Eagle Ford Development Case Study Utilizing 3D Seismic in Structurally Complex Area, Atascosa County, Texas*

Lee T. Billingsley[1], Bill Layton[1], and Luke Finger[1]

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Abstract

Development of the Eagle Ford oil accumulation in South Texas may generally be divided into two gradational trends, black oil and volatile oil. The black oil trend is characterized by: shallower depth, thinner Eagle Ford interval, lower gravity oil (<35 deg) lower GOR (<1000 to 1), and generally poorer economic returns than the volatile oil trend. Many areas of Eagle Ford development are also structurally simple with only regional basinal dip. However, Abraxas Petroleum Corporation is developing an area in the black oil trend that is structurally complex due to graben faulting and resultant folding. Because of the faulting during Eagle Ford deposition, the Eagle Ford interval expands from about 100 ft. thick outside the graben to about 180 ft. within the graben. The expanded interval provides opportunity, but economic development in this part of the trend requires extreme attention to detail and high coordination between geology, geophysics, drilling and completion.

Interpretation of the 3D seismic data set over the field area requires drastic geologic assumptions in order to accurately convert to depth. Velocity values based on the drilling and geosteering of nine widely spaced horizontal wells indicates that velocity is faster near the downthrown side of growth faults. Improved interpretation of the 3D seismic data has resulted in improved geosteering of the horizontal wells.

Stratigraphically, the Eagle Ford was divided into 13 para-sequences in an attempt to determine if certain intervals had different characteristics during hydraulic fracture treatments and resulting productivity. Hydraulic fracture gradient plots indicate that areas near faults have subnormal gradients, but position within the Eagle Ford does not exhibit a consistent trend. However, well performance relative to Eagle Ford completion interval does indicate a correlation.

Selected References

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By
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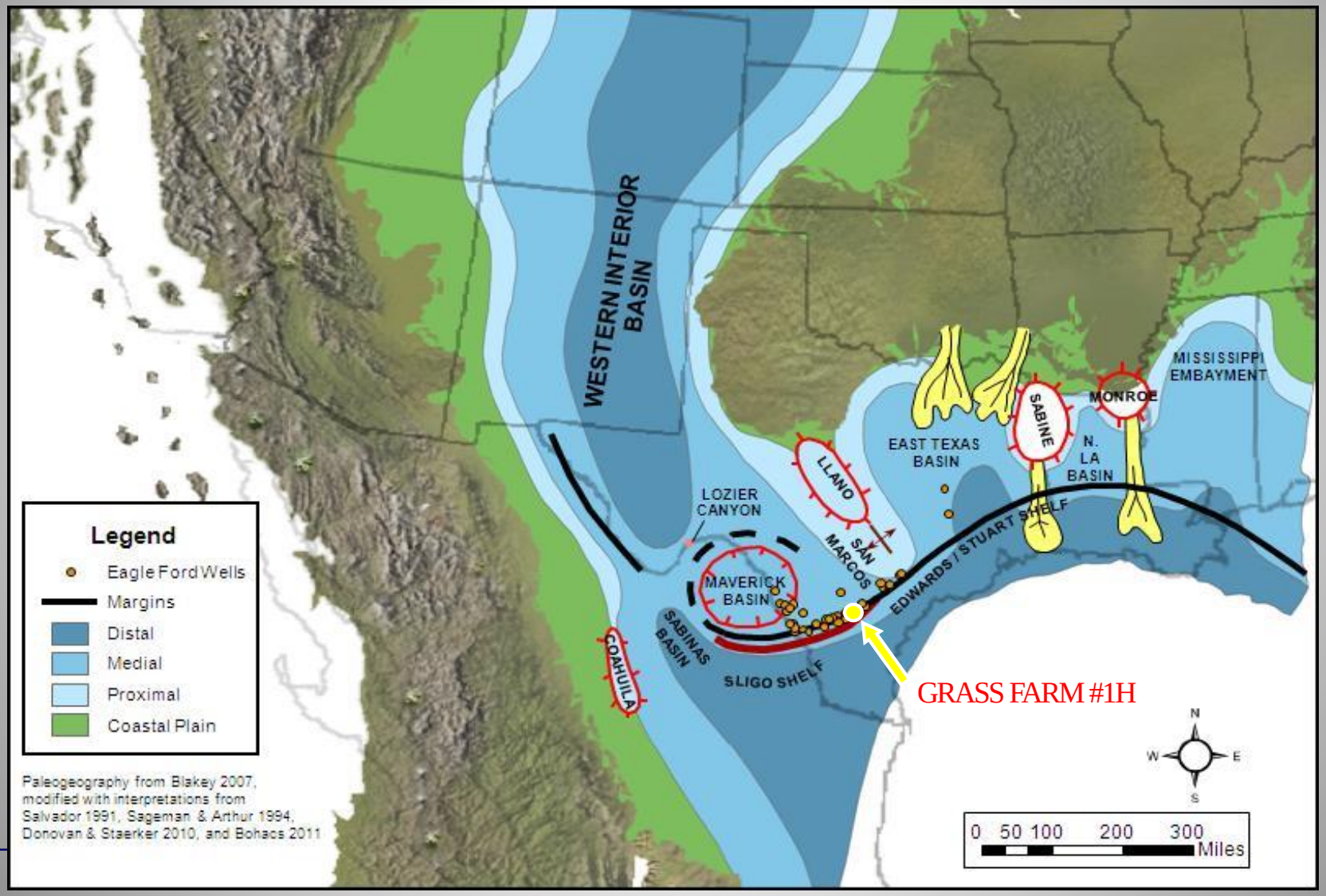
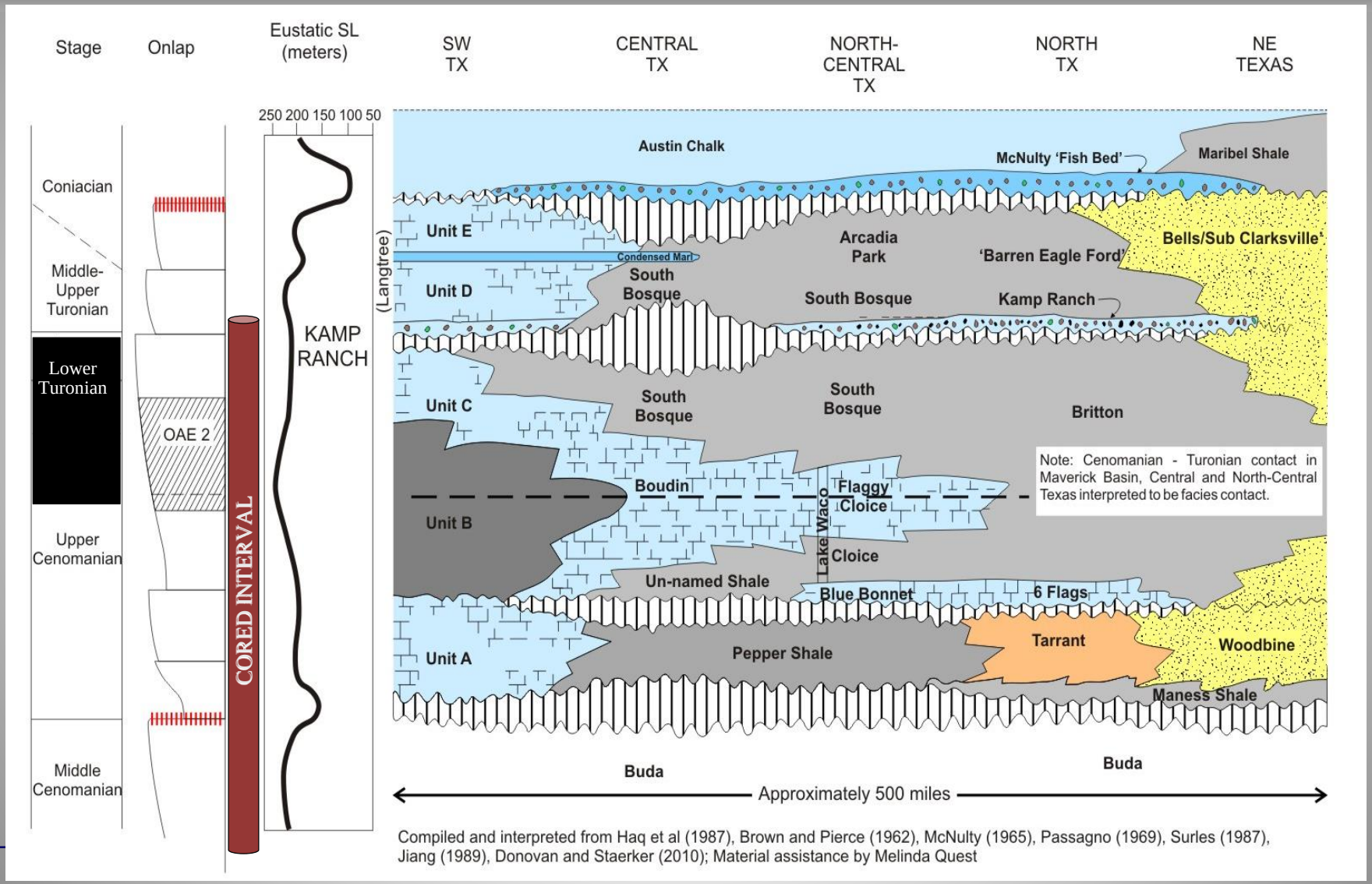
Late Cenomanian Paleogeography



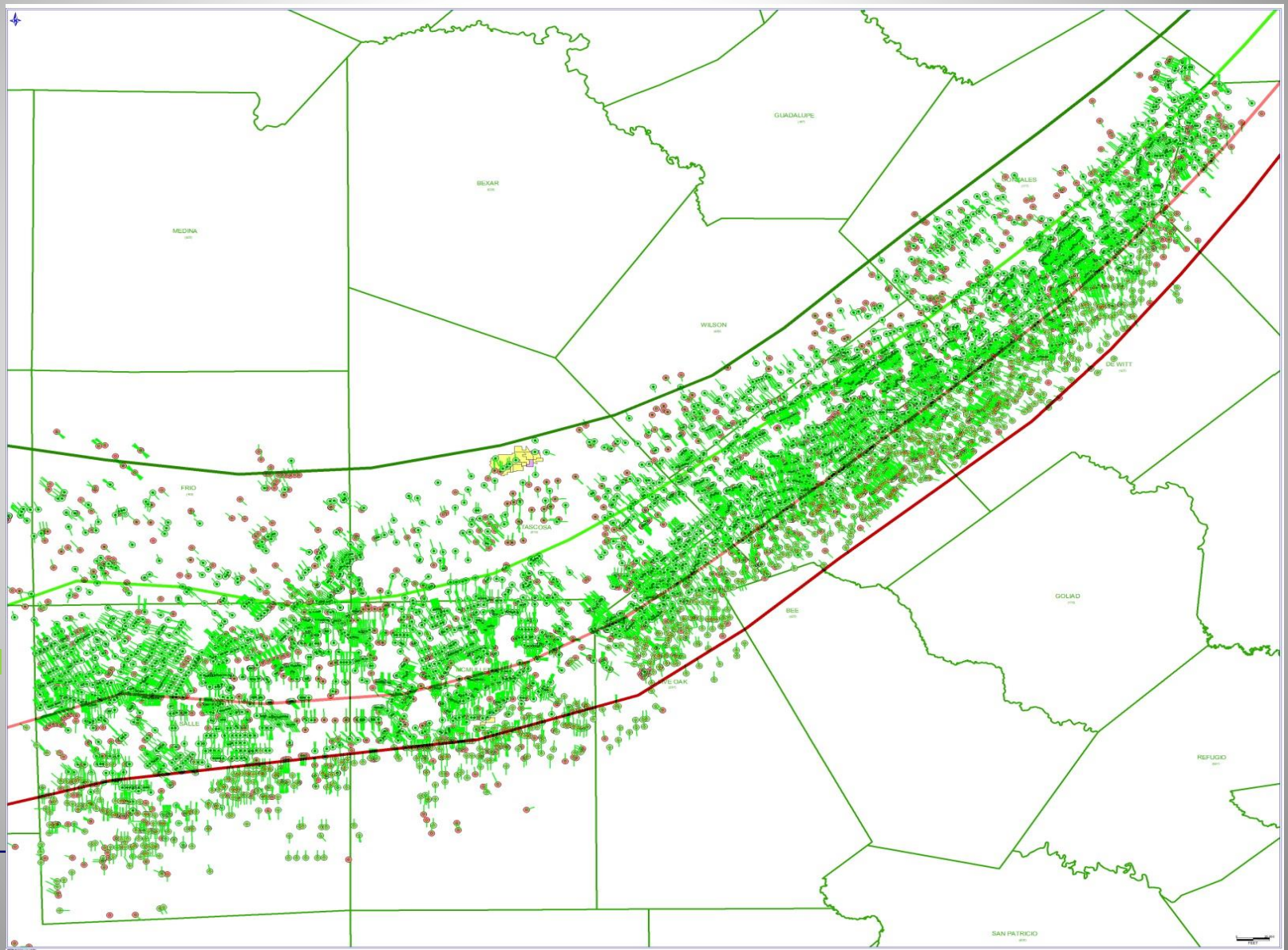
Eagle Ford Regional Sequence Stratigraphy



Compiled and interpreted from Haq et al (1987), Brown and Pierce (1962), McNulty (1965), Passagno (1969), Surles (1987), Jiang (1989), Donovan and Staerker (2010); Material assistance by Melinda Quest

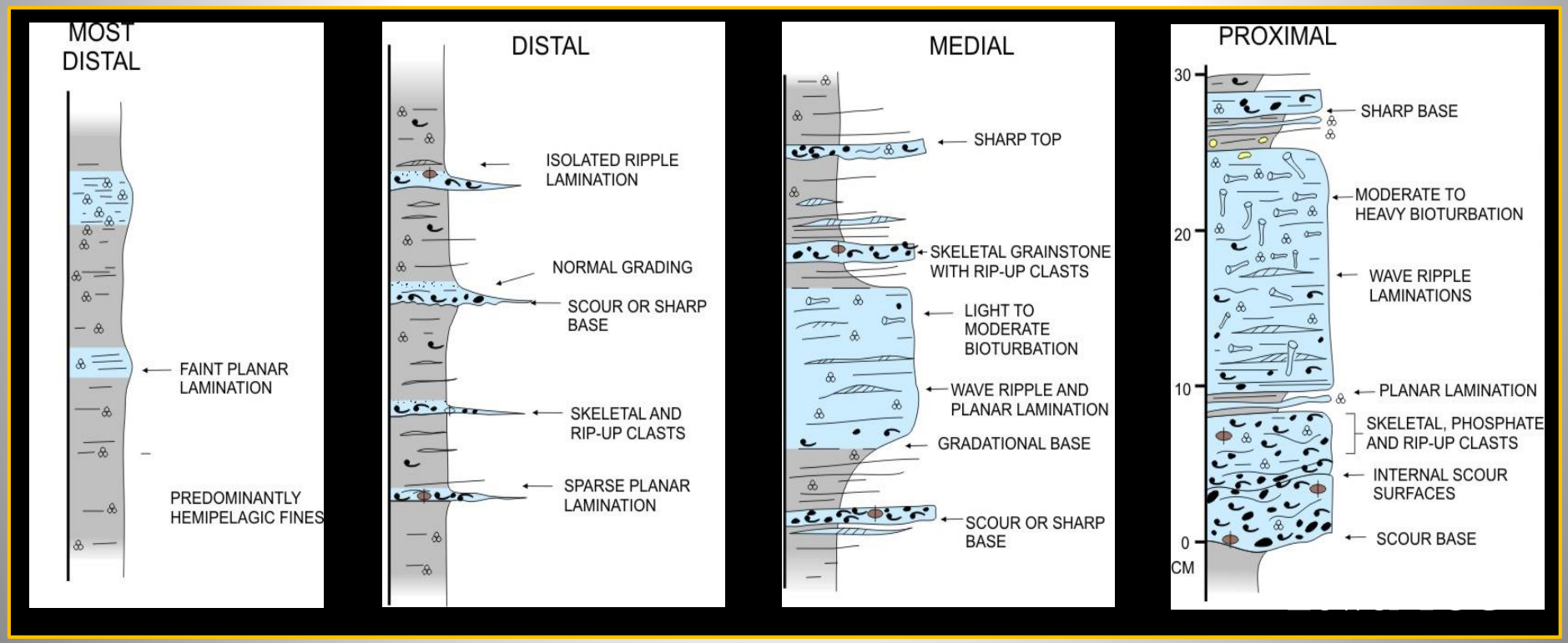
Eagle Ford *Hydrocarbon Phases*

ABRAXAS

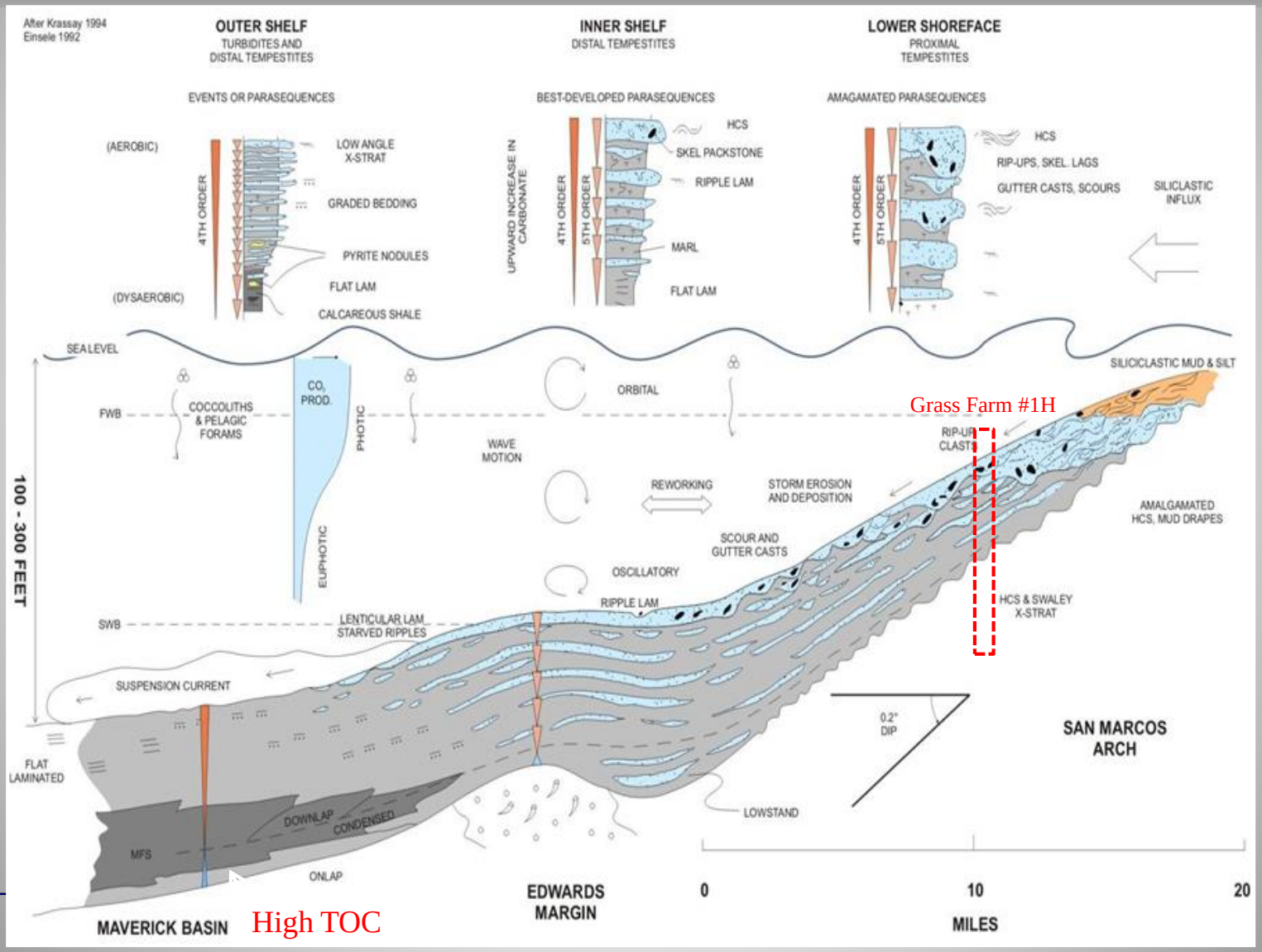


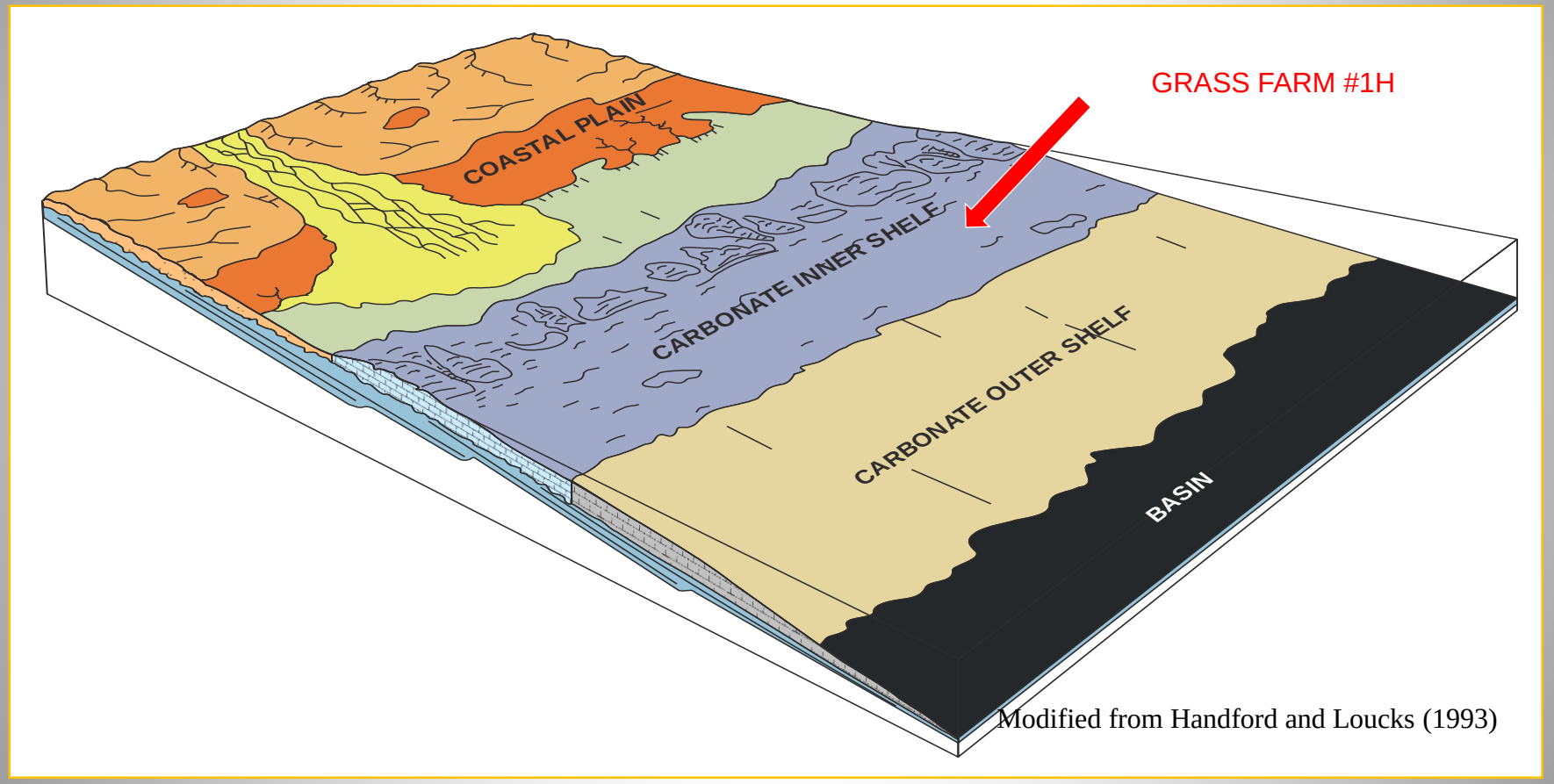
Eagle Ford Sedimentology

- Eagle Ford cores throughout the study area contain a range of facies which are dominated by foraminifera packstones with scour surfaces, planar to ripple lamination, rip-up clasts, and moderate bioturbation in the proximal depositional environments and massive to faintly laminated, biogenic marls (predominantly composed of coccoliths and forams) with thin and sparse limestone interbeds in distal settings.

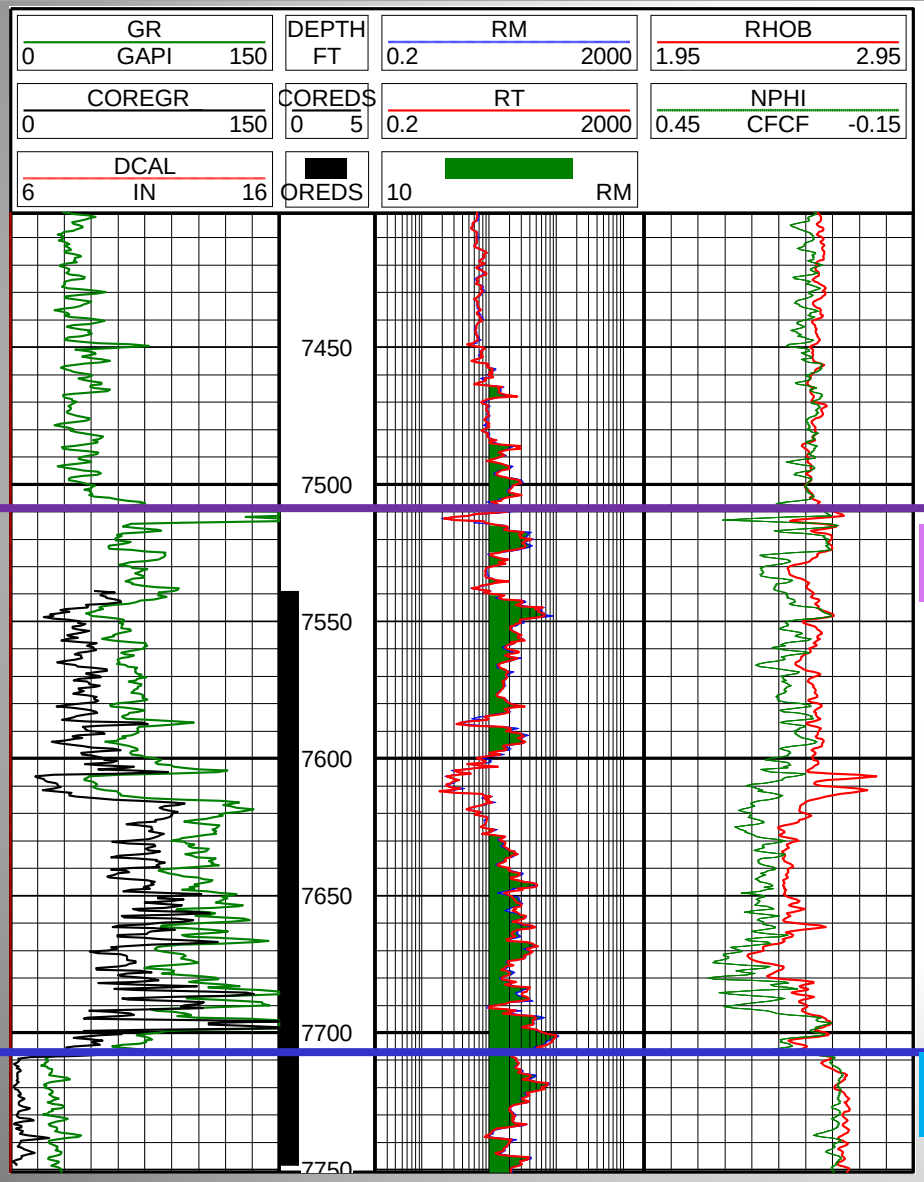


Eagle Ford Depositional Model




GRASS FARM #1H
COASTAL PLAIN
CARBONATE INNER SHELF
CARBONATE OUTER SHELF
BASIN
Modified from Handford and Loucks (1993)

Grass Farm #1H



Eagle Ford Shale (198 feet)				
Core Depth (ft)		Log Depth (ft)		Cored
7,525.0	7,735.4	7,537.0	7,747.4	210.4

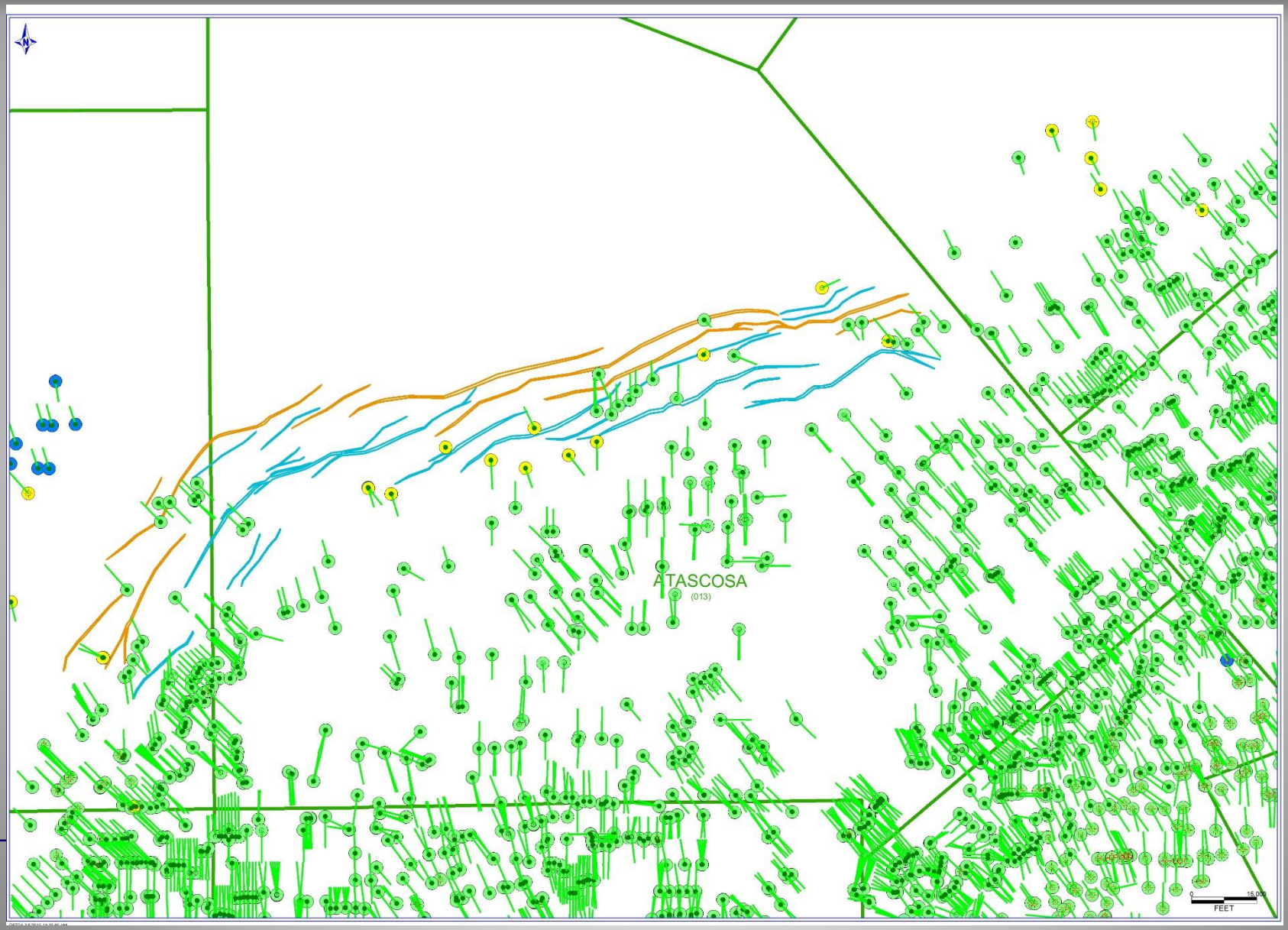
Eagle Ford

Kamp Ranch Zone

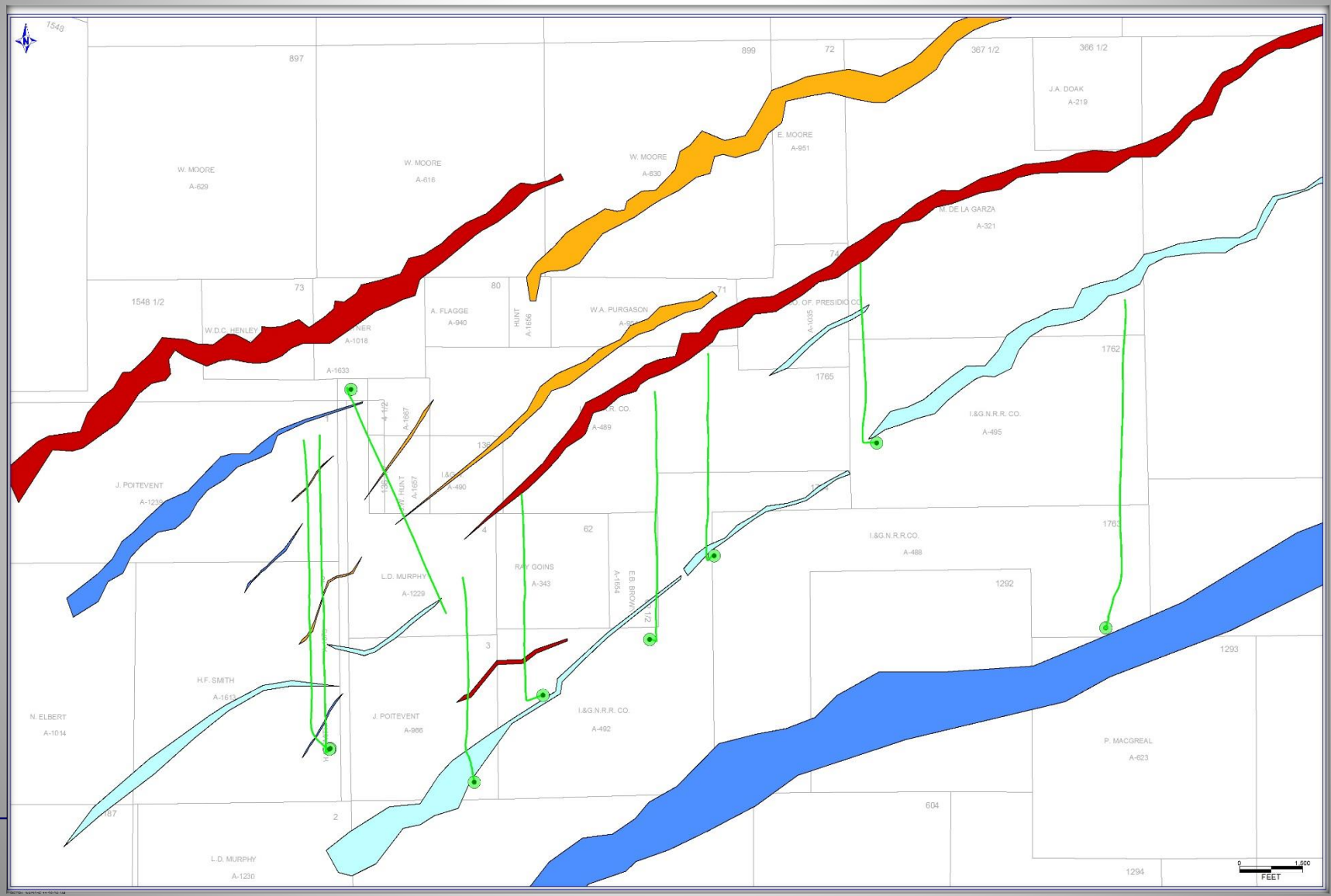
Target Interval 7670-7690' (log)
7658-7678' (core)

Buda Lms

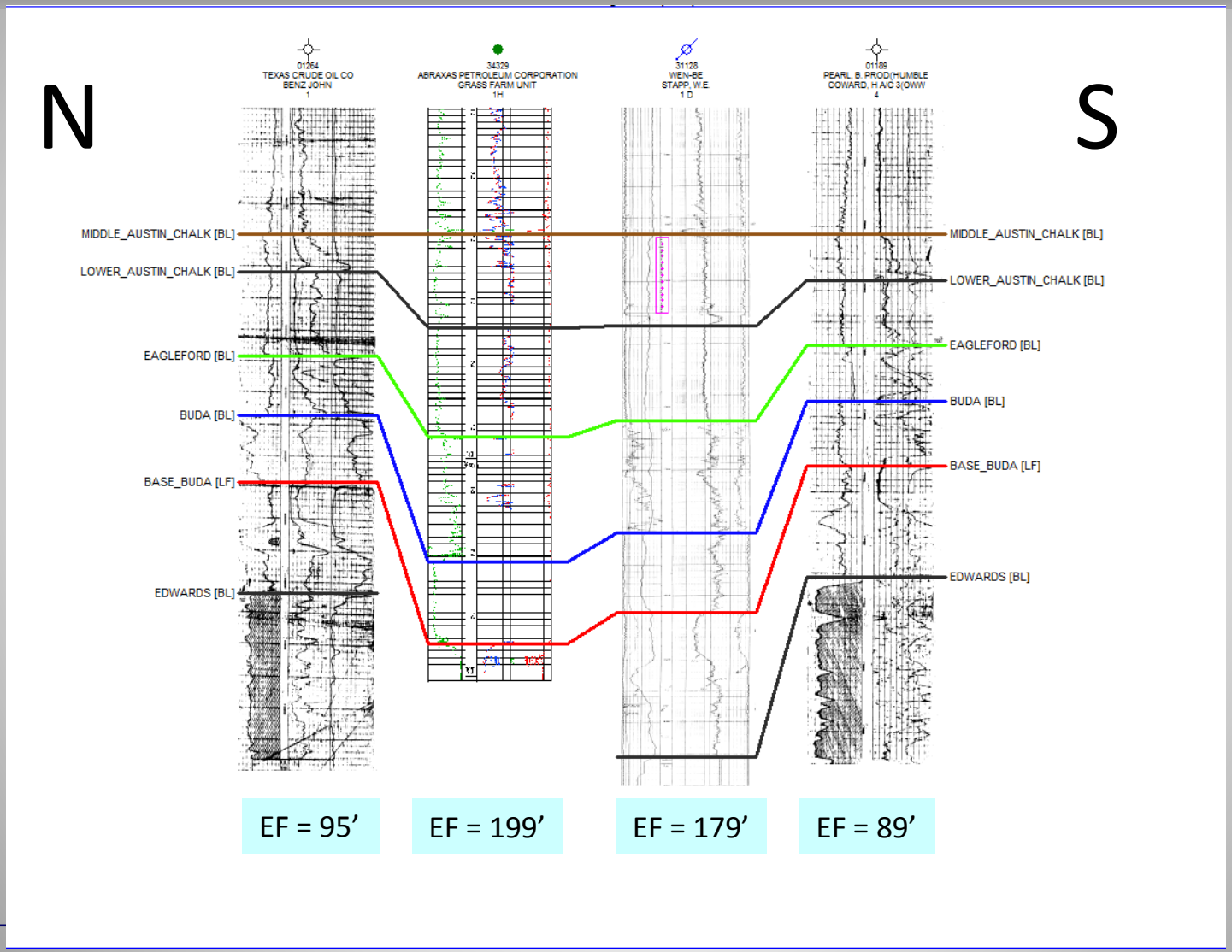
Atascosa County Graben



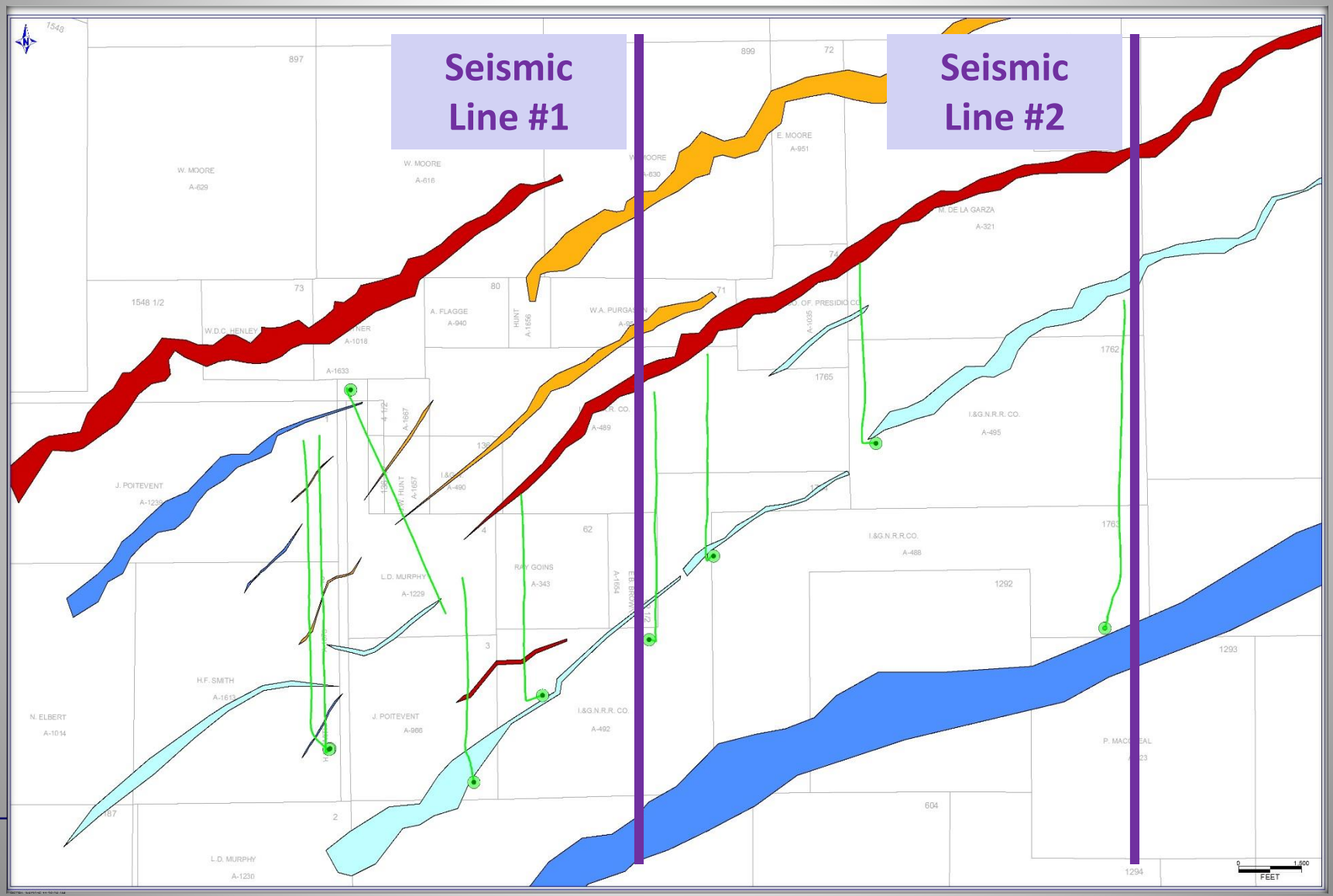
Jourdanton Fault Interpretation



Syndepositional Graben Thickening



Jourdanton Fault Interpretation

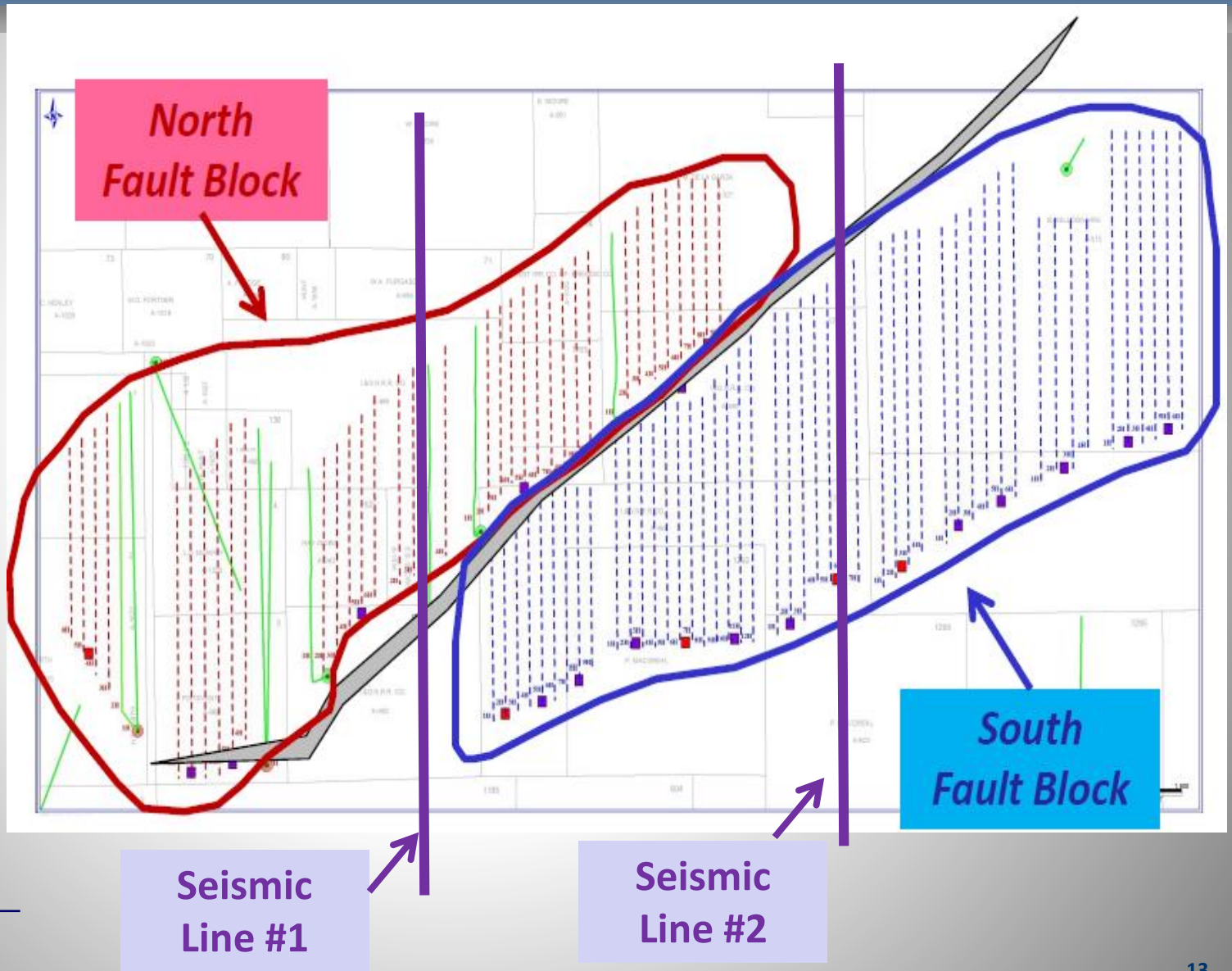


Eagle Ford

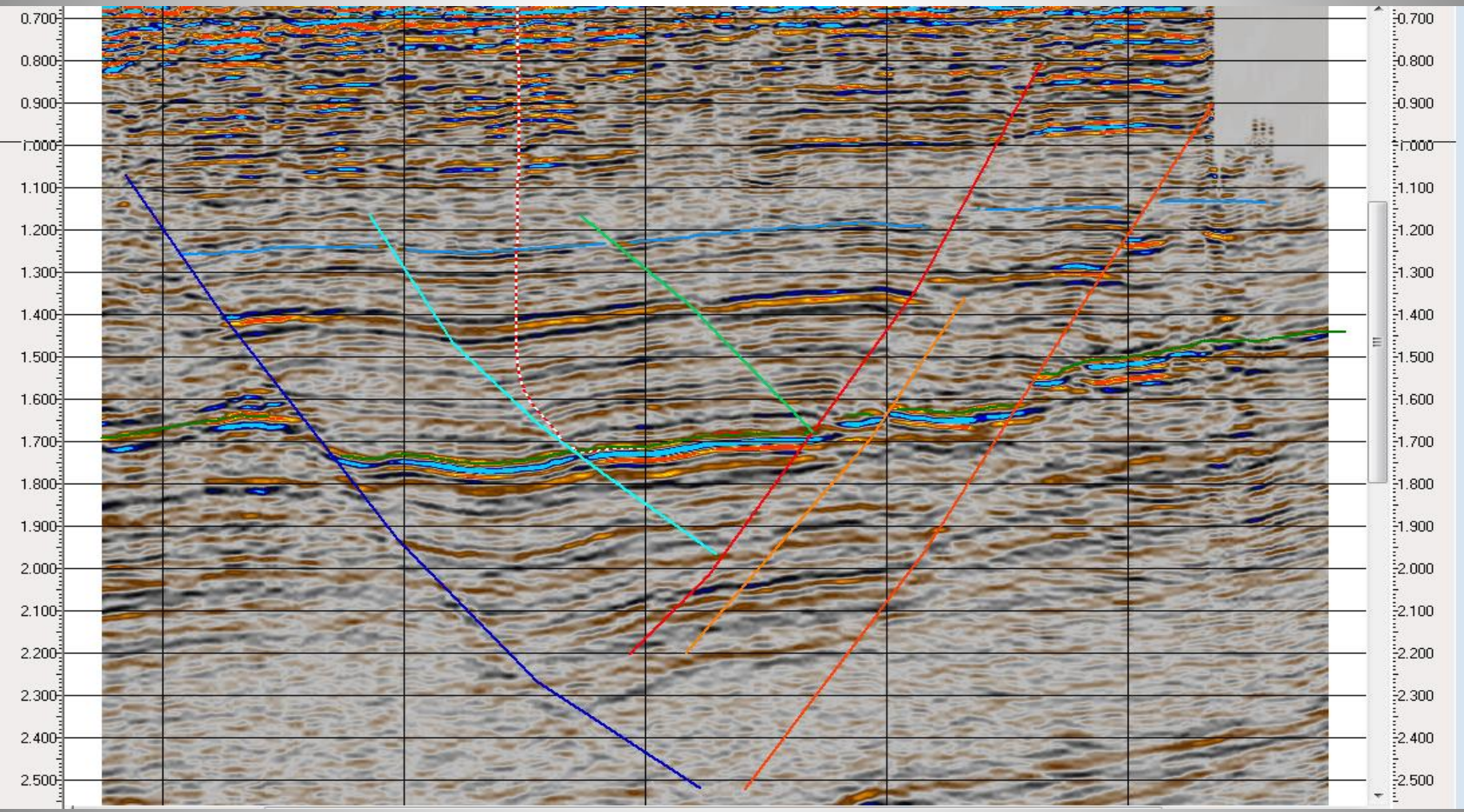
Jourdanton

North Fault Block
- HBP
- 43+ potential locations

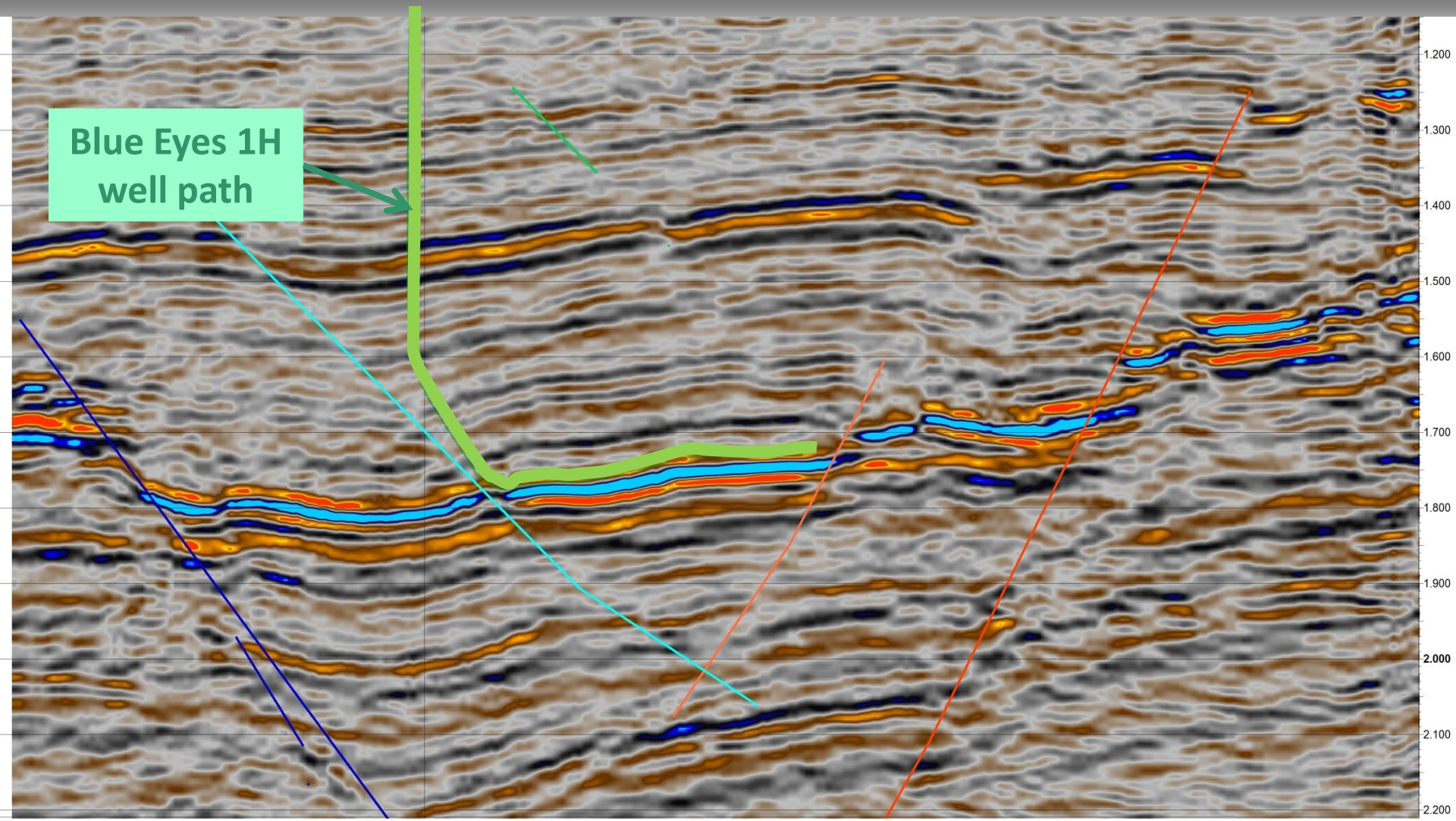
South Fault Block
- 1st well completed, 12/2014
- 48+ potential locations



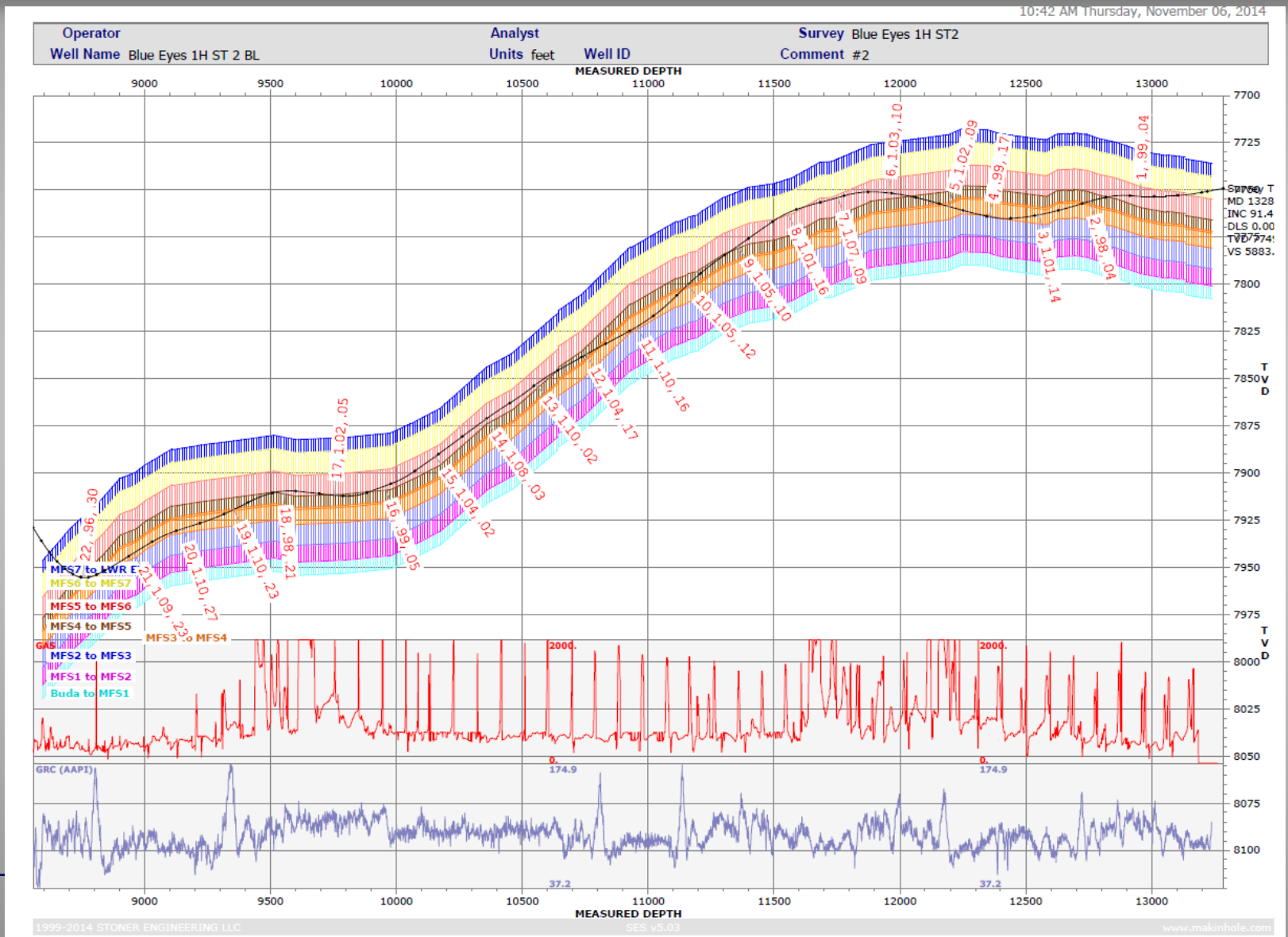
Seismic Line 1



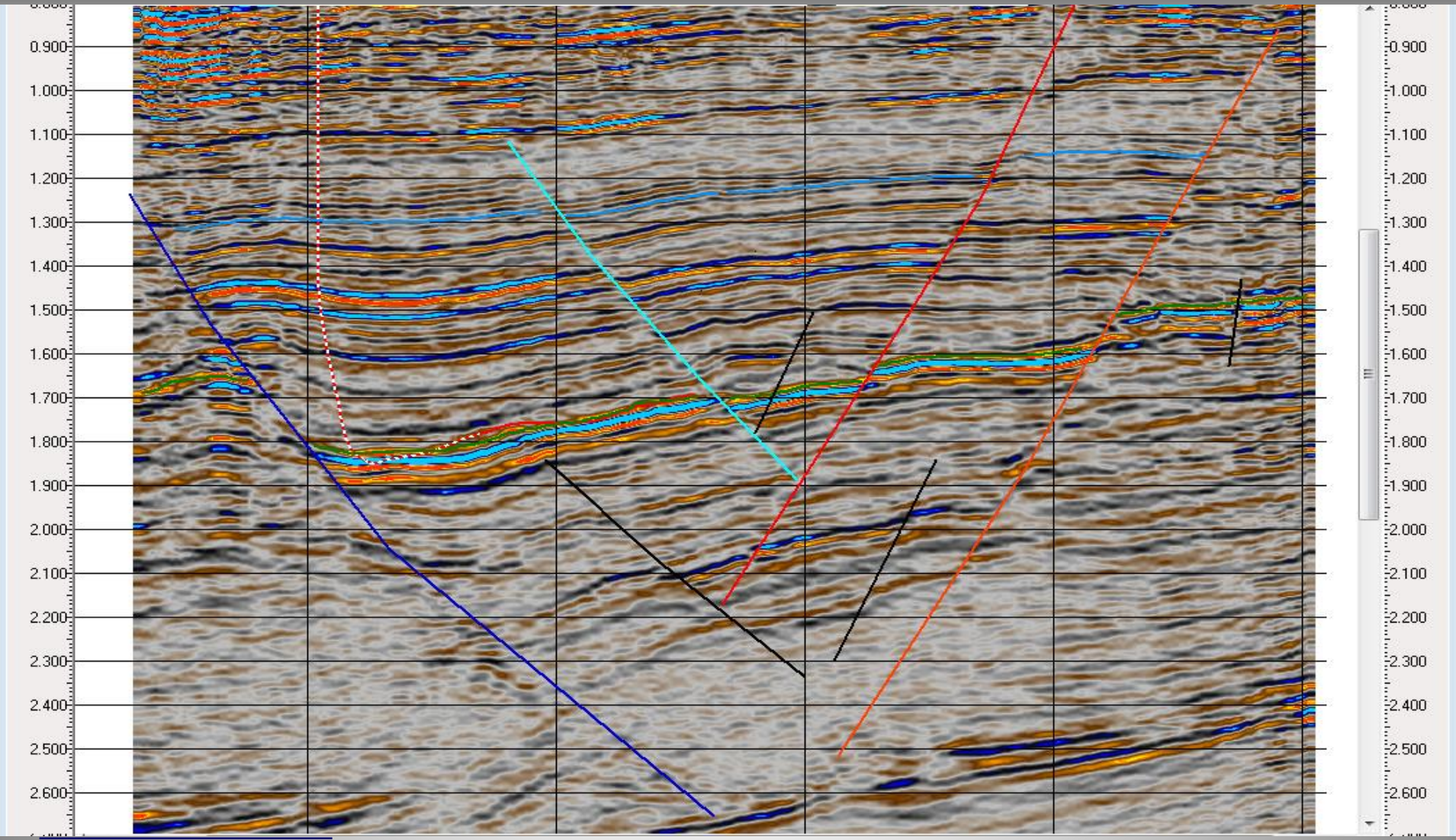
Seismic Line 1



Blue Eyes 1H, Post-Drill X-Section



Seismic Line 2



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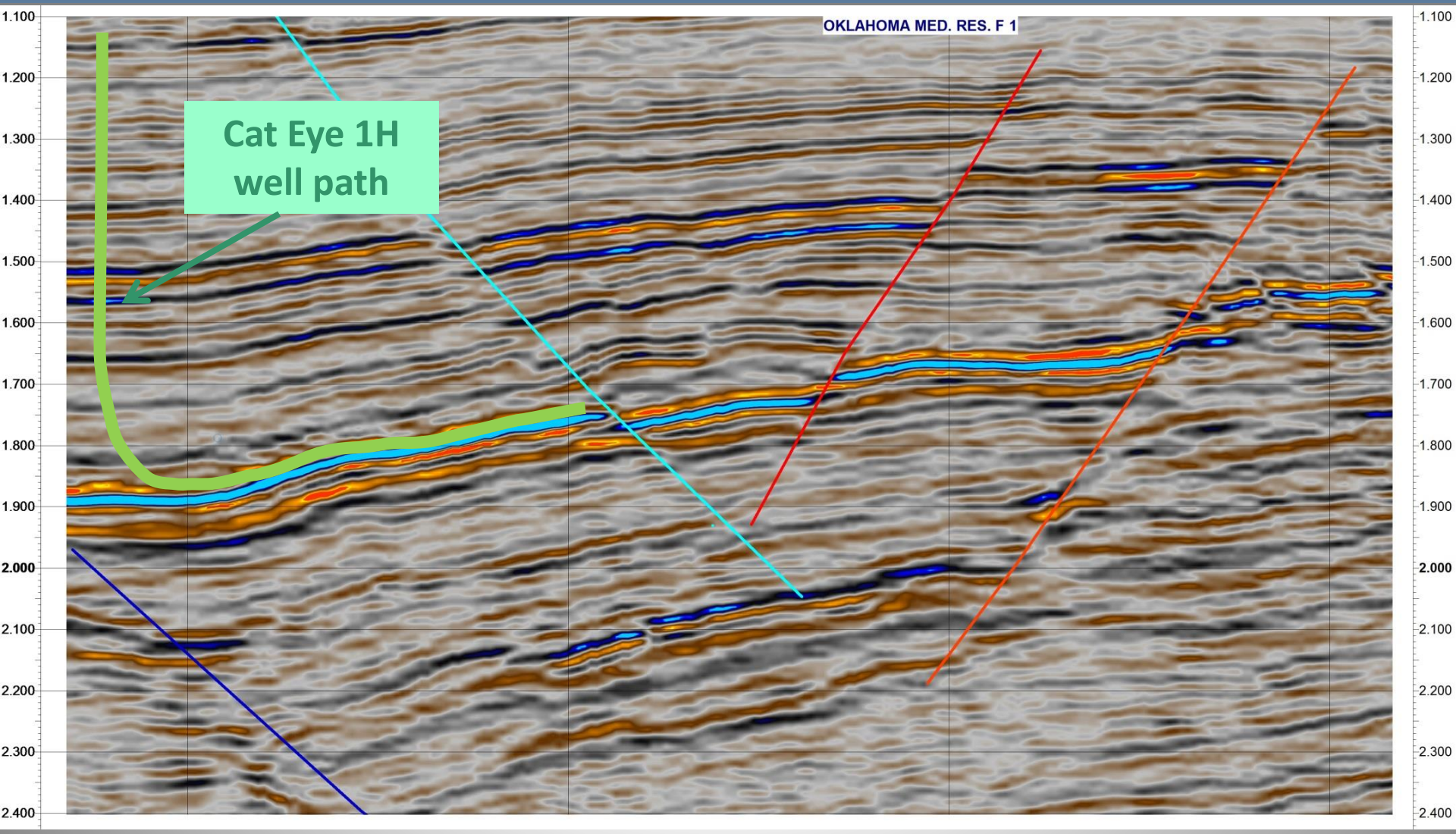
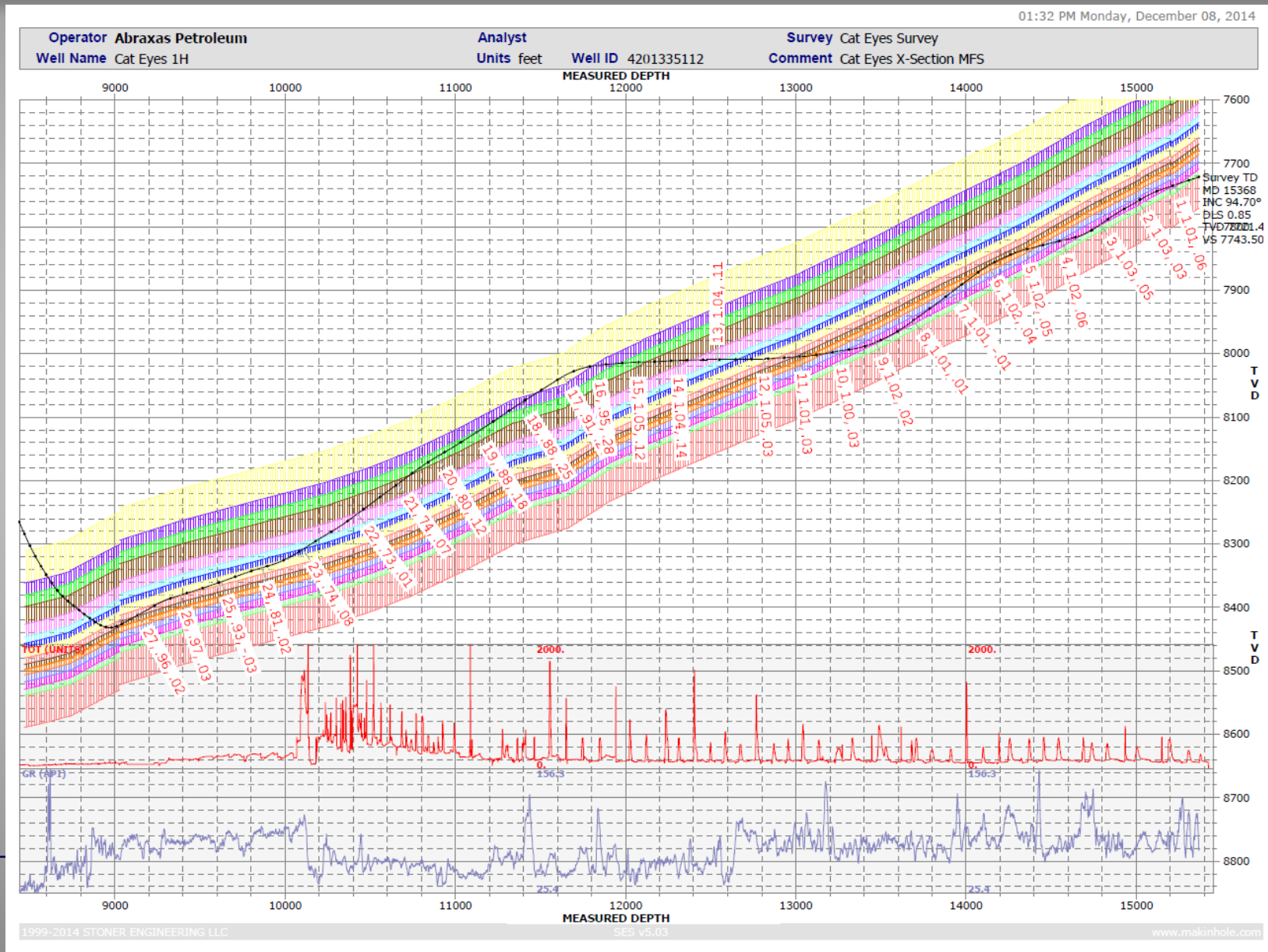
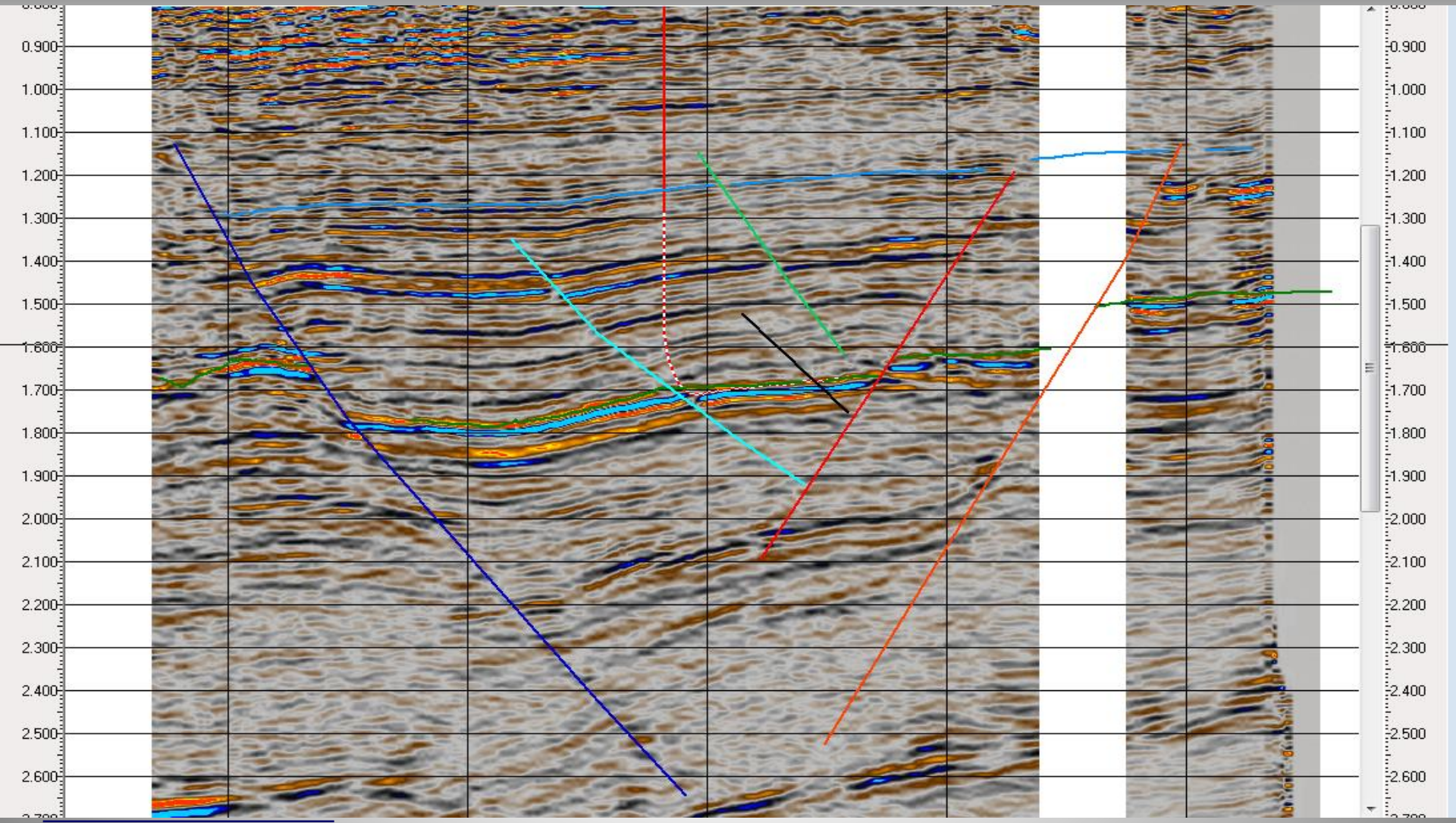


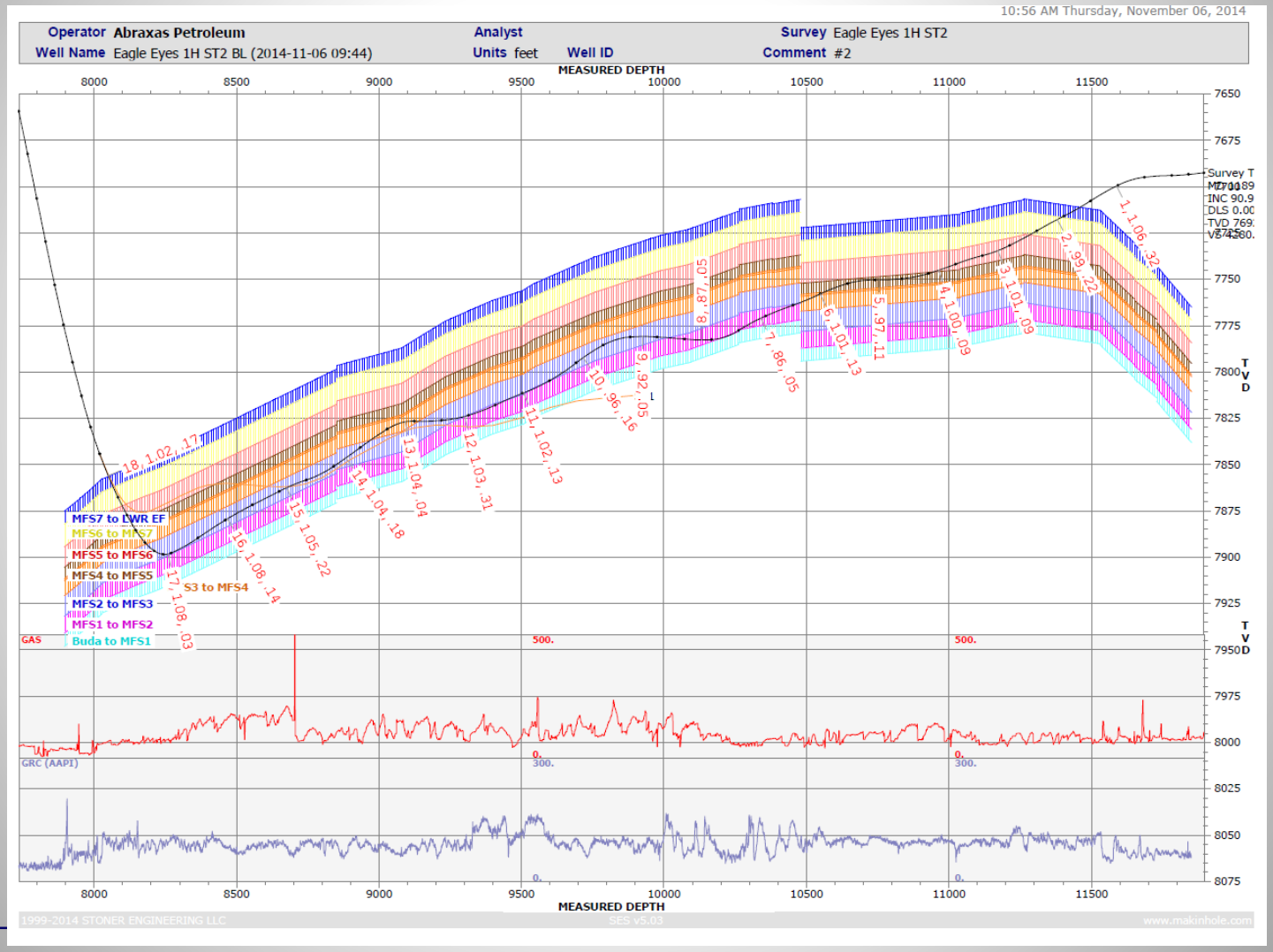
Cat Eyes 1H, Post-Drill X-Section



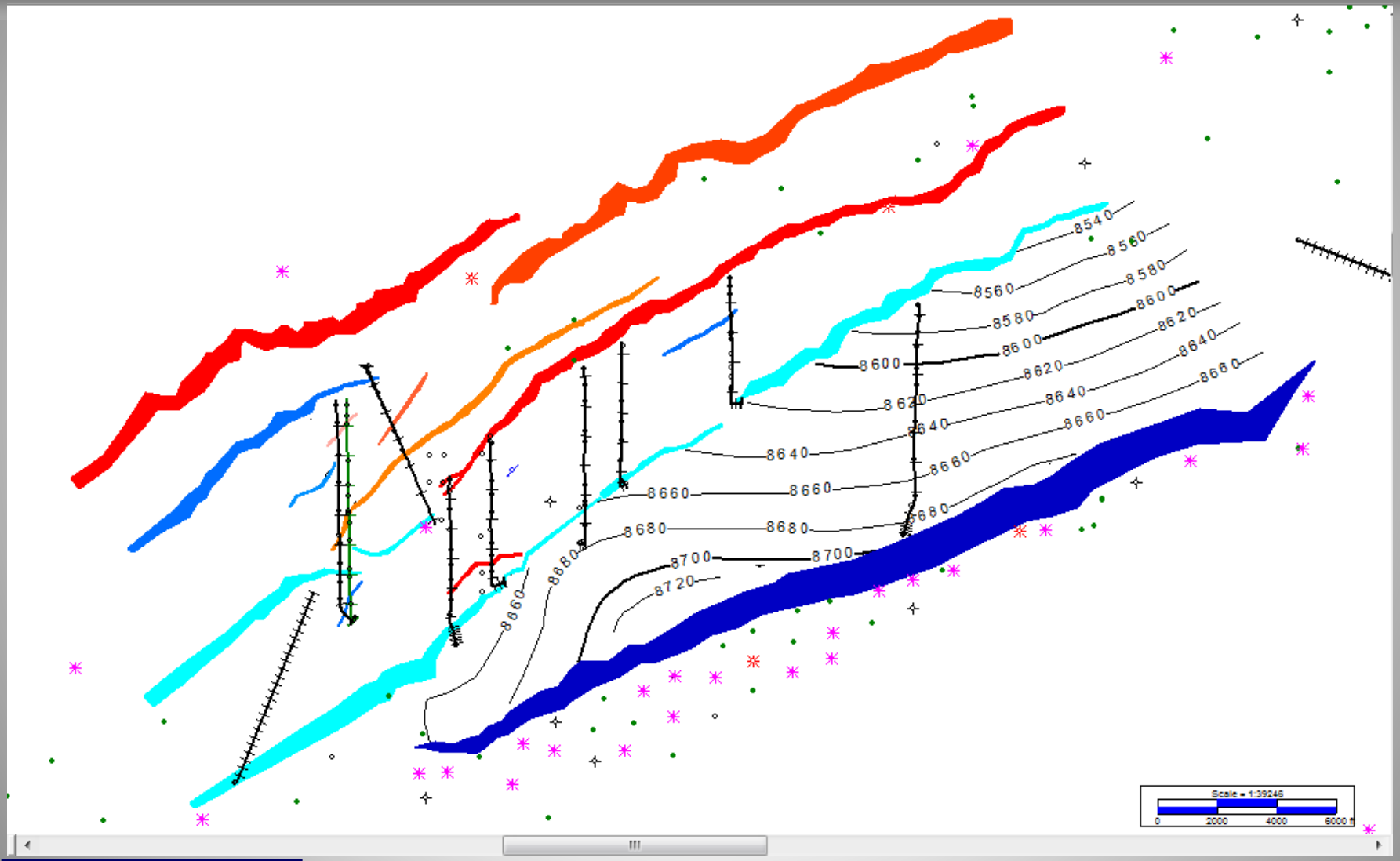
Eagle Eyes 1H Seismic Line



Eagle Eyes 1H, Post–Drill X-Section



Pre-Drill Ave. Velocity Map (Buda)



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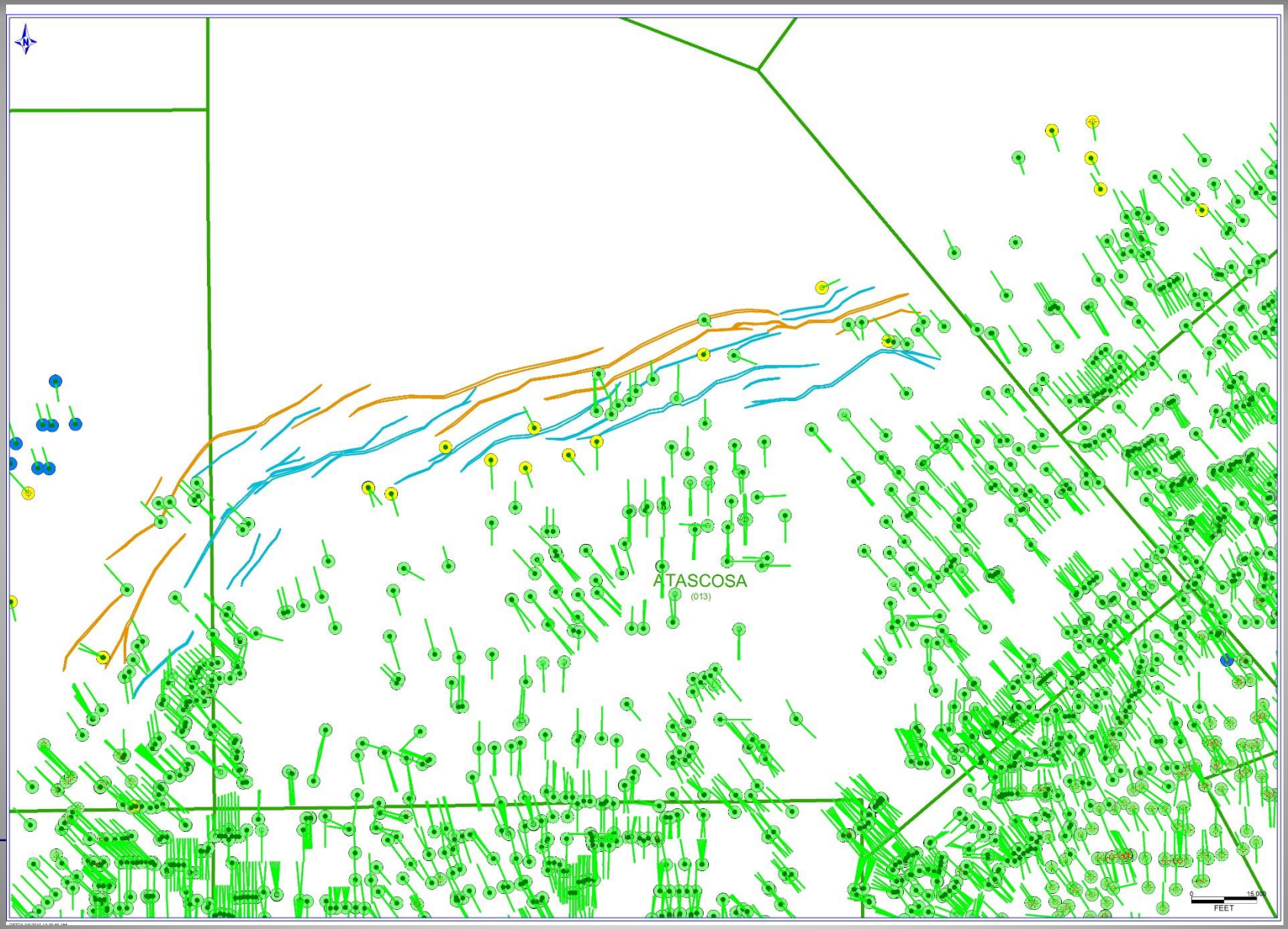
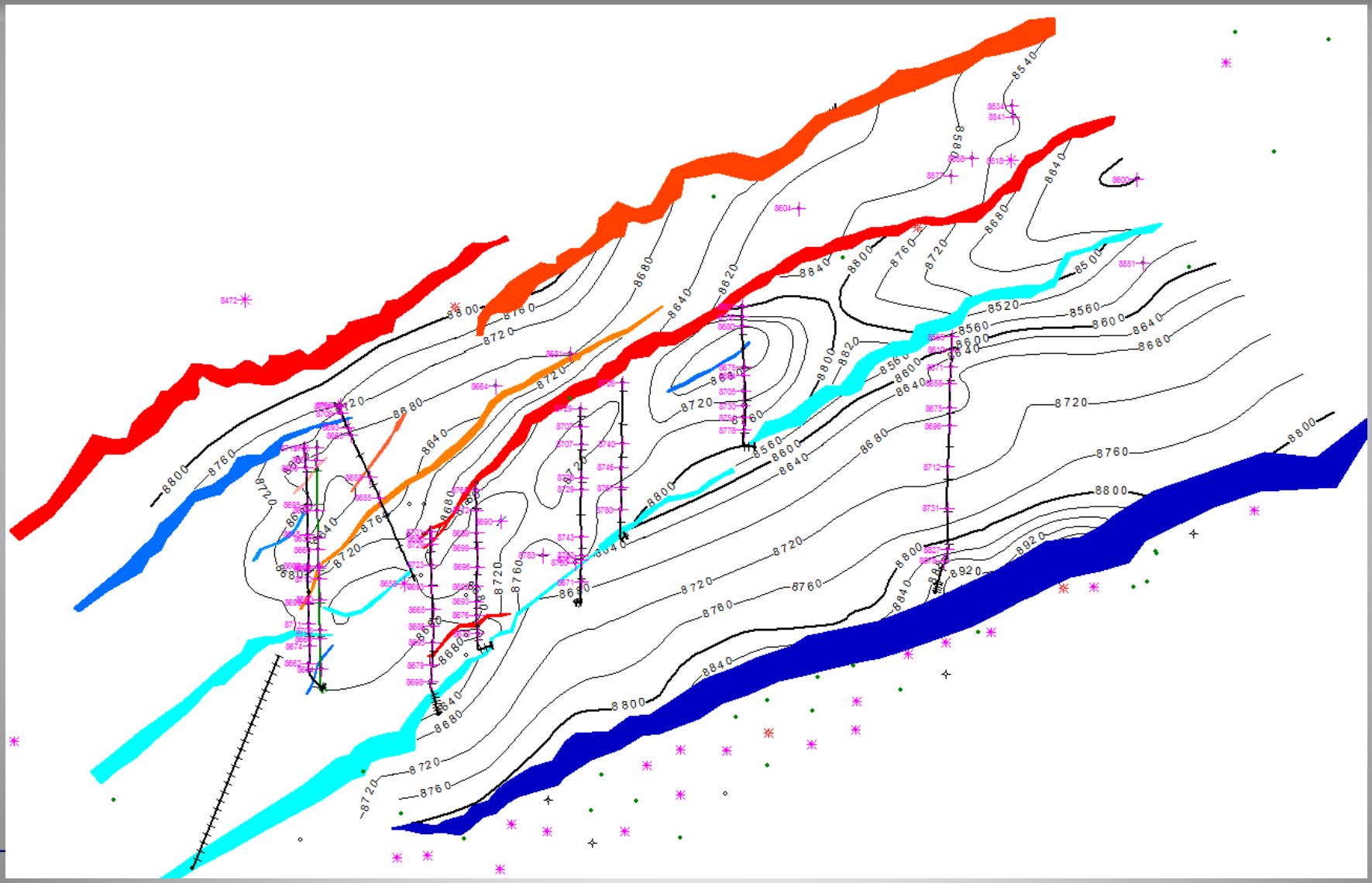


Post-Drill Ave. Velocity Map (Buda)

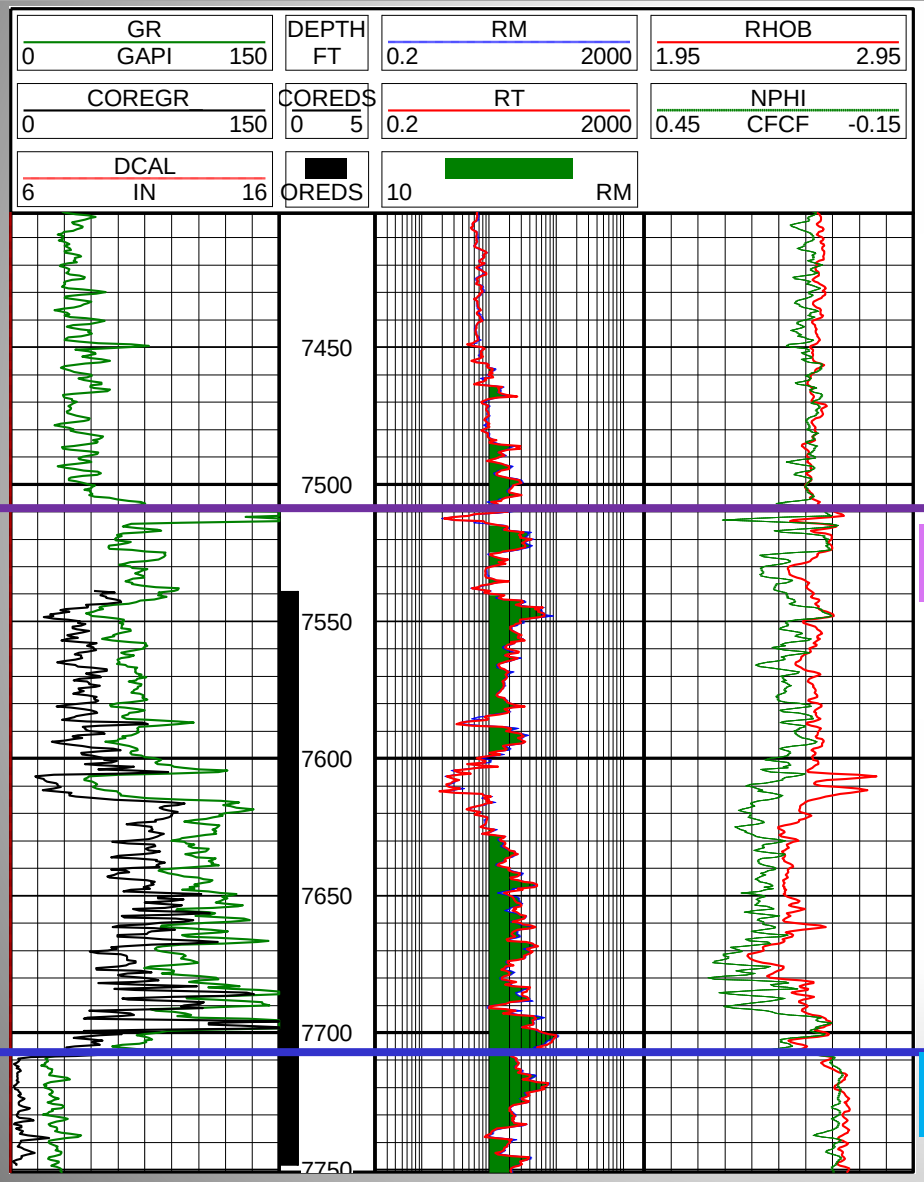


SEISMIC “INTERPRETATIONS”

- Structurally, Buda Limestone dips abruptly down near downthrown side of faults (“reverse drag”).
- Faults were active at Eagle Ford through Austin Chalk deposition, causing greater thickness of higher velocity sediments near downthrown side of faults.

Defining the Target Interval

Example from Grass Farm 1H



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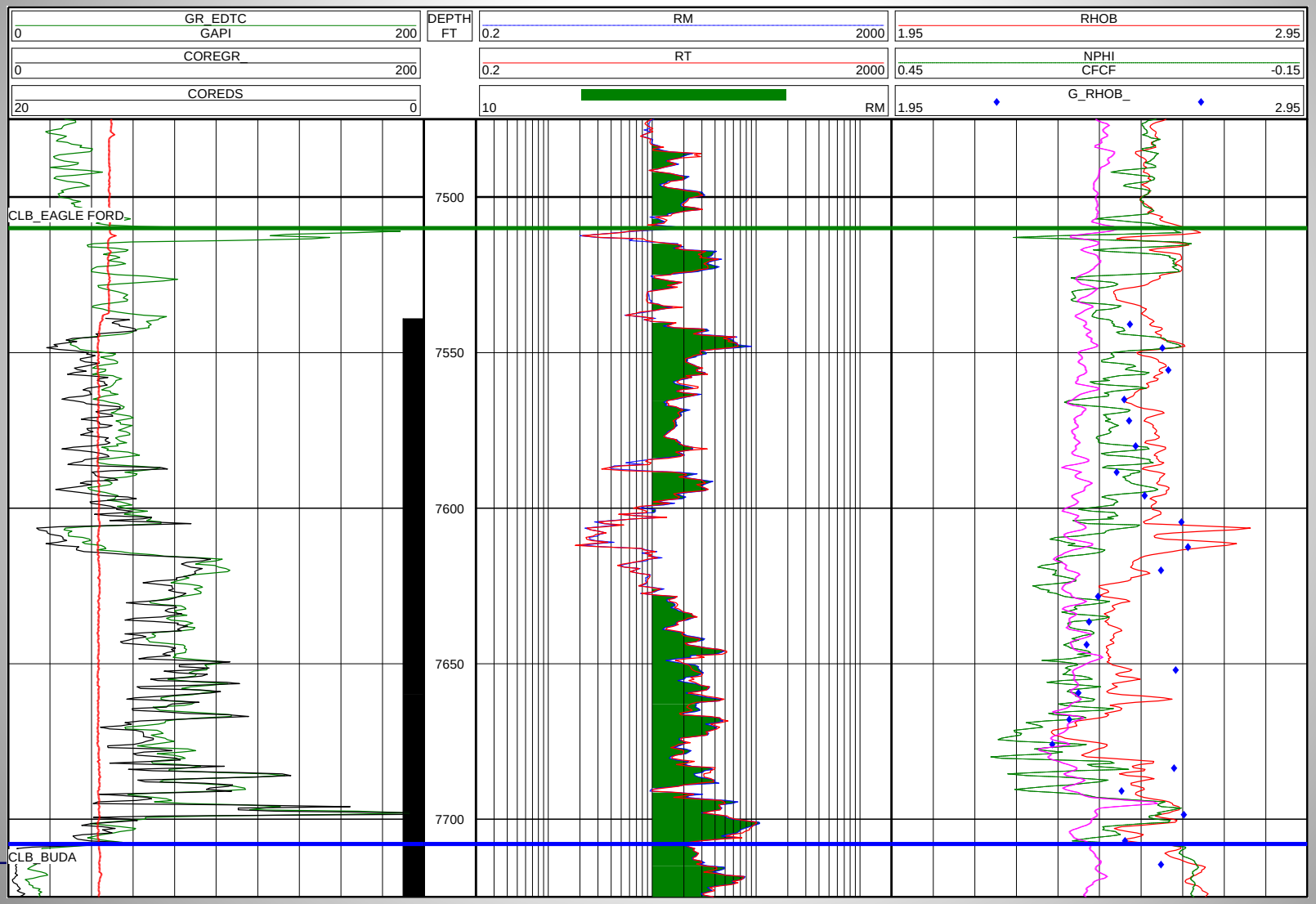
Eagle Ford

Kamp Ranch Zone

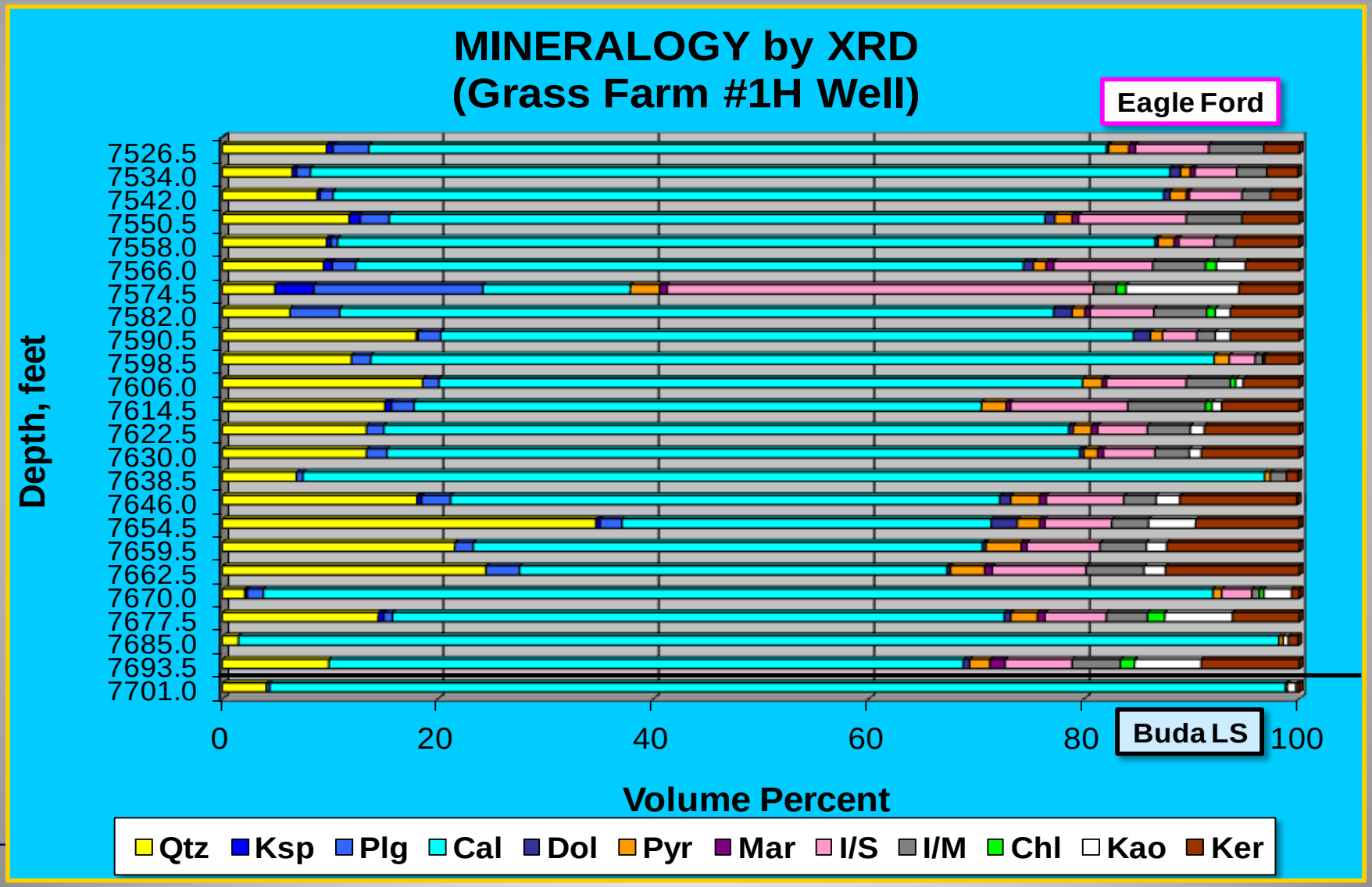
Target Interval 7670-7690' (log)
7658-7678' (core)

Buda Lms

Grass Farm 1H- Basic Log



Summary of Mineralogy By Depth



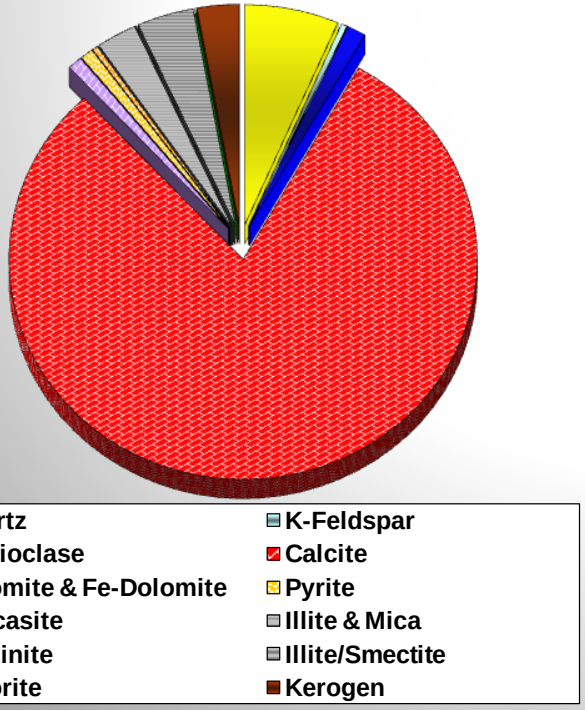
Sample Summary: 7534.0 ft Foraminifera Packstone

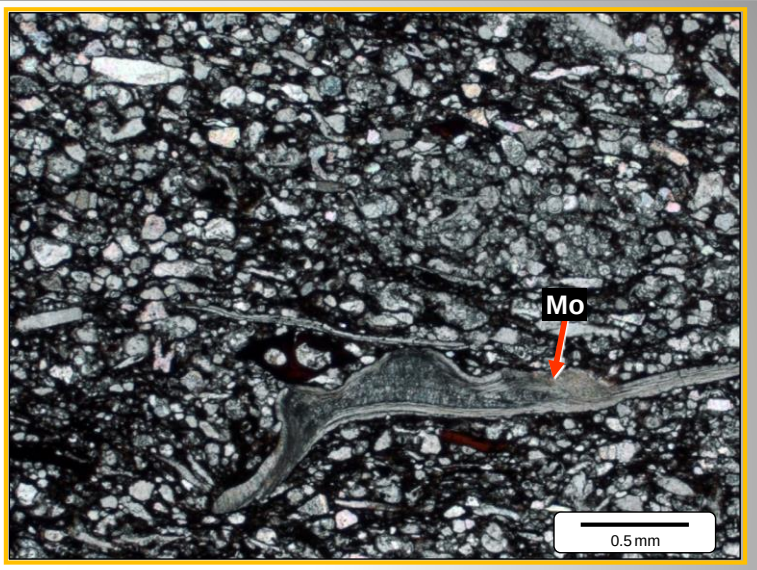
ϕ = 4.4% k_e = 1.24E-08 mD

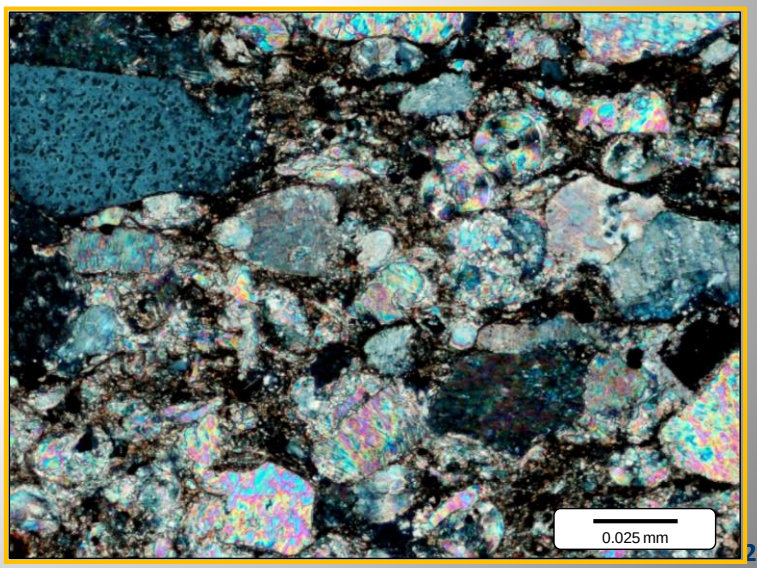
Sw = 38.0% Sg = 43.8%

So = 18.2% GD = 2.69 g/cc

TOC = 1.28% Ro = N/A







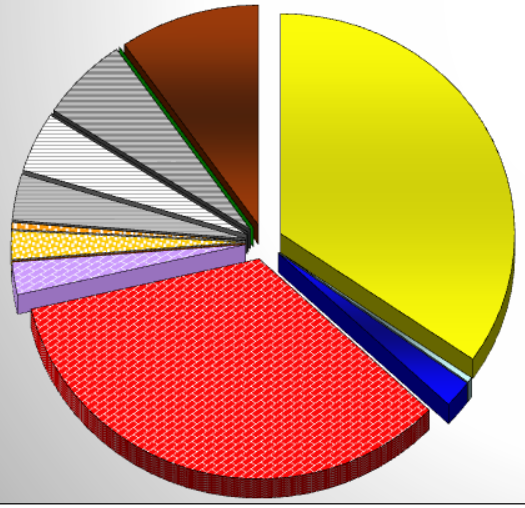
Sample Summary: 7654.5 ft Foraminifera Marl

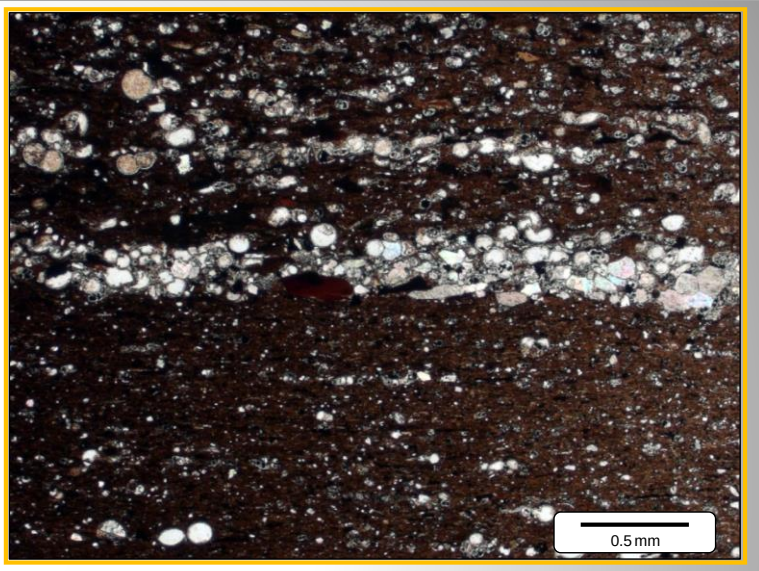
ϕ = 11.1% k_e = 6.54E-08 mD

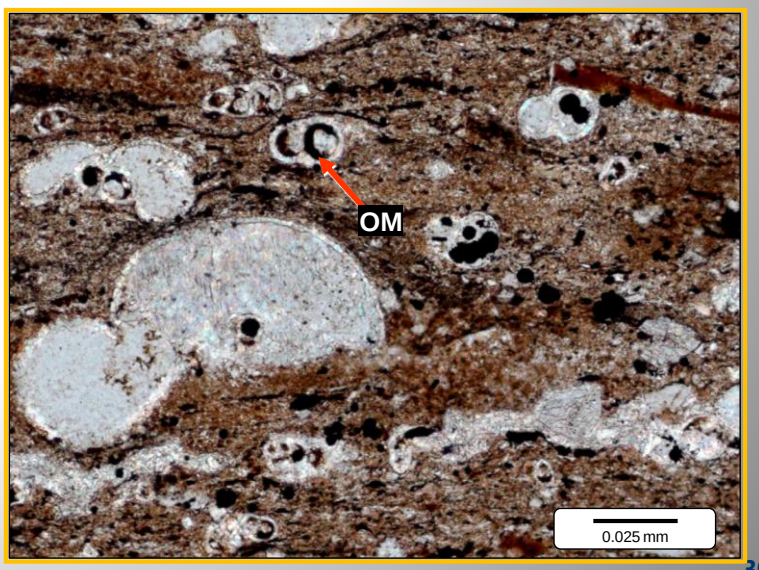
Sw = 23.2% Sg = 13.1%

So = 63.7% GD = 2.58 g/cc

TOC = 4.38% Ro = N/A







Quartz	K-Feldspar
Plagioclase	Calcite
Dolomite & Fe-Dolomite	Pyrite
Marcasite	Illite & Mica
Kaolinite	Illite/Smectite
Chlorite	Kerogen

Sample Summary: 7677.5 ft Skeletal-Foraminifera Marl

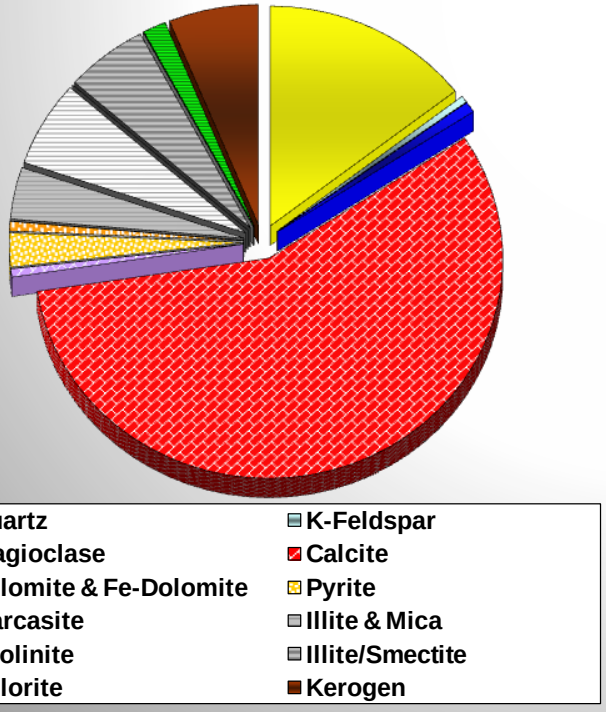
ABRAXAS

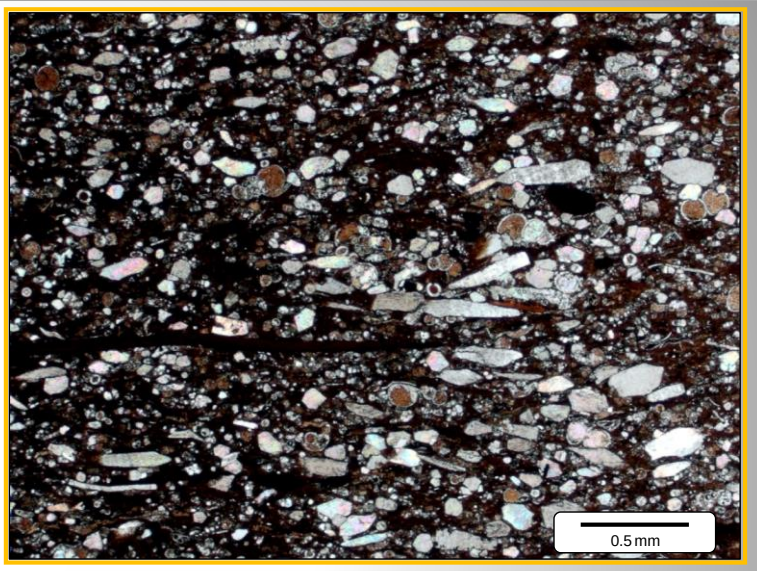
ϕ = 7.1% k_e = 7.65E-09 mD

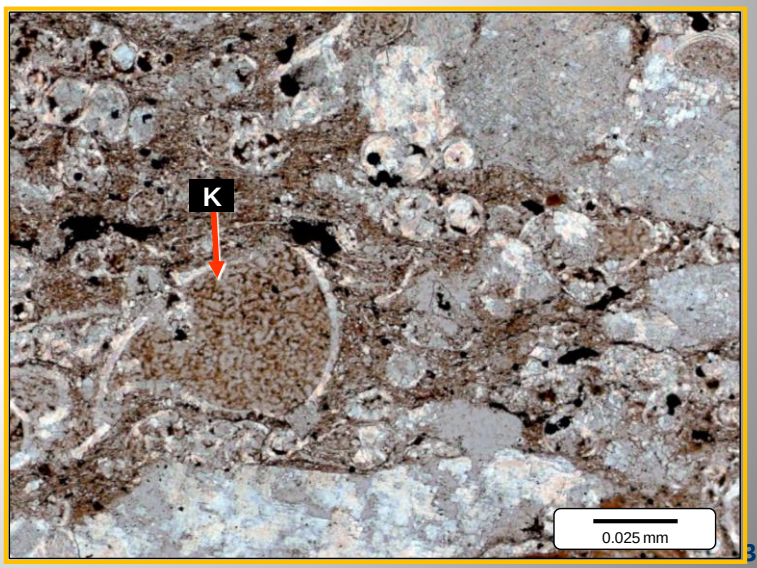
Sw = 27.6% Sg = 8.7%

So = 63.8% GD = 2.64 g/cc

TOC = 2.72% Ro = N/A







Sample Summary: 7693.5 ft Organic Marl

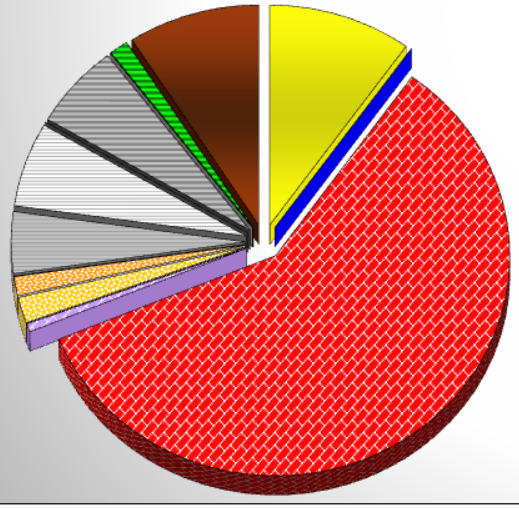
ϕ = 1.9% k_e = 3.58E-09 mD

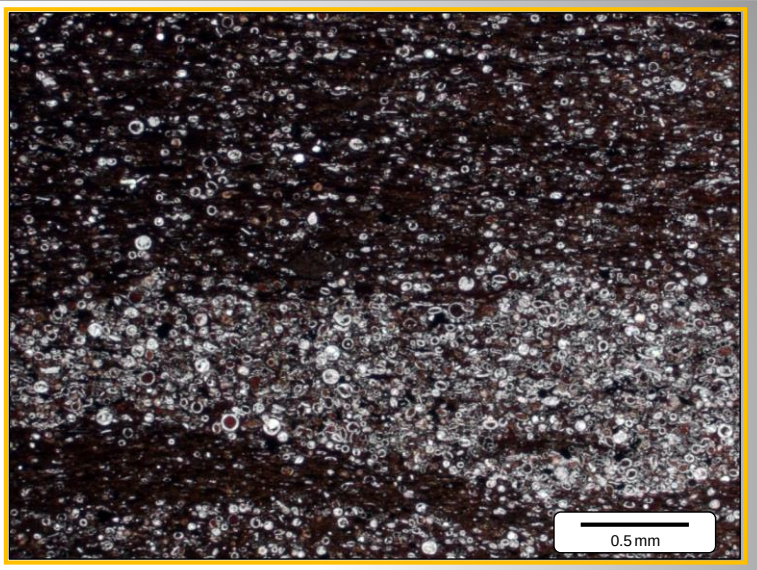
Sw = 48.9% Sg = 23.1%

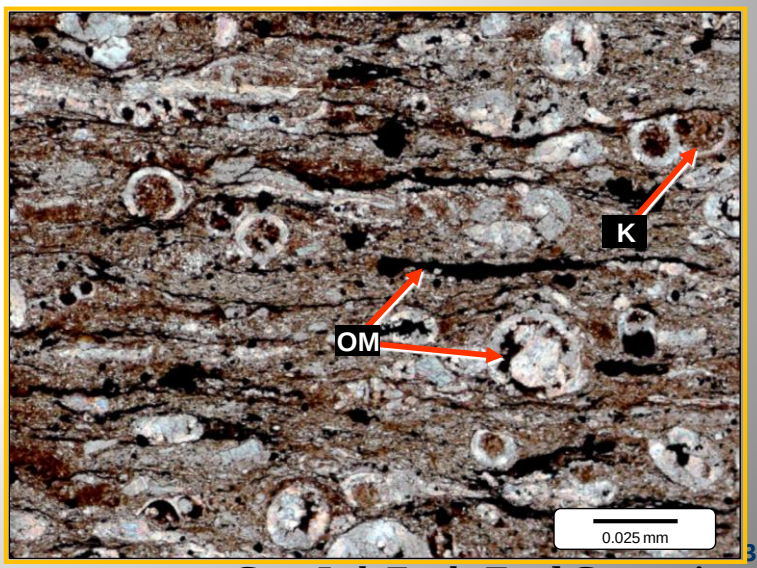
So = 28.0% GD = 2.55 g/cc

TOC = 4.08% Ro = 0.70%*

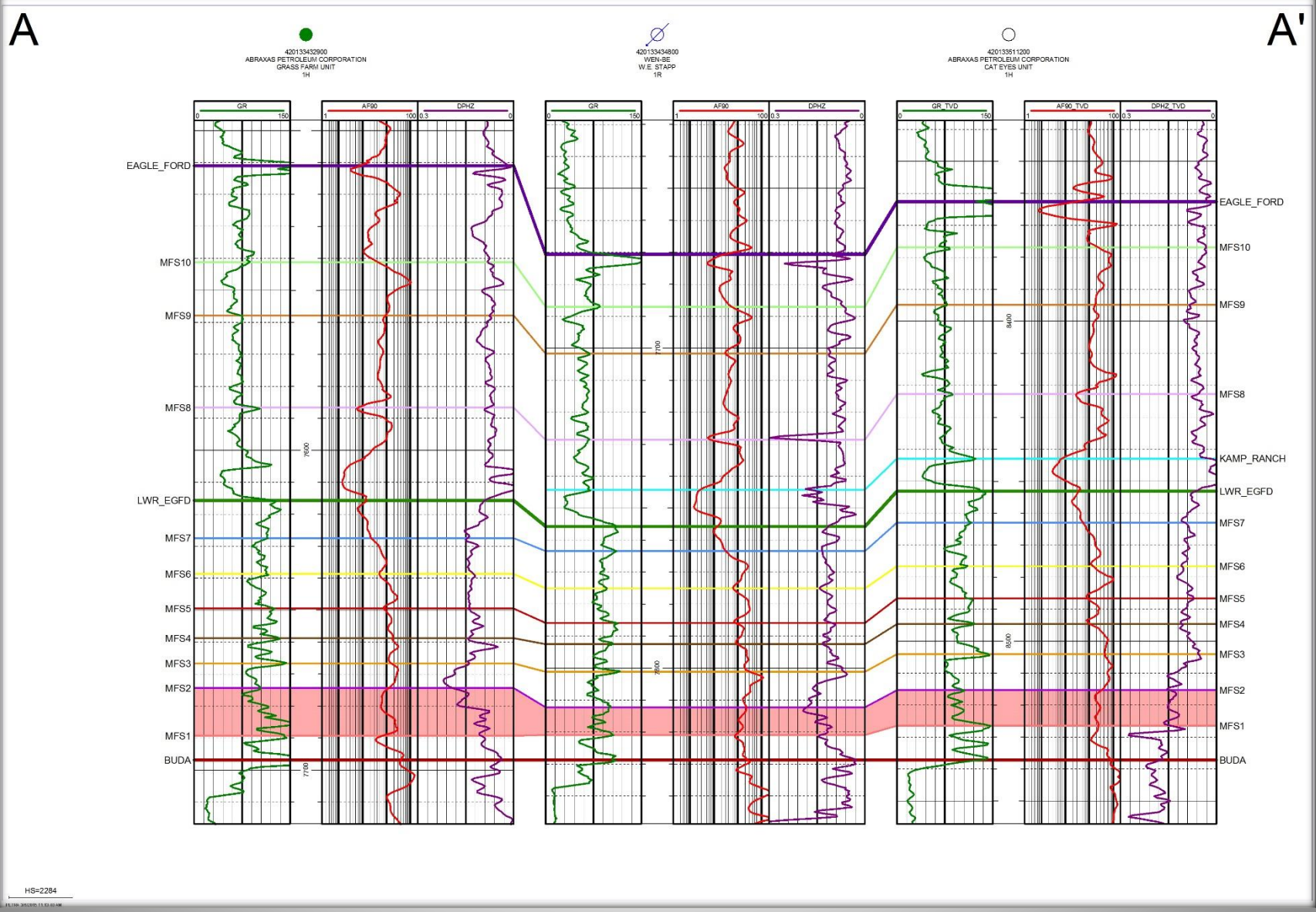
*Calculated by Jacob's formula



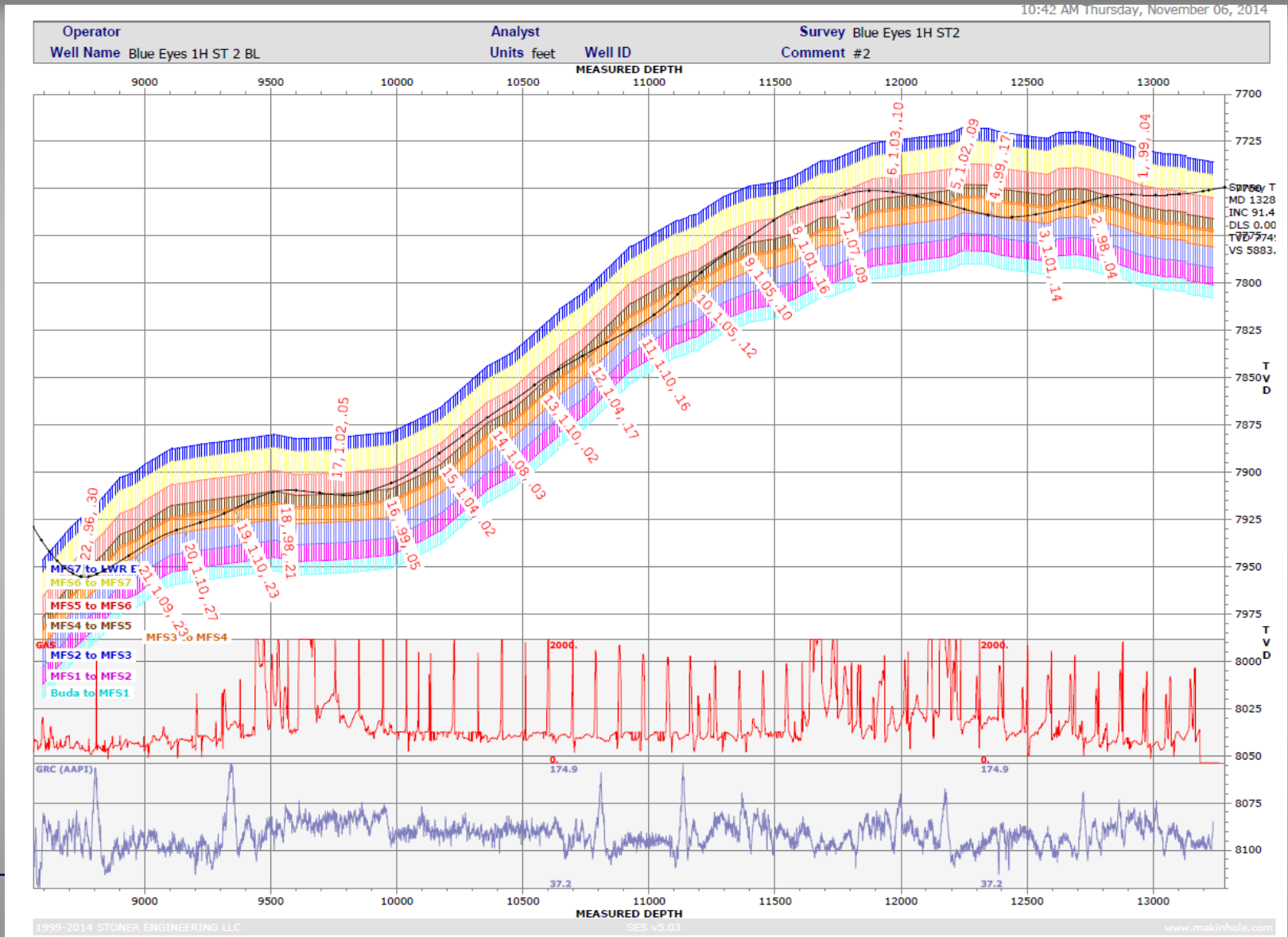




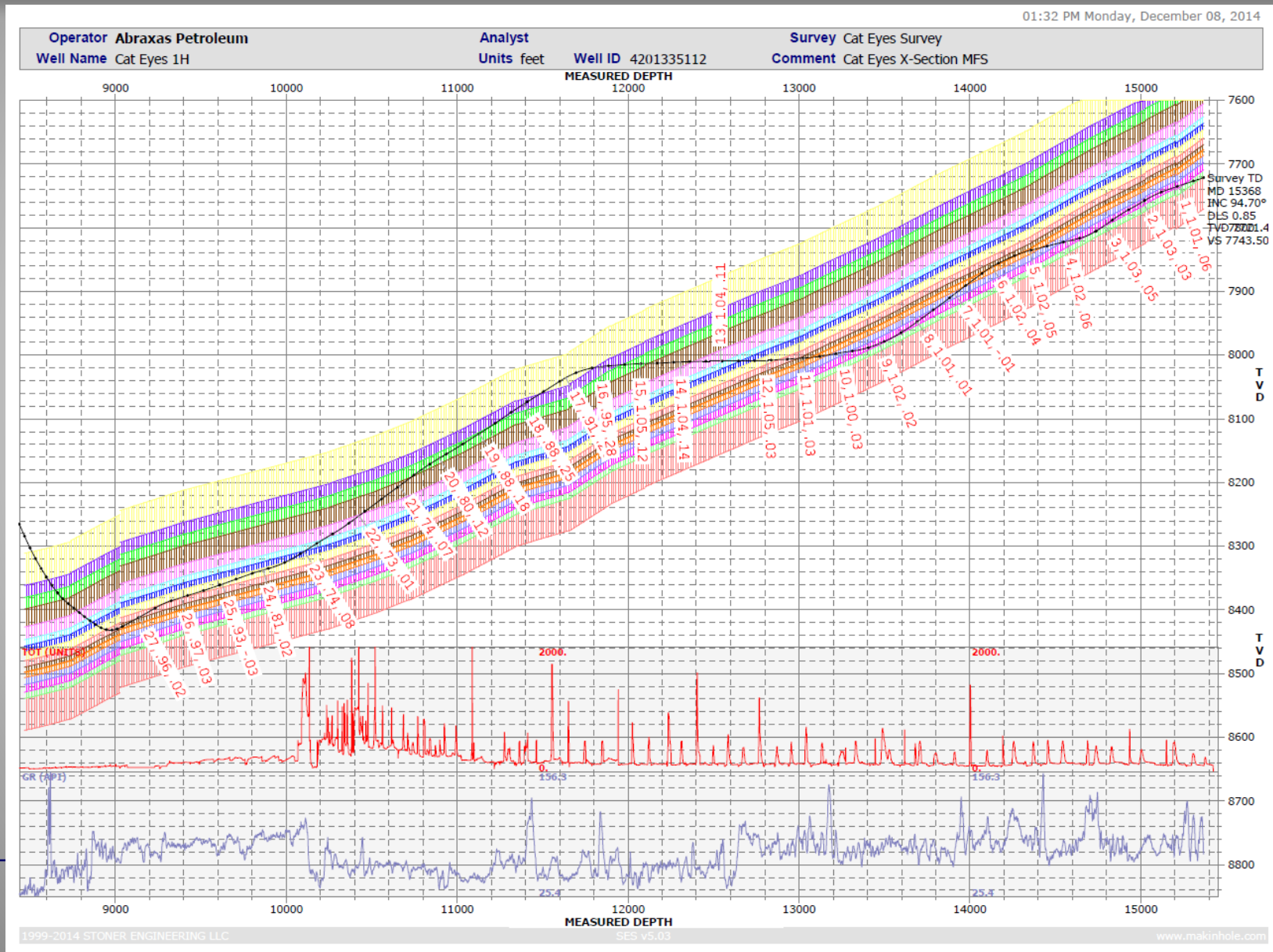
Jourdanton X-Section Eagle Ford



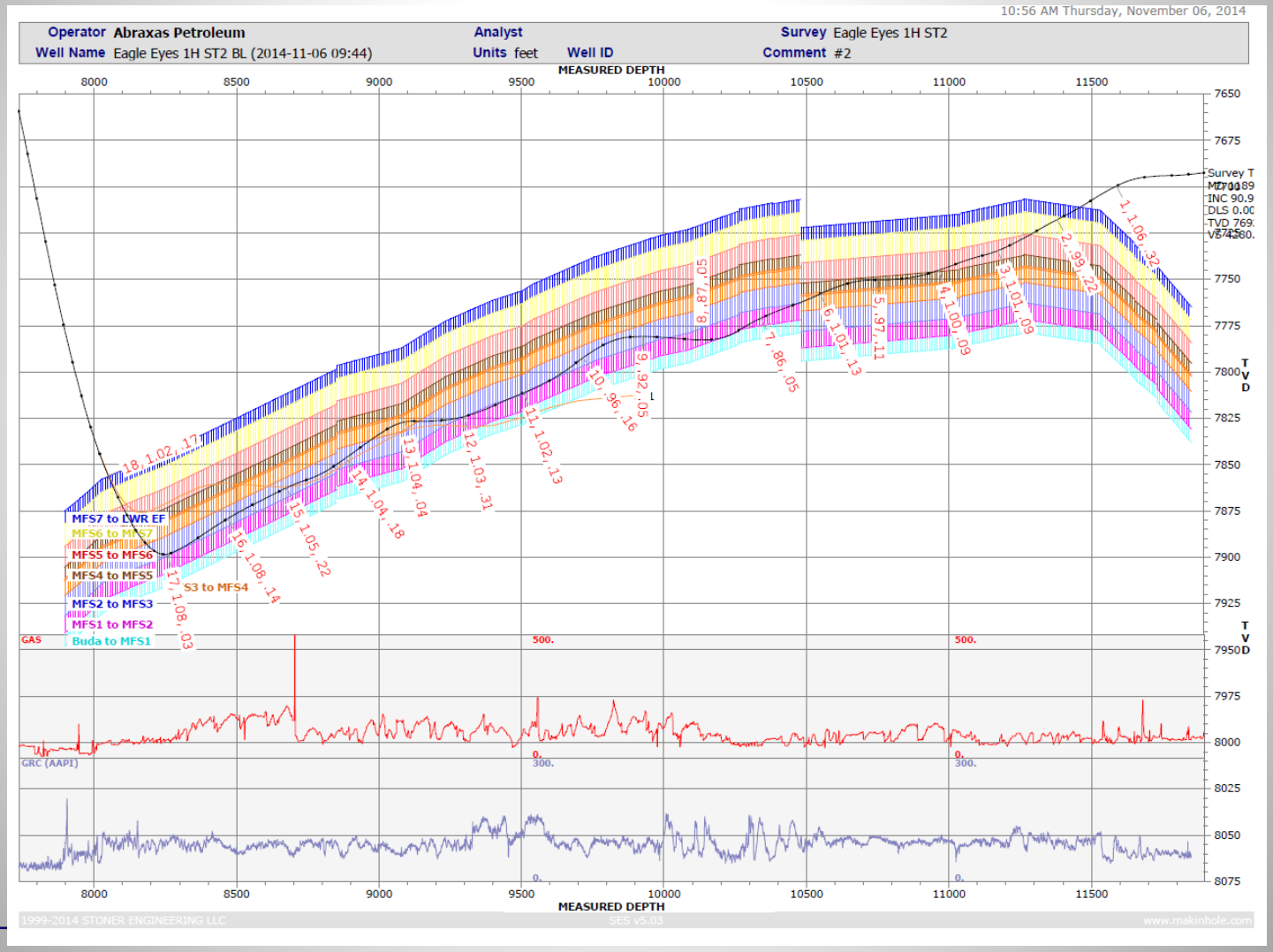
Blue Eyes 1H, Post-Drill X-Section



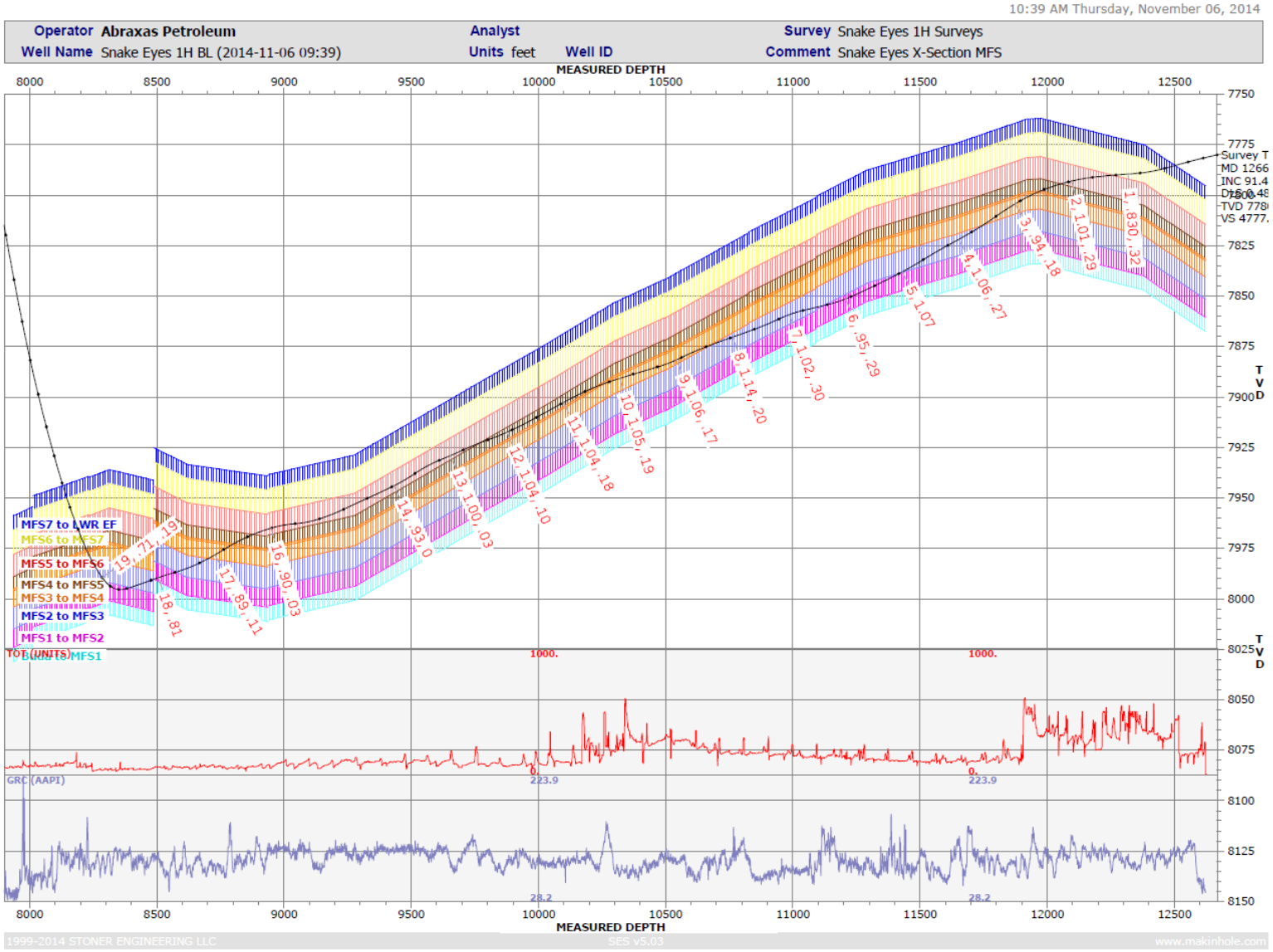
Cat Eyes 1H, Post-Drill X-Section



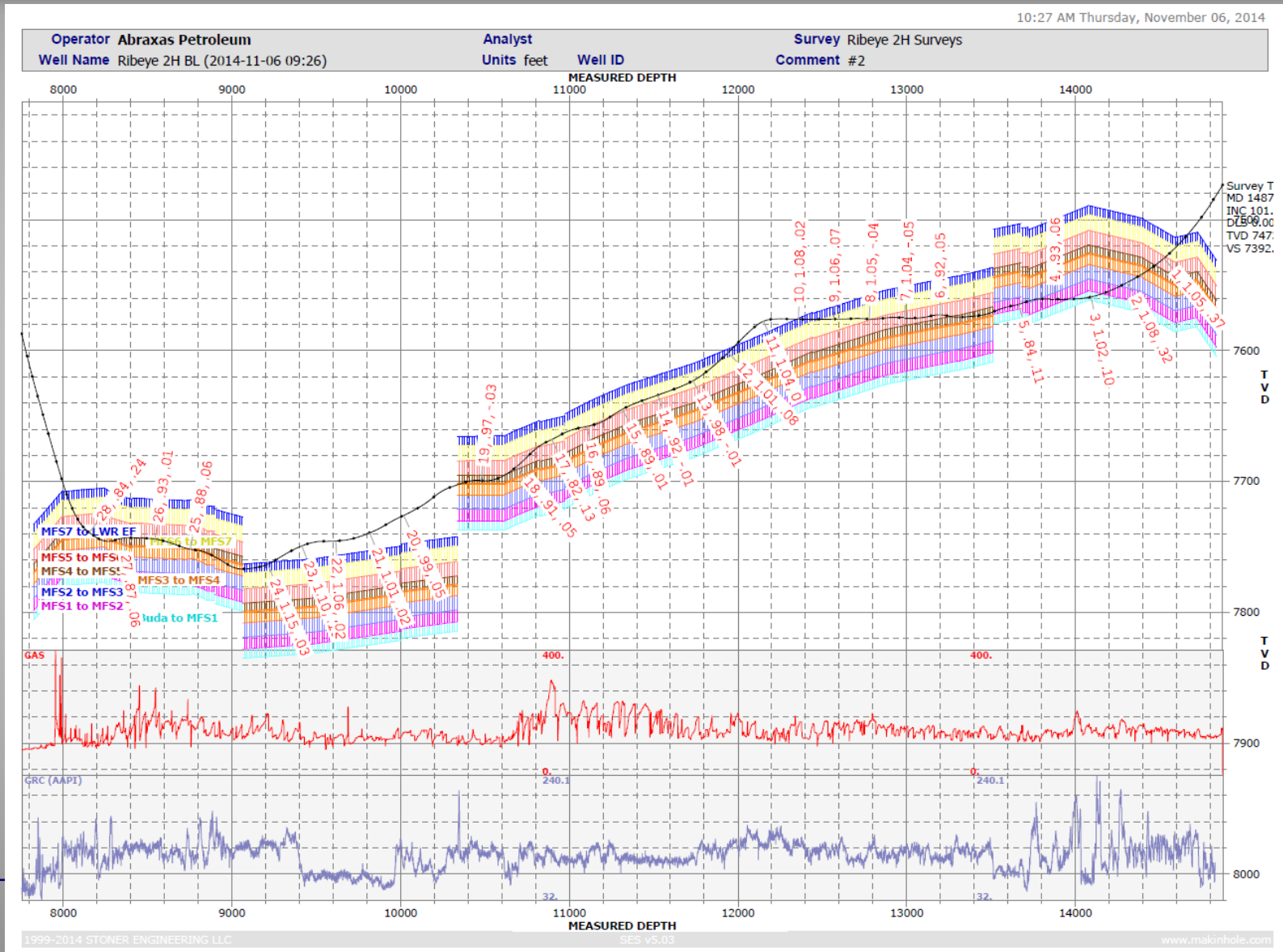
Eagle Eyes 1H, Post-Drill X-Section

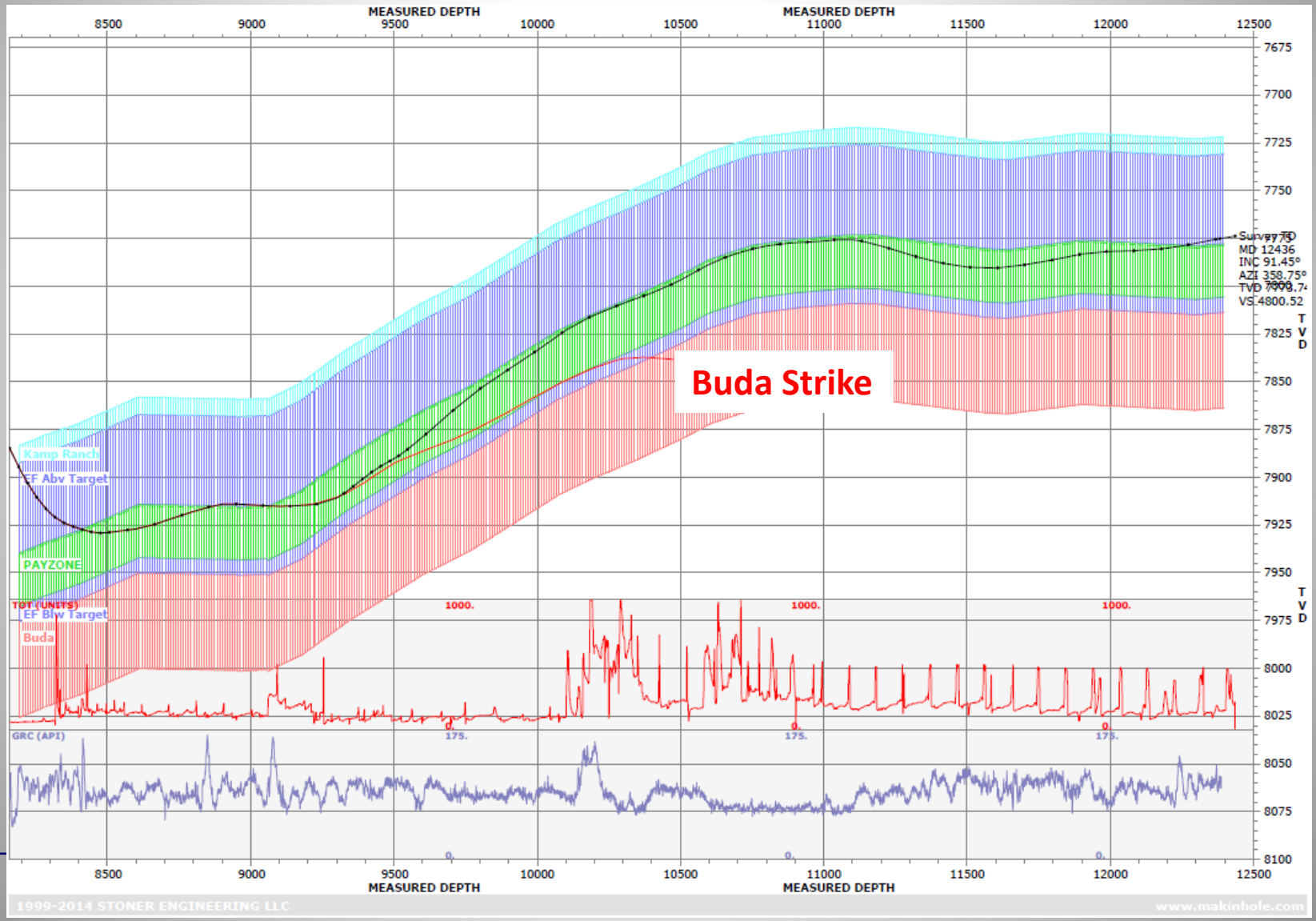


Snake Eyes 1H, Post-Drill X-Section



Ribeye 2H, Post-Drill Cross-Section




MEASURED DEPTH
8500
9000
9500
10000
10500
11000
11500
12000
12500
7675
7700
7725
7750
7775
7800
7825
7850
7875
7900
7925
7950
7975
8000
8025
8050
8075
8100
TVD
Survey 76
MD 12436
INC 91.45°
AZI 358.75°
TVD 7800.74
VS 4800.52
Buda Strike
Kamp Ranch
EF Abv Target
PAYZONE
EF Blw Target
Buda
TOT (UNITS)
1000.
0.
GRC (API)
175.
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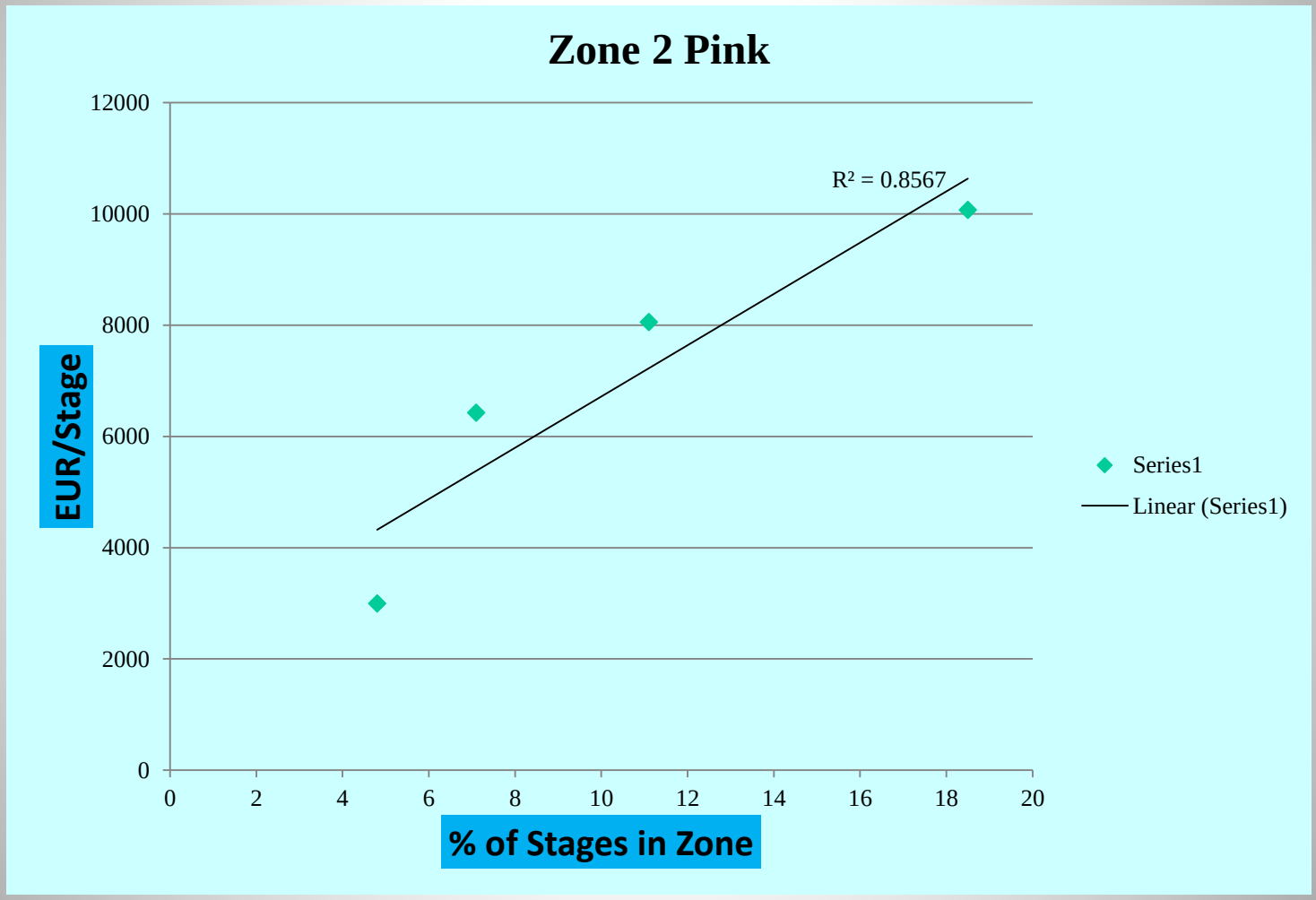
Zone 2 Pink
12000
10000
8000
6000
4000
2000
0
EUR/Stage
R² = 0.8567
0
2
4
6
8
10
12
14
16
18
20
% of Stages in Zone
Series1
Linear (Series1)

Frac Gradient and Well Results

- Frac gradient not zone dependent (0.9-1.05 psi/ft)
- Frac gradient is lower near faults (<0.85 psi/ft)
- Completion zone does not have strong correlation to well results, yet.
- Wells with sidetracks after Buda strike underperform