

Eaglebine Activity*

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Abstract

The Upper Cretaceous Eagle Ford Shale was first tapped in 2008 and now has around 21 active fields, and according to the Texas Railroad Commission, last year the shale produced 914 million cubic feet of natural gas per day and 326,978 barrels of oil per day (through October 2012). The Upper Cretaceous Shale section in Central Texas trends across Texas from the Mexican border across Southern United States Gulf Coast Region and is in outcrop along the East Coast up to the state of Maine. It is Late Cretaceous in age, resting between the Lower Cretaceous Buda Lime and the base of the Austin/Selma Chalk. This section is referred to as the Eagle Ford Shale in the Southwest Texas counties and is regionally referred to by many names, such as the Boquillas, Eagle Ford, Woodbine, Maness, and Tuscaloosa Shale. These formations, regardless of the name, are typically dark, organic-rich, brittle, fractured, fossiliferous, pyritic, siliceous, and calcareous, dark-grey to black shale. In its full extent, this shale play could be the largest unconventional resource play in the world.

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ZaZa Energy Corporation

EAGLEBINE ACTIVITY

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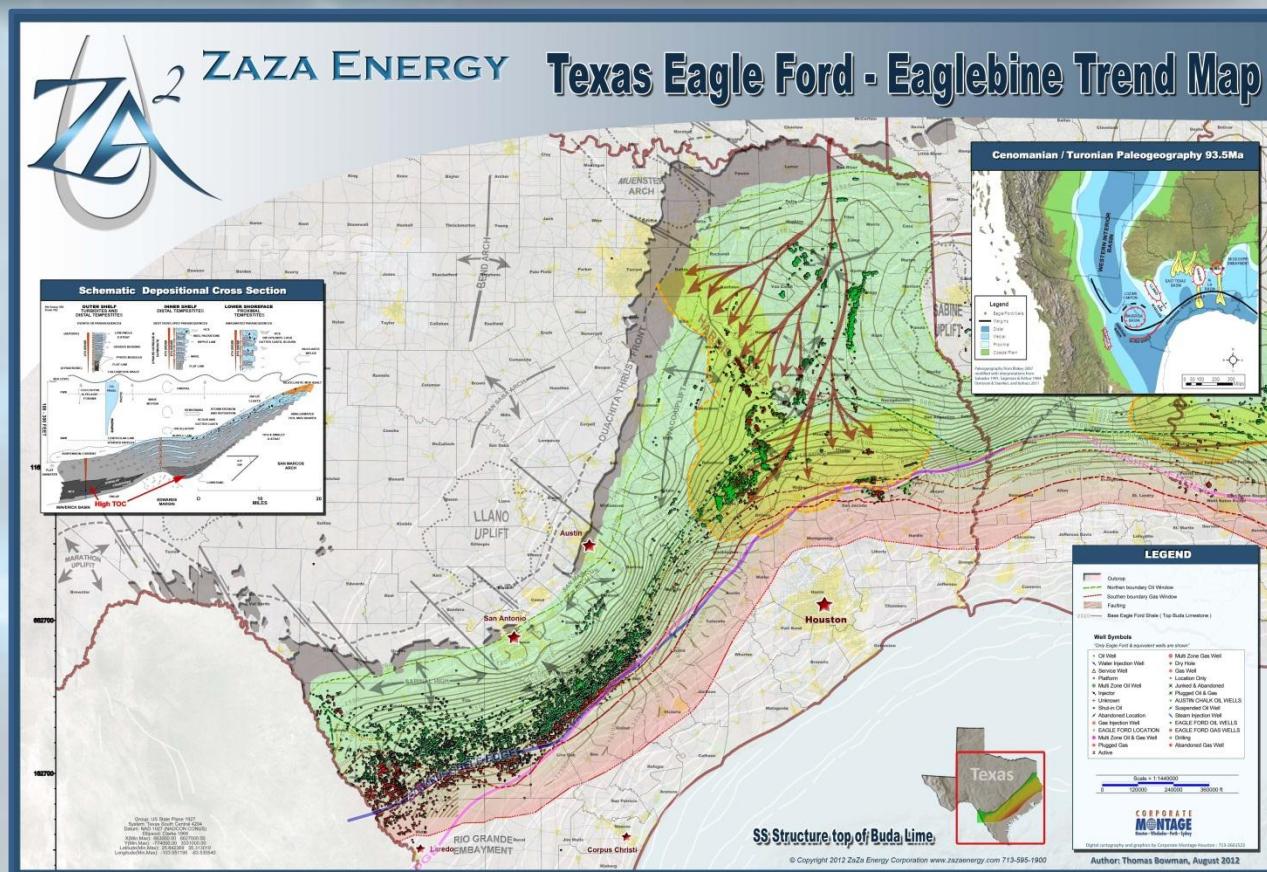


Eagle Ford Trend

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Key Points

- The shale play trends across Texas from the Mexican border up into East Texas, roughly 50 miles wide and 400 miles long with an average thickness of 250 feet.
- It is Cretaceous in age resting between the Austin Chalk and the Buda Lime at a depth of approximately 4,000 to 12,000 feet. The down-dip limits are currently defined by the Sligo shelf edge
- There were 1262 producing oil leases on schedule in 2012
- There were 875 producing gas well on schedule in 2012



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This image of the United States of America at night is a composite assembled from data acquired by the Suomi NPP satellite in April and October 2012. The image was made possible by the new satellite's "day-night band" of the Visible Infrared Imaging Radiometer Suite (VIIRS), which detects light in a range of wavelengths from green to near-infrared and uses filtering techniques to observe dim signals such as city lights, gas flares, auroras, wildfires, and reflected moonlight.

Credit: NASA Earth Observatory image by Robert Simmon, using Suomi NPP VIIRS data provided courtesy of Chris Elvidge (NOAA National Geophysical Data Center). Suomi NPP is the result of a partnership between NASA, NOAA, and the Department of Defense

Night View Resource Plays

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Key Points

- Visible Infrared Imaging
- Detects light in a range of wavelengths from green to near-infrared
- Uses filtering techniques to observe dim signals such as city lights, gas flares, auroras, wildfires, and reflected moonlight
- **Credit:** NASA Earth Observatory image by Robert Simmon, using Suomi NPP VIIRS data provided courtesy of Chris Elvidge (NOAA National Geophysical Data Center). Suomi NPP is the result of a partnership between NASA, NOAA, and the Department of Defense



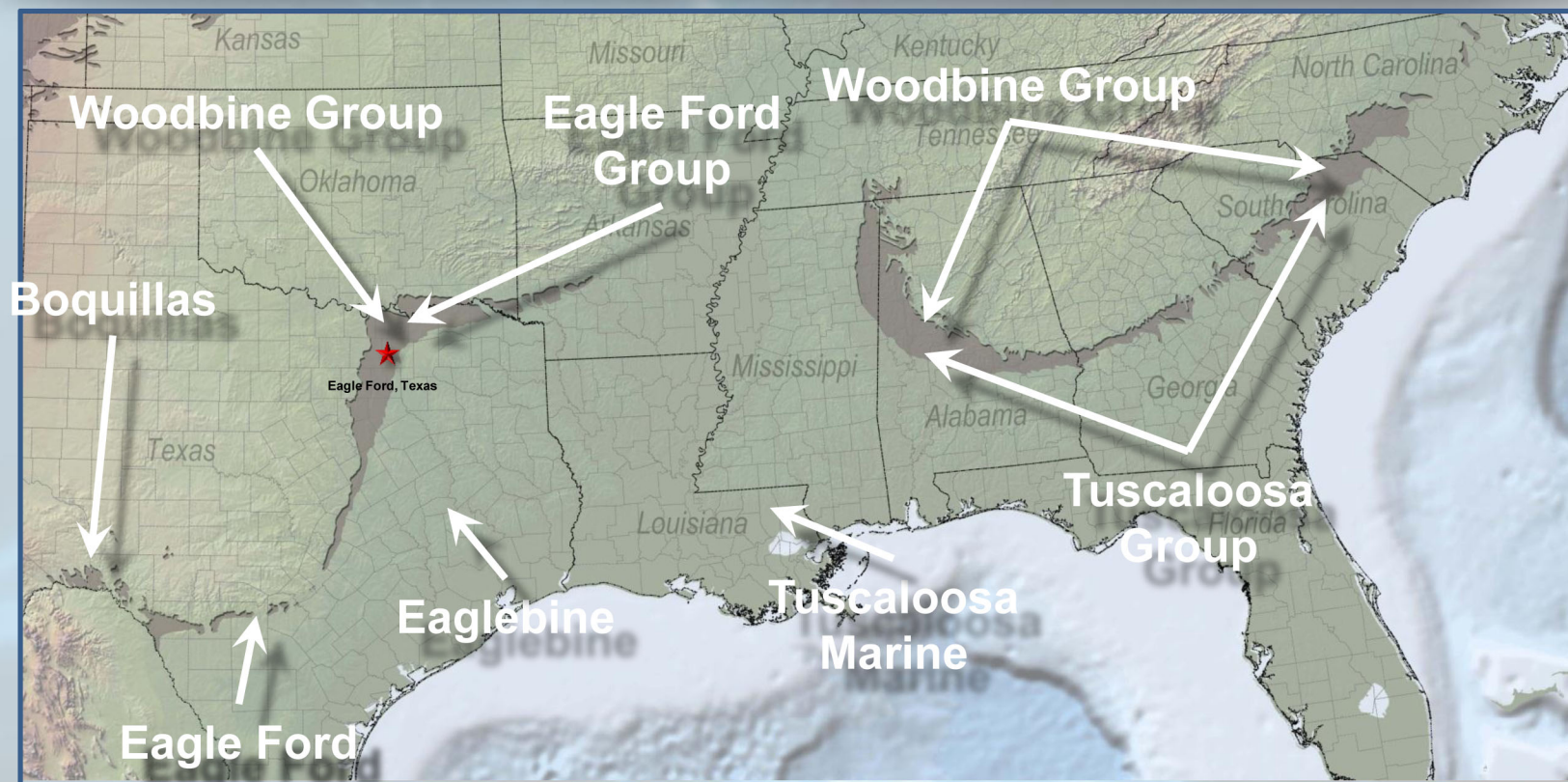
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Upper Cretaceous Shales

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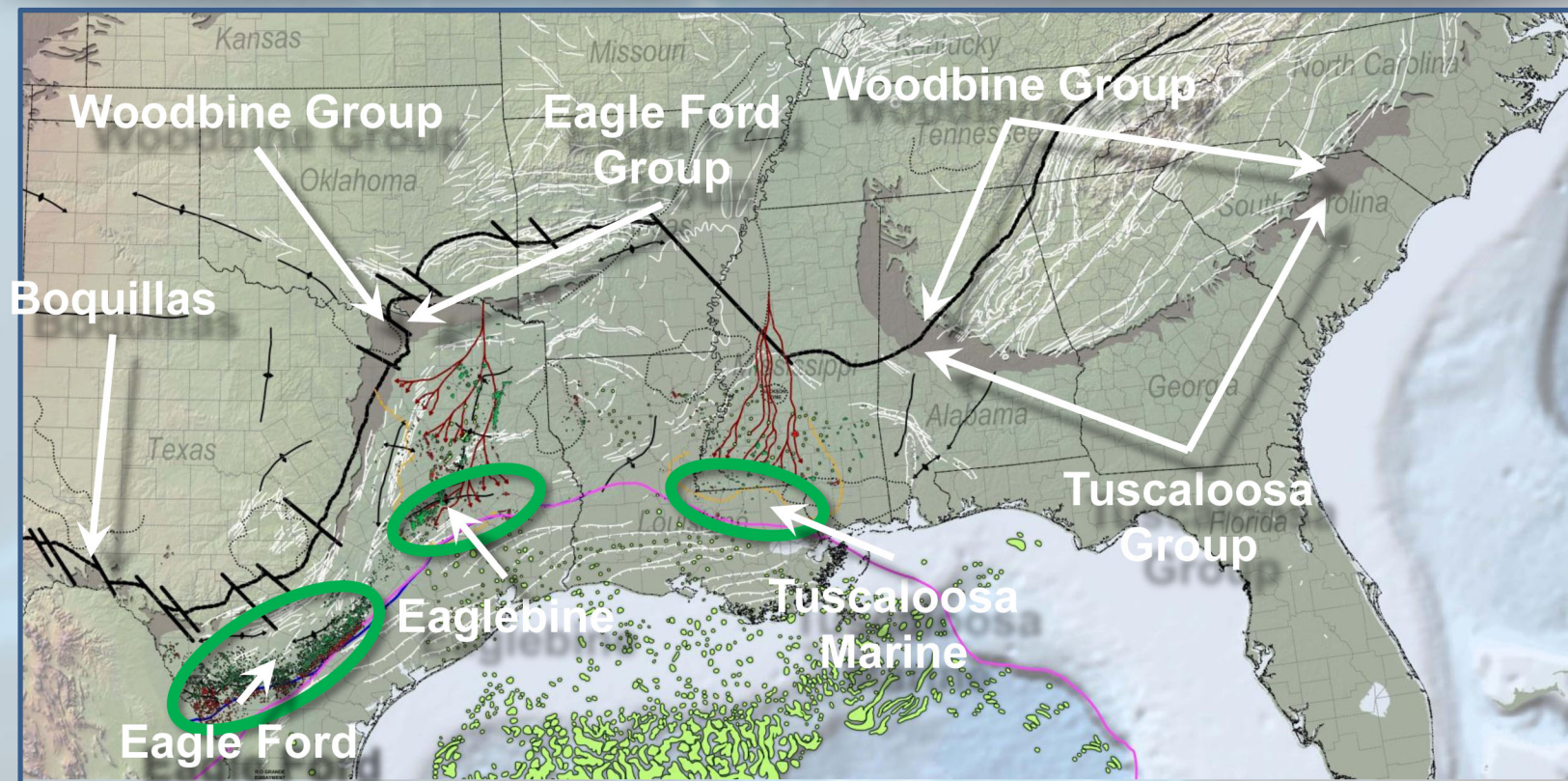


Lateral equivalents of Upper Cretaceous shale across the southern Gulf Coast of the United States, in outcrop and in subsurface. Local names include the Lewisville, Dexter, Maness, Pepper shales, and Raritan.



Upper Cretaceous Geology

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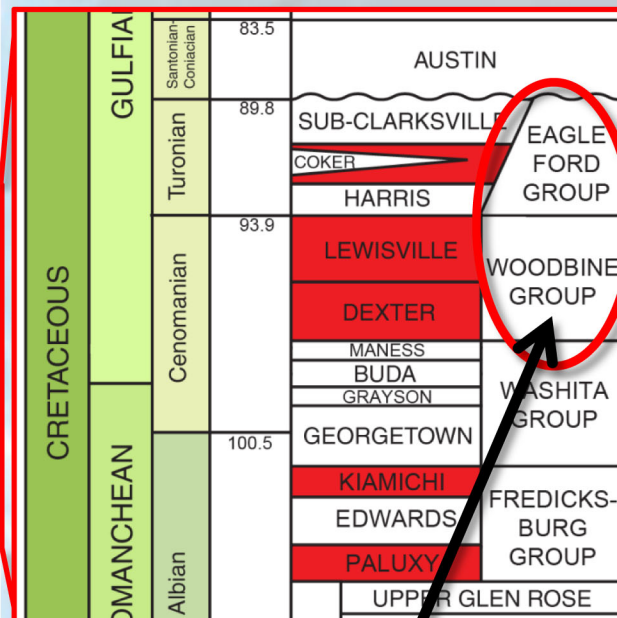
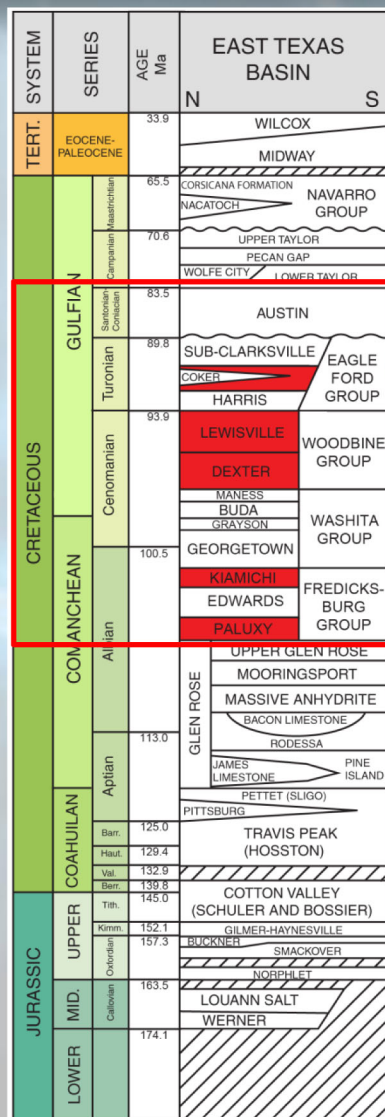
Lateral equivalents of Upper Cretaceous shale across the southern Gulf Coast of the United States, in outcrop and in subsurface. Local names include the Lewisville, Dexter, Maness, Pepper shales, and Raritan.



Eaglebine?

Key Points

- Eaglebine is the combination of the Eagle Ford Group and the Woodbine Group
- Generally the section from the base of the Austin Chalk to the top of the Buda Lime
- Generally containing the Cenomanian and Turonian Series formations
- The Eaglebine interval contains several conventional formations interlaced with organic-rich source rocks
- Additional source rocks are present in the Albian Series in the Kiamichi and Paluxy shales



← Important Source Rocks

← Important Source Rocks

← Important Source Rocks

← Important Source Rocks

EAGLEBINE

EXPLANATION	
	Potential source rocks
	Unconformity
	Disconformity
Age abbreviations	
Tert - Tertiary	
Barr. - Barremian	
Haut. - Hauterivian	
Val. - Valanginian	
Berr. - Berriasian	
Tith. - Tithonian	
Kimm. - Kimmeridgian	

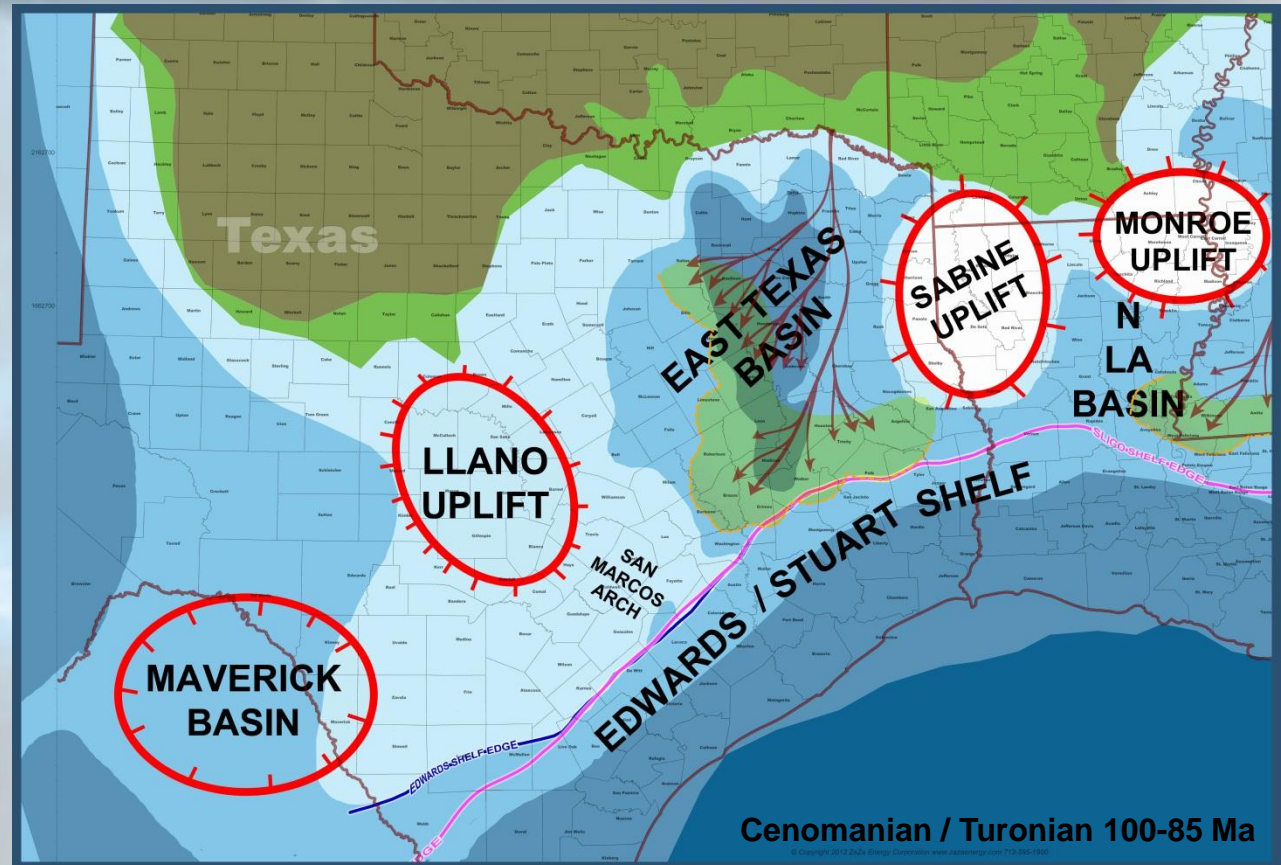
(modified from Kosters and others, 1989)

Cretaceous Paleogeography

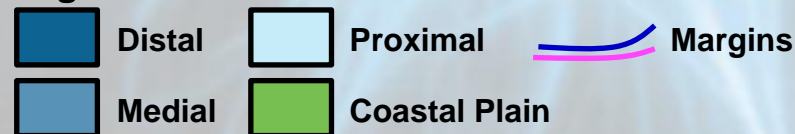
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Key Points

- Eagle Ford in Maverick Basin is dominated by carbonates
- East Texas Basin is dominated by siliciclastic deposition from the Ouachita complex to the north
- The siliciclastic formations include the Woodbine sands, Sub-Clarksville and the Harris Delta
- The influx of siliciclastic rocks are interlaced throughout the entire Eaglebine section



Legend



(Modified Paleogeography from Blakey 2007, modified with interpretations from Salvador 1991, Sageman & Arthur 1994 and Bowman 2012)

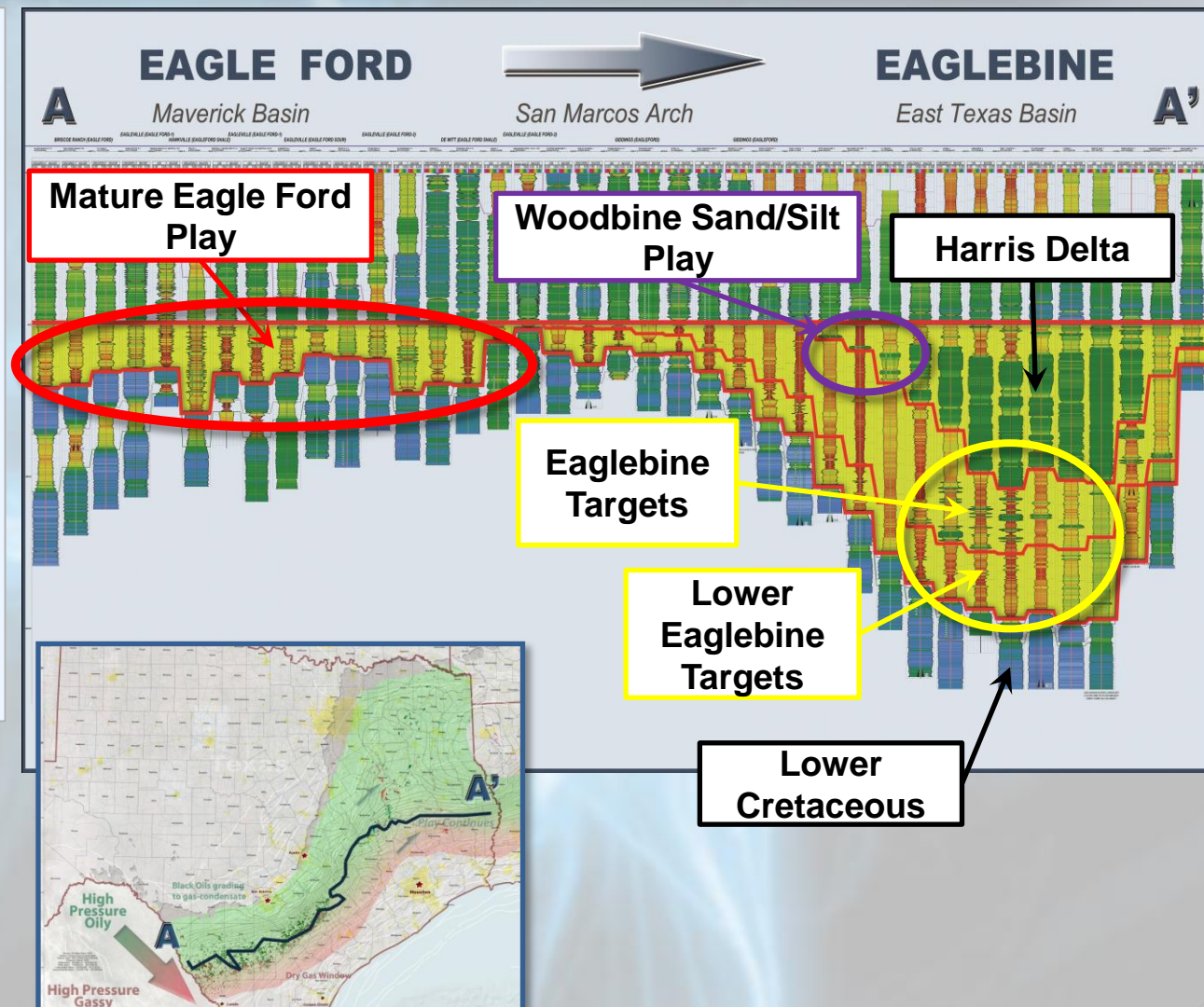


Eagle Ford to Eaglebine

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Key Points

- Eagle Ford Section is 75'-200' thick in the Maverick Basin
- The Eagle Ford section thins to <25' across the San Marcos Arch
- The combination of the Eagle Ford Group and the Woodbine Group (Eaglebine) can exceed thicknesses > 1,000'
- The Harris Delta can exceed 450' in thickness
- Additional potential exists in the Lower Cretaceous Formations – Buda, Georgetown, Edwards and Glen Rose

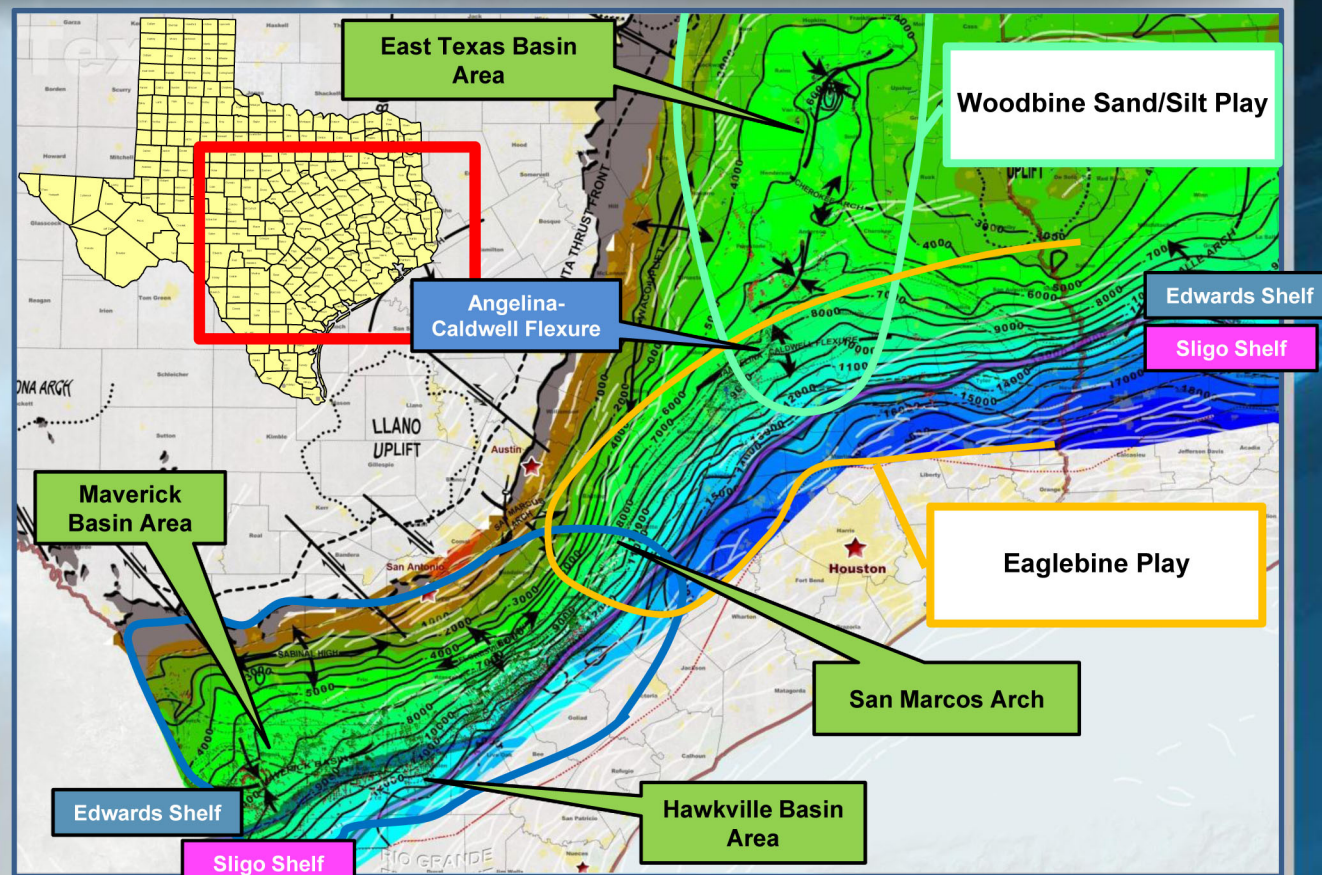


Structure – Top Buda

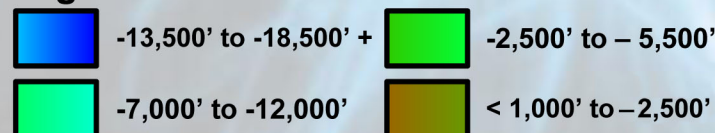
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Key Points

- Structure of the productive economic portions of the Eagle Ford to Eaglebine range from -6,500' to over -15,000'
- GOR is generally associated with depth
- The down-dip limits are currently defined by the Sligo shelf edge
- Three general plays
 - The Eagle Ford Carbonate-rich section
 - The Woodbine Sand/Silt Play
 - The Eaglebine Organic Shales



Legend



Compliments of TDB Oil Corporation.

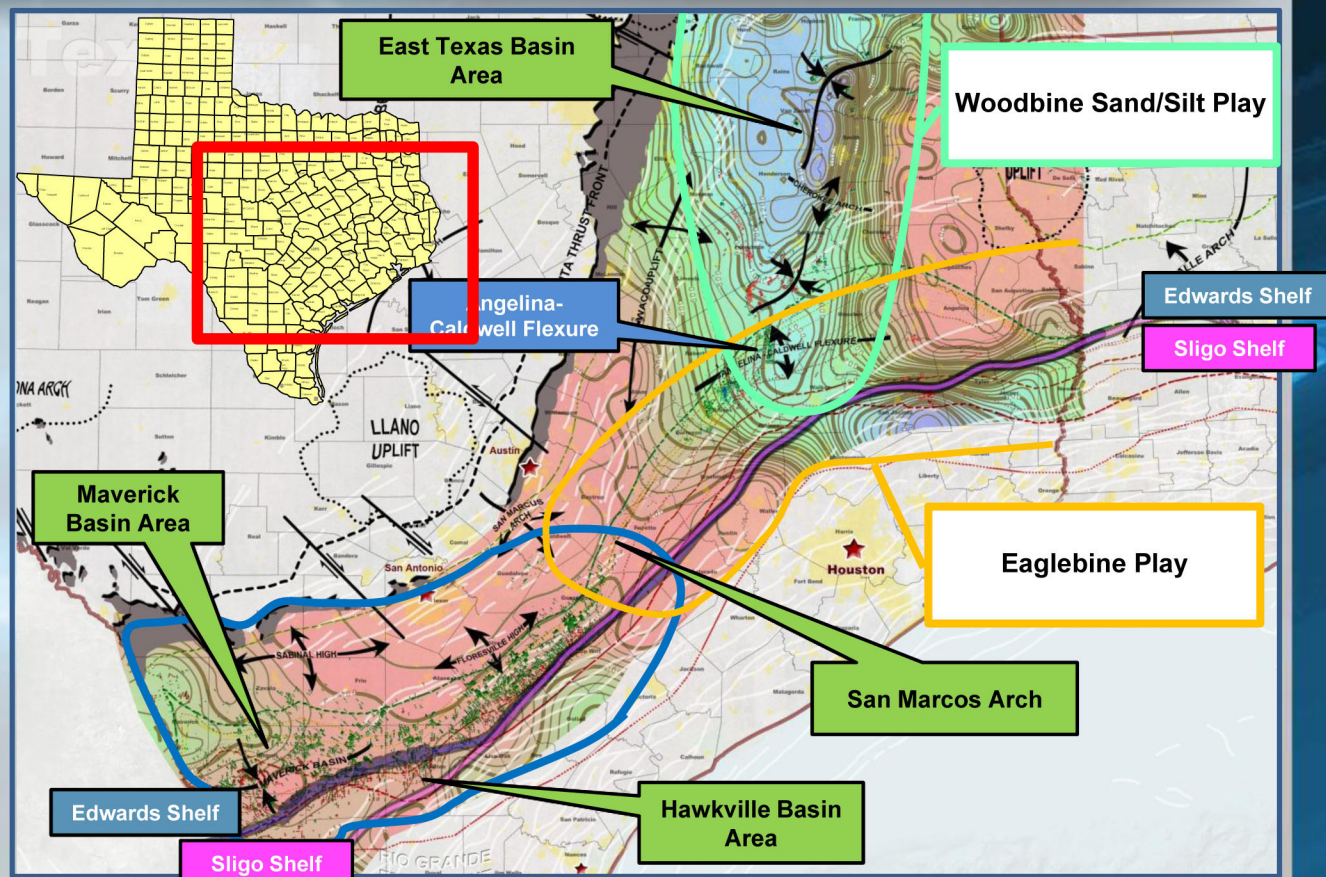


Isopach – BAC to Buda

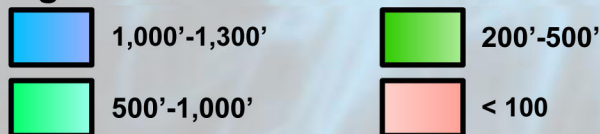
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Key Points

- Eaglebine area of interest is located between the southern portion of the East Texas Basin
- The Eaglebine section is the down-dip toe slope portion of the Harris delta system
- Gross thickness for the Eaglebine section exceeds 1,000'
- The Eaglebine section is comprised of organic-rich shales interlaced with silica-rich sand and silts
- The Eaglebine Isopach is defined as the section from the Base of the Austin Chalk (BAC) to the top of the lower Cretaceous



Legend



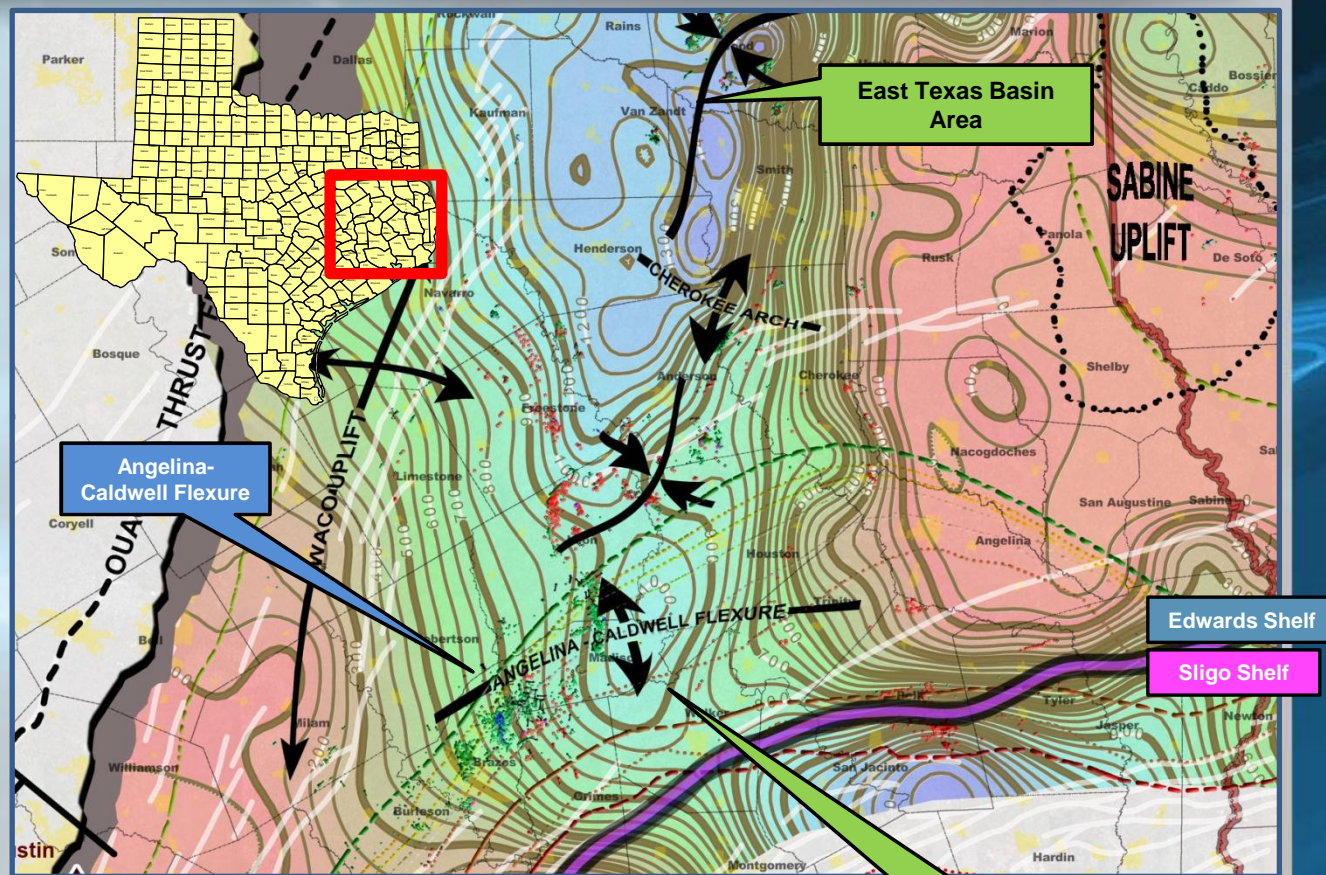
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Isopach – BAC to Buda

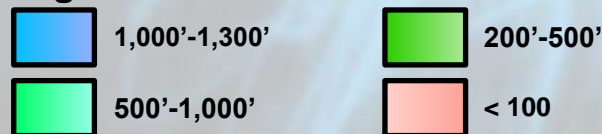
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Key Points

- Thickness in the area exceeds 1,000' of gross section; however, in many areas where the Harris Delta system is the thickest, the organic shale section ranges from 450' to 600'
- There is a restricted "sub-basin" present in the area across the acreage between the Angelina-Caldwell Flexure to the north and the Sligo / Edwards shelf edges to the south
- Several formations in the area are considerably thicker in the sub-basin including the Kiamichi and the Paluxy shales



Legend



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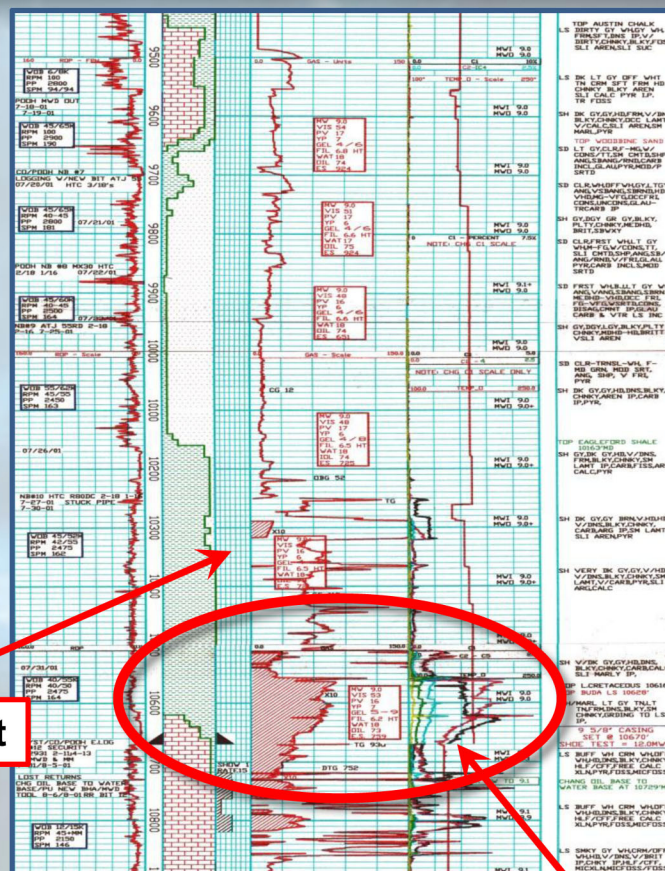
Eaglebine Mudlog Example

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Key Points

- Historical mudlogs across area have significant oil and gas shows in both upper and lower Eaglebine section
- Lower Organic-rich section is over 450' thick
- Mudlogs in area show good oil and gas shows throughout shale section
- C1-C5 oil and gas shows prevalent throughout section
- Historical wells have produced economic quantities of oil and gas in individual sand lenses throughout Eaglebine section

Upper Target



Lower Target

Austin Chalk

Eagle Ford Sub-Clarksville

Harris Delta

Lewisville

Dexter

Pepper

Maness

Buda

Eagle Ford Group

Woodbine Group

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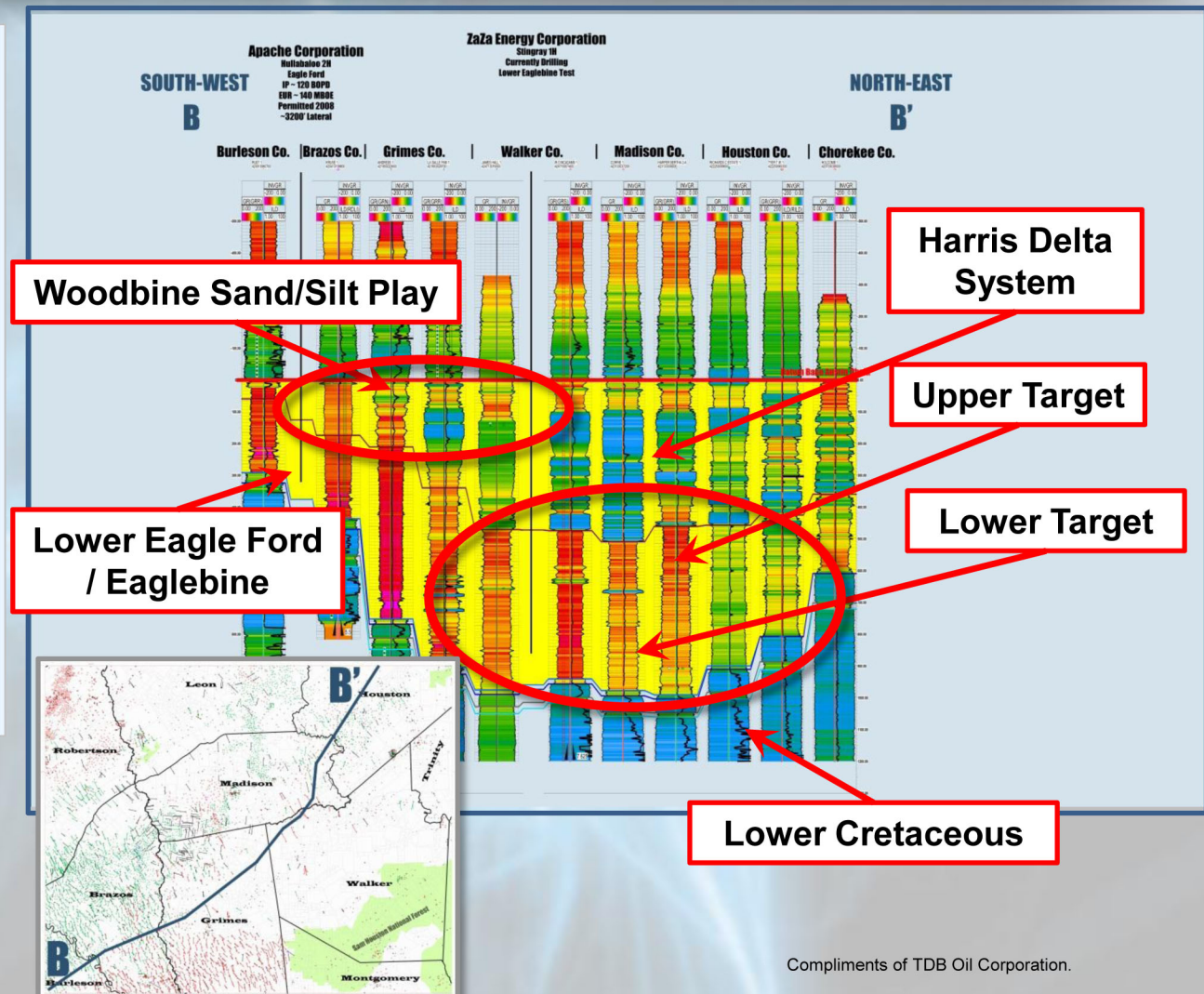


N-S Cross Section

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Key Points

- There are several conventional and unconventional targets in the East Texas Eaglebine area
 - The Woodbine Sand / Silt Play
 - Portions of the Harris Delta can be productive
 - The Lower Eaglebine Upper and Lower sections of organic-rich shale and sand
- Conventional targets have been as little as 2' in thickness
- Unconventional targets are > 250' in thickness



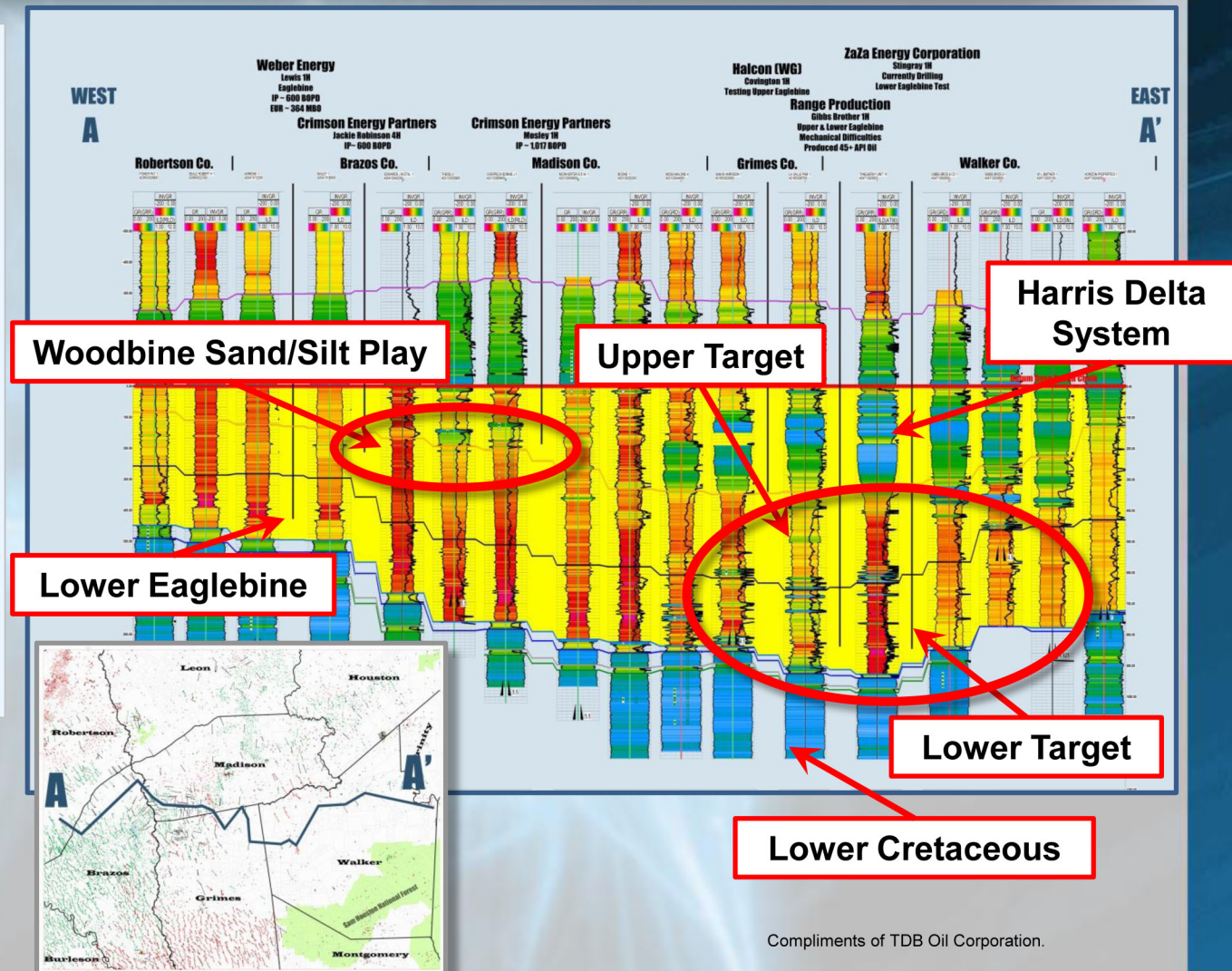
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E-W Cross Section

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Key Points

- The cross section represents the Woodbine sand / silt play, the Upper and Lower organic-rich sand / shale Eaglebine targets
- The Eaglebine is recognized as a “hot” shale with increased resistivity that exhibits oil and gas shows on mudlogs across the zone
- The recently successfully completed Weber 1H horizontal well targeted the Lower organic-rich Eaglebine in the oil window
- Halcón’s Covington 1H well appears to target the Upper Eaglebine
- The Eaglebine is similar to the TMS in Louisiana



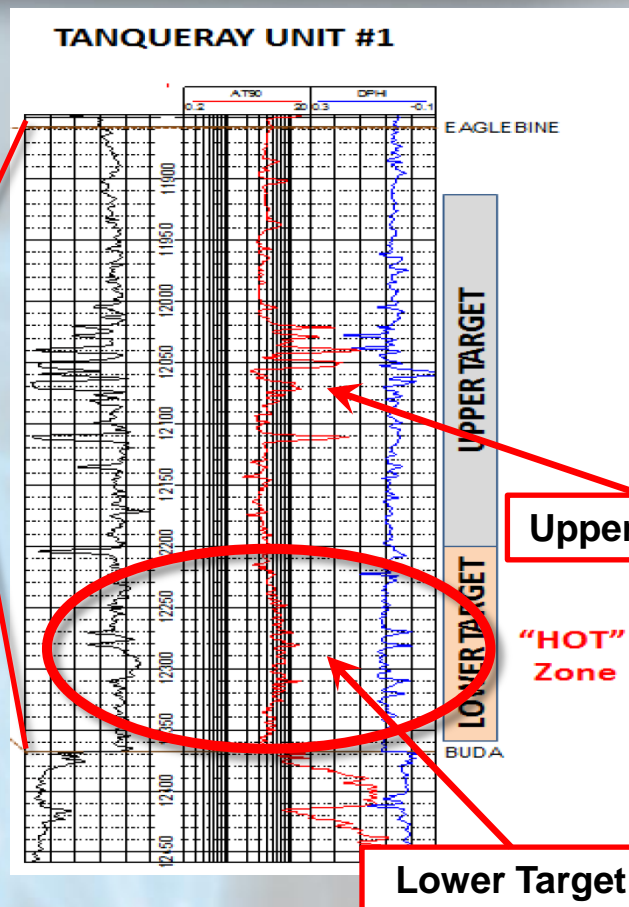
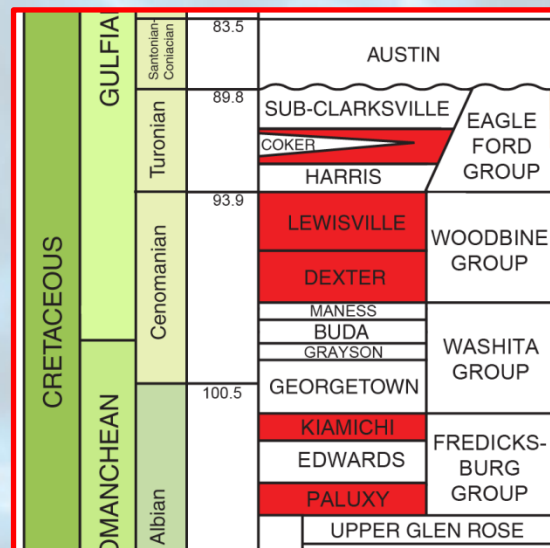
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Eaglebine Log Section

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Key Points

- Representation of the Eaglebine below the Harris Delta System the “unconventional” section of the Eaglebine
- This section is over 500' thick and is divided into two potential targets
- The Eaglebine is recognized as a “hot” shale with increased resistivity that exhibits oil and gas shows on mudlogs across the zone
- Generally the section has a lower resistivity signature than the Maverick Basin Eagle Ford
- Resistivity is suppressed because of illite clay and pyrite in the formation



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Eaglebine Section

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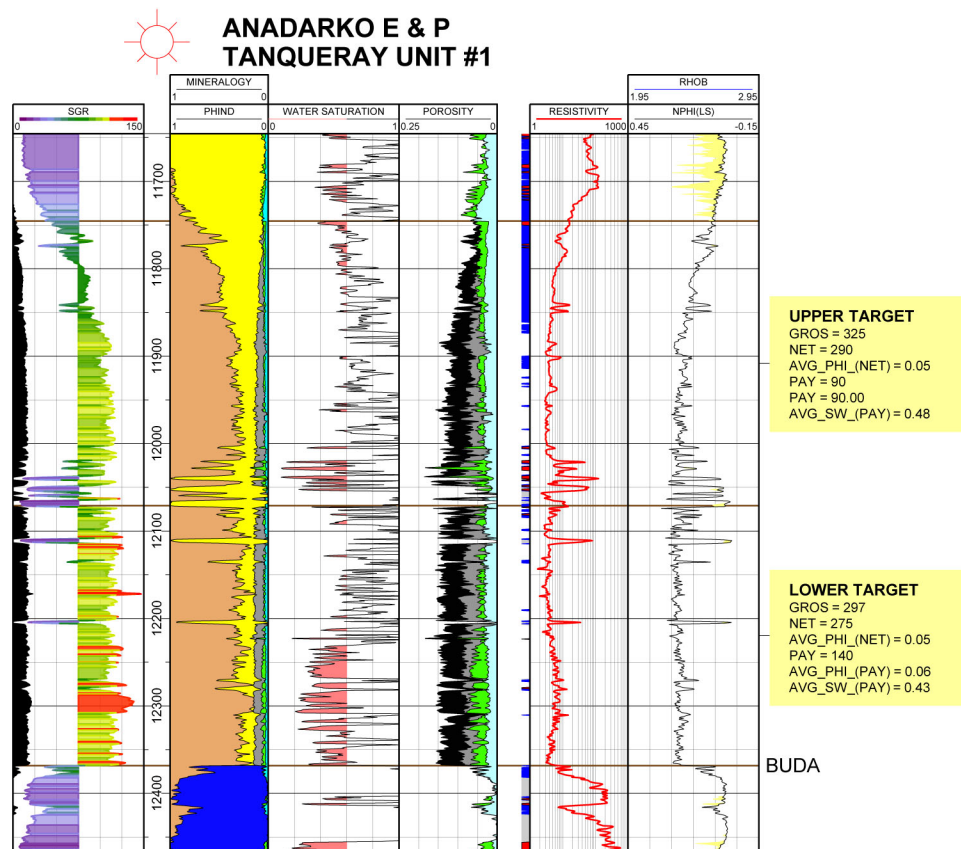
Key Points

- General log calculations can estimate the potential of the Eaglebine section below the Harris Delta
- A lot of penetrations, not a lot of full suite log combinations
- Upper section GIP ~ 30 BCFE / mi²
- Net interval of 290' based on log Net Pay of 90'
- High Liquids yield +/- 7,000 GOR
- Lower section GIP of ~50 BCFE / mi²
- Net interval of 275' based on log Net Pay of 140'
- Primary target with high liquids yield



Eaglebine reference thickness

Target



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Eagle Ford Section

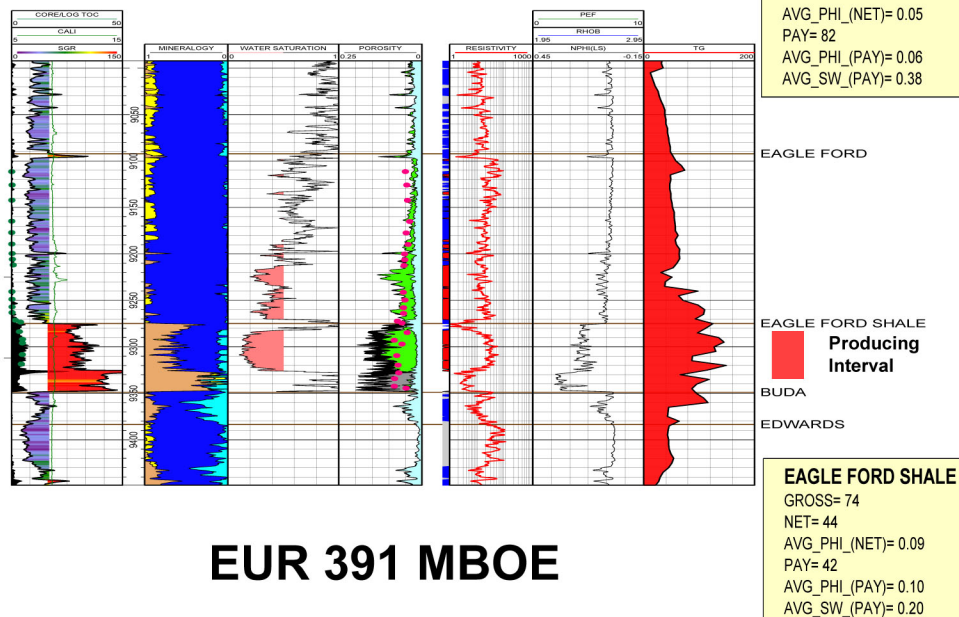
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Key Points

- General log calculations can estimate the potential of the Eagle Ford section
- Upper Eagle Ford Gross Interval of 183' based on log Net Pay of 166'
- Eagle Ford Shale Gross Interval of 74' based on log Net Pay of 42'
- This Well has been on production for 13 months and has produced 83 Mbo and 0.04 BCFg
- EUR 391 MBOE

Eaglebine reference thickness
Target

Eagle Ford Type Log Gonzales Co., TX



EUR 391 MBOE

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Lower Cretaceous

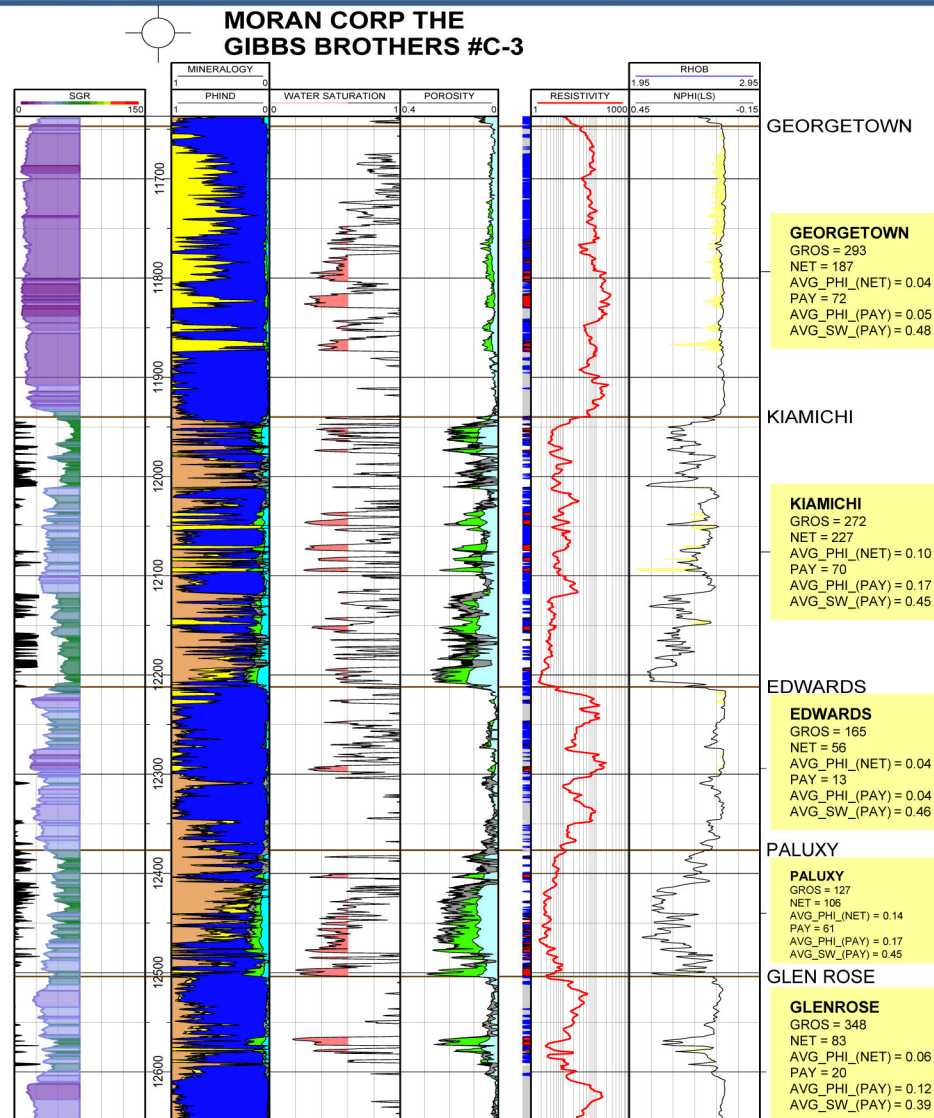
Key Points

- Two additional shale targets?
- Kiamichi – Source Rock for Edwards
- Paluxy – Source Rock for Edwards and Glen Rose
- Kiamichi Net Interval of 272' based on log Net Pay of 227"
- Paluxy Net Interval of 127' based on log Net Pay of 106"
- Navidad Resources
Ferguson Prison Unit 9-1
Producing from co-mingled Lower Cretaceous – 6 stages across entire interval - 893 BOEPD ~ 458 MBOE, 148 MBO, 0.458 BCF 20 months



Target?

Target?

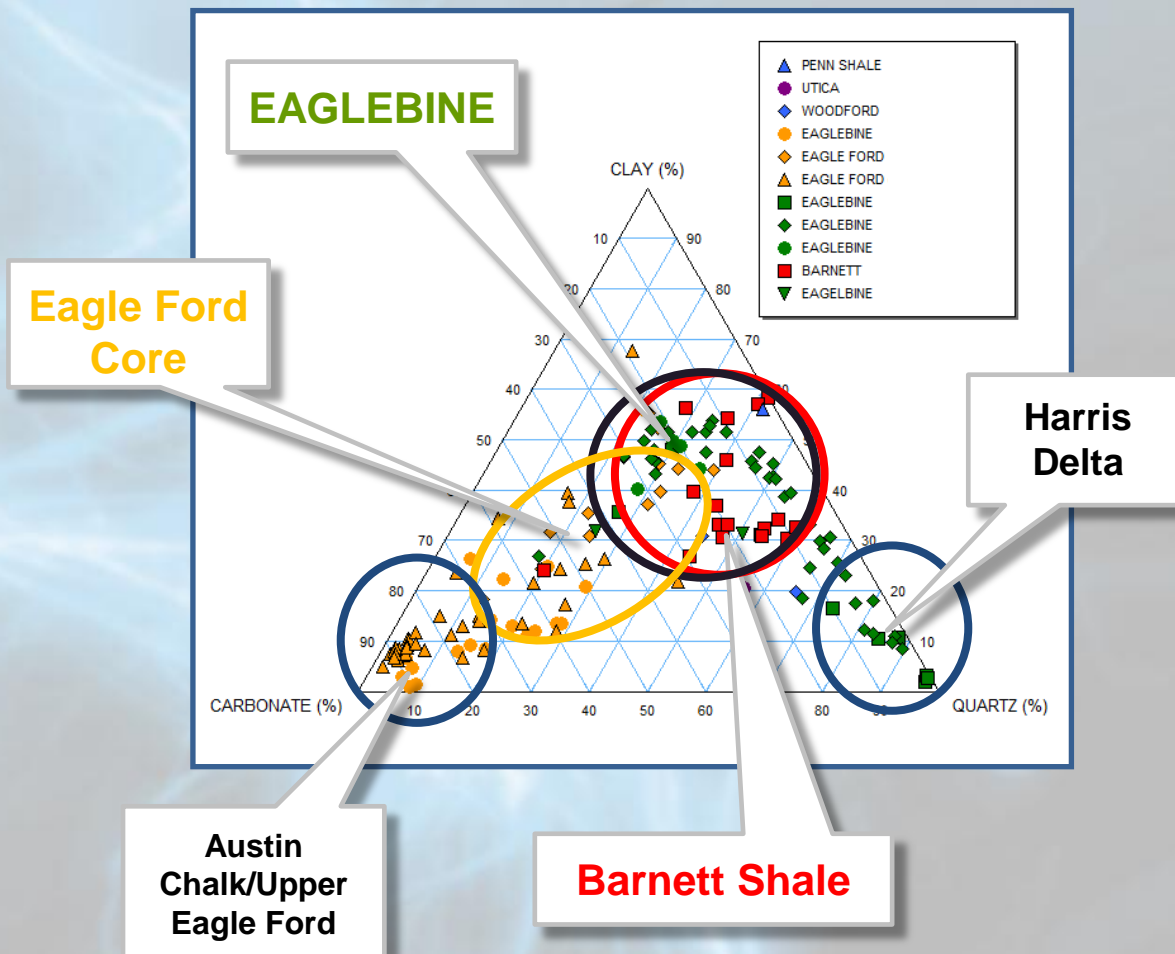


XRD Comparison of Shales

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Key Points

- Analysis of the Eaglebine vertical sections in several historical wells
- Good TOC concentrations throughout section 4-12%
- Good silica concentrations (Quartz) 20-60%
- Low expanding clay concentrations mostly illite
- XRD comparative to Barnett and Woodford shales

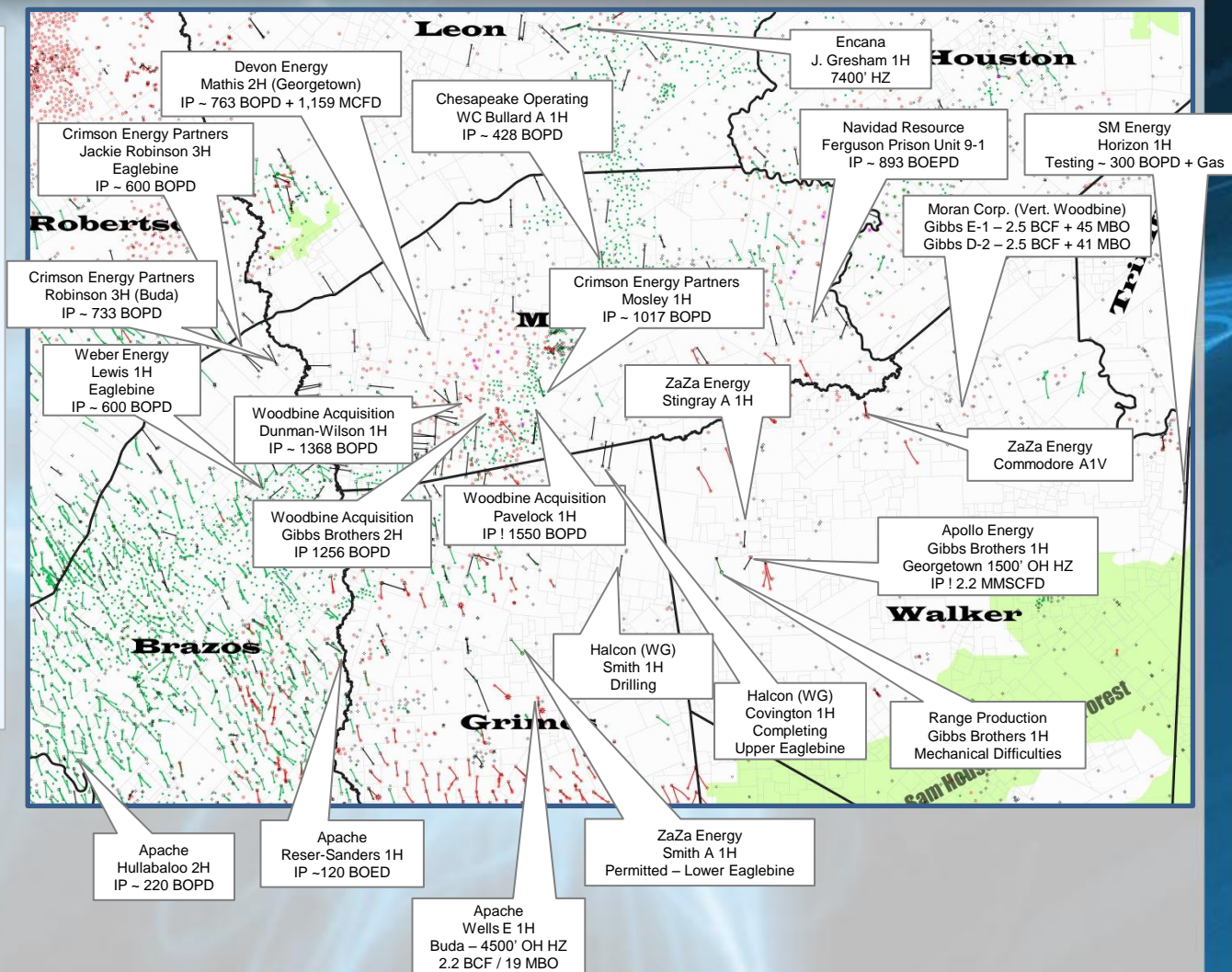


Activity Map

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Key Points

- 100+ Woodbine sand/silt horizontal completions since 2007
- Recent focus has been on the Lower portion of the Eaglebine following two recent IP's of 600+ Bopd
- The Weber Lewis 1H and the Crimson Robinson 4H
- Encana's oil window target performance appears to be in the 400+ Mboe
- Recent successful wells by Navidad indicate the potential of the commingled vertically completed Lower Cretaceous targets in the area



Conclusions

- Eaglebine is an organic-rich section situated between the Austin Chalk and the Buda
- High TOC (4-12%) and High Silica (-+40%) content provide the right mix for a highly potential resource play
- Broadly speaking the Upper Eaglebine is a collection of sandstone packages making it more conventional in nature, interbedded with organic-rich shales
- The Lower Eaglebine has characteristics of a typical “hot” shale
- Studies and log data indicate hydrocarbon-bearing formations that exhibit higher resistivity and porosity
- Permeability is generally low, but horizontal drilling and multi-stage fracs (10-25 stages) have proven successful in enhancing well productivity
- Optimum depths between 7500’ – 13,500’
- Two additional potential shale targets possible – Kiamichi and Paluxy

