well Name
42255312680000	LEEDE OIL & GAS INC	SCHOENFELD
42255312690000	PRESIDIO EXPL INC	MADDUX PARAMOUNT
42255312840000	TEXSTAR N AMER INC	HANDY SUE
42255313140000	PARKER&PARSLEY DEV	ROLF ESTELLE GAS UN
42255313250000	HANSON MINERALS CO	HALL GAS UNIT
42255313380000	NOMECO OIL & GAS CO	TEXSTAR-MCDOWELL
42255313650000	CHEYENNE PET CO	YOUNG RUBY
42255313680000	CHESAPEAKE OPERG INC	BLACKWELL
42255313820000	CHESAPEAKE OPERG INC	RHODES TRUST
42255314010000	BASS ENTRPRS PROD CO	WESSENDORFF
42255314460000	CHEVRON U S A INC	KELLER ETAL GAS UNI
42255314660000	PIONEER NAT RES USA	WERNLI GU 1
42255314880000	YATES ENERGY CORP	CLARK-HABY UNIT
42255314940000	WHITING OIL & GAS	RHODES TRUST
42255315060000	DEWBRE PETRO CORP	RUHMANN R GAS UNIT
42297305970000	CITIES SERVICE	SCHULTE /A/
42297317540000	SHELL OIL CO	TM CURRER
42297320220000	GETTY OIL COMPANY	KUENSTLER HNRY GU 1
42297327000000	TEXAS O&G CORP	MCCLELLAND GU /B/
42297327010000	HILLIARD O&G INC	PATTESON RANCH INC
42297328480000	INGRAM EXPL INC	DULLIHAM JOSEPHINE
42297329680000	SUN EXPL & PROD CO	MITCHLL-THOMPSON UN
42297333060000	SANCHEZ-OBRIEN O & G	GEFFERT GAS UNIT #2
42297333510000	MCMORAN EXPL CO	DULLAHAN JOSEPHINE
42297334660000	ARCO OIL & GAS CORP	ARCO SANGER ESTATE
42297335260000	CENERGY EXPL CO	GEORGE RAY
42297337400000	FORNEY OIL CORP	WENDEL A J
42297337930000	RUTHERFORD OIL CORP	BAKER
42297342640000	ABRAXAS PETRLM CORP	SCHULZ
42297343170000	ABRAXAS PETRLM CORP	SCHULZ
42297343930000	PHILLIPS PETRLM CO	BURLINGTON FEE `301
42297345260000	PIONEER NAT RES USA	BENHAM ERNA P
42297345460000	PIONEER NAT RES USA	BENHAM ERNA P GAS U
42297345590000	PIONEER NAT RES USA	CURRER T M
42297345610000	PIONEER NAT RES USA	KUENSTLER
42297345740000	PIONEER NAT RES USA	BENHAM GAS UNIT A
42297345930000	PIONEER NAT RES USA	BENHAM GAS UNIT A

API	Operator	Well Name
42297346630000	PIONEER NAT RES USA	NICHOLS CHARLES GAS
42297346670000	PIONEER NAT RES USA	FULBRIGHT HERSCHEL
42297346690000	PIONEER NAT RES USA	SINOR RANCH
42127305640000	STRINGER J FRANK	N C KING TRACT 2
42127307200000	MGF OIL CORP	N C KING
42127310440000	SUBURBAN PROPANE EXP	R M BOWER A 1
42127310450000	GALAXY OIL CO	EALEN BRAY
42127310770000	GALAXY OIL & TIME O&	H A FITZSIMONS/B/
42127310880000	THOMPSON JOHN R OP I	L P WILLIAMS
42127310950000	GOSE STEVE	BRISCOE /B/
42127311020000	SNYDER JOHN C INC	HENRICHSON /A/
42127311060000	DIAMOND SHMROCK CORP	EUBANK
42127311200000	BTA OIL PRODUCERS	7702 JV-P GOOD HOPE
42127311360000	GALAXY OIL CO	ANNE G DROUGHT
42127311670000	COTTON PETROLEUM	MCKNIGHT TR 1
42127311920000	CHAMPLIN PETRO CMPNY	J B BAGGETT
42127312100000	FOREST OIL CORPORATN	SUGARLAND RANCH E
42127315450000	GALAXY OIL CO	SEM
42127315460000	GAMMA RESORCS INC	GARDNER
42127316030000	NORTHWEST ARK O&G PR	WM VERNOR
42127316180000	CANUS PETROLEUM INC	GARNER-DEEP
42127316600000	CANUS PETROLEUM INC	HALSELL-DEEP
42127316690000	TESORO PETRO CORP	E L DISMUKES
42127317010000	LOVELADY I W	REYNOLDS - WILSON
42127317150000	CANUS PETROLEUM INC	EUBANKS
42127317290000	LOUISIANA LAND&EXPL	MARRS MCLEAN BOWMAN
42127317320000	MARLINE OIL CORP	J G GROCE
42127317330000	MARLINE OIL CORP	J G GROCE
42127318560000	TEXAS O&G CORP	SILVER LAKE RANCH
42127319100000	DAVIS OIL CO	STUMBERG H E JR
42127322920000	EVERGREEN OIL CORP	MCKNIGHT S A TRUST
42127323000000	EVERGREEN OIL CORP	WILSON CHARLES
42127326190000	RGR PRODUCTION	MCROREY
42127330000000	TEX-CON OIL & GAS CO	WHATABURGER
42127330870000	VIRGIN OIL COMPANY	KING N C

API	Operator	Well Name
42127332080000	EXPLORATION CO THE	MYERS
42127332090000	EXPLORATION CO THE	VIVIAN G W
42127332160000	H & M RESOURCES LLC	BOWERS
42127332290000	EXPLORATION CO THE	KOTHMAN I O K
42127332320000	SAXET ENERGY LIMITED	COVERT F M
42127332330000	EXPLORATION CO THE	KOTHMAN
42127332340000	CMR ENERGY LP	COMANCHE RANCH
42127332350000	EXPLORATION CO THE	OMEARA
42127332520000	EXPLORATION CO THE	WEBB F J UNIT 1
42127332570000	ENCANA O&G (USA) INC	KOTHMAN I O K
42127332600000	EXPLORATION CO THE	KOTHMAN I O K
42127332670000	CMR ENERGY LP	COMANCHE RANCH
42127332680000	EXPLORATION CO THE	SPEER
42127332710000	EXPLORATION CO THE	TROTTER
42127332720000	EXPLORATION CO THE	LATHAM-MCKNIGHT
42127332970000	ENCANA O&G (USA) INC	WEBB F J
42127333140000	ENCANA O&G (USA) INC	KOTHMAN
42163016510000	SHELL OIL CO	JANE BURNS
42163016530000	SHELL OIL CO	TEMPLE DAVIDSON
42163300070000	TENNECO OIL CO	T J GOAD
42163300120000	TENNECO & PENNZOIL U	W A ROBERTS
42163301930000	SKELLY OIL COMPANY	S B DAVIES
42163302060000	MGF OIL CORP	COMBS
42163304340000	TIPPERARY O&G CORPOR	BISSETT
42163304400000	M K OIL & GAS	ROSA LOUISE KELLER
42163305030000	GETTY OIL COMPANY	SHINER RANCH
42163305910000	QUINTANA PET CORP	H A HALFF ETAL
42163307280000	TESORO PETRO CORP	J H CALVERT
42163307920000	TEJAS	R K HARLAN ET
42163309990000	TEJAS PRODUCTION CO	R K HARLAN ETAL /A/
42163316220000	COLLIER DIAMOND OILS	T C MORROW
42163317830000	SE PIPE LINE CO	WILLIAMS BLAKE JR
42163318390000	ACIETEROS LIMITED	CULPEPPER CURTIS L
42163319960000	GIEBEL AARON F	SHINER /A/
42163320140000	EXXON CORPORATION	EXXON MCLEAN FEE A
42163320200000	RESERVE ENERGY CORP	LITTLE-DUKES
42163320280000	LONE STAR NAT RS INC	ADAMS GEORGE

API	Operator	Well Name
42163320980000	EVERGREEN OIL CORP	EICHELBERGER H L
42163321280000	GLENNCO EXPL LTD	GRACEY RANCH
42163321380000	SEAROC OIL CO INC	THOMPSON ETHEL C
42163321620000	LAKE RONEL OIL CO	OPPENHEIMER
42163321900000	FAIR ENERGY	NIXON & DILLARD /C/
42163322230000	H-M OIL COMPANY	CALVERT H L ETAL
42163322550000	ANDREWS OIL COMPANY	BACK BURNER
42163322990000	ENERGY RESV GRP INC	BURNS MARTHA DOBSON
42163323340000	ENERGY RESV GRP INC	BURNS MARTHA DOBSON
42163323430000	SEAROC OIL CO INC	AVANT JAMES R
42163323550000	ENERGY RESV GRP INC	BURNS MARTHA DOBSON
42163323890000	BROCK EXPL CORP	ESCHENBURG
42163324060000	ENERGY RESV GRP INC	SHINER RANCH
42163324320000	COX EDWIN L&BARRY EN	HILDEBRAND
42163325700000	COX OIL & GAS INC	HILDEBRAND
42163329060000	PLAINS PETR OPERG CO	BURNHAM
42163332750000	PROPERTY DEVELOPMENT	HITZFELDER
42163333040000	DALE OPERATING CO	OPPENHEIMER-CALVERT
42163333060000	VIRTEX PET CO INC	HARLAN
42163333070000	VIRTEX PET CO INC	HARLAN
42163333120000	VIRTEX PET CO INC	WILLIAMS GEORGE M
42163333280000	NICHOLS EDWIN EXPINC	KINCAID
42283003230000	HUMBLE OIL & REFG CO	J E BISHOP
42283302560000	SHELL OIL CO	A MARTIN ESTATE
42283302600000	SHELL OIL CO	ALEAN N EVANS ETAL
42283302610000	GETTY OIL COMPANY	J T WILSON
42283303010000	LOVELADY I W	PENA /A/
42283303040000	LOVELADY I W	GANCHAN TRUSTEE
42283303490000	QUINTANA PET CORP	S TEXAS SYN II
42283306370000	SAXON OIL CO	STOREY
42283307300000	SOHIO PETROLEUM CO	GLUECK REBECCA
42283307830000	AMMEX PETROLEUM CORP	A-1 NRG
42283308110000	AMMEX PETROLEUM CORP	BETTY
42283308570000	ENERGY RESV GRP INC	BURNS MARTHA D ETAL
42283309470000	COX EDWIN L&BARRY EN	EHLERT E O

API	Operator	Well Name
42283310300000	ENERGY RESV GRP INC	BURNS MARTHA DOBSON
42283310960000	TEXACO INCORPORATED	BURNS M D TRUST
42283311070000	ENERGY RESV GRP INC	BURNS MARTHA DOBSON
42283311670000	COX EDWIN L&BARRY EN	TILLER
42283311910000	BHP PET(AMERICAS)INC	WILSON J T
42283312440000	SUTTON PRODUCING COR	APPLING
42283312520000	YOUNG JOHN H INC	RITA
42283312540000	SUTTON PRODUCING COR	APPLING
42283312590000	WEBER ENERGY CORP	BURNS HEIRS
42283312630000	ORYX ENERGY CO	BECKMAN M A
42283312650000	YOUNG JOHN H INC	HELEN
42283313130000	SUTTON PRODUCING COR	GUTIERREZ R M
42283314590000	SUTTON PRODUCING COR	REEVES /A/
42283314790000	ORYX ENERGY CO	BECKMAN M A
42283314860000	UNION PACIFIC RES CO	PENA-PENA UNIT
42283315170000	SUTTON PRODUCING COR	PRYOR
42283315190000	WASHINGTON ENRGY EXP	BECKMAN M A
42283315200000	YOUNG JOHN H INC	CHRISTINA
42283315210000	SUTTON PRODUCING COR	GUTIERREZ R M
42283315230000	ASHER RESOURCES	COOKE C N /A/ GU
42283315260000	ASHER RESOURCES	COOKE C N GAS UNIT
42283315330000	SUTTON PRODUCING COR	PRYOR
42283315340000	ANADARKO PET CORP	COOKE /A/
42283315400000	ANADARKO PET CORP	COOKE `B`
42283315530000	ANADARKO PET CORP	CARTWRIGHT `A`
42283316110000	QUINTANA PET CORP	SOUTH TEXAS SYNDICAT
42283316240000	TEXAS CRUDE ENERGY	COOKE C N TRUST
42283316360000	TEXAS CRUDE ENERGY	KILLAM
42283316700000	FREDONIA RES INCORP	EVANS-BUENA SUERTE
42283316730000	FREDONIA RES INCORP	HIXON
42283317800000	LEWIS PET PROP INC	HARLE `H`
42283319060000	PIONEER NAT RES USA	SOUTH TEXAS SYNDICA
42283319070000	PIONEER NAT RES USA	SOUTH TEXAS SYNDICA
42323000860000	CONTINENTAL OIL CO	N J CHITTIM
42323000870000	CONTINENTAL OIL CO	N J CHITTIM
42323006180000	CONTINENTAL OIL CO	N J CHITTIM
42323306620000	EXXON CO USA	ROBERT BARCLAY JR

API	Operator	Well Name
42323306980000	SAXON OPERATING CO	HALSELL RANCH
42323312700000	LONGHORN GAS COMPANY	HALSELL RANCH #2-3
42323317520000	OSBORNE OIL CO	CHITTIM ANNIE E
42323317540000	OSBORNE OIL CO	CHITTIM ANNIE E
42323317560000	OSBORNE OIL CO	CHITTIM ANNIE E
42323318650000	OSBORNE OIL CO	BARCLAY
42323319030000	OSBORNE OIL CO	CHITTIM ANNIE E
42323319680000	OSBORNE OIL CO	CHITTIM ANNIE E
42323320200000	OSBORNE OIL CO	BARCLAY
42323321980000	OSBORNE OIL CO	BARCLAY
42323323600000	SHAW T G	CHITTIM ANNIE E
42323323910000	EXPLORATION CO THE	LA PALOMA
42323324330000	HUNTER EXPL CO	CHITTIM 92
42323324580000	J-W OPERATING CO	CHITTIM 78
42323324700000	GYPSY PRODUCTION CO	CHITTIM ANNIE E
42323325000000	EXPLORATION CO THE	PALOMA `D`
42323325050000	EXPLORATION CO THE	PALOMA `D`
42323325090000	COBRA OIL & GAS CORP	CHITTIM RANCH
42323325180000	EXPLORATION CO THE	PALOMA `E`
42323325230000	EXPLORATION CO THE	PALOMA `E`
42323325290000	EXPLORATION CO THE	CHITTIM
42323325340000	EXPLORATION CO THE	CHITTIM
42323325400000	EXPLORATION CO THE	BRISCOE-SANER
42323325540000	J-W OPERATING CO	CHITTIM ANNIE E(115)
42323325560000	EXPLORATION CO THE	CHITTIM
42323325830000	EXPLORATION CO THE	PALOMA E
42323326010000	EXPLORATION CO THE	PALOMA `E`
42323326030000	BROOKS E B JR	WILLIAMS
42323326040000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326060000	EXPLORATION CO THE	CHITTIM
42323326170000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326180000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326190000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326270000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326280000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326290000	SAXET ENERGY LIMITED	COMANCHE RANCH

API	Operator	Well Name
42323326480000	EXPLORATION CO THE	PALOMA
42323326490000	EXPLORATION CO THE	CHITTIM
42323326570000	EXPLORATION CO THE	TAYLOR 1
42323326580000	EXPLORATION CO THE	CHITTIM
42323326600000	EXPLORATION CO THE	BRISCOE-SANER
42323326630000	EXPLORATION CO THE	BRISCOE-SANER
42323326640000	EXPLORATION CO THE	CHITTIM
42323326650000	EXPLORATION CO THE	BRISCOE-SANER
42323326660000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326670000	EXPLORATION CO THE	CHITTIM
42323326790000	EXPLORATION CO THE	CHITTIM
42323326830000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326840000	EXPLORATION CO THE	CHITTIM
42323326850000	EXPLORATION CO THE	CHITTIM
42323326860000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326870000	EXPLORATION CO THE	CHITTIM
42323326920000	EXPLORATION CO THE	CHITTIM
42323326930000	SAXET ENERGY LIMITED	CAGE MINERALS LTD ET
42323326940000	SAXET ENERGY LIMITED	CAGE MINERALS LIMITE
42323326950000	SAXET ENERGY LIMITED	COMANCHE RANCH
42323326980000	EXPLORATION CO THE	CHITTIM
42323326990000	EXPLORATION CO THE	CHITTIM
42323327020000	EXPLORATION CO THE	BRISCOE-SANER
42323327040000	EXPLORATION CO THE	BRISCOE-SANER
42323327070000	EXPLORATION CO THE	BRISCOE-SANER
42323327120000	EXPLORATION CO THE	CHITTIM
42323327140000	EXPLORATION CO THE	CHITTIM
42323327150000	CMR ENERGY LP	COMANCHE RANCH
42323327180000	EXPLORATION CO THE	CHITTIM
42323327190000	EXPLORATION CO THE	PALOMA E
42323327200000	CMR ENERGY LP	COMANCHE RANCH
42323327230000	EXPLORATION CO THE	CHITTIM
42323327270000	EXPLORATION CO THE	CHITTIM
42323327300000	EXPLORATION CO THE	CHITTIM
42323327500000	EXPLORATION CO THE	CHITTIM E
42323327580000	TOUCHSTONE RES USA	DENMAN
42323327650000	CMR ENERGY LP	CAGE RANCH G UNIT

API	Operator	Well Name
42323327970000	TOUCHSTONE RES USA	DENMAN
42323328050000	BLUE STAR OPERG CO	NUNLEY
42323328100000	EXPLORATION CO THE	CAGE RANCH
42323328150000	EXPLORATION CO THE	CAGE RANCH
42323328170000	EXPLORATION CO THE	CAGE-BRISCOE B 138 U
42323328190000	EXPLORATION CO THE	CAGE RANCH
42323328300000	EXPLORATION CO THE	BRISCOE-SANER
42323328570000	EXPLORATION CO THE	CHITTIM G
42507007360000	TENNECO OIL CO	J W NIXON
42507303890000	GOSE STEVE	MELVIN D RAY
42507304060000	TIPPERARY O&G CORPOR	ROD TRUST
42507304110000	HARRISON HUBERT J	R S CRAWFORD
42507304130000	LOVELADY I W	HOLDSWORTH
42507304290000	CONVEST ENERGY PRTNR	JOHN B LUPE
42507304560000	COYLE JOHN J	GEORGE WEST
42507304920000	TIPPERARY O&G CORPOR	BUCHANAN /A/
42507308970000	EAKIN T L	PRYOR IKE T
42507312960000	EASON OIL CO	FLOWERS & WARD
42507313950000	GOSE STEVE	CAPPS ELLA ETAL
42507315870000	EXXON CORPORATION	CHINN & ASHBY
42507316340000	MINUTEMEN CONSLT INC	CARDWELL
42507317050000	CRB OIL & GAS INC	LEE RANCH
42507317210000	BOMMER ENGR CO	MATHEWS R
42507318790000	GRAHAM EXPL LTD	WINTERBOTHAM G S
42507318800000	GRAHAM EXPL LTD	WINTERBOTHAM G S
42507320910000	RISA ENERGY CORP	BARTLETT ESTATE
42507324950000	CHI OPERATING INC	HUISACHE
42507325200000	REGAL PETRLM SERVCS	EL VIEJO
42507326360000	HUGHES DAN A CO	CHAPARROSA `D`
42507326440000	HUGHES DAN A CO	CHAPARROSA E
42507326450000	RIO TEX INC	PICOSA CREEK
42507326520000	TOUCHSTONE RES USA	TRAVIS L O 641
42507326560000	MESTENA OPERATNG LTD	HARGIS
42507326570000	MESTENA OPERATNG LTD	THOMPSON
42507326870000	GENESIS GAS &OIL LLC	BENNETT GGO
42479048570000	RICHARDSON PET ENTPR	GATES RANCH CO
42479328460000	AMOCO PROD CO	KILLAM-HURD-AMOCO

API	Operator	Well Name
42479342250000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479350670000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479351530000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479352200000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479352310000	NULL W M	BOOTH W V JR
42479353130000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479353420000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479353740000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479353940000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479353990000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479354050000	LEWIS PET PROP INC	DAWSON K
42479354320000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479354530000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479354540000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479354600000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479354790000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479355210000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479355370000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479355770000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479356150000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479356300000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479356360000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479356400000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479356460000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479356840000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479357610000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479357650000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479357720000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479361940000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479366270000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479367920000	MOBIL PRDUCNG TX&NM	SOUTH CALLAGHAN RAN
42479371010000	MICHAEL PET CORP	SOUTH CALLAGHAN RAN
42479371460000	MICHAEL PET CORP	SCHWARZ E H
42479377950000	MICHAEL PET CORP	GILL F J
42479378520000	LEWIS PET PROP INC	BOOTH W V ETAL
42479380530000	LEWIS PET PROP INC	PALAFOX GALAN `H`
42479385100000	LEWIS PET PROP INC	BOOTH W V ETAL H

API	Operator	Well Name
42479388660000	LEWIS PET PROP INC	BOOTH W V JR H
42479389940000	LEWIS PET PROP INC	BOOTH W V JR H
42123320980000	PIONEER NAT RES USA	MENN GAS UNIT
42013018850000	PLYMOUTH OIL COMPANY	E L POWELL
42013302980000	BTA OIL PRODUCERS	7610 JV-P RICE
42013303020000	BROWN TOM INC	J W GORMAN ETAL
42013309780000	GULF OIL CORP	TARTT EMMA ETAL
42013309810000	WATSON OIL CORP	SCHRUTKA KARL
42013311590000	GIERHART B J INC	SMITH T W
42013311740000	GULF OIL CORP	HENDERSON ETAL GU 2
42013312830000	ENSERCH EXPL INC	TOM J L /A/ UNIT 3
42013312950000	ENERGY RES O&G CORP	LITTLE J LD LTD
42013313140000	CPC EXPLORATION INC	LINKENHOGER LILLIE
42013313300000	EVERGREEN OIL CORP	GORMAN J W SOUTH
42013313440000	TOWNSEND COMPANY	DRAGON FRANK
42013313610000	EVERGREEN OIL CORP	GORMAN J W
42013313730000	EXXON CORPORATION	FOSTER LAMAR
42013314300000	TOWNSEND COMPANY	ALBERT
42013314680000	SANTA FE WINDSOR PRD	JAMES
42013316310000	LANG EXPL CO	LYDA GERALD UNIT E
42013317370000	PETROLIA DRLG CORP	KUBACAK J W ETAL
42013317680000	CASHCO OIL CO	POTEET SCHOOL BD
42013317980000	ENSERCH EXPL INC	TOM J L /A/ UNIT 2
42013318760000	ENSERCH EXPL INC	RICHTER H UNIT
42013319190000	KELPETRO INC	WHEELER MARTIN LSE
42013321020000	ULTRAMAR PETROLEUM	EISENHAUER ERHARD 1
42013321960000	BLAIR JACK N	ABERCROMBIE J S 74
42013323980000	HUGHES & HUGHES	MARSH WOODROW
42013325590000	ULTRAMAR O&G LTD	EISENHAUER CLIFFORD
42013329020000	EXXON CORPORATION	NIXON LUCILLE
42013330830000	LANTANA RES INC	NAEGELIN JOHN JR
42013331790000	ENSERCH EXPL INC	TOM J L /A/ UNIT 4
42013333840000	CHEVRON U S A INC	HENDERSON ETAL GAS U
42013333950000	BAY ROCK CORP	HEINEN D D JR
42013334070000	CSA EXPL CO LTD	NIXON
42013334900000	ARCO OIL & GAS CORP	SMITH MARY CAROL TRU
42013335090000	EP OPERATING CO	SCHUMANN H A /A/ UN

API	Operator	Well Name
42013335120000	CARR F WILLIAM	SCOTT C L
42013336250000	HUGHES TEXAS PET LTD	OLIVARRI HORTENCIA
42013336510000	LAWBAR PETROLEUM INC	WILLIAMS J K
42013337870000	COTTONWOOD EXPL CO	BOYD
42013338000000	BRIGHT & CO	MCDANIEL
42013338050000	COTTONWOOD EXPL CO	VRANA
42013338340000	HUGHES TEXAS PET LTD	BURKHARDT KATIE
42013338430000	RGR PRODUCTION	SCHEARRER
42013339020000	ABRAXAS PETRLM CORP	NAEGLIN
42013339160000	BURK ROYALTY CO	KINSEL
42013339240000	EP OPERATING CO	TOM J L /A/ UNIT 4
42013339270000	AMERICAN COMETRA INC	DOWDY
42013339280000	SANDIA OPRTNG CORP	SUMMERS
42013339400000	BURK ROYALTY CO	HOWARD-BRAUN
42013339480000	EP OPERATING CO	TOM J L /A/ UN 1
42013339720000	DELCAR INCORPORATED	MUELLER UNIT
42013339770000	CHEVRON U S A INC	TARTT EMMA ETAL
42013339790000	EP OPERATING CO	KELLNER ETAL GU
42013339820000	EP OPERATING CO	SCHUMANN `A` UNIT 1
42013339890000	CHEVRON U S A INC	WEGNER ETAL GAS UN
42013339920000	CHEVRON U S A INC	TARTT EMMA ETAL
42013339930000	BURK ROYALTY CO	KINSEL
42013340060000	EP OPERATING CO	SCHUMANN H A UNIT /A
42013340090000	EP OPERATING CO	RICHTER
42013340200000	EP OPERATING CO	URBANCZYK GAS UN 2
42013340230000	BURK ROYALTY CO	KING UNIT
42013340260000	CHEVRON U S A INC	HENDERSON ETAL UNIT
42013340270000	CHEVRON U S A INC	HENDERSON ETAL GAS U
42013340300000	EP OPERATING CO	URBANCZYK L T GAS UN
42013340310000	EP OPERATING CO	TOM J L -A- UNIT 2
42013340320000	BURK ROYALTY CO	MAREK
42013340330000	WATERS ENGR&OPRTNG	SARAH E FERRY UNIT
42013340340000	ENSERCH EXPL INC	SCHUMANN H A B UNIT
42013340400000	CHEVRON U S A INC	HURT W T ETAL
42013340430000	CHEVRON U S A INC	WEGNER ETAL GAS UNI
42013340560000	TECH RESOURCES INC	LANGE L F
42013340590000	DIRNETT INC	ESCHENBURG-POLLOK

API	Operator	Well Name
42013340720000	CHEVRON U S A INC	TARTT EMMA ET AL
42013340730000	PEDECO INCORPORATED	MALLARD
42013340740000	CHEVRON U S A INC	HENDERSON ETAL UNIT
42013340970000	ENRON OIL & GAS CO	SCHWARZ A W
42013341010000	AMPAK OIL COMPANY	NEWMAN
42013341030000	VENUS EXPL INC	SMITH M C
42013341040000	AMPAK OIL COMPANY	NEWMAN
42013341180000	SONAT EXPL INC	DE ATLEY M K
42013341360000	BURK ROYALTY CO	RUBSAMEN
42013341390000	EOG RESOURCES INC	BIRDWELL R R
42013341750000	HUNTINGTON ENERGY	CHILIPITIN UNIT
42013341800000	BAY ROCK OPERTNG CO	STAFFORD
42013341900000	WAGNER OIL COMPANY	SMITH MARY CAROL TRU
42013341940000	XTO ENERGY INC	SCHUMANN ETAL GAS UN
42013341950000	XTO ENERGY INC	TARTT EMMA
42013342060000	RIO TEX INC	DODSON
42013342170000	PROPERTY DEVELOPMENT	LAWSON WEST
42177301380000	PAN EASTERN EXPL CO	MALATEK
42177301620000	PRAIRIE PRODUCING CO	HENSLEY T HURT
42177305560000	ROBINSON BROTHERS	BYRD BALL UNIT
42177306220000	AMMEX PETROLEUM CORP	MAGEE MOLLIE
42177307800000	CZAR RESOURCES LTD	HILBRICH EDWIN ETUX
42177308890000	CZAR RESOURCES LTD	BURT VIVIAN CARTER
42177309400000	ENERGETICS INC	NORRIS T M
42177309850000	ALCORN PRODUCTION CO	PATTESON J B ETAL
42177310450000	NUCORP ENERGY INC	KING RUFUS /A/
42177311460000	TEXAS GENERAL PETRO	POLAN
42177313690000	CHISHOLM OIL INVEST	JIMMIE
42177314470000	PYRO ENERGY CRP	LINDEMANN #1
42177314790000	PYRO ENERGY CRP	LESTER J B
42177315180000	WOG INC	PARKER
42177315330000	HAGEN-GREENBRIAR EXP	BROWN WM BREWSTER
42177315540000	HAGEN-GREENBRIAR EXP	BAKER SHELBY
42177315970000	ROYAL OIL & GAS CORP	JARMON H T ET AL
42177317070000	ENRON OIL & GAS CO	MALAER ETAL GAS UNIT
42177317260000	MODERN EXPL CO	KING HOWARD

API	Operator	Well Name
42177317490000	BURK ROYALTY CO	BELL /G/
42177317530000	LACY & BYRD INC	BARTA /C/
42177318460000	KERR-MCGEE CORP	CAMPBELL-HAHN UN
42177318860000	COX&PERKINS EXPL INC	ALLEN DORIS
42177319650000	COX&PERKINS EXPL INC	ALLEN DORIS
42177319670000	AUSTIN RES CORP	ROBINSON
42177319800000	YATES ENERGY CORP	BORCHERS-HILBRICH-GA
42177320150000	PEDECO INCORPORATED	COOK L D & SONS
42177320180000	PEDECO INCORPORATED	PATILLO
42177320410000	HUNT OIL CO	PIPHER L A
42177320500000	HOUSTON EXP CO THE	BAROSH
42177320510000	ENERQUEST OPER LLC	BAKER UNIT
42187305320000	PRAIRIE PRODUCING CO	JANE W BLUMBERG /B/
42187305330000	PRAIRIE PRODUCING CO	JANE W BLUMBERG /A/
42187318650000	EXXON CORPORATION	WELLS GEORGIA B
42187323940000	COHO RESOURCES LTD	WEINERT H H EST
42187332930000	BURK ROYALTY CO	MARTIN-BOOTH UNIT
42187333100000	BURK ROYALTY CO	DINGLER-BATEY UNIT
42187333730000	P S N PETROLEUM INC	DAVENPORT UNIT
42311012150000	HUMBLE OIL & REFG CO	DILWORTH FIELD
42311022400000	PAN AMERICAN PROD CO	G W HENRY
42311301160000	HUMBLE OIL & REFG CO	DILWORTH J C JR
42311303770000	EXXON CO USA	DILWORTH J C JR
42311305230000	EXXON CO USA	JEAN TYLER HARRIS
42311308640000	EXXON CO USA	DILWORTH J C JR
42311308760000	SHELL OIL CO	FELIX MORALES
42311309680000	EXXON CO USA	DILWORTH FLD GU #1
42311310640000	EXXON CORPORATION	DILWORTH J C JR
42311312470000	COX EDWIN L	FOSTER
42311314770000	SHELL OIL CO	HORTON R P
42311316450000	SHELL OIL CO	HUBBERD W
42311317850000	PLACID OIL CO	PEELER
42311321590000	ARKLA EXPL CO	HOLLAND
42311321630000	TENNECO OIL CO	JACOBS LEONARD CORP
42311322710000	AMAX PETROLEUM CORP	NISSEN MABEL
42311323710000	CAPRINA CORP	PAISANO RANCH
42311325170000	SUTTON PRODUCING COR	WHEELER

API	Operator	Well Name
42311329150000	QUINTANA PET CORP	DILWORTH
42311329730000	TANA OIL & GAS CORP	MAFRIGE
42311336430000	BASS ENTRPRS PROD CO	WHEELER RANCH
42311336680000	HTP ENERGY	LIME UNIT
42493302080000	PRAIRIE PRODUCING CO	BRECHTEL WAYNE
42493302160000	WAINOCO INC	SAM MOY
42493302360000	CAYMAN EXPL CORP	F W MARTIN
42493303920000	PENINSULA RES CORP	VICTOR MUENSTER
42493306740000	MGF OIL CORP	URBANCZYK UNIT
42493306800000	MARK IV ENERGY	COPELAND WE ETL EST
42493306840000	HENRY PETROLEUM INC	BROWN /A/
42493307230000	AMMEX PETROLEUM CORP	CLARA UNIT
42493307360000	HAWN BROS CO	MOCZYGEMBA UNIT
42493307480000	INEXCO OIL CO	BRYAN E S
42493307690000	MGF OIL CORP	BUDEWIG ESTATE UNIT
42493307730000	LONGHORN O & G CO	CHILEK V J ETAL
42493307760000	LONGHORN O & G CO	HUBERT FRANK
42493307850000	ENERGY RES O&G CORP	PAWELEK
42493307980000	LONGHORN O & G CO	COMPTON O D
42493308250000	MARSHALL&WINSTON INC	MANFORD
42493308380000	LINGEN EXPL INC	BAIN FRANK L
42493308490000	WALKER & WITHROW INC	ZIDEK ED
42493308690000	HAWN BROS CO	FELUX JOE JR
42493309950000	U S OPERATING INC	OLD KING COLE UN
42493310030000	LONGHORN O & G CO	RICE ROBERT M
42493310160000	EUROPEAN-SOUTHWST CO	FLIELLER C
42493310190000	U S OPERATING INC	WEBER
42493310240000	MENGDEN WALTER H	MENGDEN P ETAL
42493310610000	EUROPEAN-SOUTHWST CO	SWIENTEK THEODORE
42493310740000	EXXON CORPORATION	HANDY K L
42493310770000	EUROPEAN-SOUTHWST CO	FLIELLER CLIFTON
42493310820000	BAXTER MURPHY H	GORHAM
42493310860000	CLAYTON WILLIAMS ENR	ROBBINS IRENE
42493311060000	KAISER OIL USA LTD	CONNELLY JOHN B
42493312820000	EUROPEAN-SOUTHWST CO	LANGILLE S M EST

API	Operator	Well Name
42493314310000	EQUITY DRLG CO	HEWELL W W ETAL
42493315440000	SPG EXPLORATION CORP	SCHNEIDER
42493315850000	CLAYTON WILLIAMS ENR	KOPECKI THADDEUS UNI
42493316870000	EQUITY DRLG CO	KOENIG
42493317540000	HOLLUB LAMBRT DRL CO	WEBER
42493317770000	TRIDENT CORP	BIELA
42493318290000	BLUCO PROD CO INC	PROSPER LABUS UNIT
42493318420000	HUBER BROTHERS OPER	OLENICK
42493318520000	VARNADORE EXPL CO	JASKINIA FRED
42493318980000	EUROPEAN-SOUTHWST CO	STADLER
42493319120000	NELSON & TUCKER OPER	FANNIN ROBERT
42493319140000	NELSON & TUCKER OPER	KELLER
42493319230000	FOSSIL EXPLORATION	PRUSKE HENRY
42493319380000	TEXLARK EXPL CO INC	TITZMAN
42493319810000	DBO OIL INCORPORATED	CASARES A K
42493319920000	LATIMER D GAIL ENTP	WALL DARDEN
42493319980000	BURK ROYALTY CO	WILEY-BIRD UNIT
42493320370000	DBO OIL INCORPORATED	CASARES A K /A/
42493320460000	BURK ROYALTY CO	FINCH-BIRD UNIT
42493321000000	BURK ROYALTY CO	LEHMANN UNIT
42493321090000	BURK ROYALTY CO	EMBRY
42493321290000	BURK ROYALTY CO	BUSH-JONES UNIT
42493321370000	SABRE OPERATING INC	ALLEN
42493321390000	UNITED OIL & GAS INC	LEAH
42493321570000	P S N PETROLEUM INC	MILLIKIN
42493321790000	BURK ROYALTY CO	SETLIFF
42493321820000	BURK ROYALTY CO	BRYAN
42493322060000	BURK ROYALTY CO	LEHMANN UNIT /A/
42493322270000	JENNINGS EXPL CO	BROLL HENRY JR
42493323950000	ENRE CORPORATION	LOPEZ ALMA
42493324450000	ENRE CORPORATION	BAIN J H
42493324890000	MARK IV ENERGY	MCCLOSKEY R B ET AL
42013342270000	VIRTEX PET CO INC	SCHORSCH `A`
42123322020000	GEOSOUTHERN ENERGY	MIGURA
42123322290000	ENDURING RES LLC	BLACKWELL GAS UNIT 2
42127333480000	ENCANA O&G (USA) INC	COVERT F M
42127333530000	HURD ENTERPRISES LTD	KONE ESTATE B

API	Operator	Well Name
42127334210000	ANADARKO E & P CO LP	BRISCOE CATARINA WES
42163333350000	VIRTEX PET CO INC	HARLAN R K
42163333360000	VIRTEX PET CO INC	HARLAN R K
42163333460000	VIRTEX PET CO INC	HARLAN R K
42163333550000	BLACKBRUSH OIL & GAS	MORALES PEDRO
42163333580000	ALAMO OPERATING COLC	WILLIAMSON
42163333710000	MANTI OPERATING CO	BENKE L INC
42255315420000	BLACKBRUSH OIL & GAS	PERSON OTHA D
42255315570000	ENDURING RES LLC	WESSENDORF GAS UNIT
42255315740000	BURLNGTN RE OG CO LP	BORDOVSKY A7
42255315750000	BLACKBRUSH OIL & GAS	PAWELEK MIKE UNIT
42283321620000	PETROHAWK OPERATING	MARTIN DORA
42297347440000	PIONEER NAT RES USA	FULBRIGHT HERSCHEL
42297347930000	PIONEER NAT RES USA	BENHAM ERNA P GAS U
42323328900000	EXPLORATION CO THE	CAGE-BRISCOE A 119
42323329130000	EXPLORATION CO THE	CAGE-BRISCOE `C` 142
42323329320000	CORNERSTONE E & P CO	NUNLEY
42323329450000	CMR ENERGY LP	COMANCHE RANCH
42255316060000	ENDURING RES LLC	WESSENDORFF GAS UNI
42013329890000	EXXON CORPORATION	PRUITT E J
42283321900000	ROSETTA RES OPER LP	SPRINGER RANCH
42479405770000	ST MARY LAND&EXP CO	GALVAN RANCH
42283321990000	COMMON RESOURCES LLC	NUECES MINERALS COMP
42283322190000	MURPHY EXPL&PROD CO	CRESCENT C
42283322230000	MURPHY EX&PR CO-USA	NUECES MINERALS COMP
42311341397000	MURPHY EX&PR CO-USA	MILES GEORGE (PILOT)
42255316167100	MURPHY EX&PR CO-USA	DREES A-179
42013342700000	HARPER HEFTE INC	JACOB HOLDINGS LTD
42123321937000	BURLNGTN RE OG CO LP	HOOKS
42297348510000	BURLNGTN RE OG CO LP	PLOMERO RANCH
42163334030000	CABOT OIL & GAS CORP	WEST PATRICK
42283322307000	MURPHY EXPL&PROD CO	ASCHE RANCH (PILOT)
42255316600000	HAWTHORN ENGY PRTNR	ORR
42123323270000	GEOSOUTHERN ENERGY	SEIFERT A
42255316827000	MURPHY EX&PR CO-USA	SCHENDEL A
42255316517000	MURPHY EX&PR CO-USA	JOG UNIT
42127336597000	MURPHY EX&PR CO-USA	BRIGGS (PILOT)

API	Operator	Well Name
42127337660000	SHELL WESTERN EXP&PR	PILONCILLO
42311343077000	MURPHY EX&PR CO-USA	SWAIM (PILOT)
42311342960000	COMSTOCK OIL&GAS LP	CARLSON `A`
42255317670000	COMSTOCK OIL&GAS LP	COATES `A`
42255317840000	BURLNGTN RE OG CO LP	YANTA NORTH
42311345107000	MURPHY EX&PR CO-USA	TYLER (PILOT)
42311344920000	COMSTOCK OIL&GAS LP	HILL
42013344537000	MURPHY EX&PR CO-USA	RYCHLIK UNIT (PILOT)
42311347317000	MURPHY EX&PR CO-USA	SAYLEE SOUTH (PILOT)
42013343597000	MURPHY EX&PR CO-USA	TOM UNIT (PILOT)
LP_YBAR_3H	MURPHY EX&PR CO-USA	YBAR_LP
42311349207000	MURPHY EX&PR CO-USA	CARVER UNIT 1
42013344690000	COMSTOCK OIL&GAS LP	MESQUITE
42297348497000	PIONEER NAT RES USA	CRAWLEY ROBERT GAS
42311341767000	SWIFT ENERGY OPER	PC-Q EF
42479404937000	ST MARY LAND&EXP CO	BRISCOE `G`
42479406037000	ST MARY LAND&EXP CO	BRISCOE AR
42479407057000	SWIFT ENERGY OPER	FASKEN `A` EF
42013344457000	COMSTOCK OIL&GAS LP	LUCAS `A`
42311350590000	MURPHY EX&PR CO-USA	Y-BAR 16H
42311349500000	PYOTE WATER SYST LLC	TILDEN HIGHWAY 72
42025322630000	PRIMARY FUELS	WHIDDON
42479330820000	SOUTHLAND ROYALTY CO	BRUNI MINERAL TR
42479340010000	EP OPERATING CO	LAUREL A Z LTD
42479343300000	EP OPERATING CO	LAUREL ALONZO Z LTD
42479365540000	TRANSTEXAS GAS CORP	BENAVIDES R V `B`
42013344697000	COMSTOCK OIL&GAS LP	MESQUITE