

# **Limestone Frequency and Well Performance, Eagle Ford Shale (Cretaceous), South Texas\***

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Search and Discovery Article #51091 (2015)\*\*

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## **Abstract**

The Lower Eagle Ford on the southwestern flank of the San Marcos arch consists of cyclic interbeds of thin, brittle, recrystallized limestone and thicker, more ductile, organic-rich calcareous mudstone (marl). The limestones can be recognized, but not fully resolved, by their log signature. The number of limestone beds can be ascertained from the logs and their thickness approximated. The limestone bed frequency can be calculated by dividing the number of limestones in an interval by the thickness of the interval. Mechanical models show that the density of natural fractures increases as bed thickness decreases, suggesting overall fracture effectiveness and complexity will increase as limestone bed thickness decreases. In the North Longhorn area, limestone bed frequency and limestone bed thickness are inversely related, and increased limestone frequency has been identified as a key driver for well performance. Another operator in the play has identified thin limestones interbedded with organic-rich marls as “the most productive and most brittle” facies in the Eagle Ford. Shale reservoirs can be considered in terms of reservoir quality and completions quality. In the Eagle Ford, marl thickness is an important component of reservoir quality and limestone frequency of completions quality. Other factors being equal, the best production will be associated with thick marl sequences with enough interbedded limestone to maximize the complexity of the combined natural and induced fracture network, but not so much limestone as to substantially lower storage of hydrocarbons in the system.

### **References Cited**

McCallum, H.D., 1933, Darst Creek oilfield, Guadalupe County, Texas: AAPG Bulletin, v. 17/1, p. 16-37.

Ruppel, S.C., R.G. Loucks, and G. Frébourg, 2012, Guide to field exposures of the Eagle Ford-equivalent Boquillas Formation and related Upper Cretaceous units in southwest Texas: The University of Texas at Austin, Bureau of Economic Geology, Mudrock Systems Research Laboratory Field-Trip Guidebook, 151 p.

Tian, Y., 2014, Occurrence of Multiple Fluid Phases across a Basin, in the Same Shale Gas Formation – Eagle Ford Shale Example: Doctoral dissertation, Texas A & M University, Available electronically from <http://hdl.handle.net/1969.1/152773>.

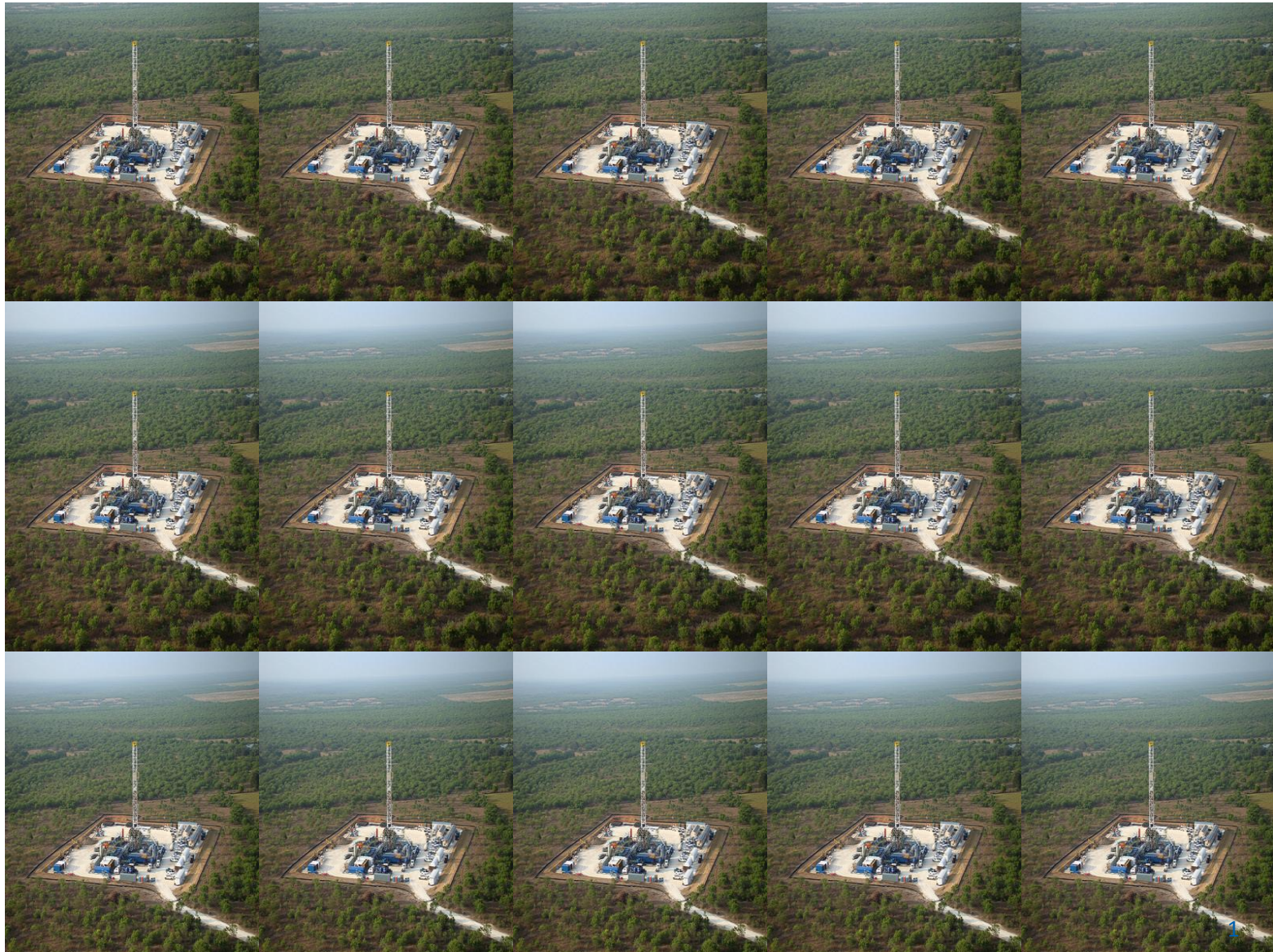
# **Limestone Frequency and Well Performance, Eagle Ford Shale (Cretaceous), South Texas**

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Authors: R. H. Wilty , Y. Tian, A. Salman, K. W. O'Connor, B. Kurtoglu,  
R. J. Hooper , R. M. Daniels, R. W. Butler, J. A. Breyer and D. Alfred



# The Eagle Ford Play



# The Eagle Ford Play

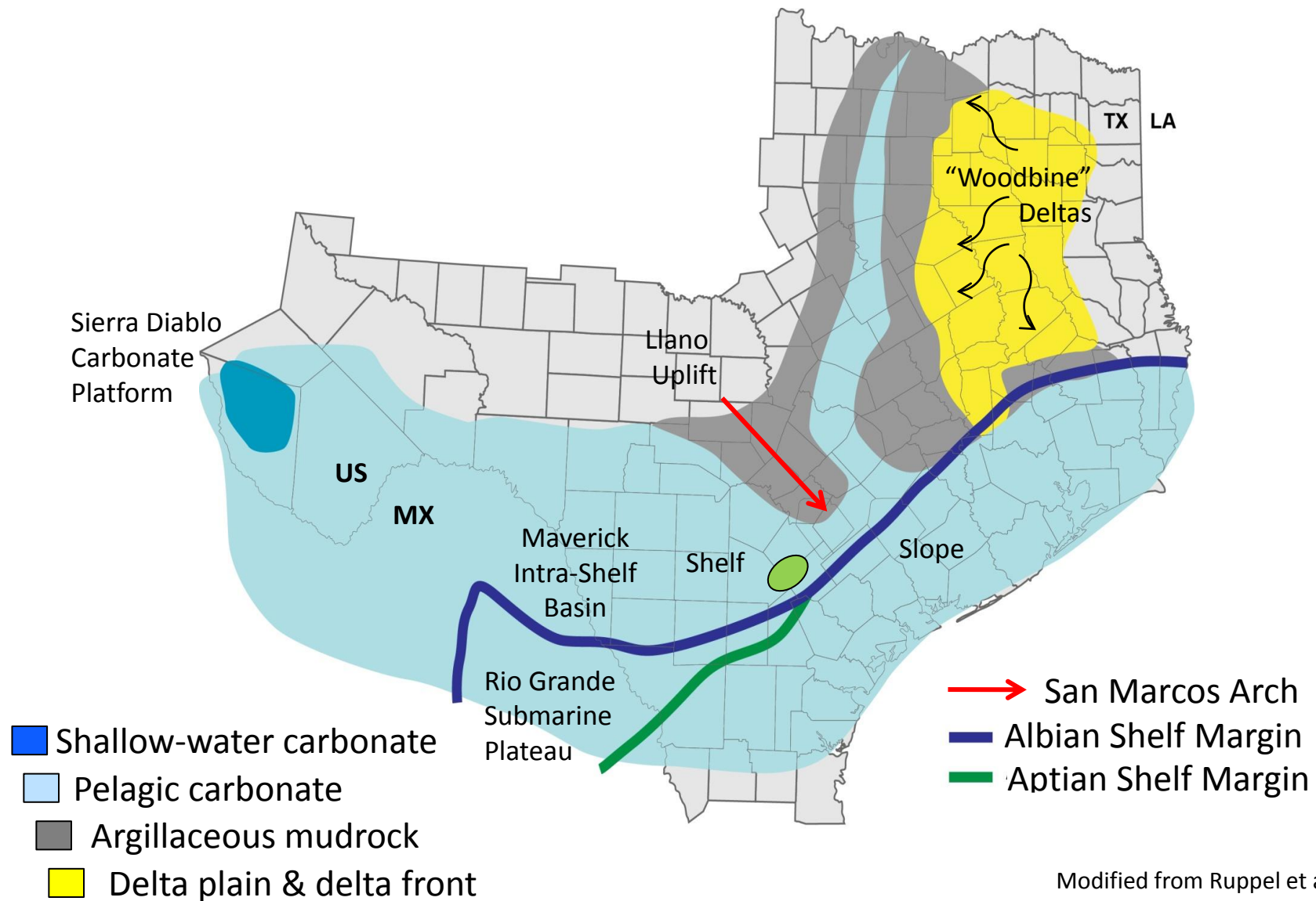


There are two distinct types of Eagle Ford shale in the Darst Creek field...Both types are fossiliferous, and almost invariably present a rich showing of oil where penetrated. Many tests, however, have proved this showing valueless.

McCallum, AAPG Bulletin 1933

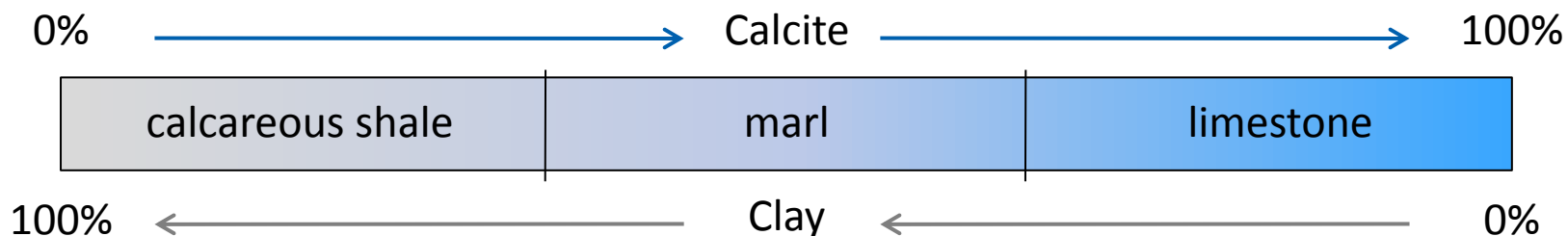


# Regional Depositional Setting



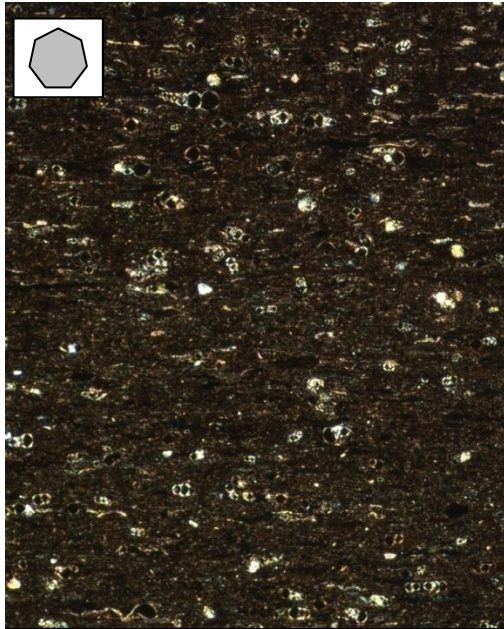
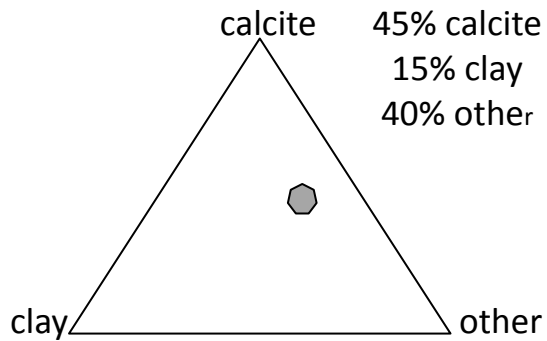
Modified from Ruppel et al. (2012)

# Rock Types in the Eagle Ford Shale

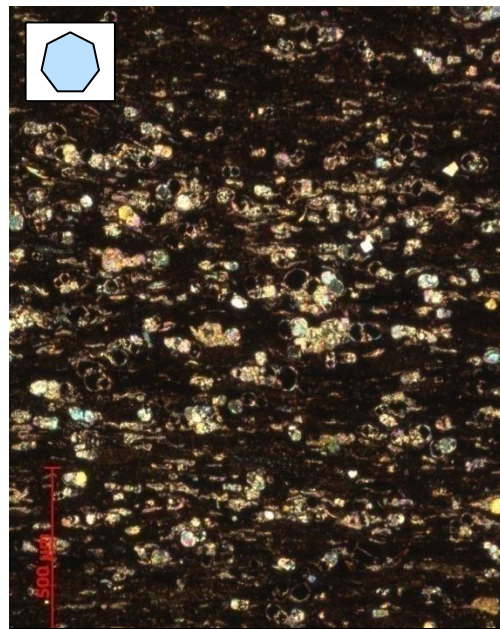
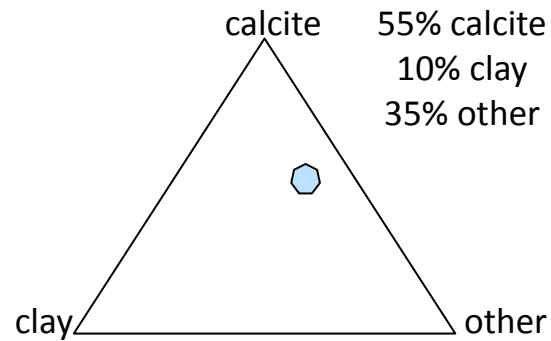


Attribute	Shale	Marl	Limestone
Abundance	<5%	60-70%	30-40%
Calcite	<25%	45-55%	75-85%
Clay	50-60%	10-15%	5%
TOC	<2%	2-10%	<2%
Porosity	---	8-12%	3-4%
Young's Modulus	--	2-4	4-6

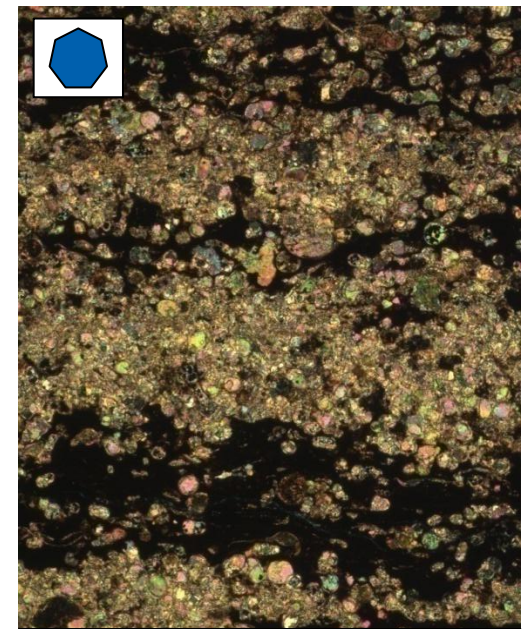
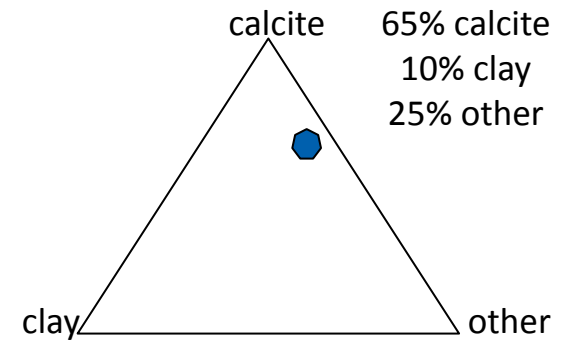
# Marls



Marl

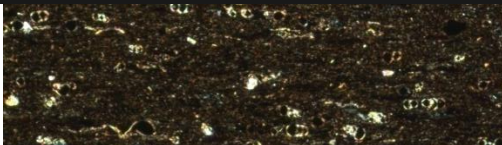
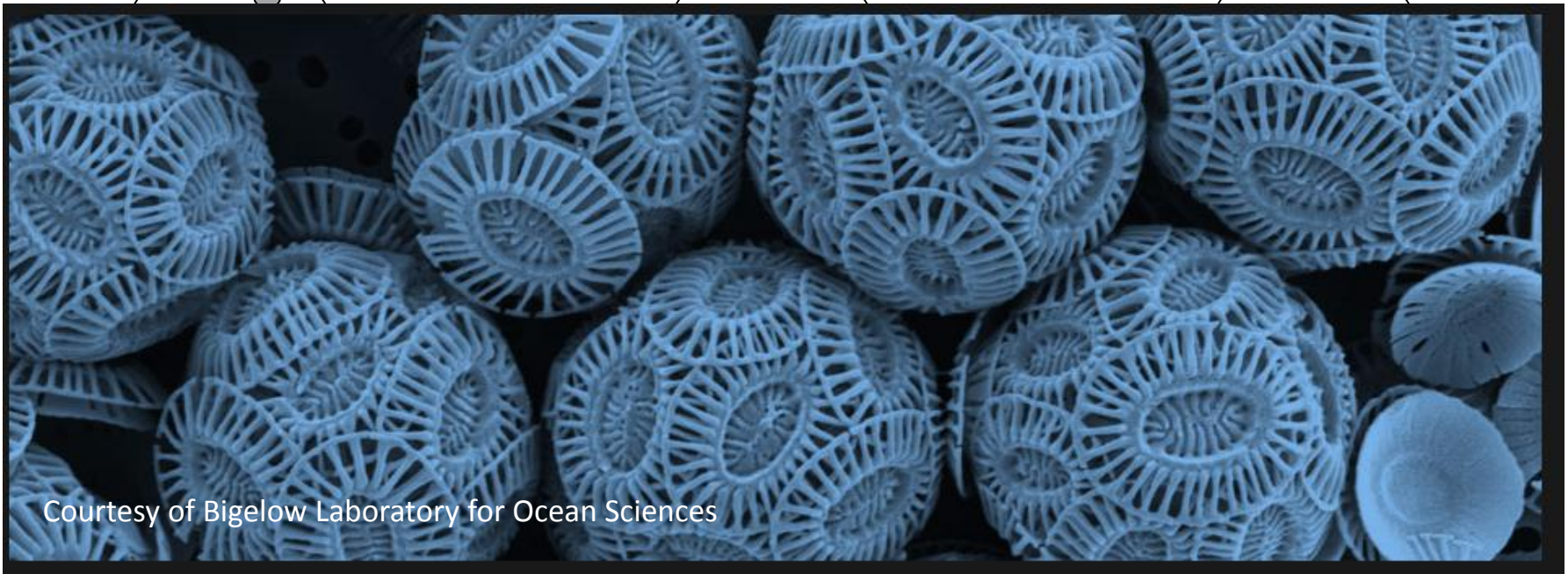
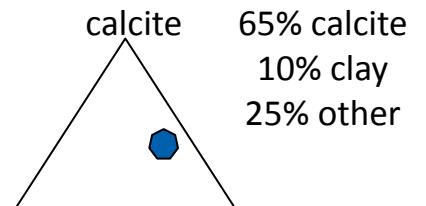
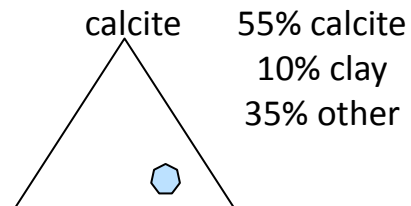
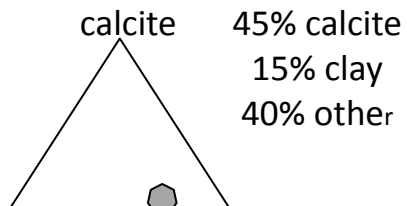


Foraminiferal Marl

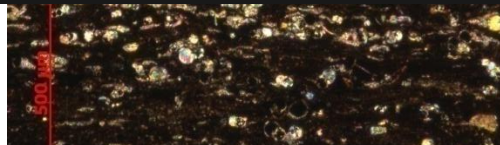


Foram-Rich Marl

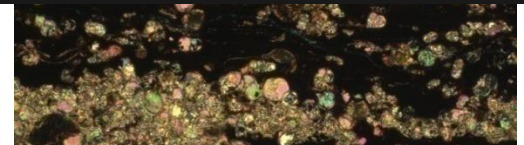
# Marls



Marl

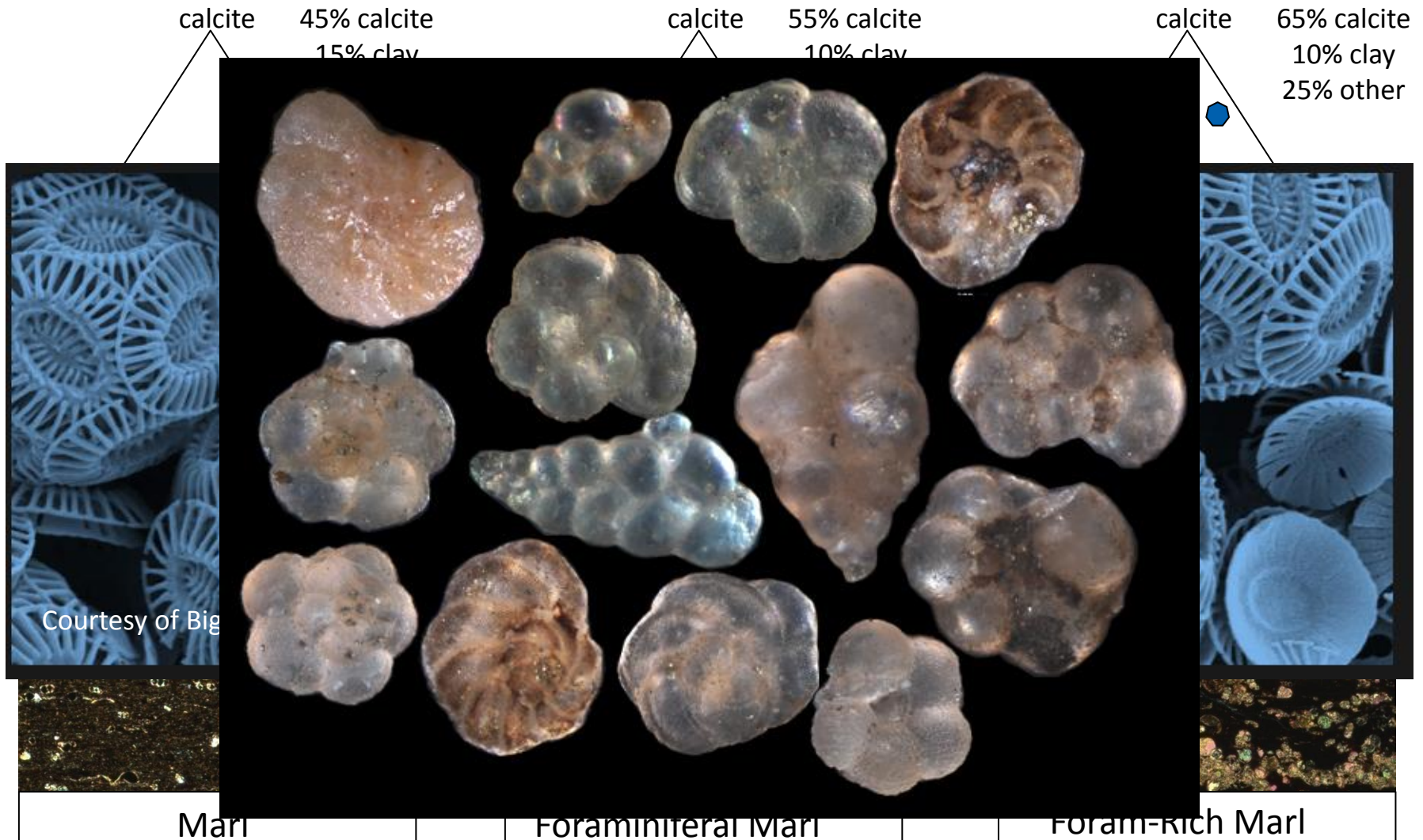


Foraminiferal Marl

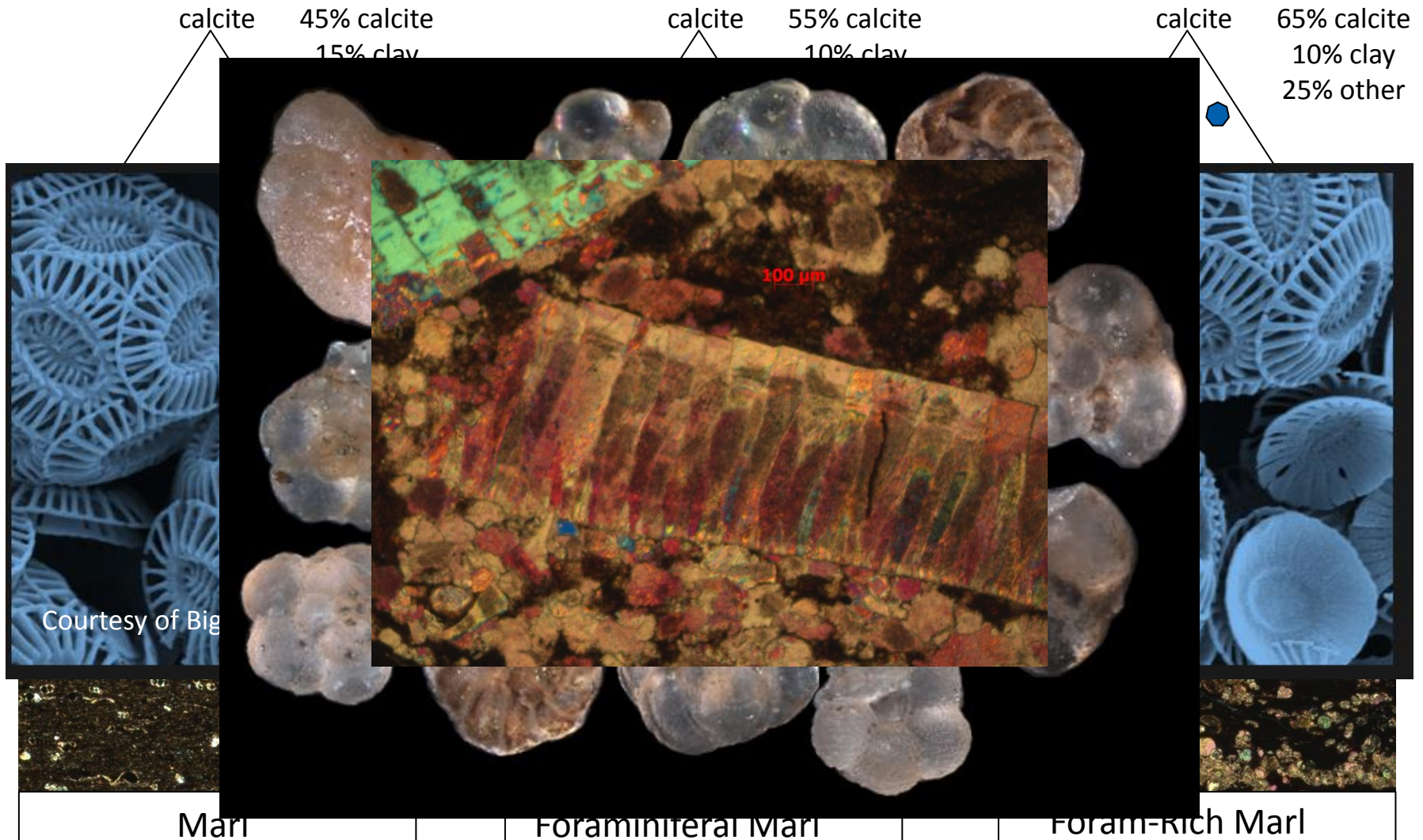


Foram-Rich Marl

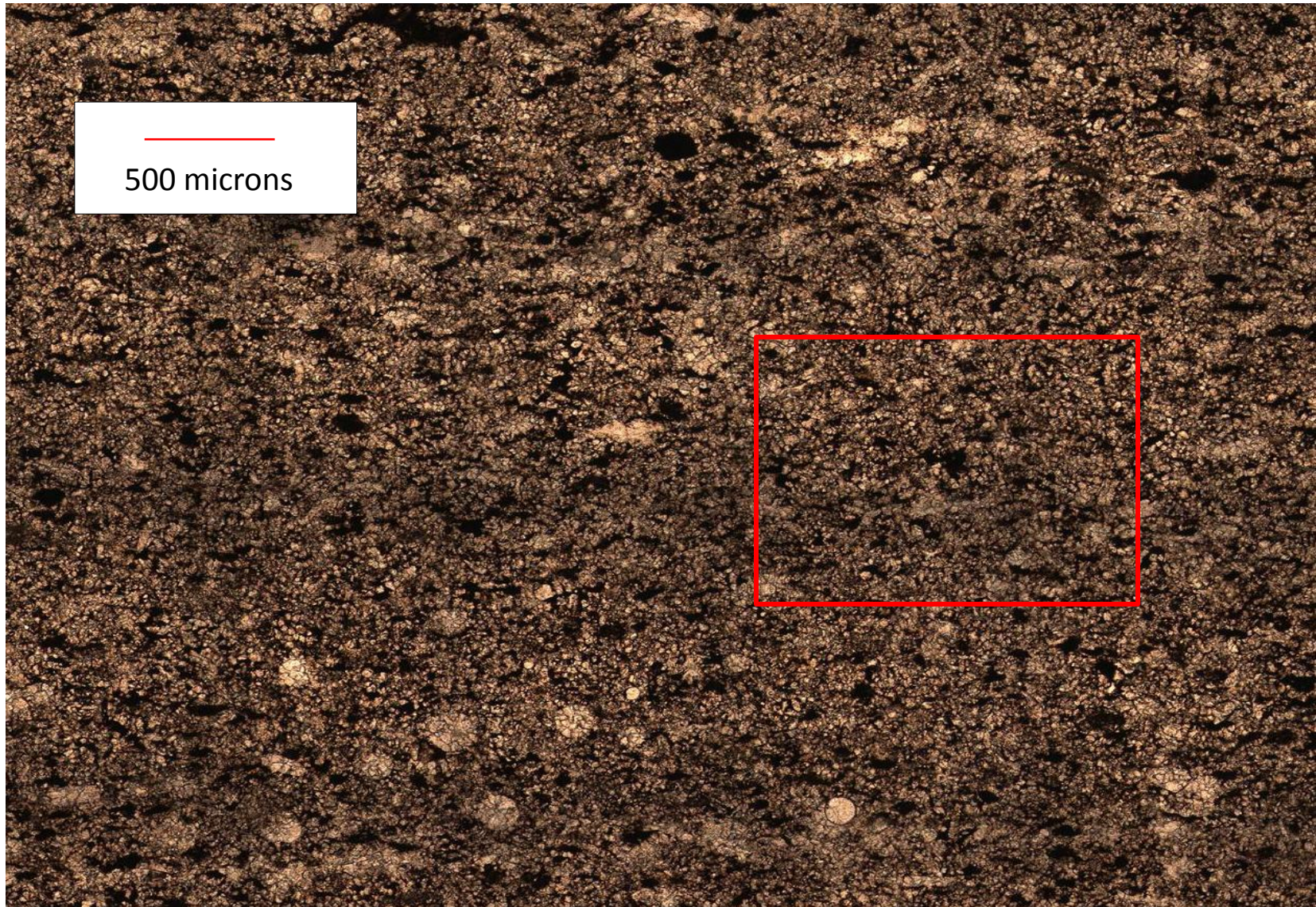
# Marls



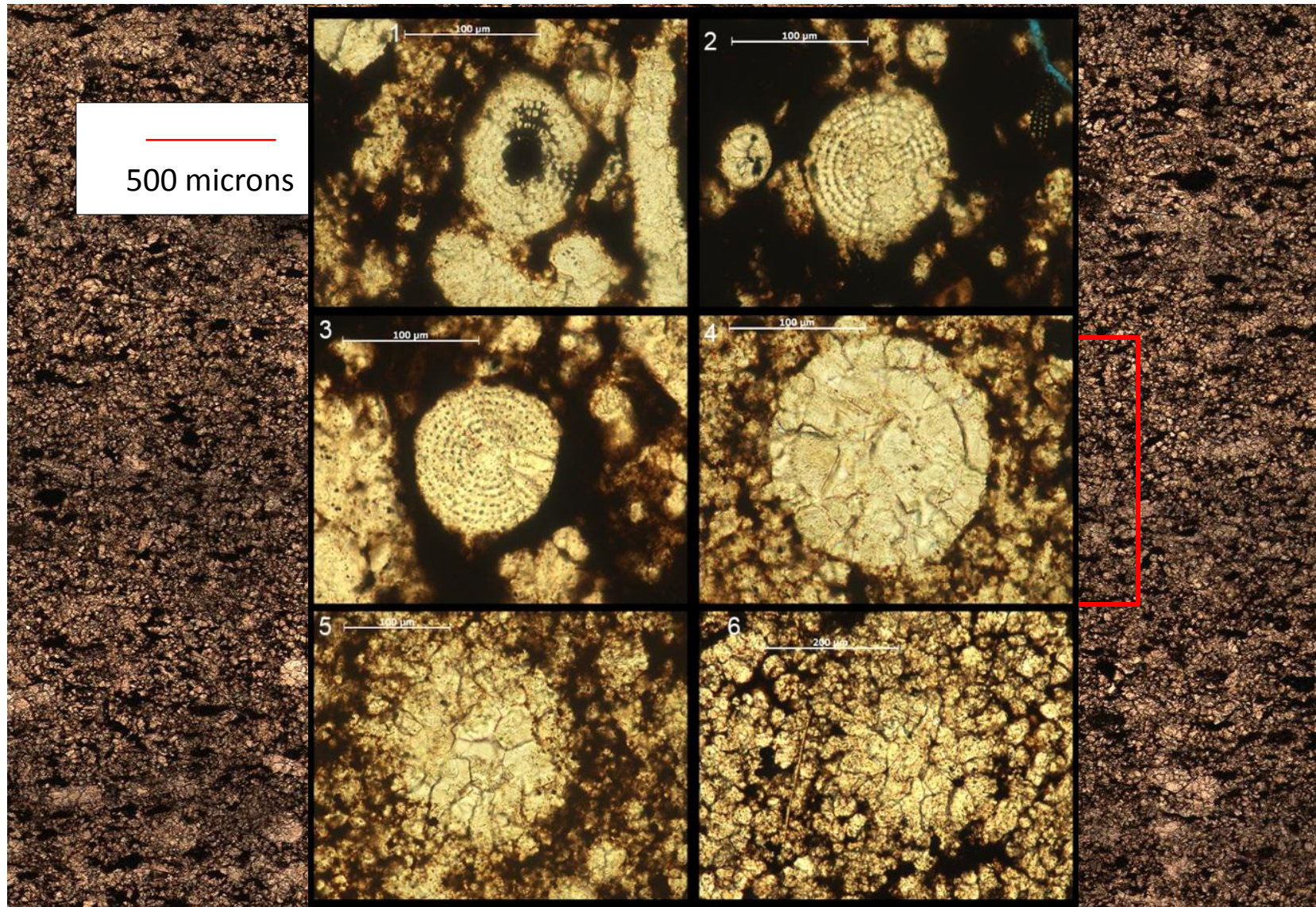
# Marls



# Replaced and Recrystallized Limestone



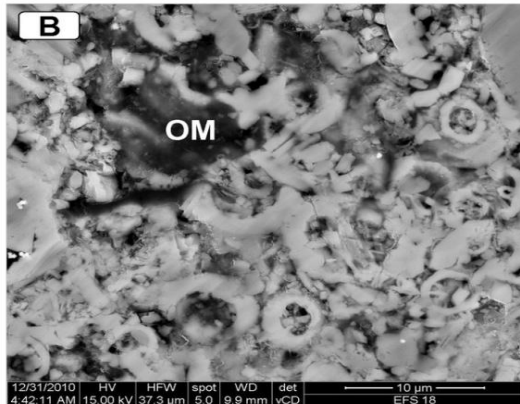
# Replaced and Recrystallized Limestone



# Basic Assumptions



## Reservoir Quality

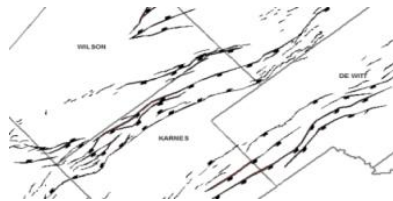


Pressure, Porosity, Thickness,  
Fluid Type

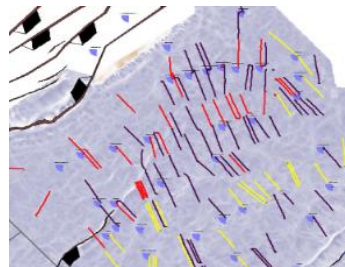
## Completions Quality

### Faults/Natural Fractures

#### From Offset Tops

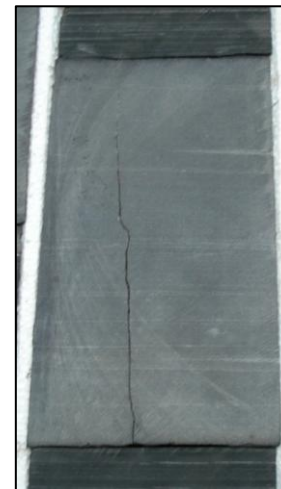


#### From Attributes

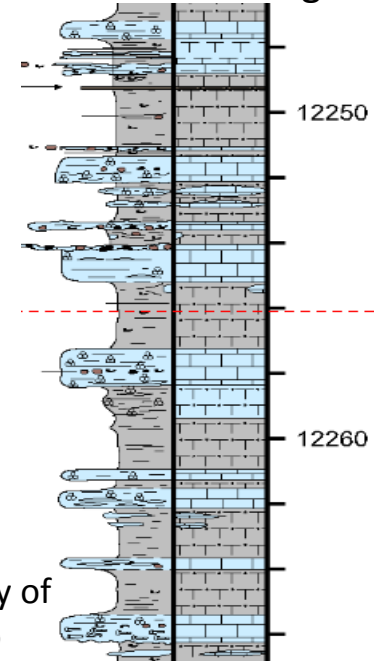


### Induced Fractures

#### Rock "Strength"

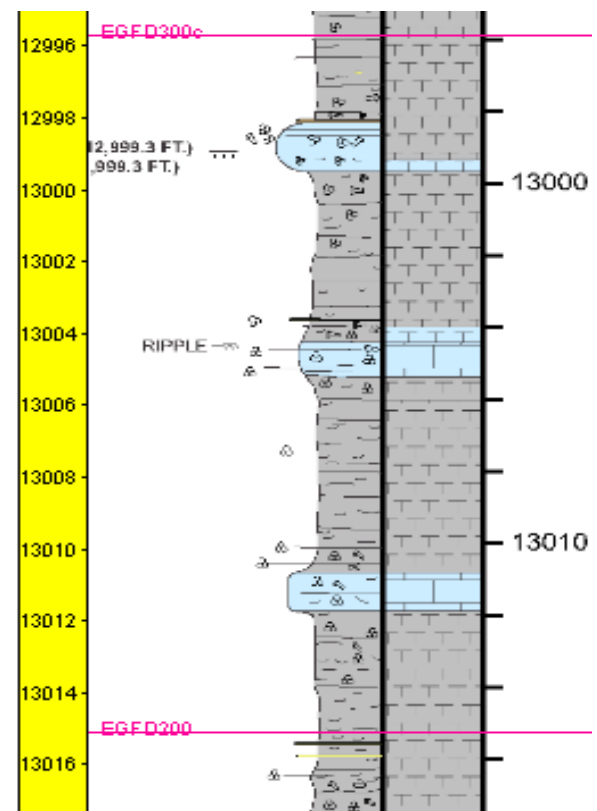
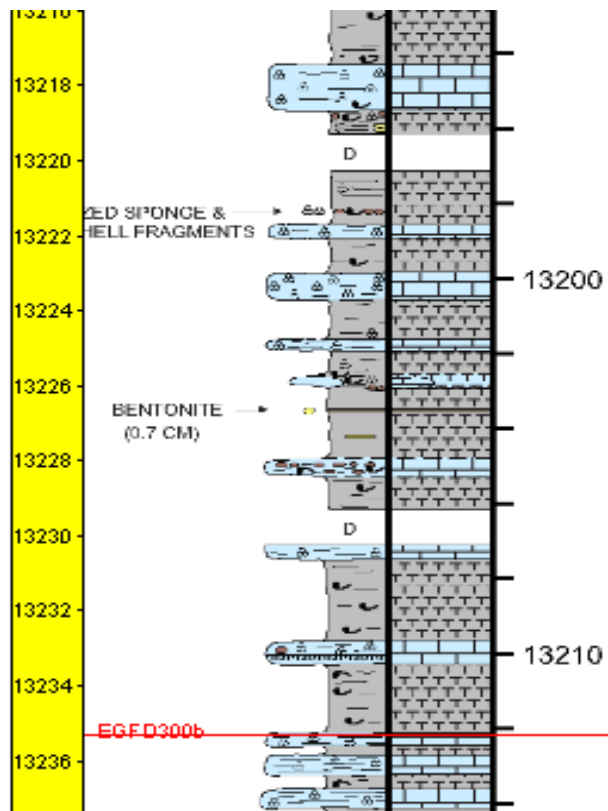


#### Interbedding



Courtesy of  
CoreLab

# Basic Assumptions



Graphic logs courtesy of CoreLab

# Numerical Modeling Set-Up



Model 1



Model 2



Model 3



Top Load



Weak Layer



Stiff Layer



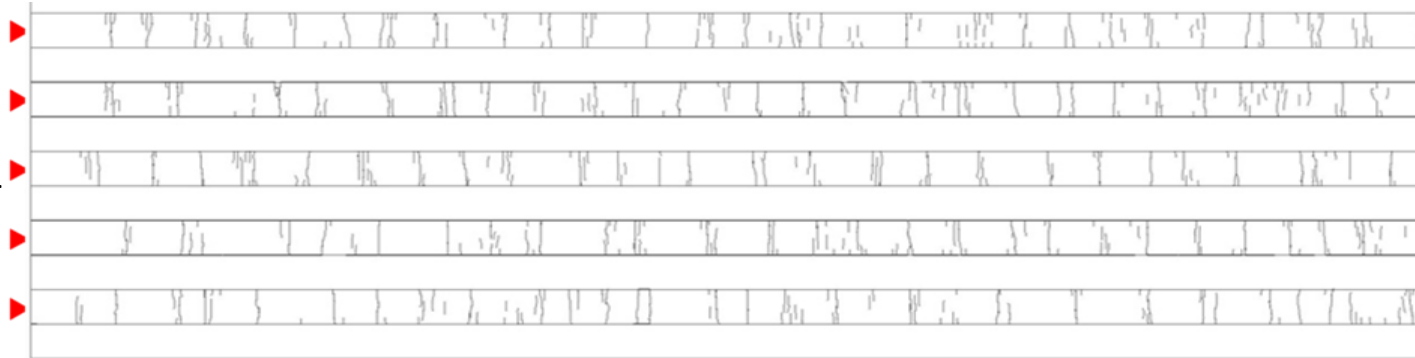
Side



Base

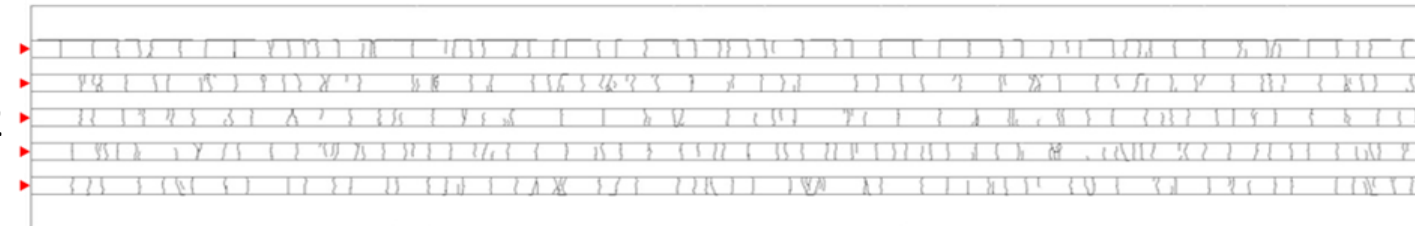
# Numerical Modeling Results

Model 1



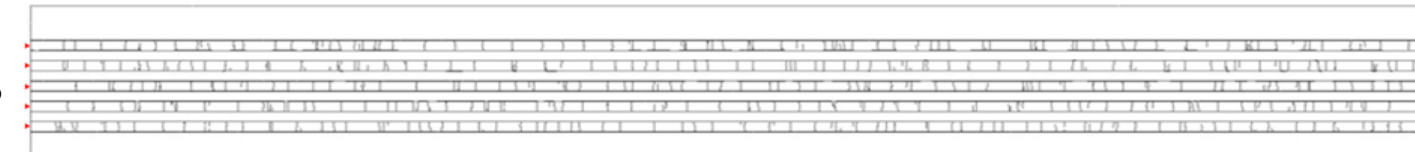
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Model 2



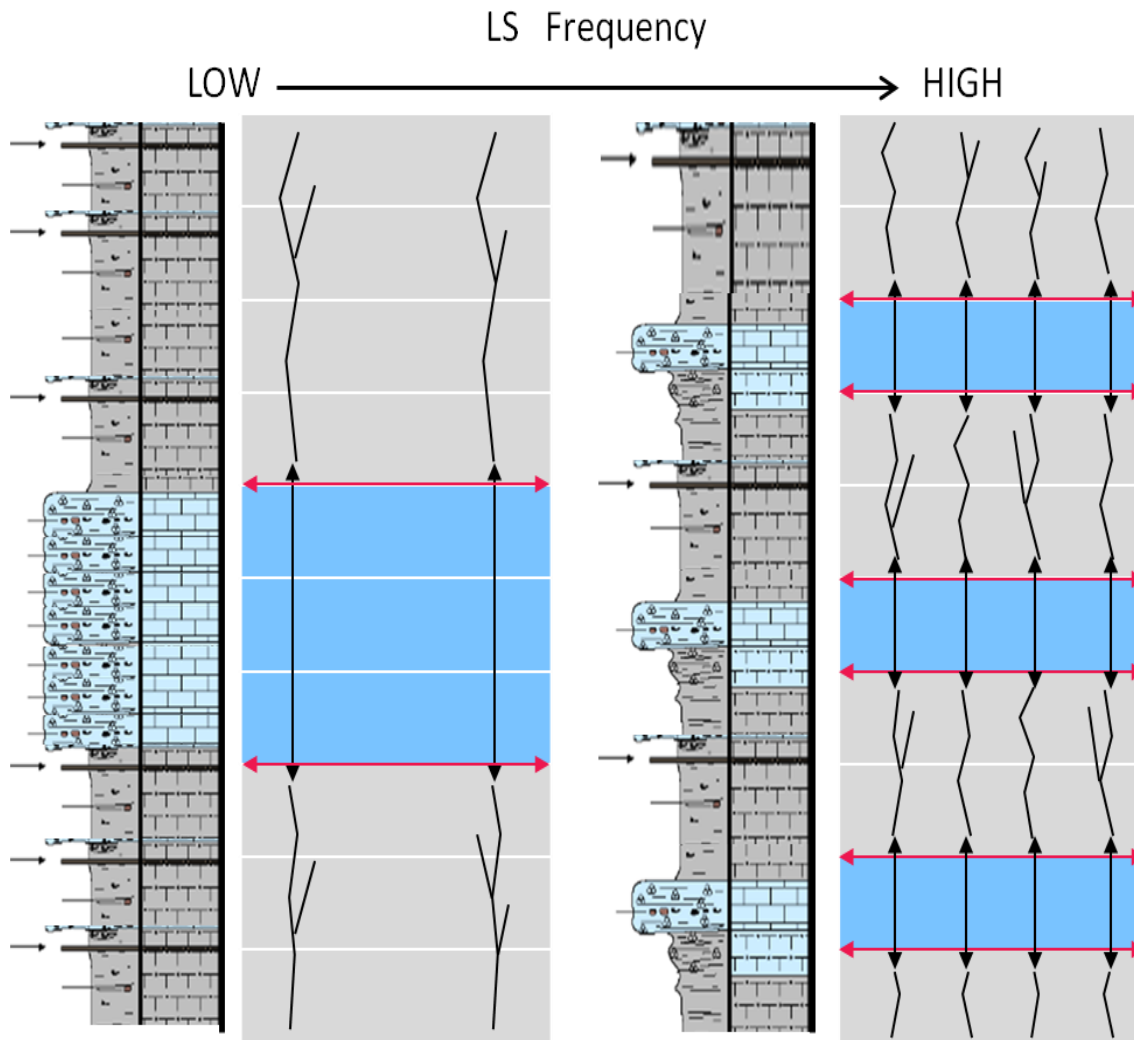
84

Model 3



115

# Bed Thickness and Fracture Frequency

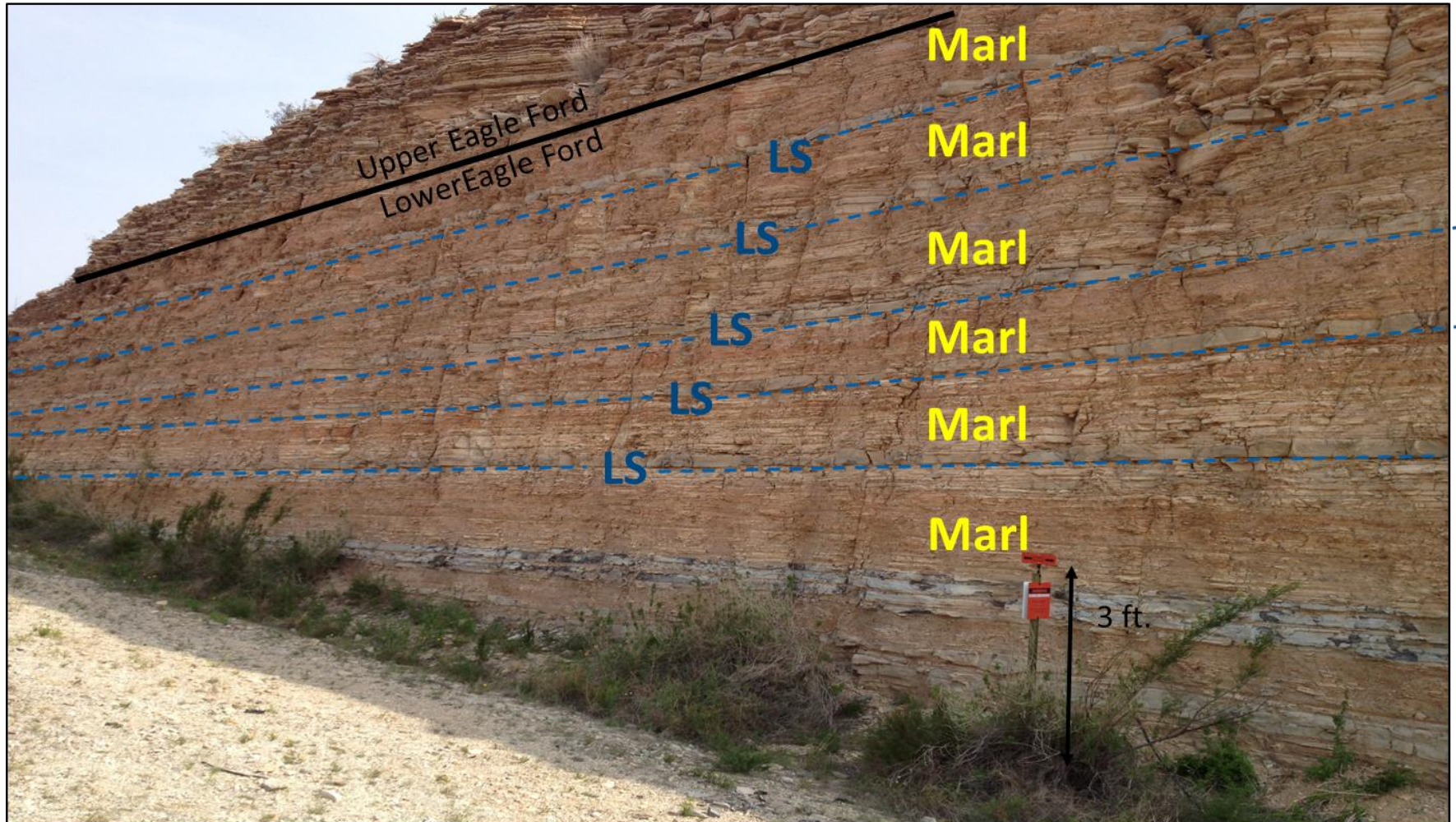


Both 10 ft sections have 70% marl and 30% limestone

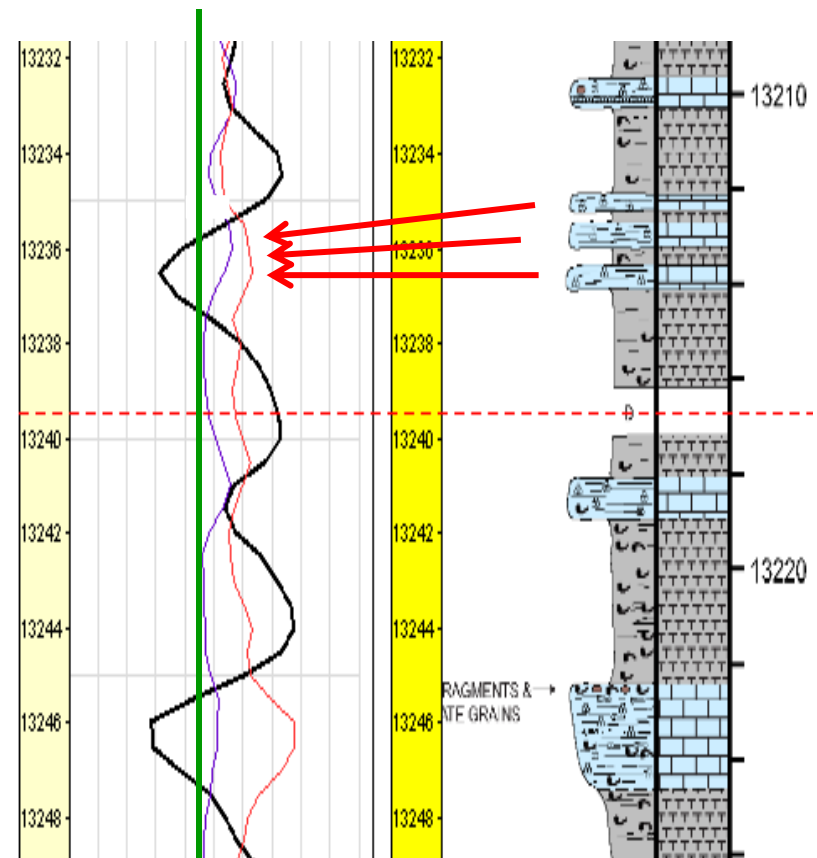
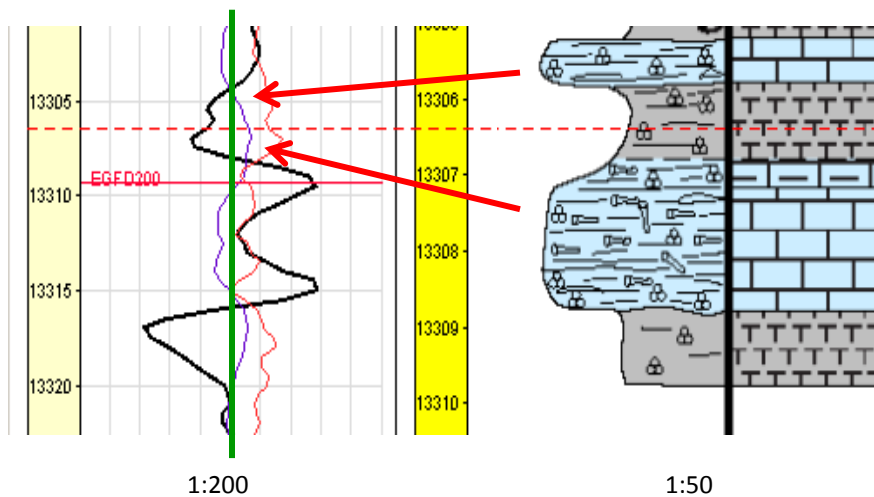
The LS frequency in the example on the left 0.1/ft.

The LS frequency in the example on the right is 0.3/ft.

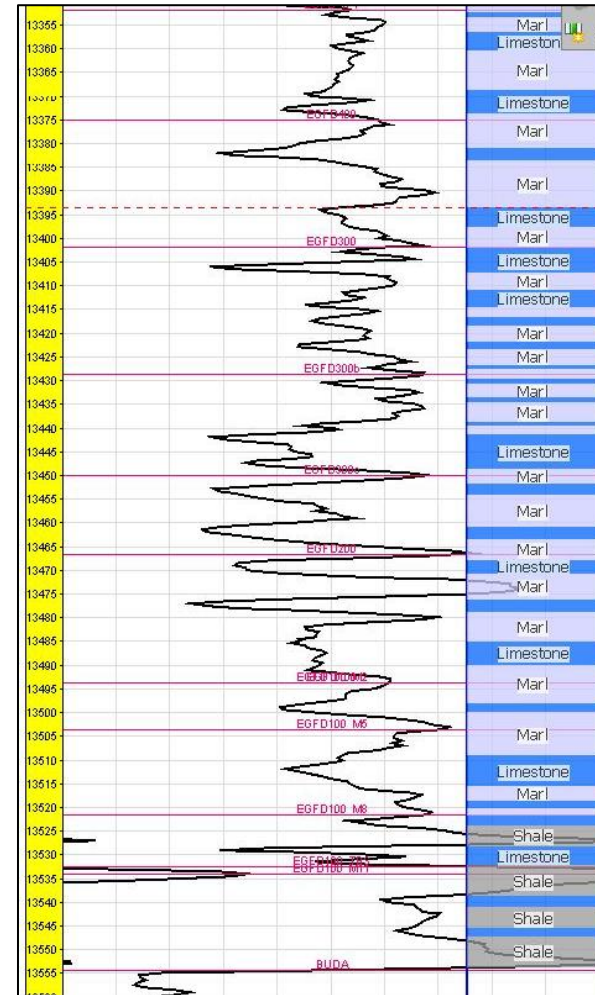
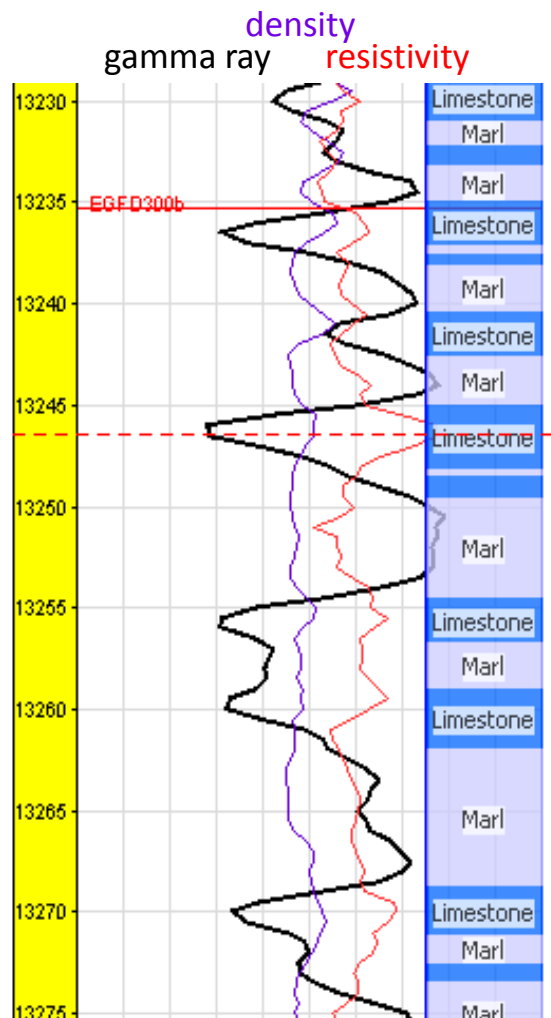
# Counting Limestones in Outcrop



# Counting Limestones on Logs

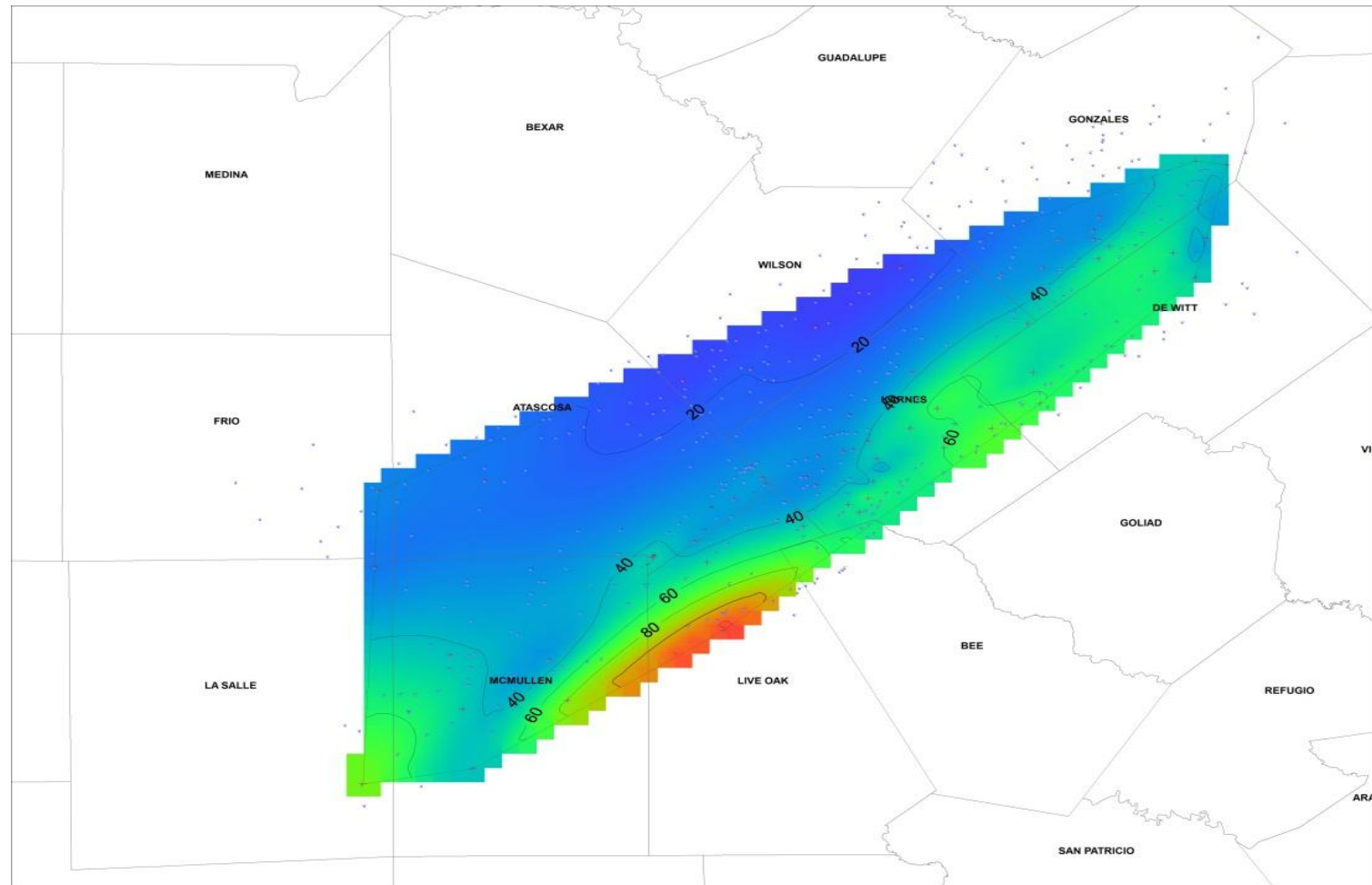


# Counting Limestones on Logs



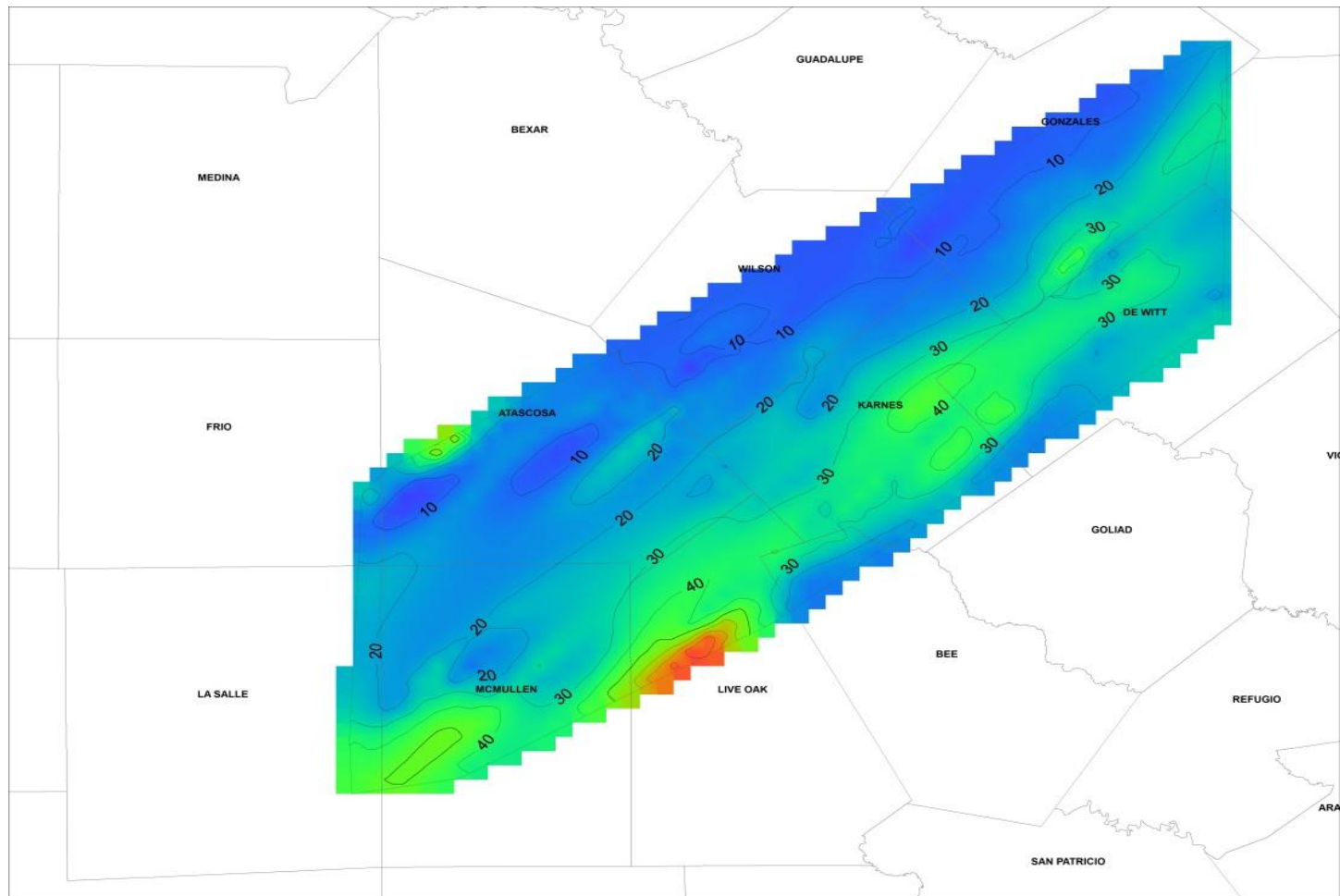
Graphic logs courtesy of CoreLab

# Number of Limestone Beds 1



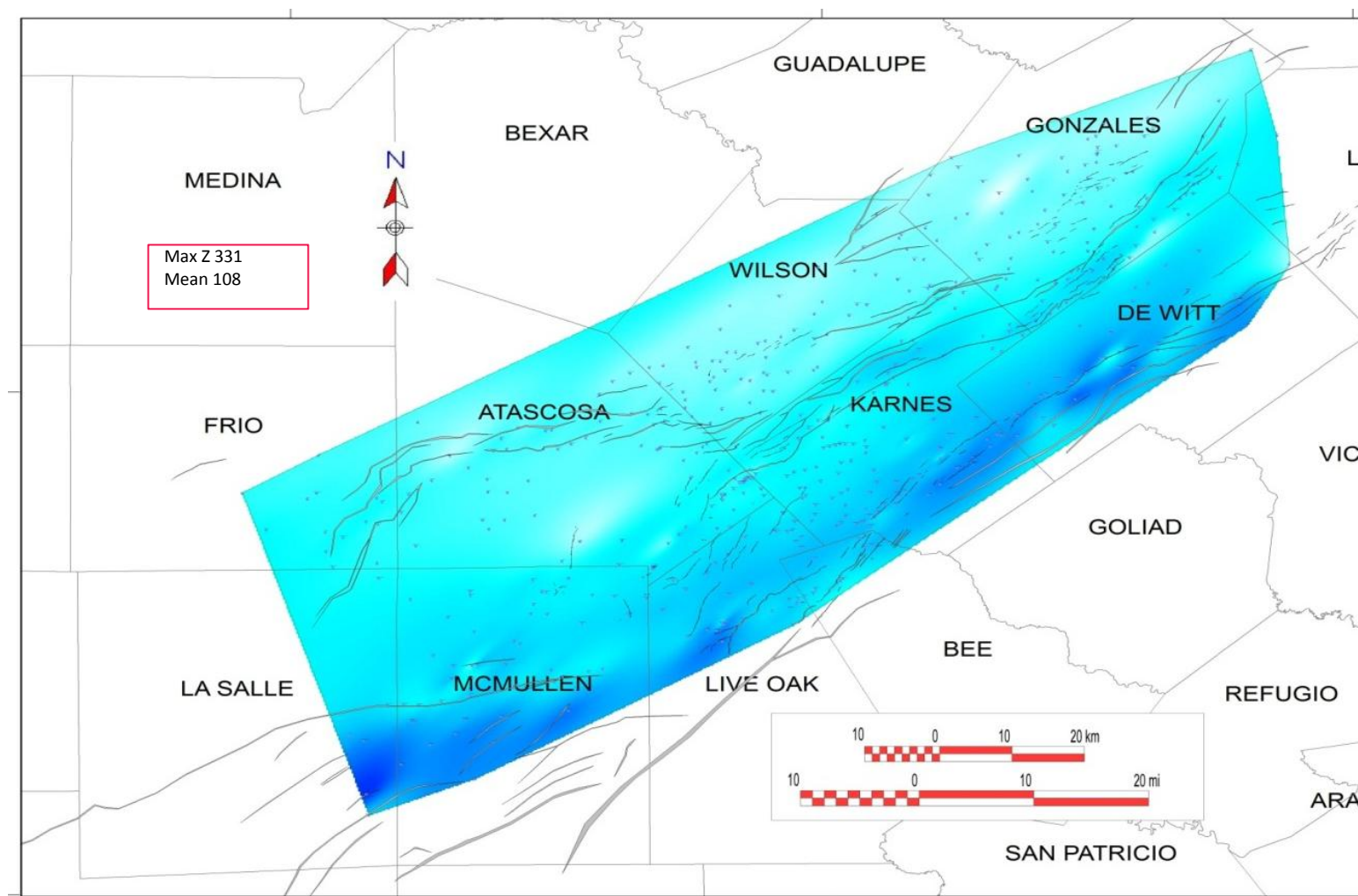
100-80-60-40

# Number of Limestone Beds 2

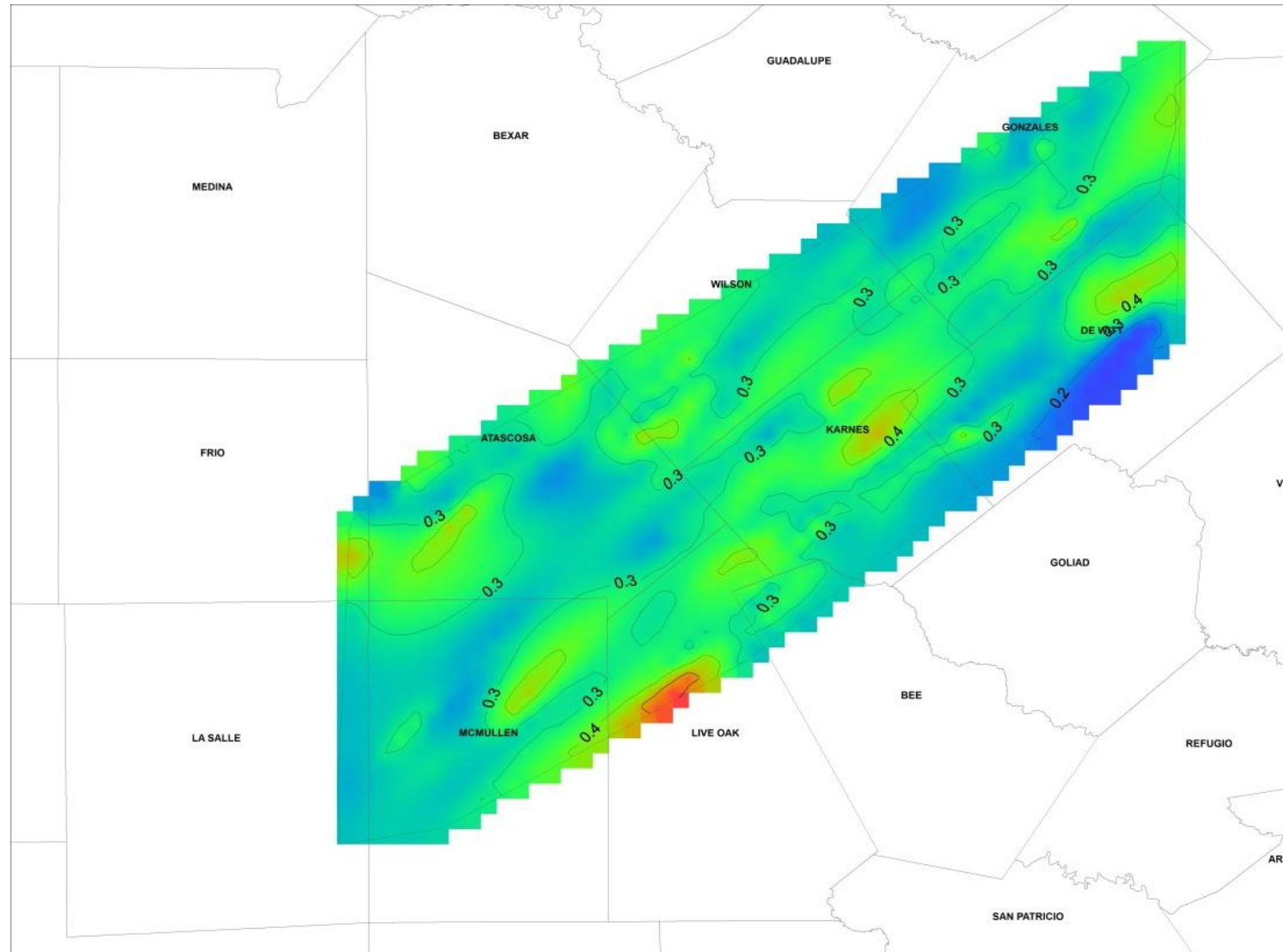


80-70-60-50

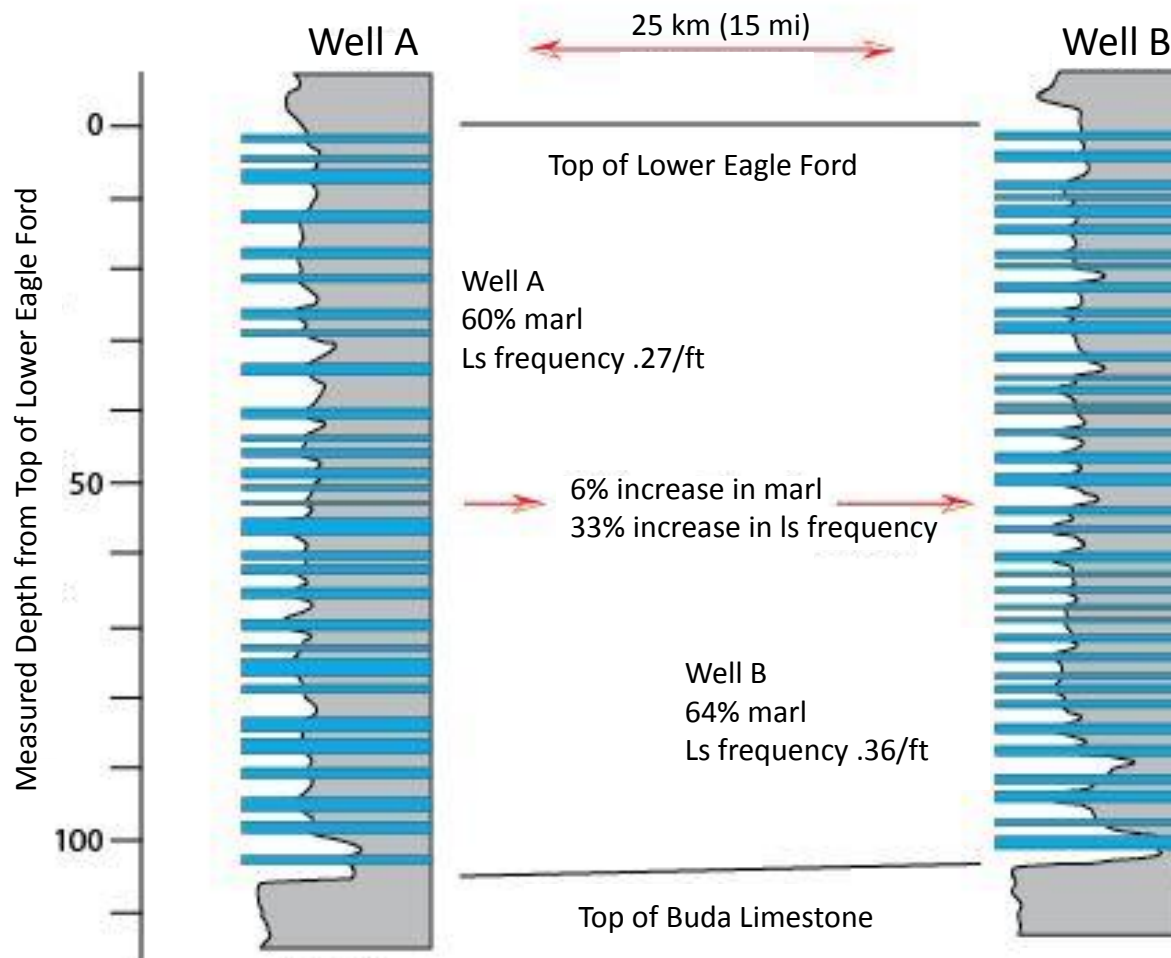
# Lower Eagle Ford Isopach Map



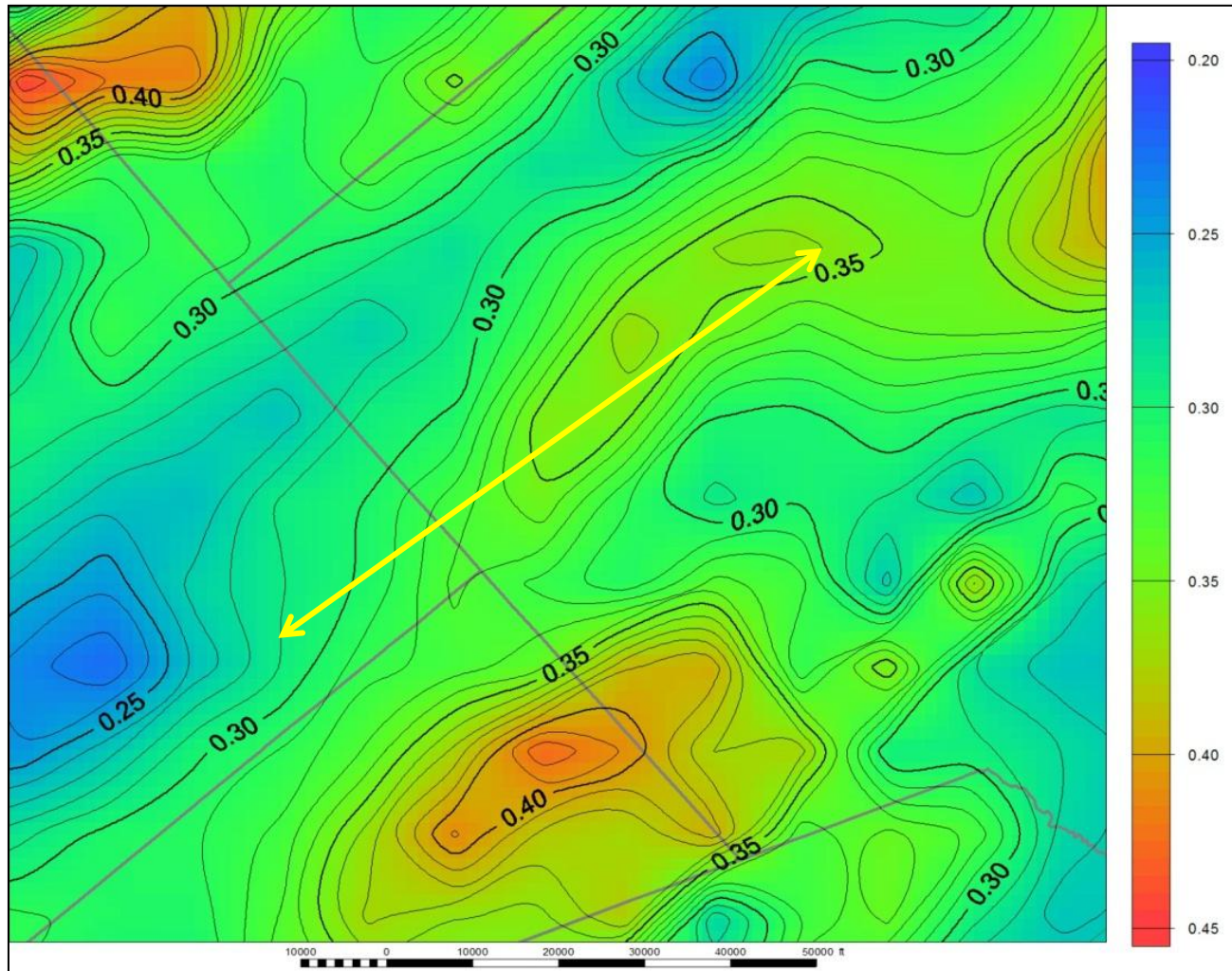
# Frequency of Limestone Beds



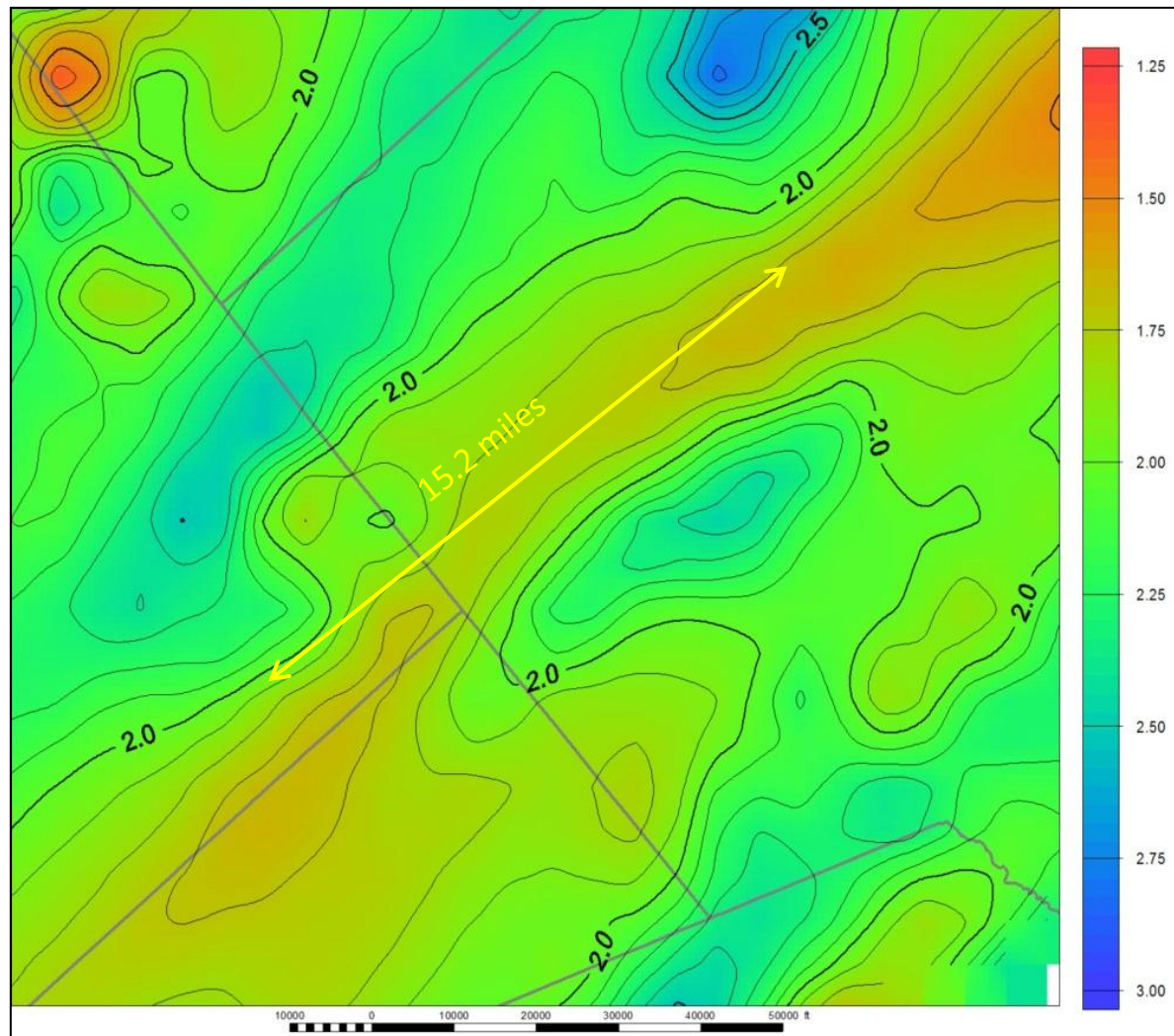
# Facies Changes in Lower Eagle Ford



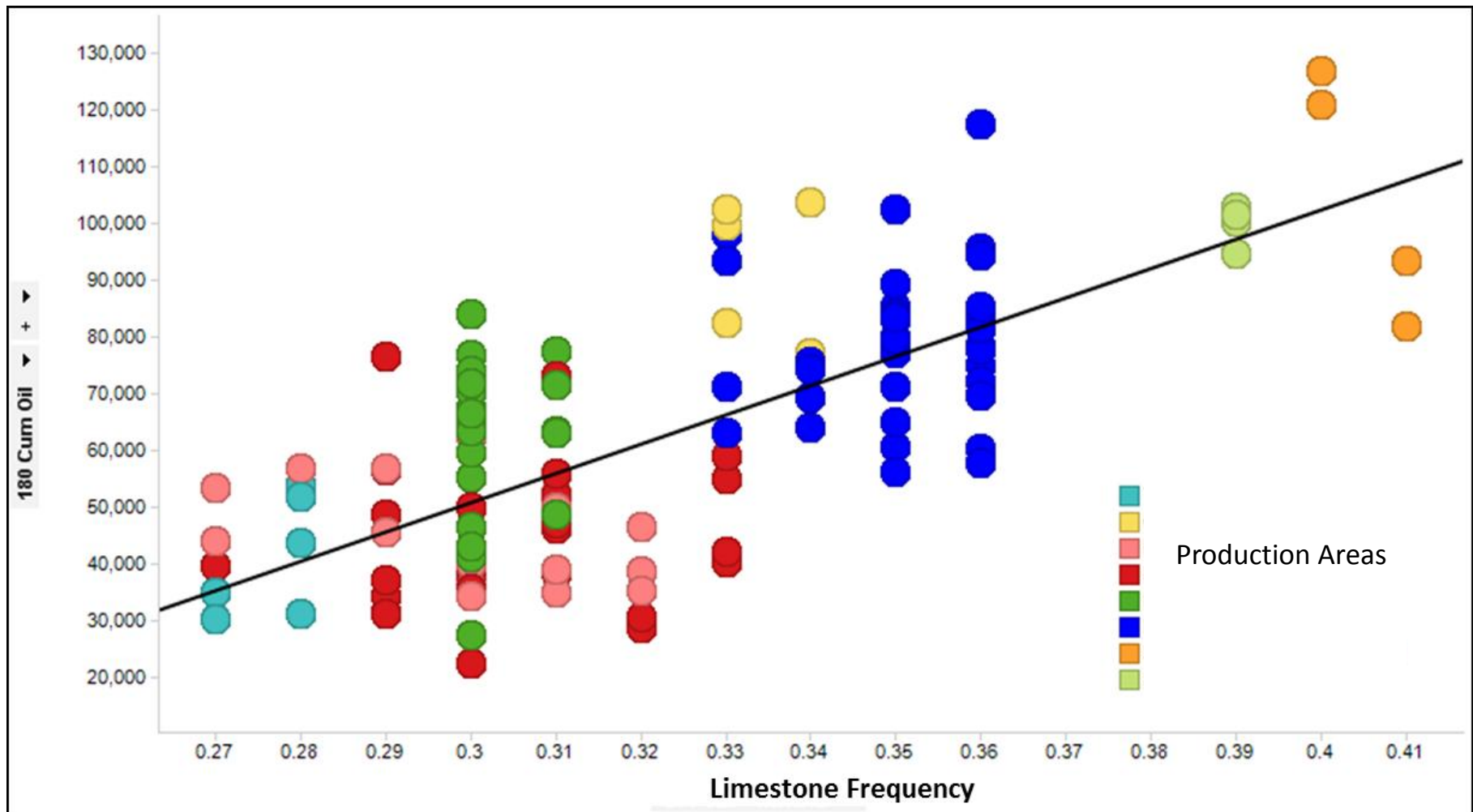
# Lower EGFD Limestone Frequency



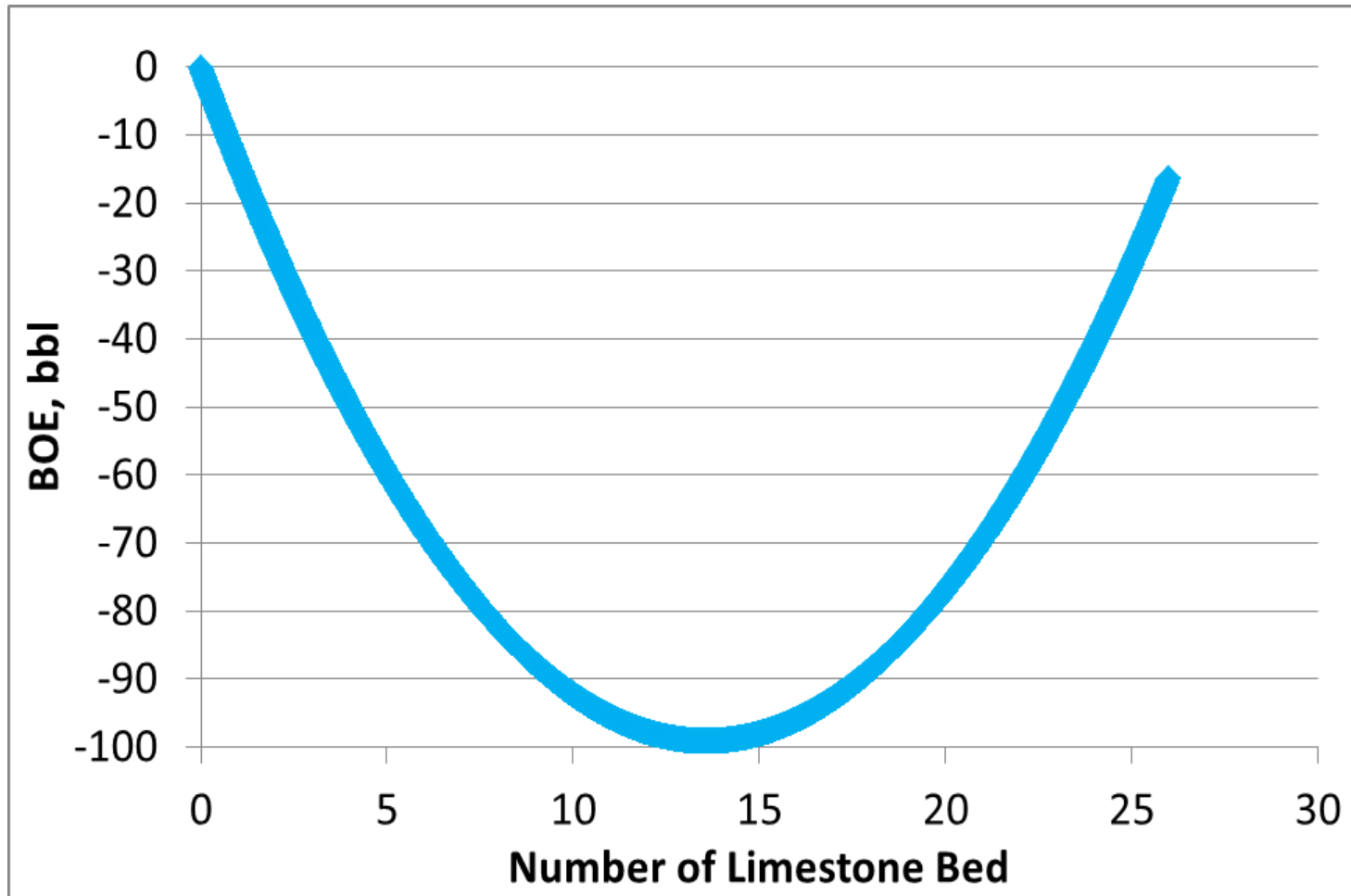
# Lower EGFD Average Limestone Thickness



# Well Performance vs Limestone Frequency



# Another View?

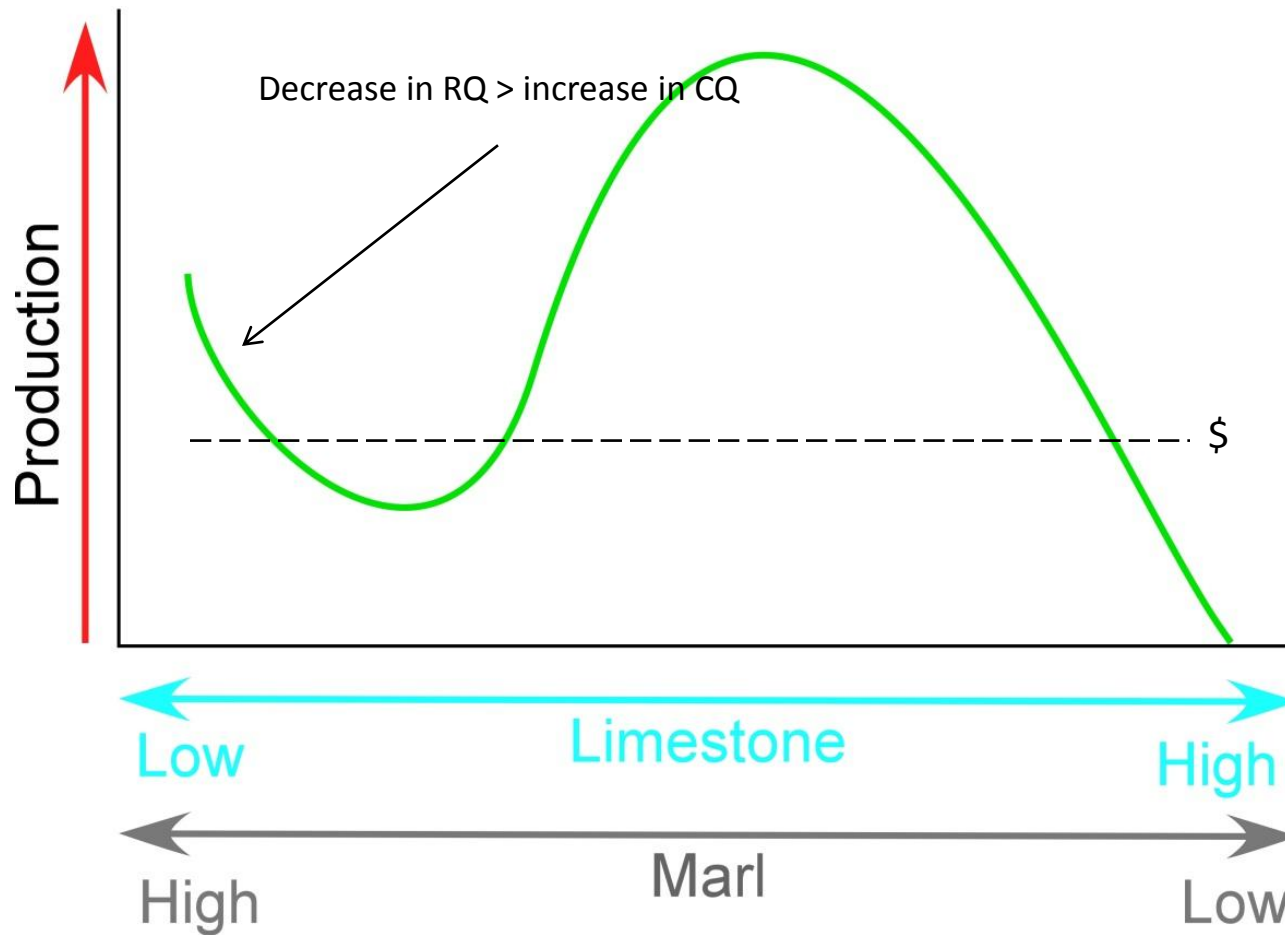


Courtesy of Yao Tian PhD Dissertation Texas A&M 2014

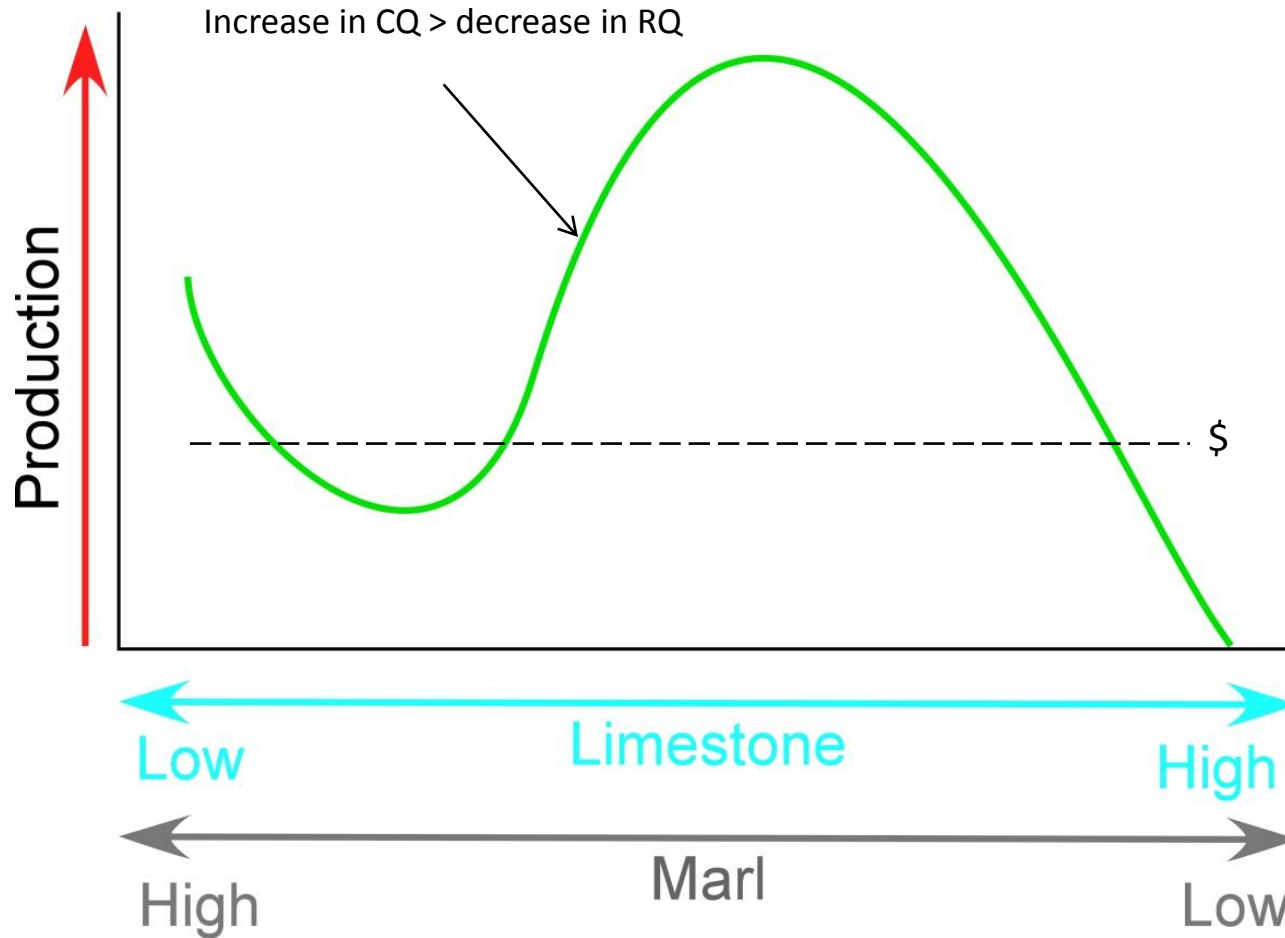
# Possible Solution



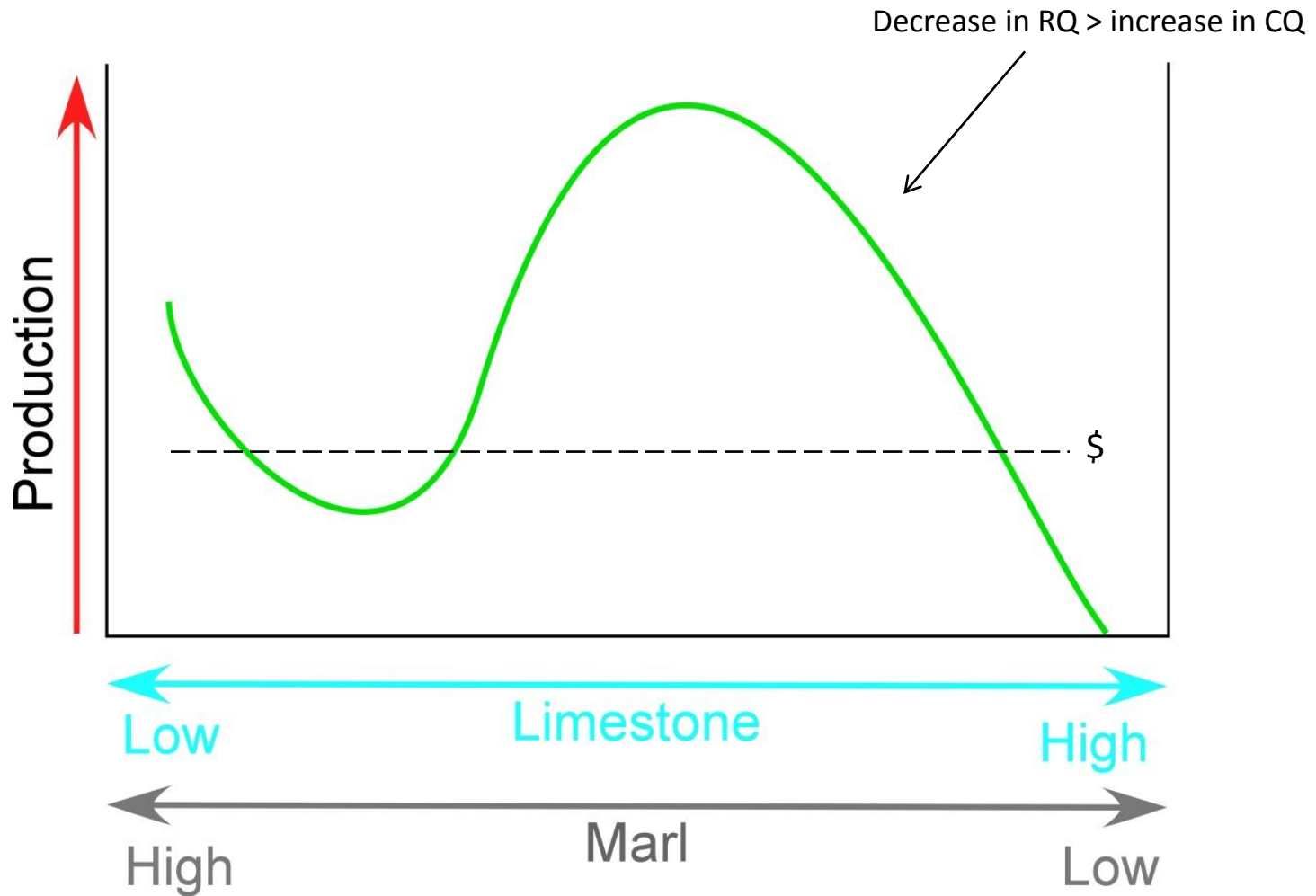
# Possible Solution



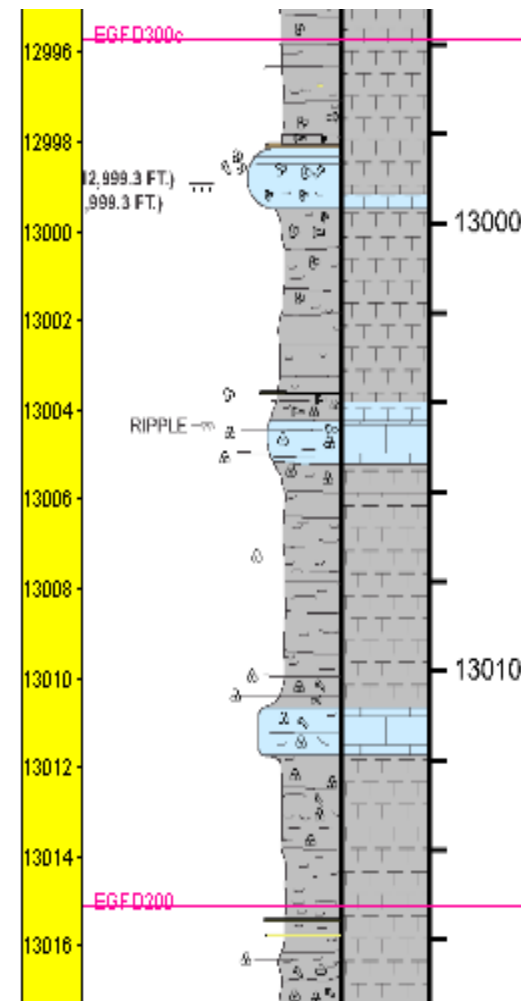
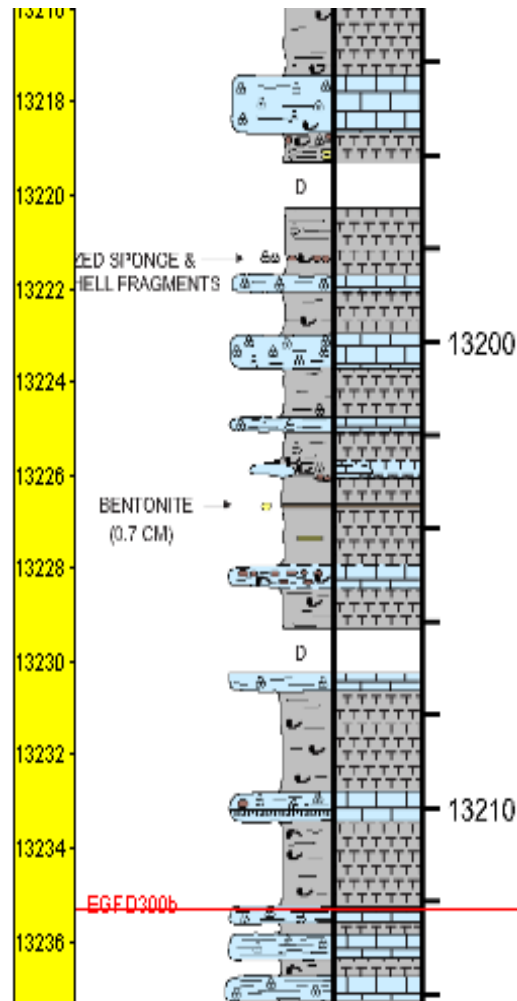
# Possible Solution



# Possible Solution



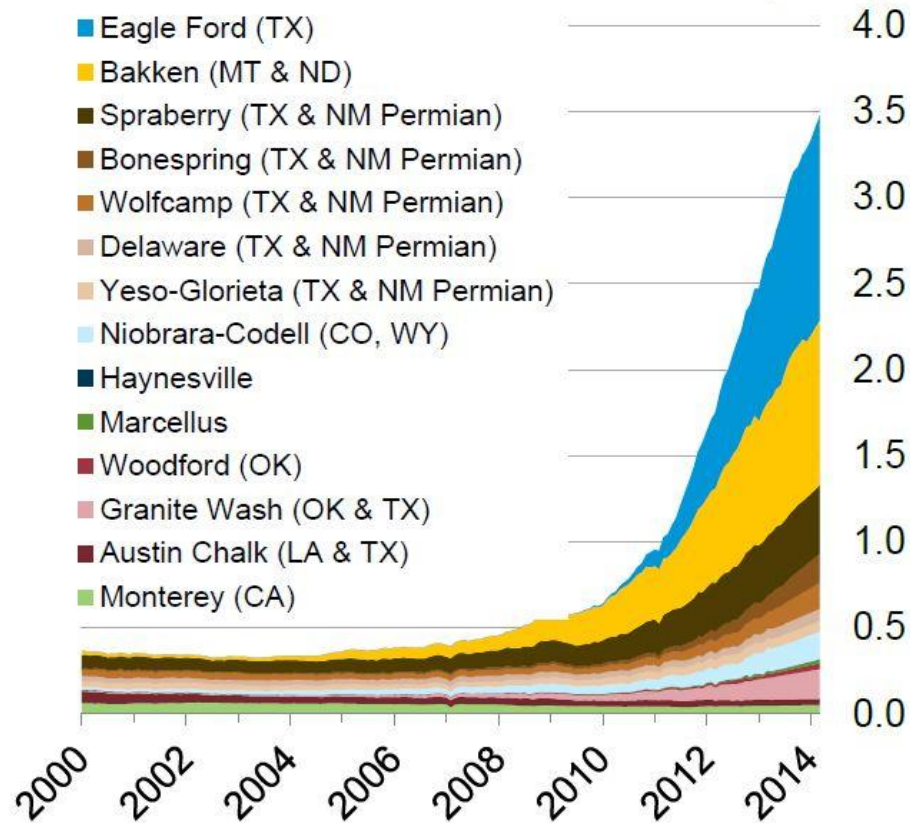
# An Epiphany



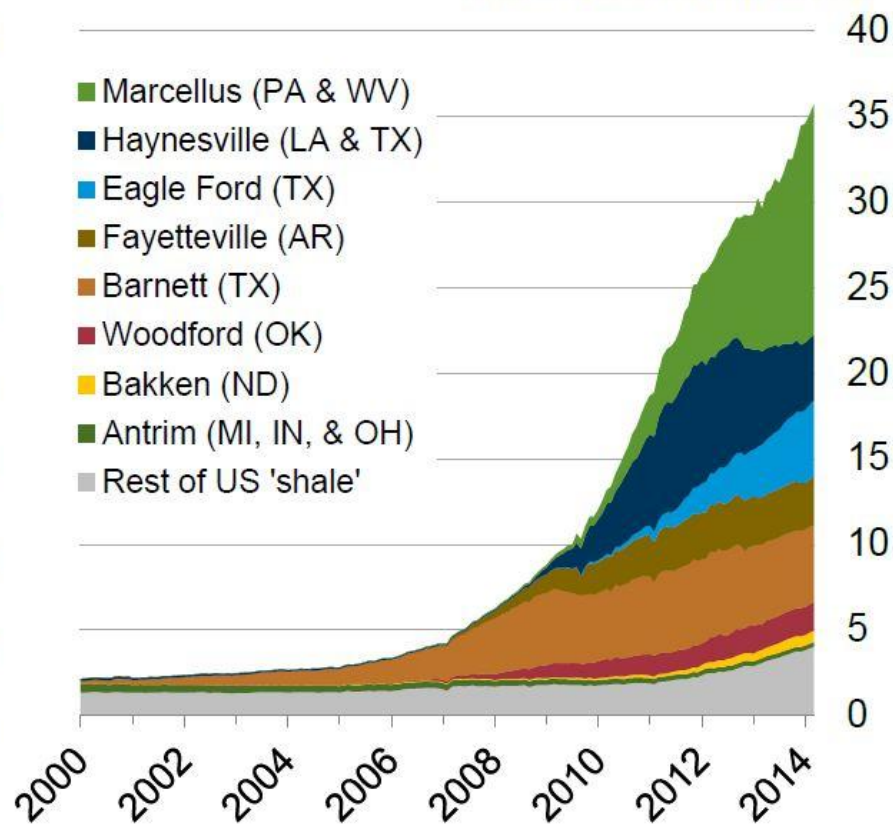
Graphic logs courtesy of CoreLab

# Shale Oil and Shale Gas

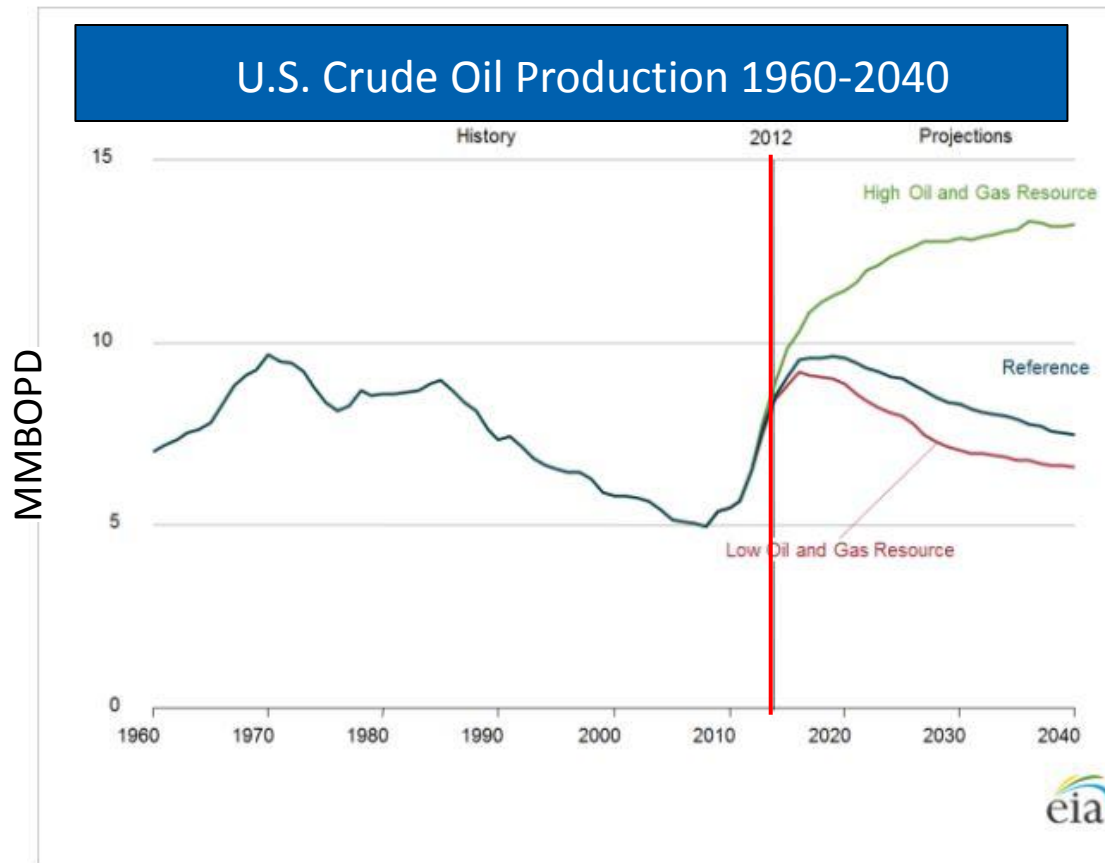
U.S. tight oil production  
million barrels of oil per day



U.S. dry shale gas production  
billion cubic feet per day



# The Uncertain Future



Uncertainty from:  
Well decline  
Drainage area  
Geologic extent  
**Technological advances!**

# The Uncertain Future

