Hydrocarbon Potential of Upper Cretaceous Shale Sections, Including the Eagle Ford, Woodbine and Maness Shale, Central Texas*

Thomas D. Bowman[1]

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*Adapted from oral presentation at AAPG Annual Convention and Exhibition, Houston, Texas, USA, April 10-13, 2011

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Abstract

Understanding the similarities and differences in any developing shale play is important as core acreage becomes leased and vigorous evaluation and understanding of these changes becomes important before extending a play and expanding the potential lease area. The Upper Cretaceous Shale section in Central Texas trends across Texas from the Mexican border in Southwest Texas into East Texas, roughly 50 miles wide and over 500 miles long. It is Upper Cretaceous in age resting between the Buda Lime and the base of the Austin Chalk. This section is referred to as the Eagle Ford shale in the Southwest Texas counties and is referred to as the Eagle Ford, Woodbine and Maness shale (Upper Cretaceous) of the East Texas counties. These formations are typically dark, organic-rich, brittle, fractured, fossiliferous, pyretic, and calcareous dark-grey to black shale.

The generally dark, organic-rich shale intervals exhibit increased natural radioactivity compared with lighter-colored shale that contain less organic matter. Referenced studies, both laboratory and natural, indicate gamma-ray spectral logging in open and/or cased wellbores indicate this increase in radioactivity to be primarily a result of increased uranium concentrations. Shale in the Eagle Ford/Woodbine/Maness formations attract radioactive isotopes of potassium, thorium and uranium, and can be characterized as falling into two categories: Dark, organically rich shale having radioactive characteristics of high potassium and high thorium, and having excessively high uranium content; and brittle, calcareous or silty, fractured shale that often produces oil and gas having a low potassium and thorium content with excessively high uranium response. The two kinds of log responses may have very similar total gamma-ray radiation, but the variation of the radioactive components that comprise the total gamma-ray response may be quite different when the components are broken down into their respective spectral concentrations. Changes these uranium, potassium and thorium percentages are most likely the response of regional changes in clay content. Across the play fairway from Southwest to East Texas these changes in clay content have been the major concern for hydrocarbon storage, drilling and completion techniques required

for successful expansion of the Eagle Ford/Woodbine/Maness shale formations and resulting resource plays into East Texas and beyond.

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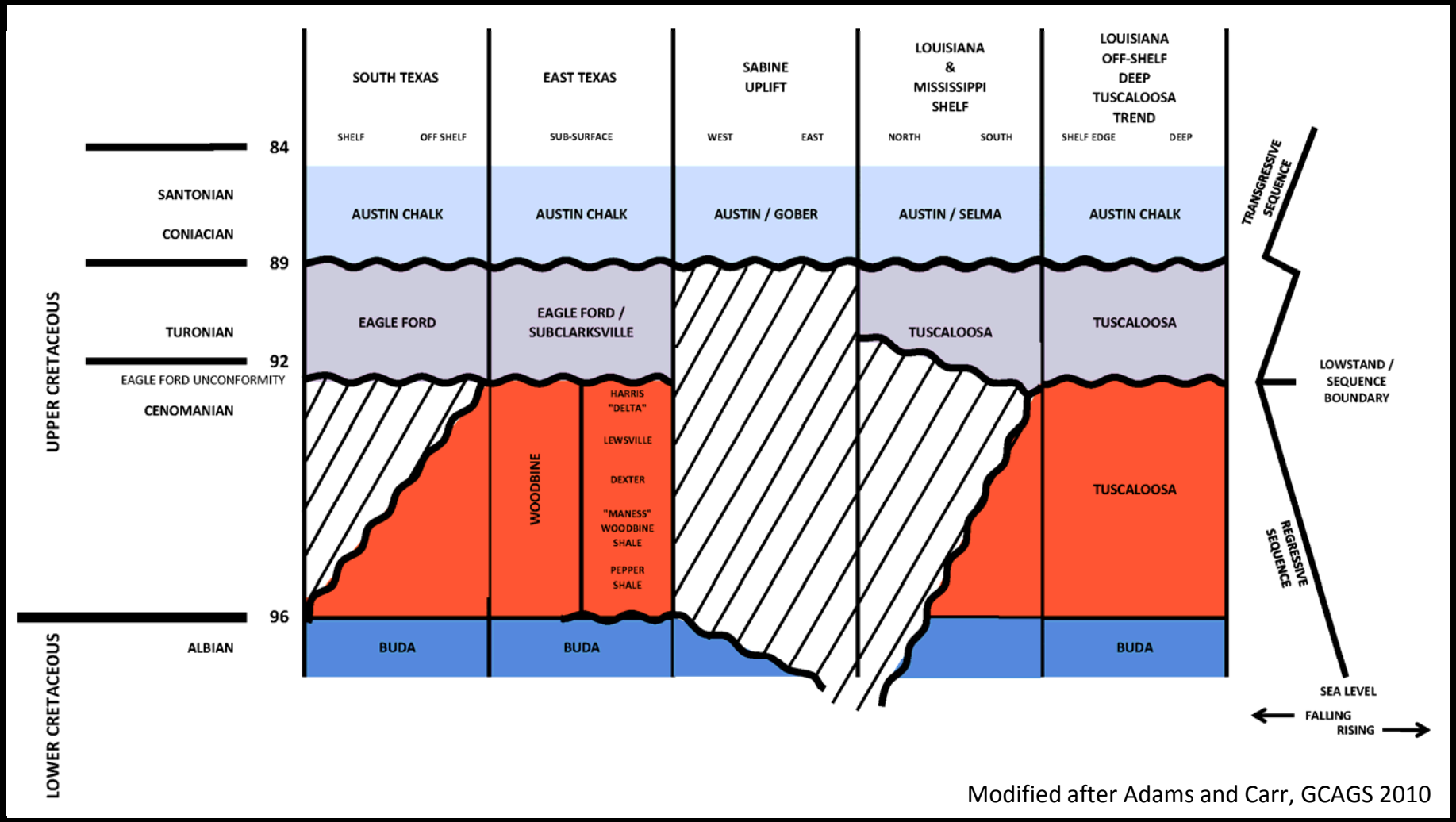
Agenda

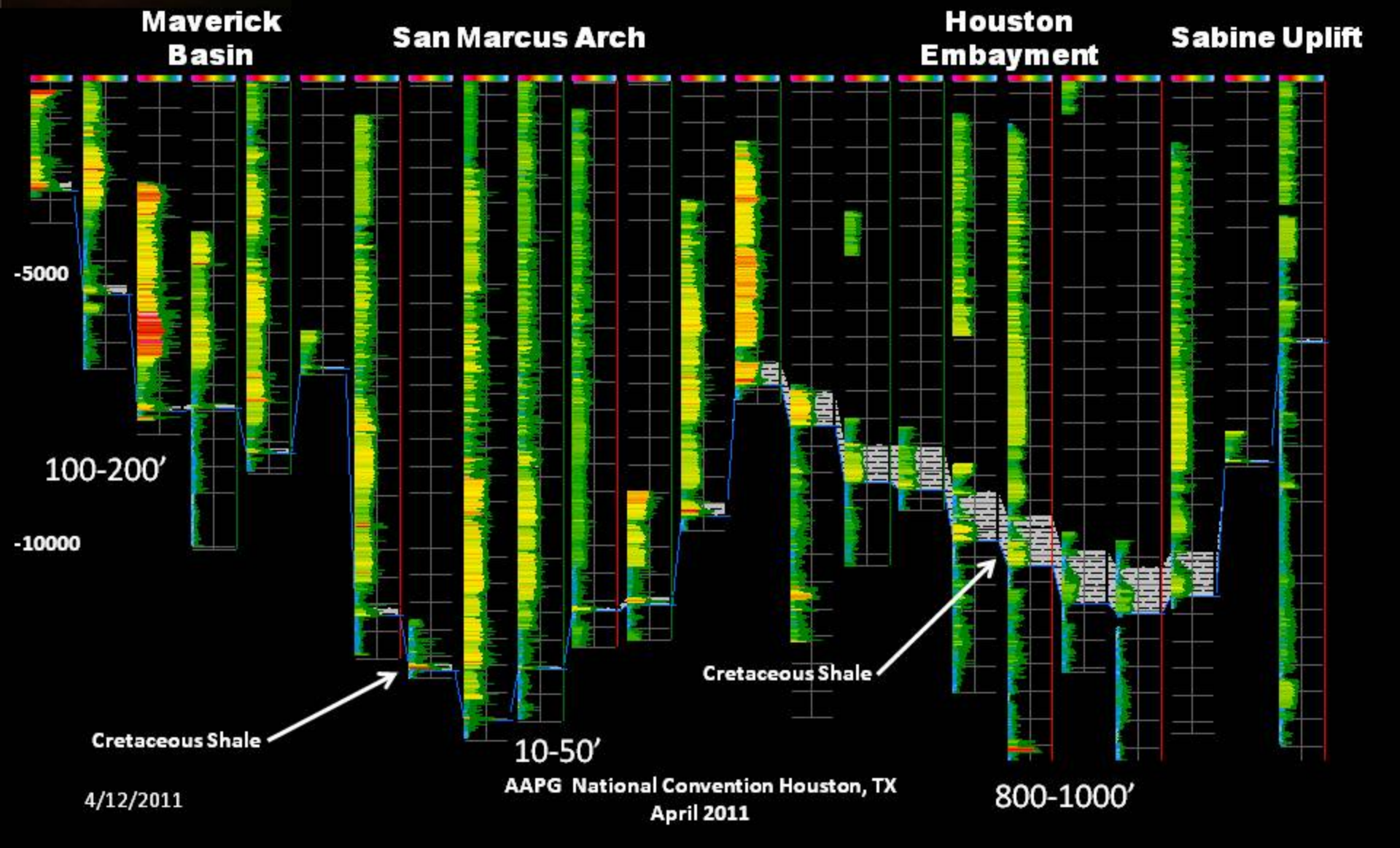
- Stratigraphy definitions
- Regional Cross Section
- Regional Setting of the Basement influences
- Detailed Log Examples
- Passey Delta Log R Examples
- Spectral Gamma Examples
- Conclusions

Stratigraphic Column



Modified after Adams and Carr, GCAGS 2010

Regional Cross Section

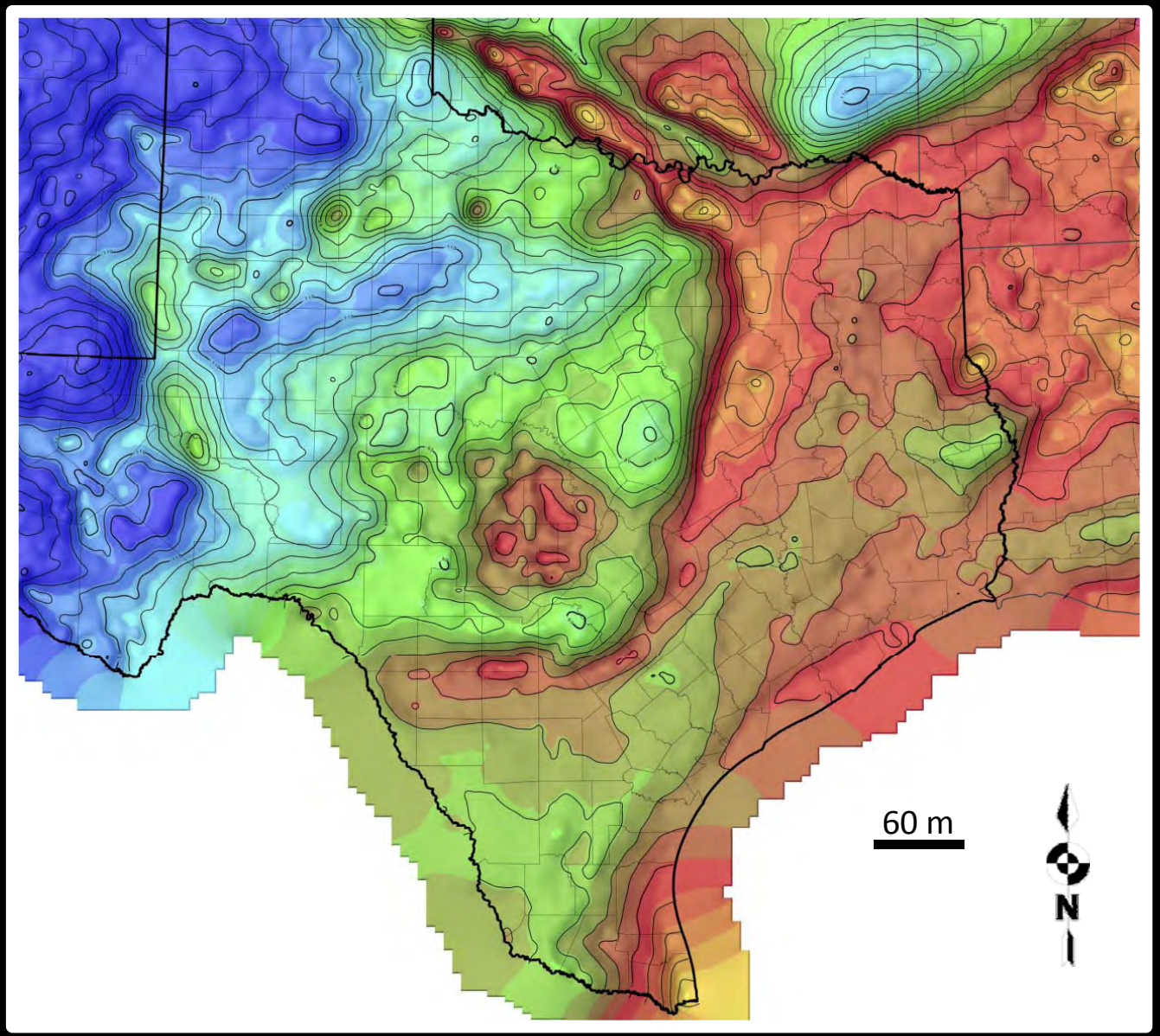


4/12/2011

AAPG National Convention Houston, TX
April 2011

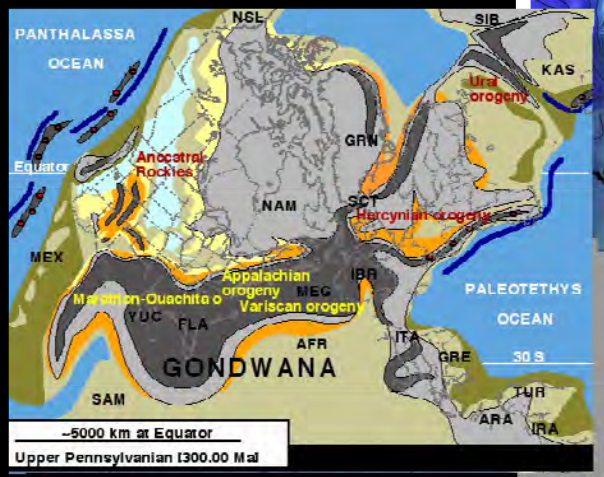
Regional Gravity Map Texas

Gravity helps define the basement structure relating to the future deposition and deformation of the Cretaceous.

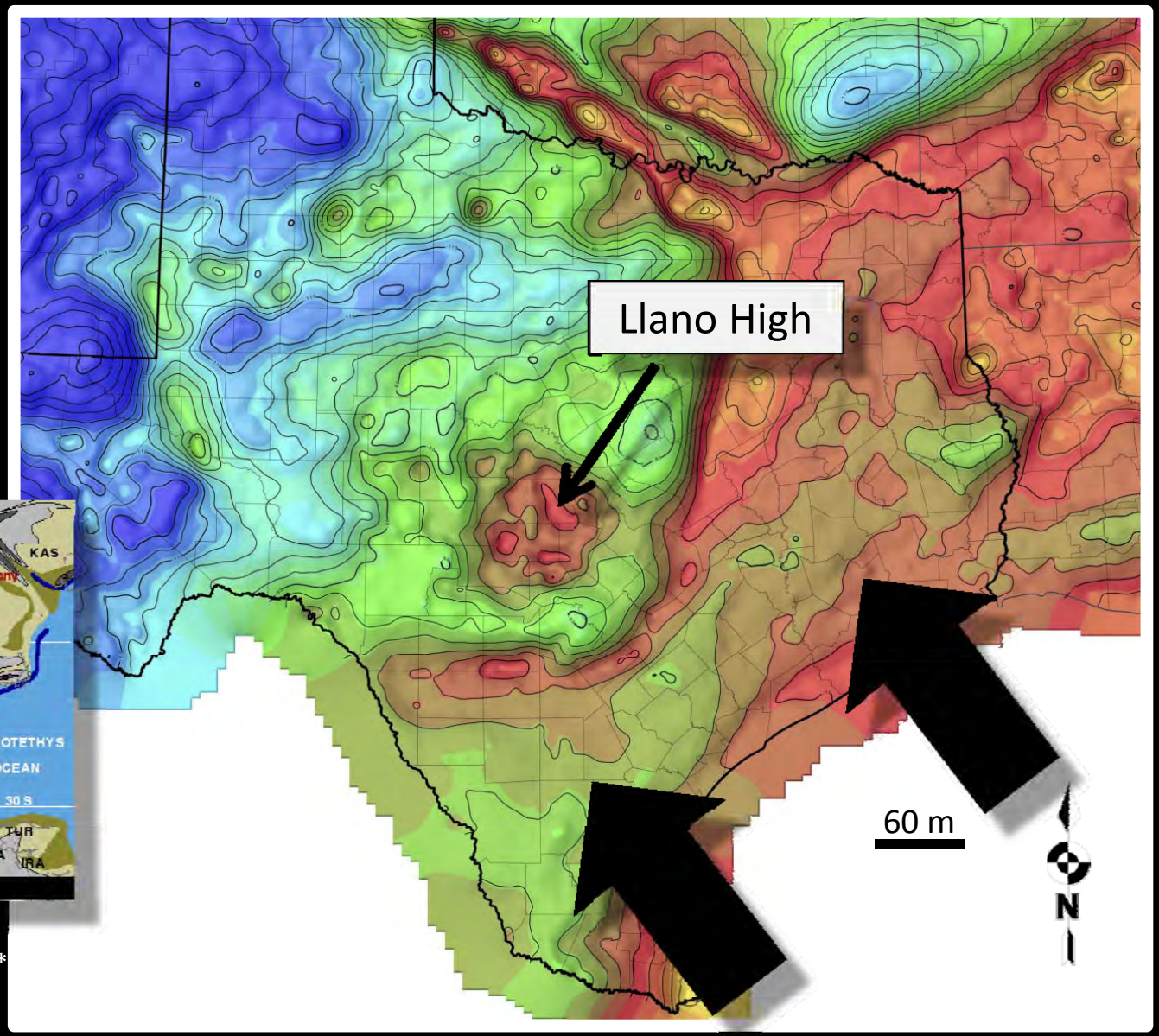


Deformation of Basement

Paleozoic structures formed during the collision of South America with North America forming the Ouachita over-thrust.



~ 5000 km at Equator
Upper Pennsylvanian (300 M a)*

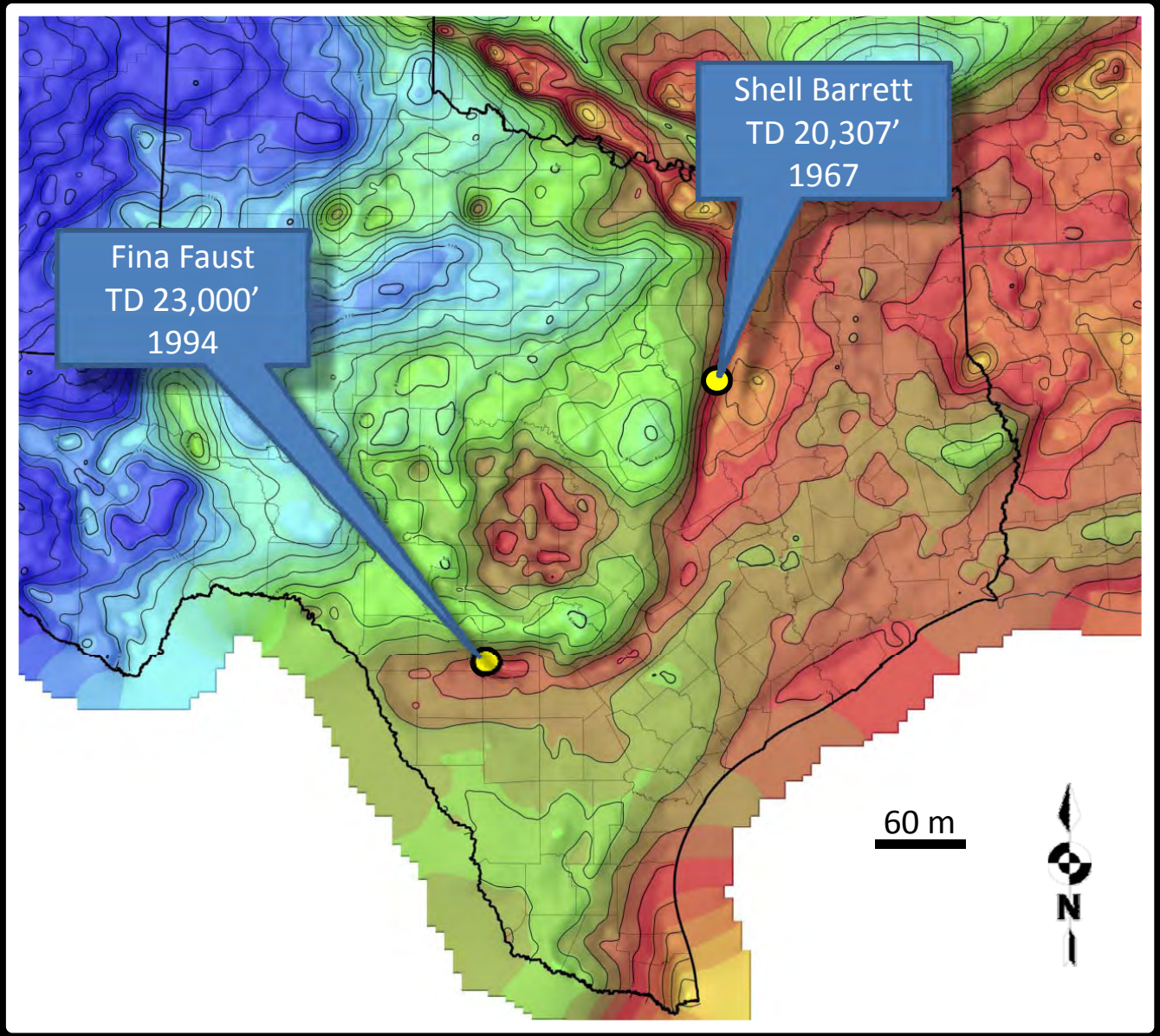


*From Ron Blakey Department of Geology
Northern Arizona University

Deep Well Control

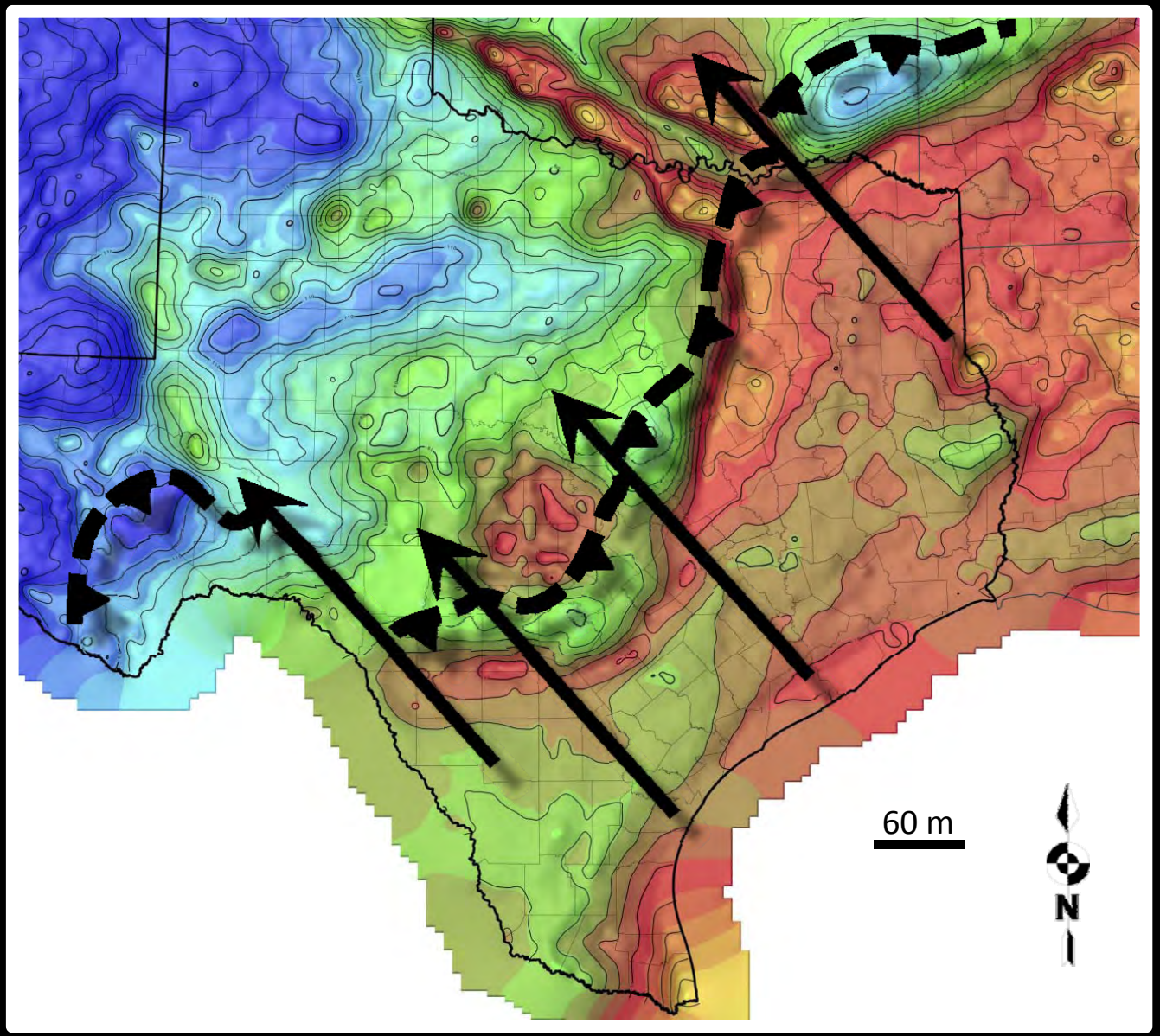
Two deep wells penetrating the lower Paleozoic section confirming the large structures depicted on gravity.

The Shell Barrett in Hill County (20,307') drilled in 1967 and the Fina Faust in Media County (23,000') drilled in 1994



Shallow Deformation

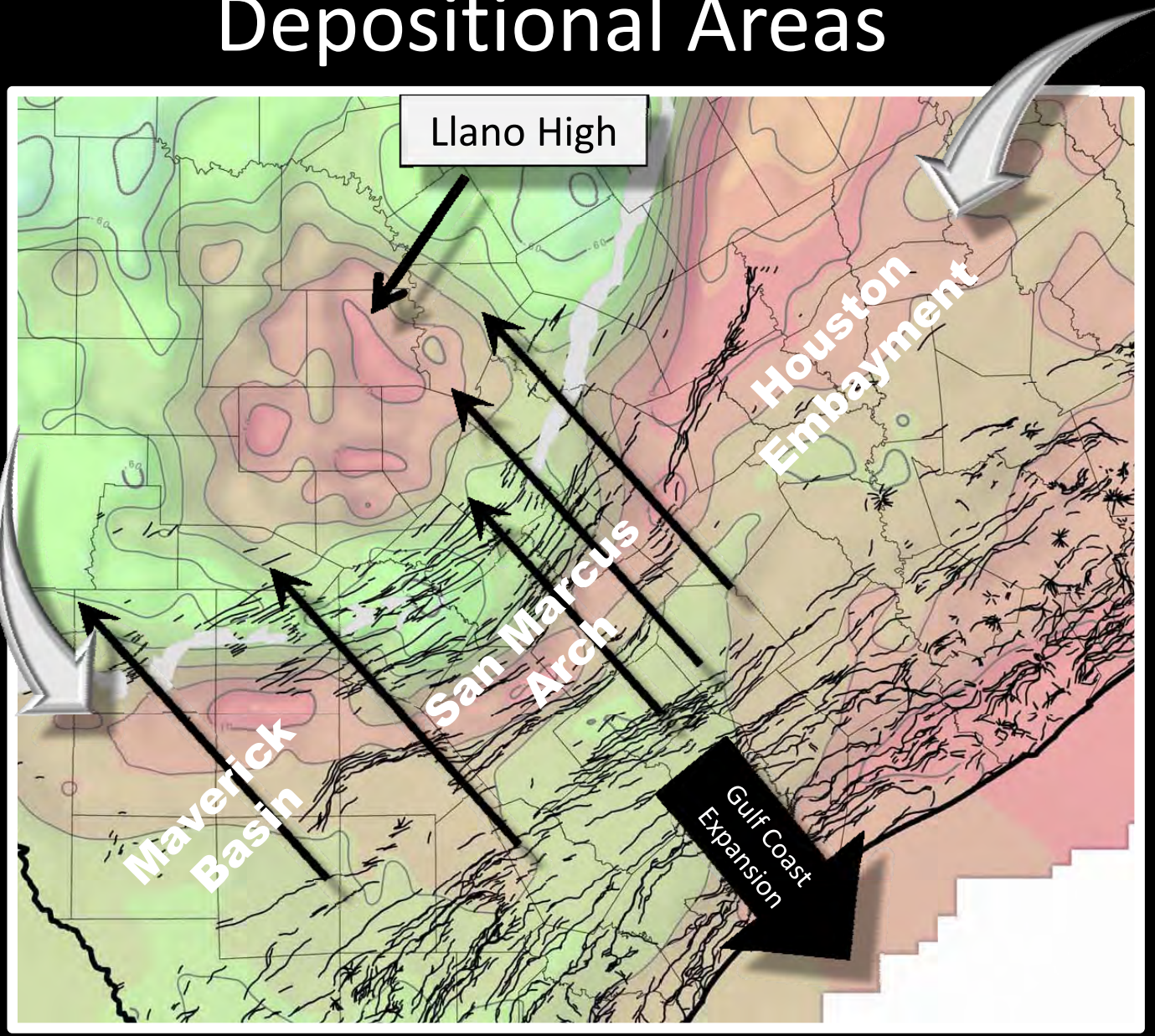
The shallow expression on the Ouachita mountain front furthers the definition of the basement topography.



Depositional Areas

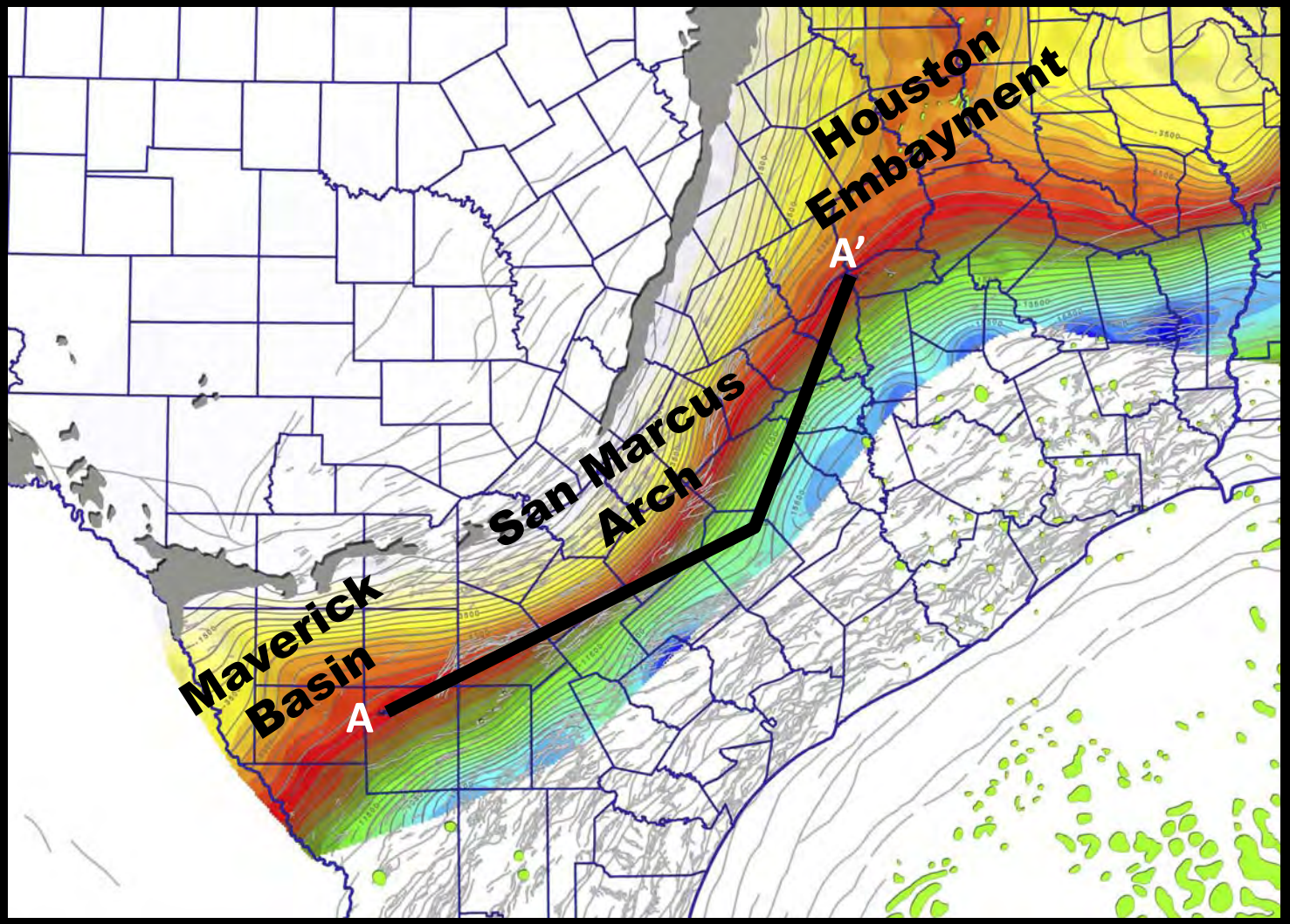
A combination of the deep structure topography and depositional rates create the three different depositional areas.

1 – Maverick Basin
2 – San Marcus Arch
3 – Houston Embayment



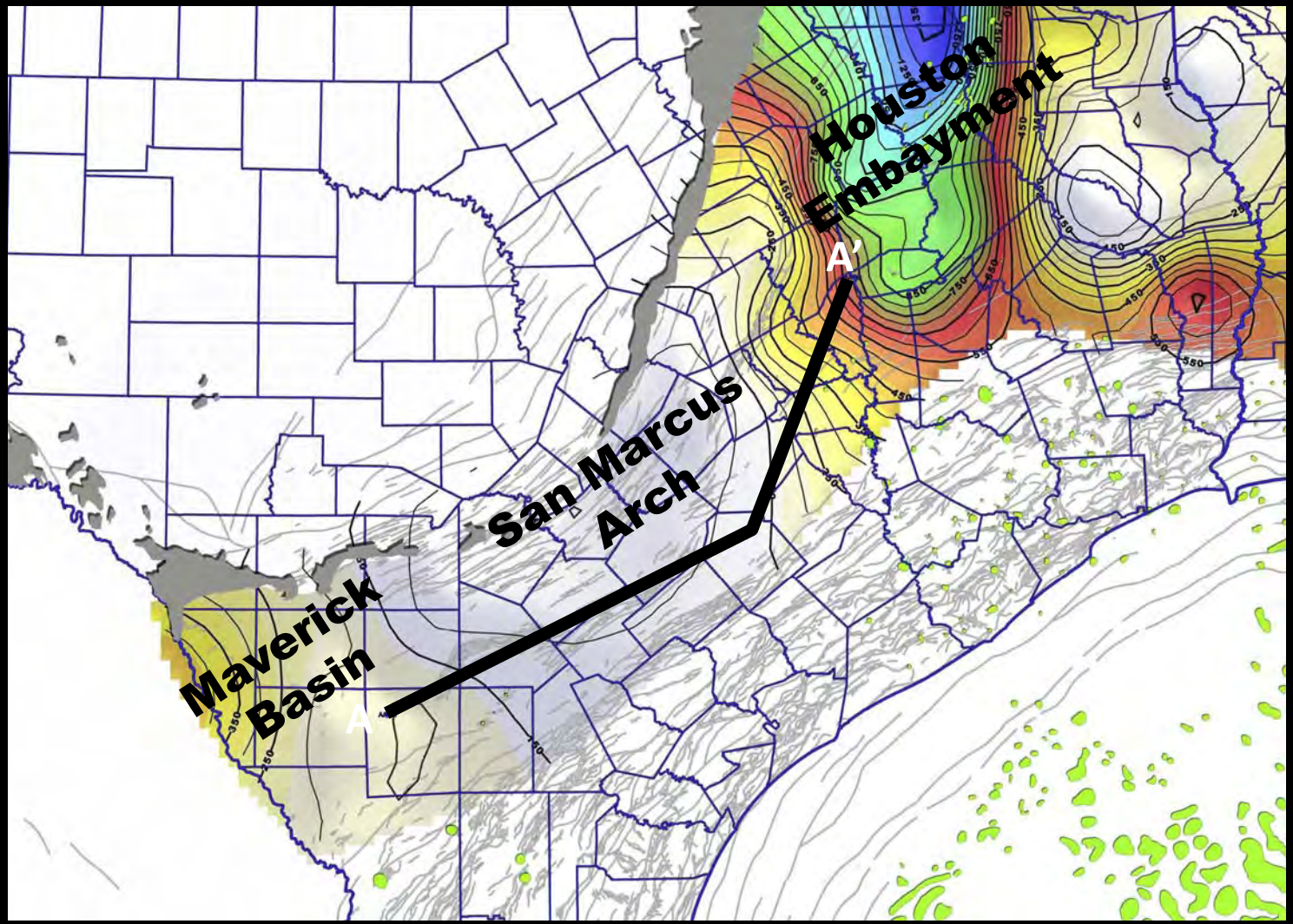
Regional Structure Base of Cretaceous Shale Section

Present day structure does not indicate the presence of the San Marcus Arch.



Generalized Isopach of Cretaceous Shale Section

Isopach of the Cretaceous shale section indicates the presence of the San Marcus Arch.



SW – NE Cross Section A-A’

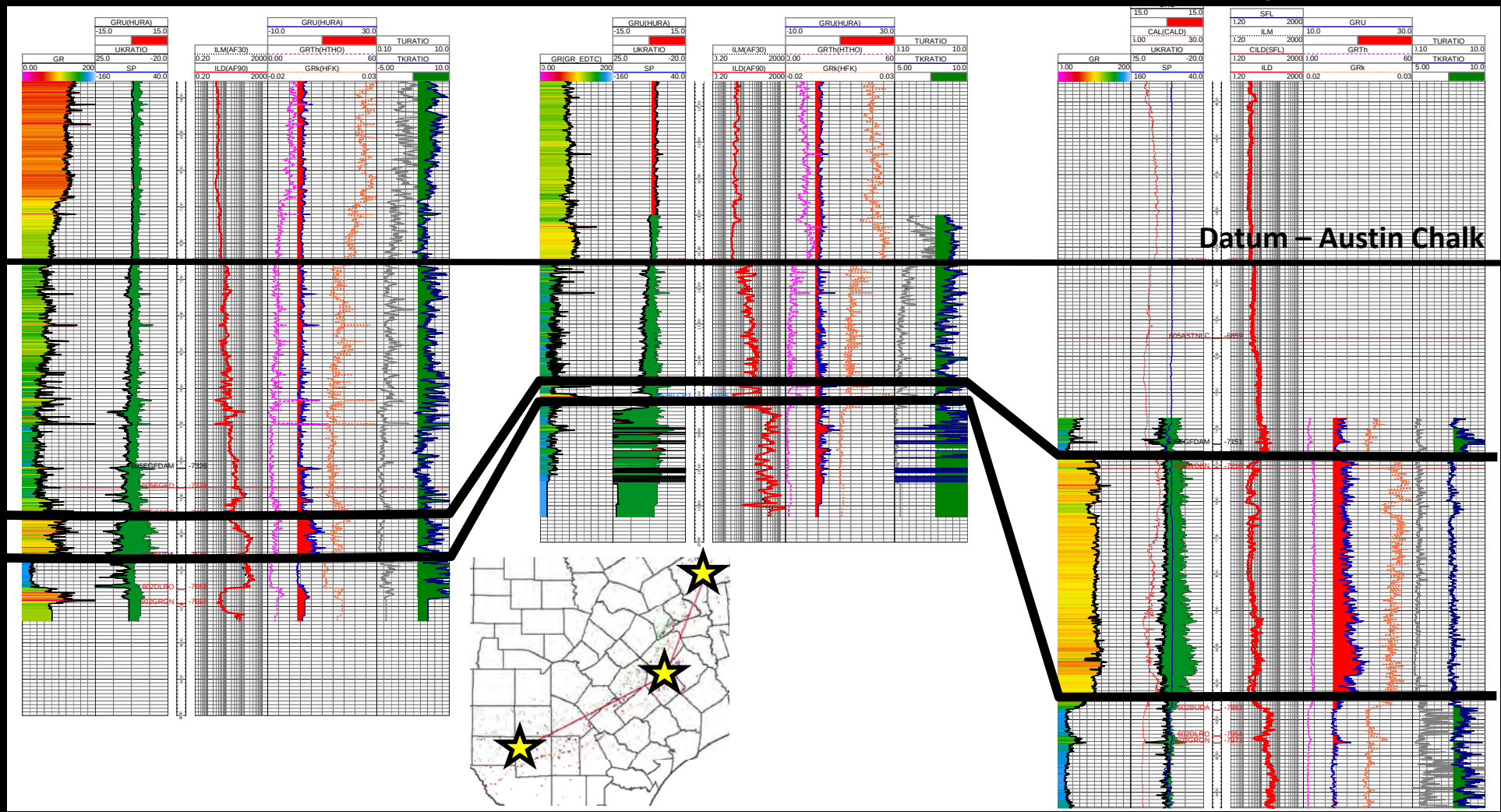
A

Maverick Basin

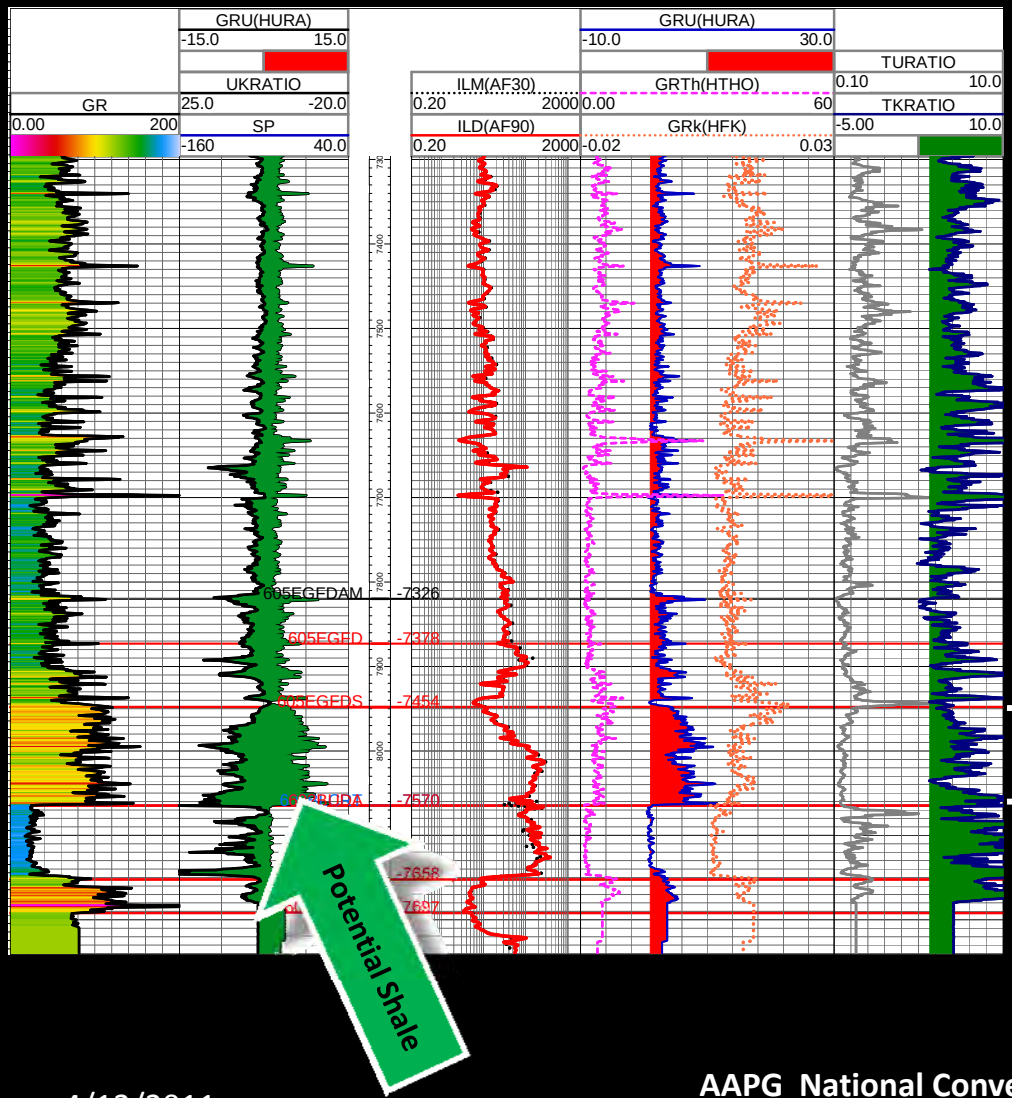
San Marcus Arch

Houston Embayment

A’

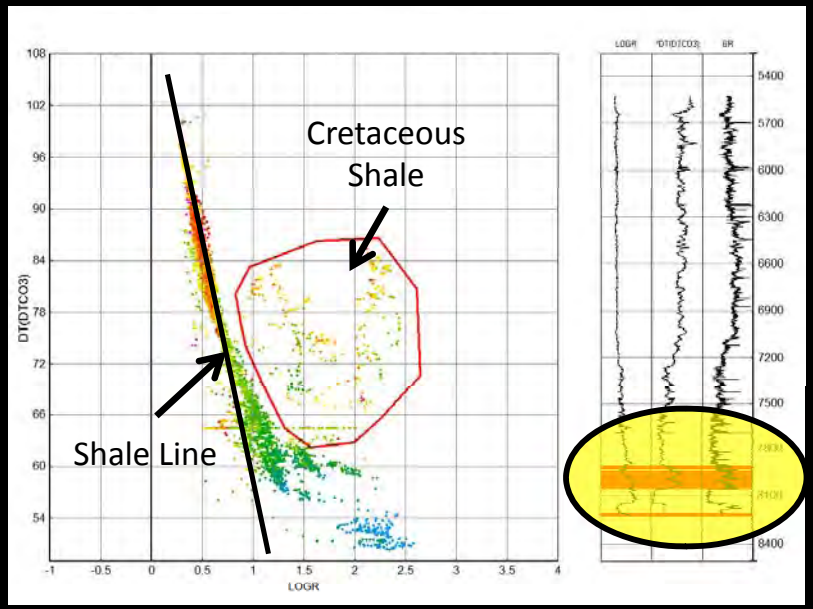


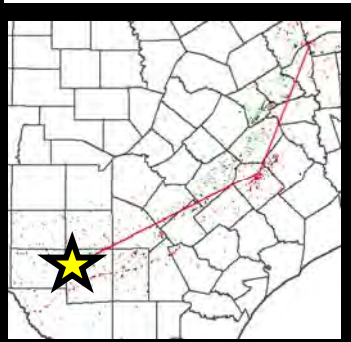
Maverick Basin Well



Upper Cretaceous Shales
Productive Interval

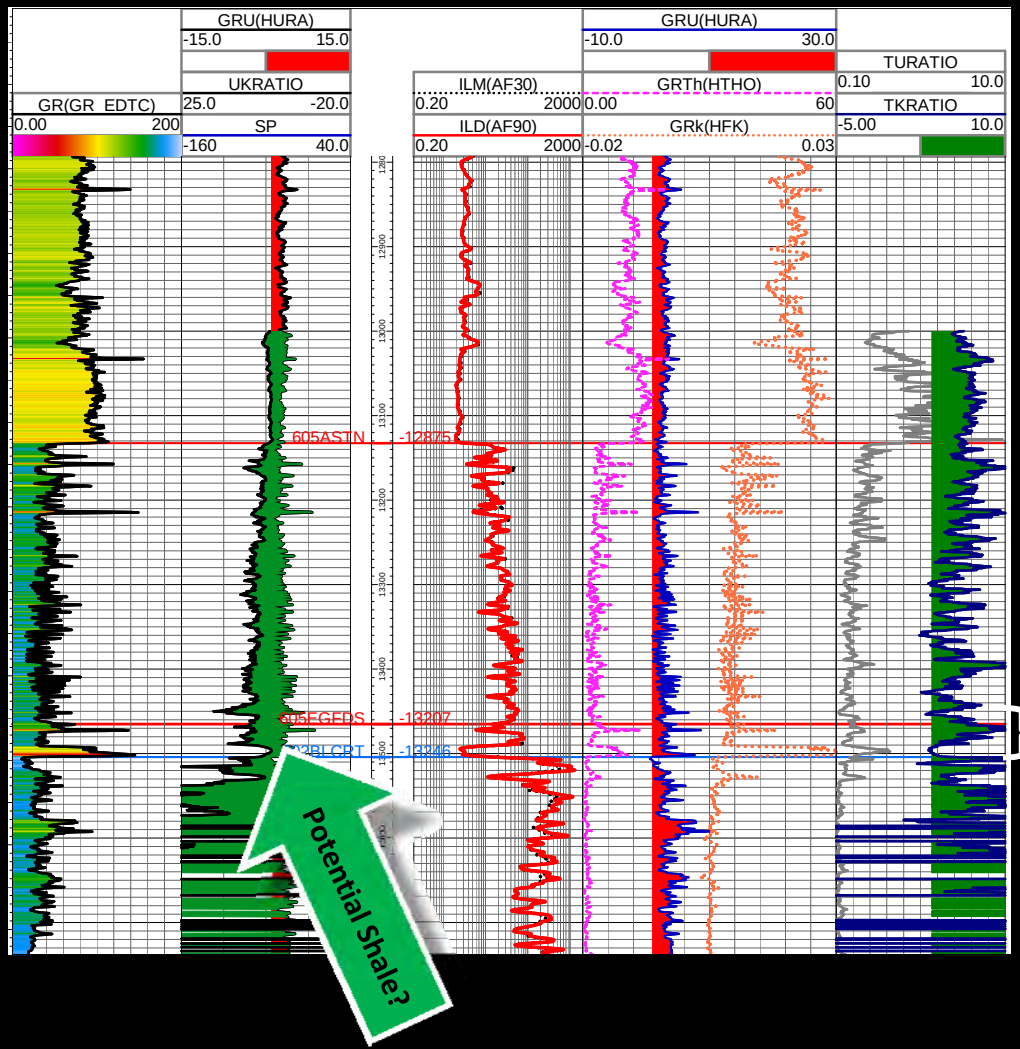
Passey Delta Log R Plot





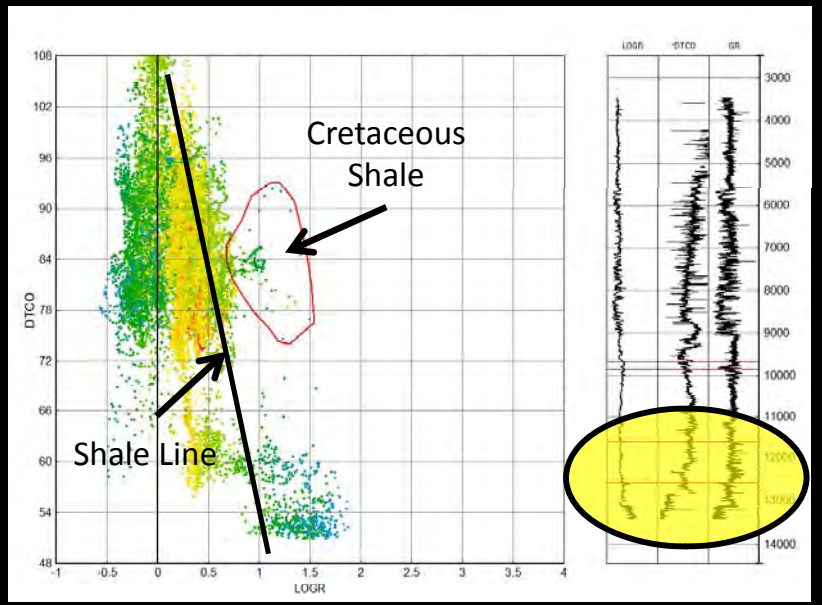
- ~120’ Shale Section
- Resistivity > 100 ohm
- High Uranium > 1 PPM
- High Potassium > 10%

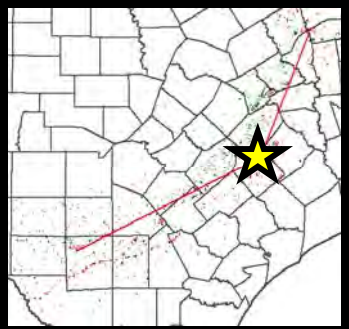
San Marcus Arch Well



Upper Cretaceous Shales Productive Interval?

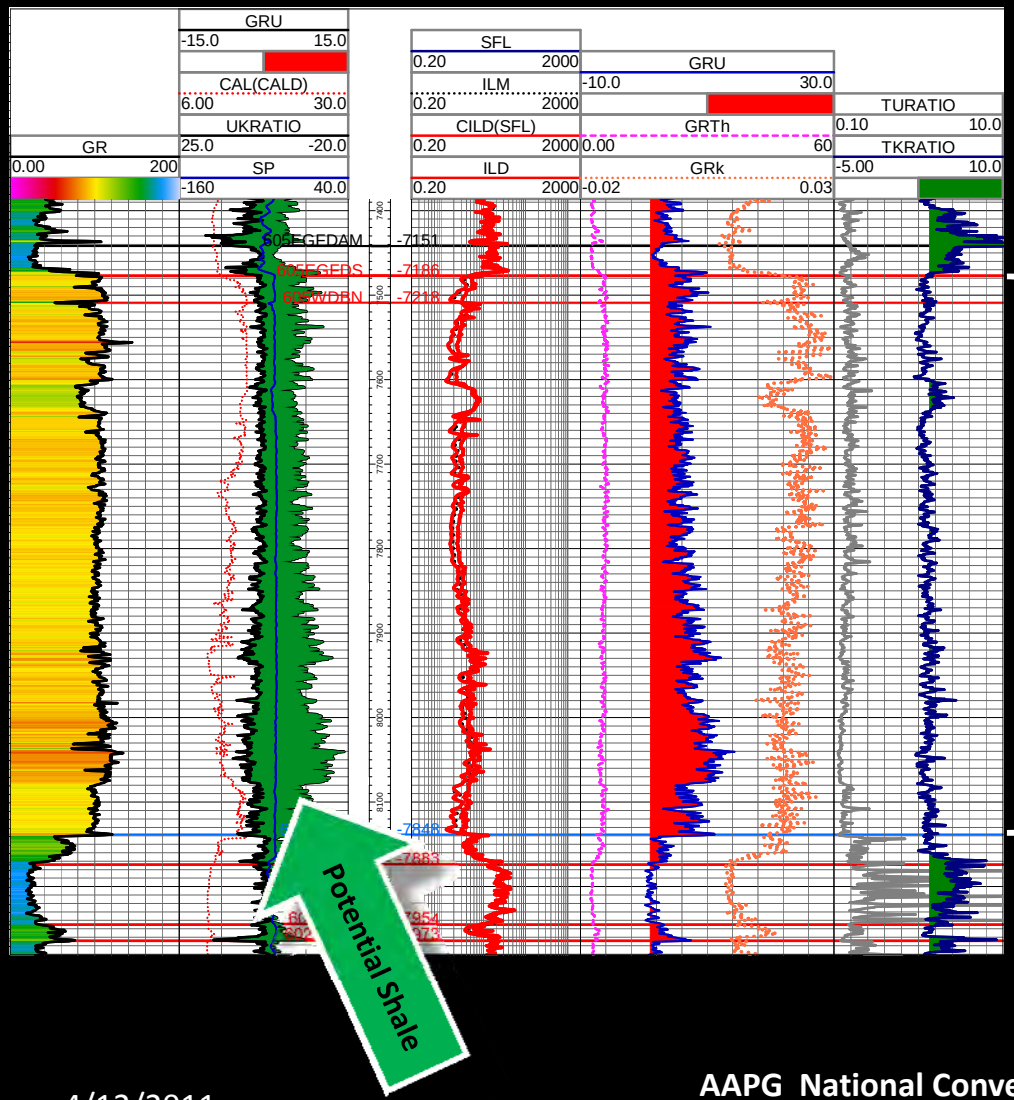
Passey Delta Log R Plot





- ~40’ Shale Section
- Resistivity > 5 ohm
- High Uranium > 1 PPM
- High Potassium > 20%

Houston Embayment Well



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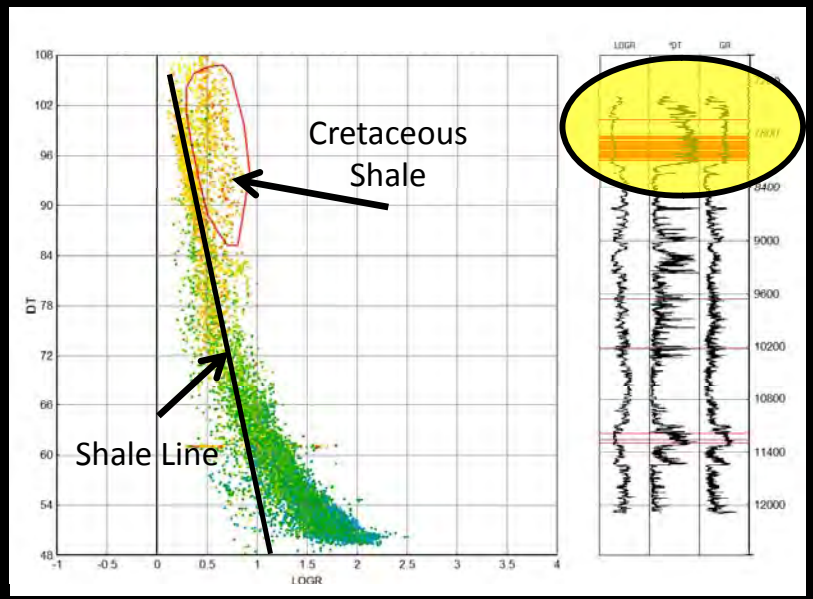

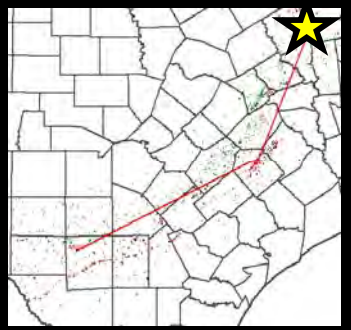

- ~700’ Shale Section
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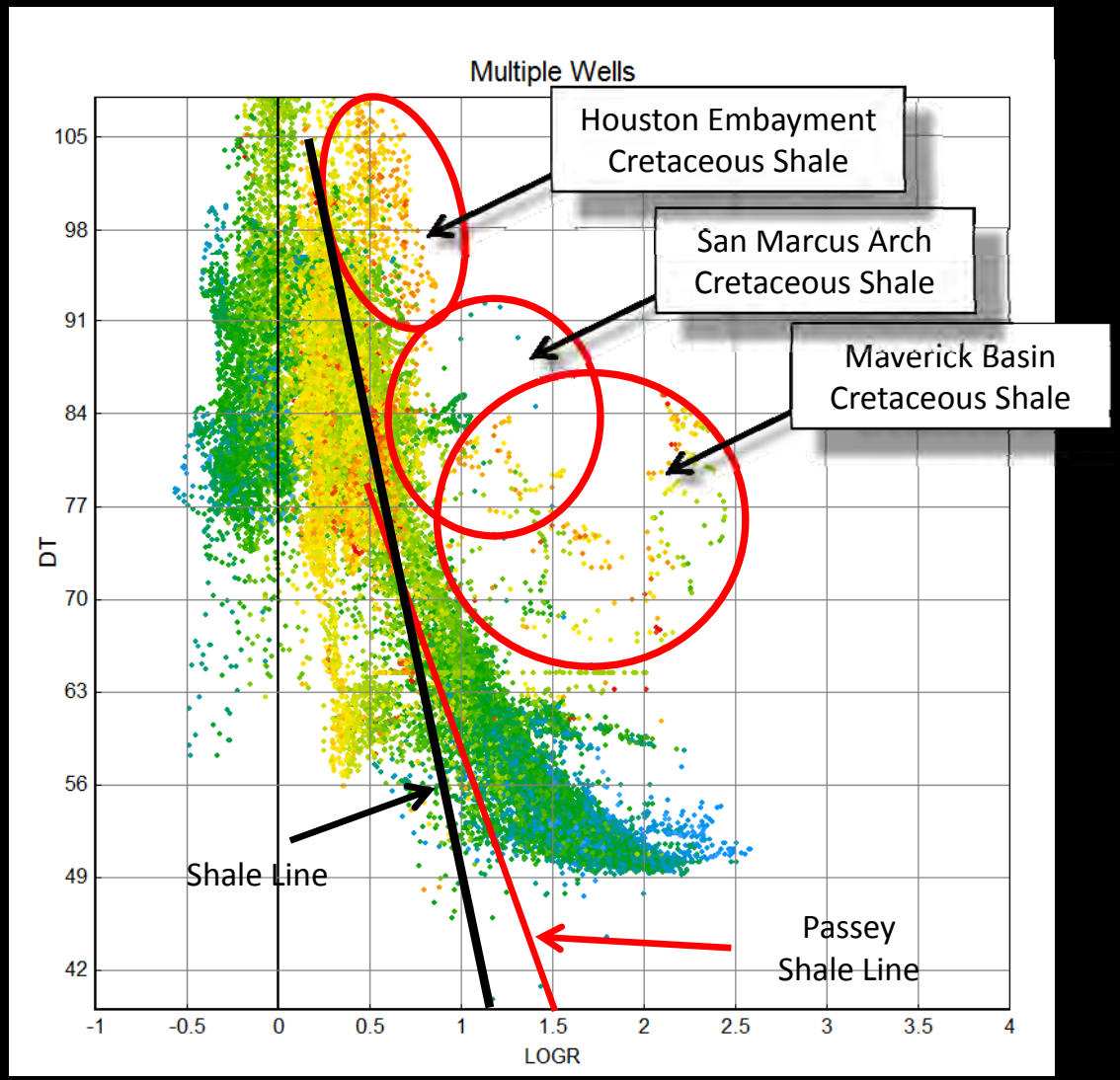
Passey Delta Log R Comparison



Regional comparison of the Upper Cretaceous shale section indicate the various areas are quite different, however, the shale line remains the same for each area.

Resistivity may not be the deciding factor in determining the productive potential of an area.

Identification of Organic Rich Intervals Using Spectral Gamma Ray Logs

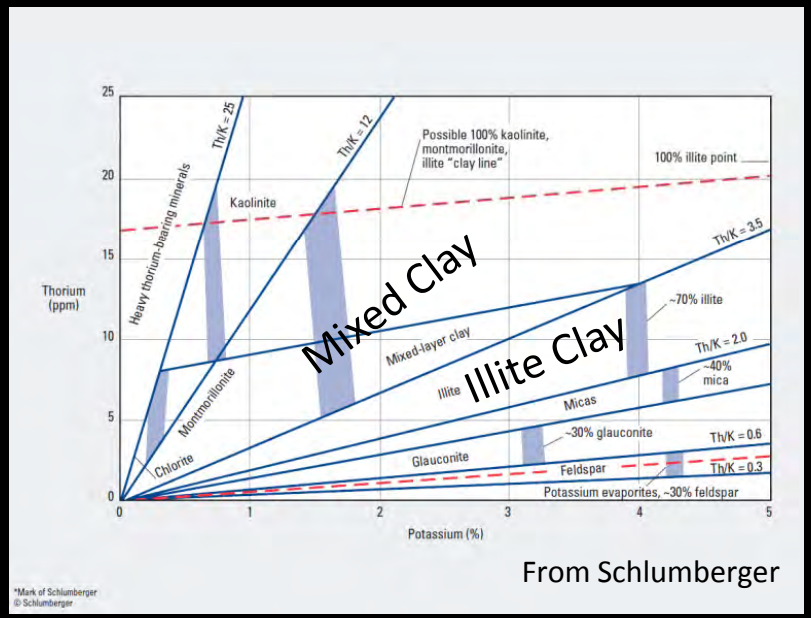
- Thorium – Generally associated with clay minerals and heavy minerals from igneous rock
- Uranium – Not generally associated with clay, generally associated with organic material
- Potassium – One of the primary constituents of typical “shale” clay minerals

  T/K – Illite < 3.5; Chlorite > 10; 3.5< Mixed < 10

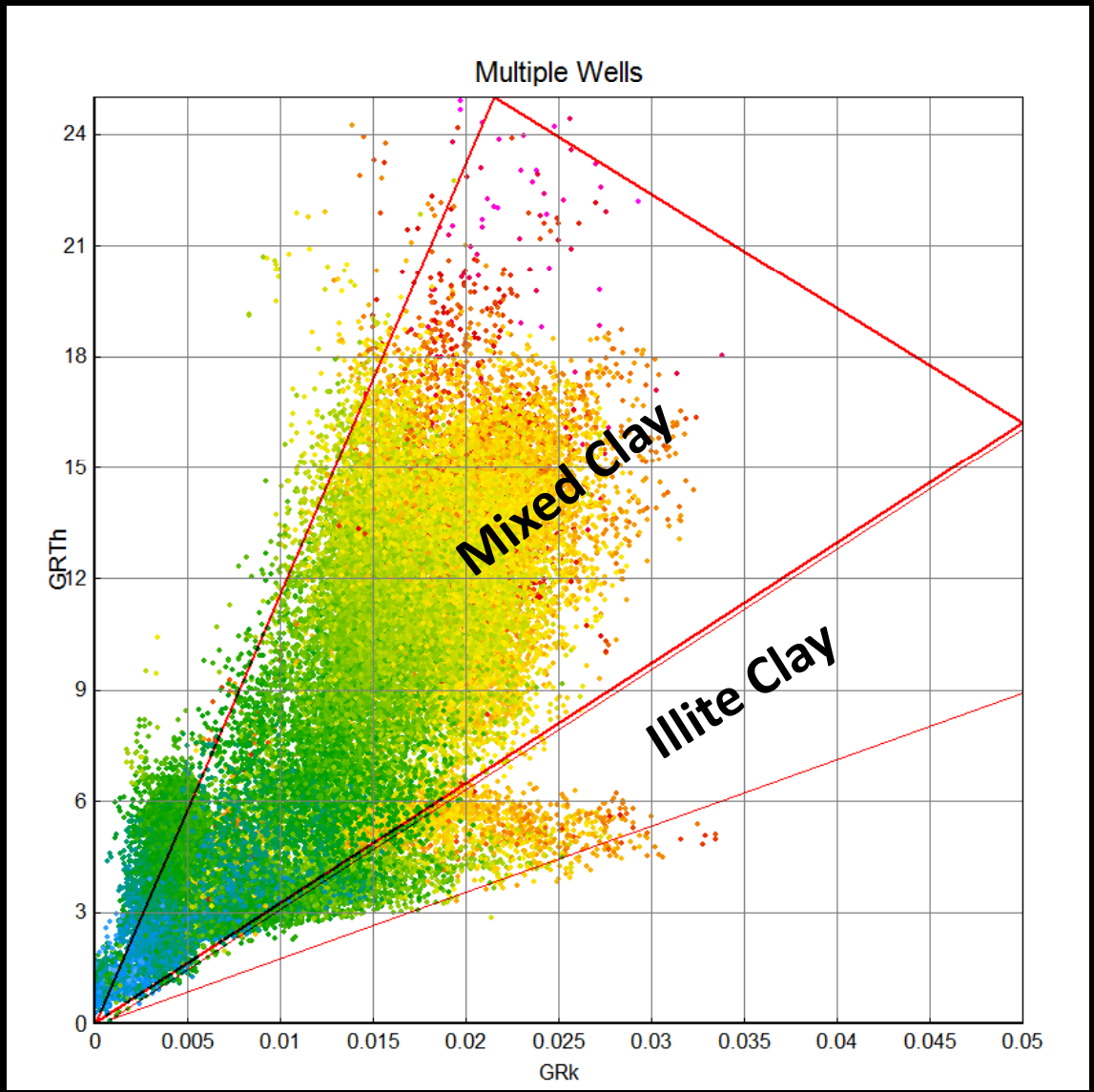
  T/U – Marine < 6.5

  U/K – Organic rich interval

Potassium/Thorium Ratios



Comparison of Potassium/Thorium ratios is an indication of the clay type.



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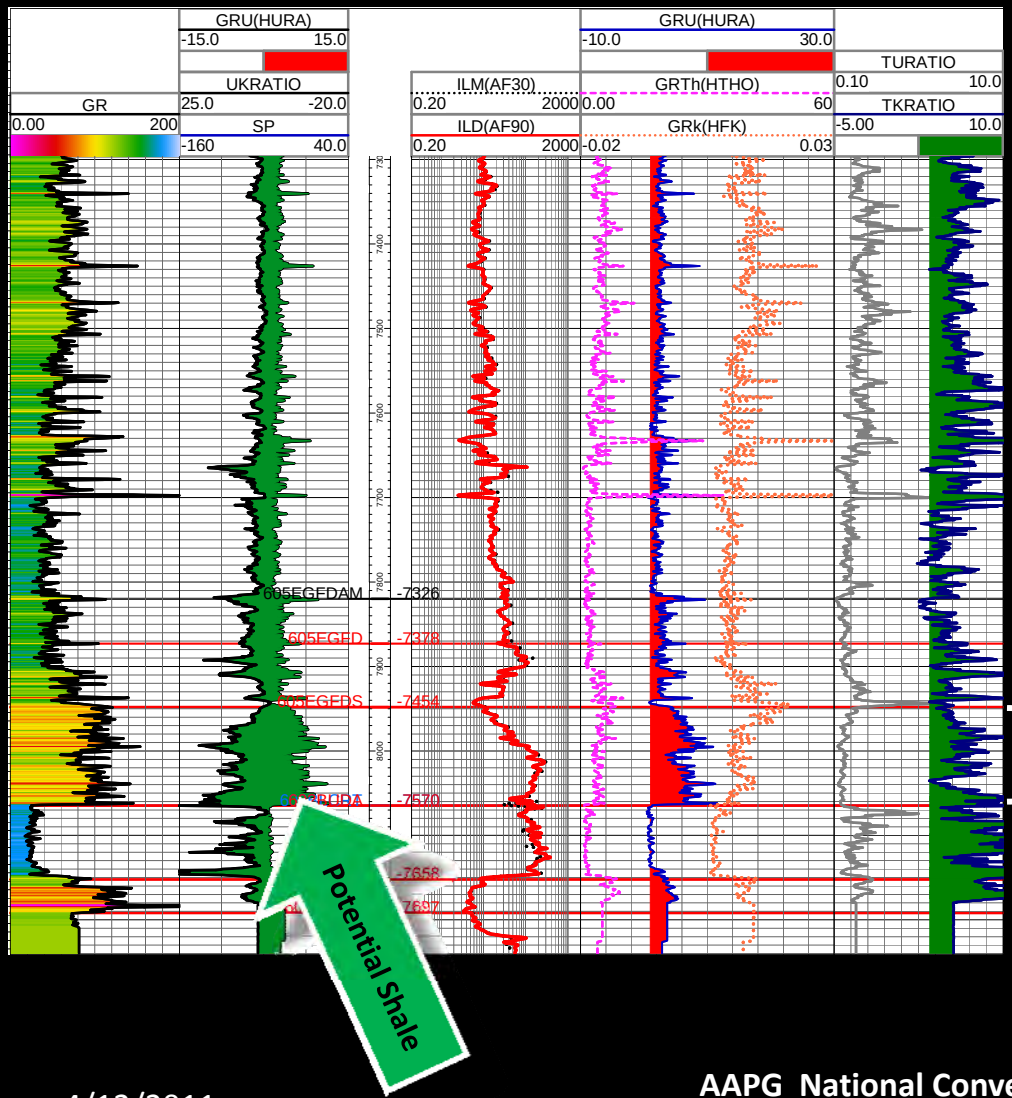

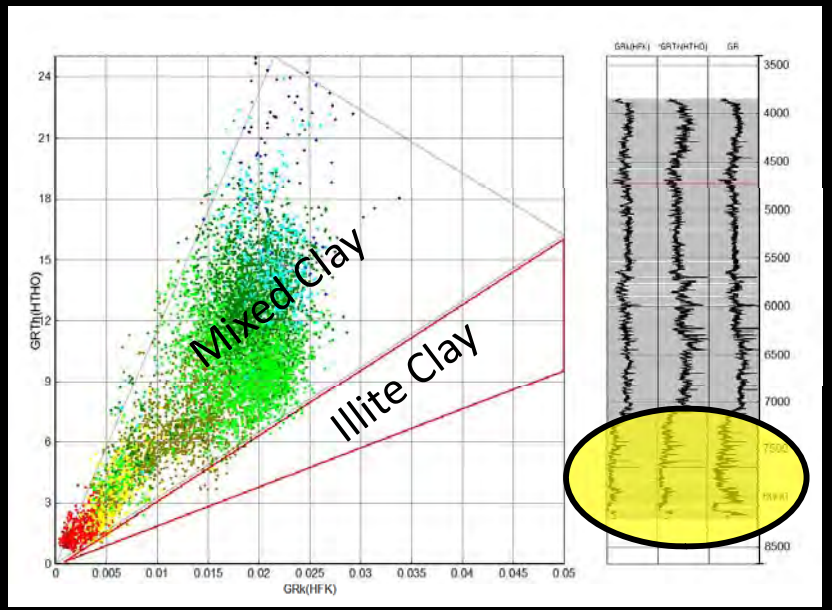

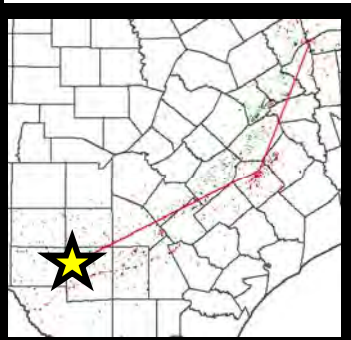

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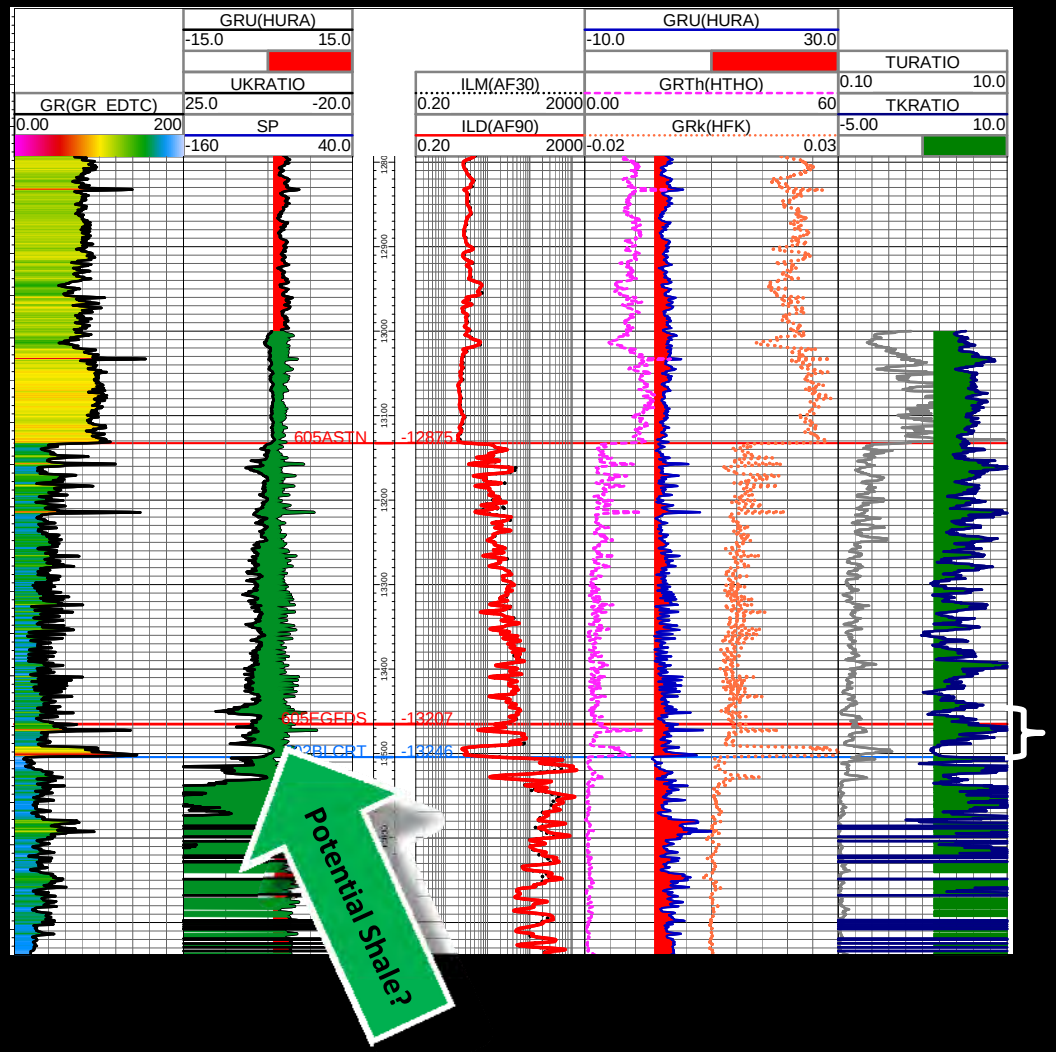
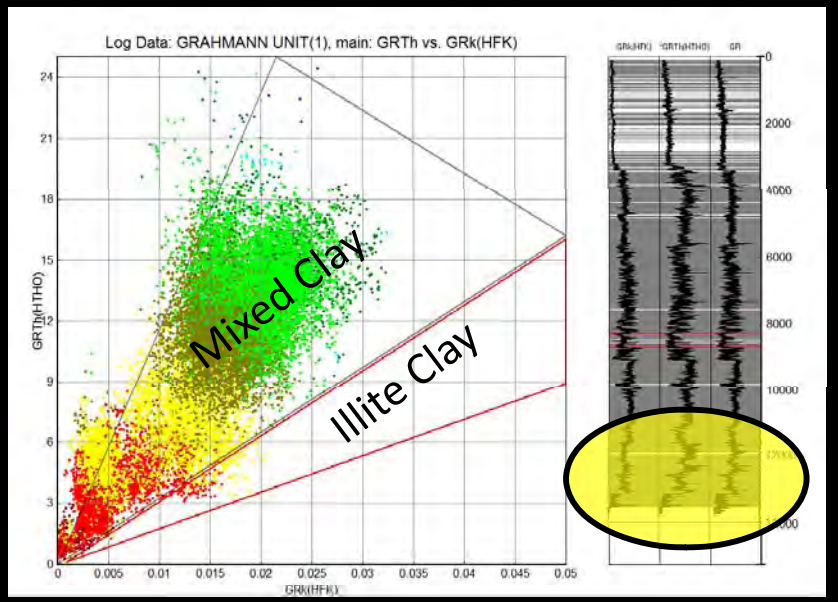
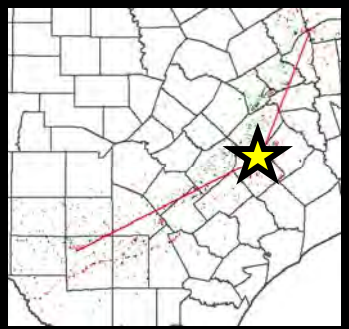


Upper Cretaceous Shales Productive Interval?





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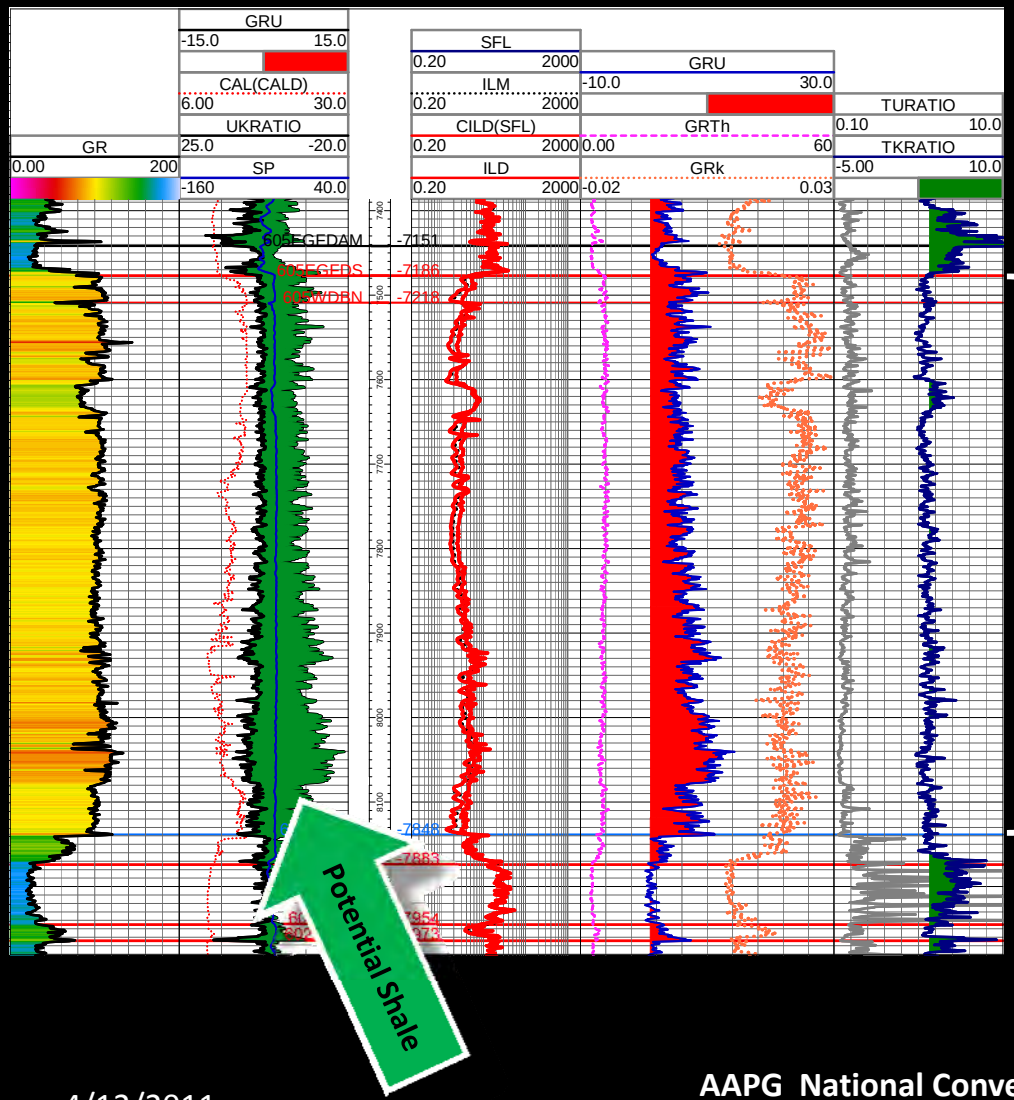

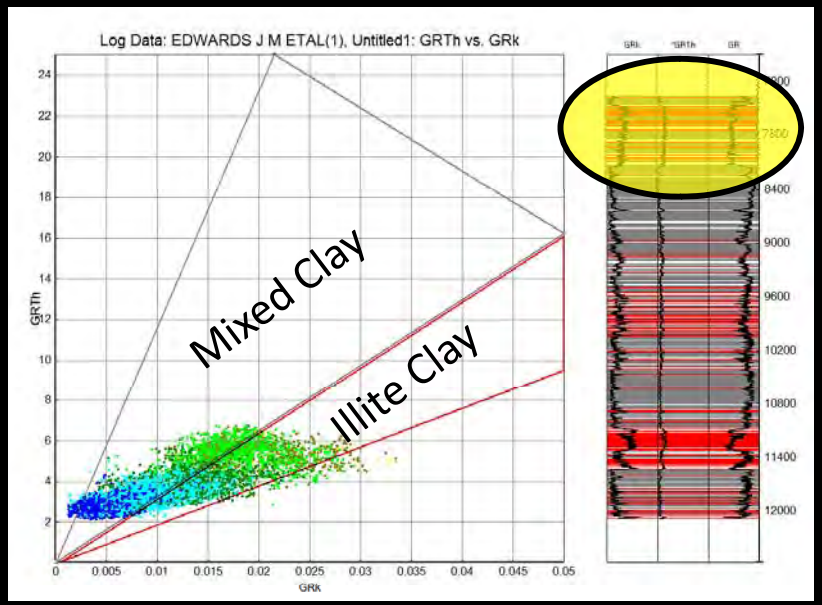

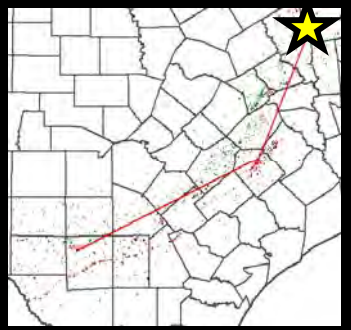

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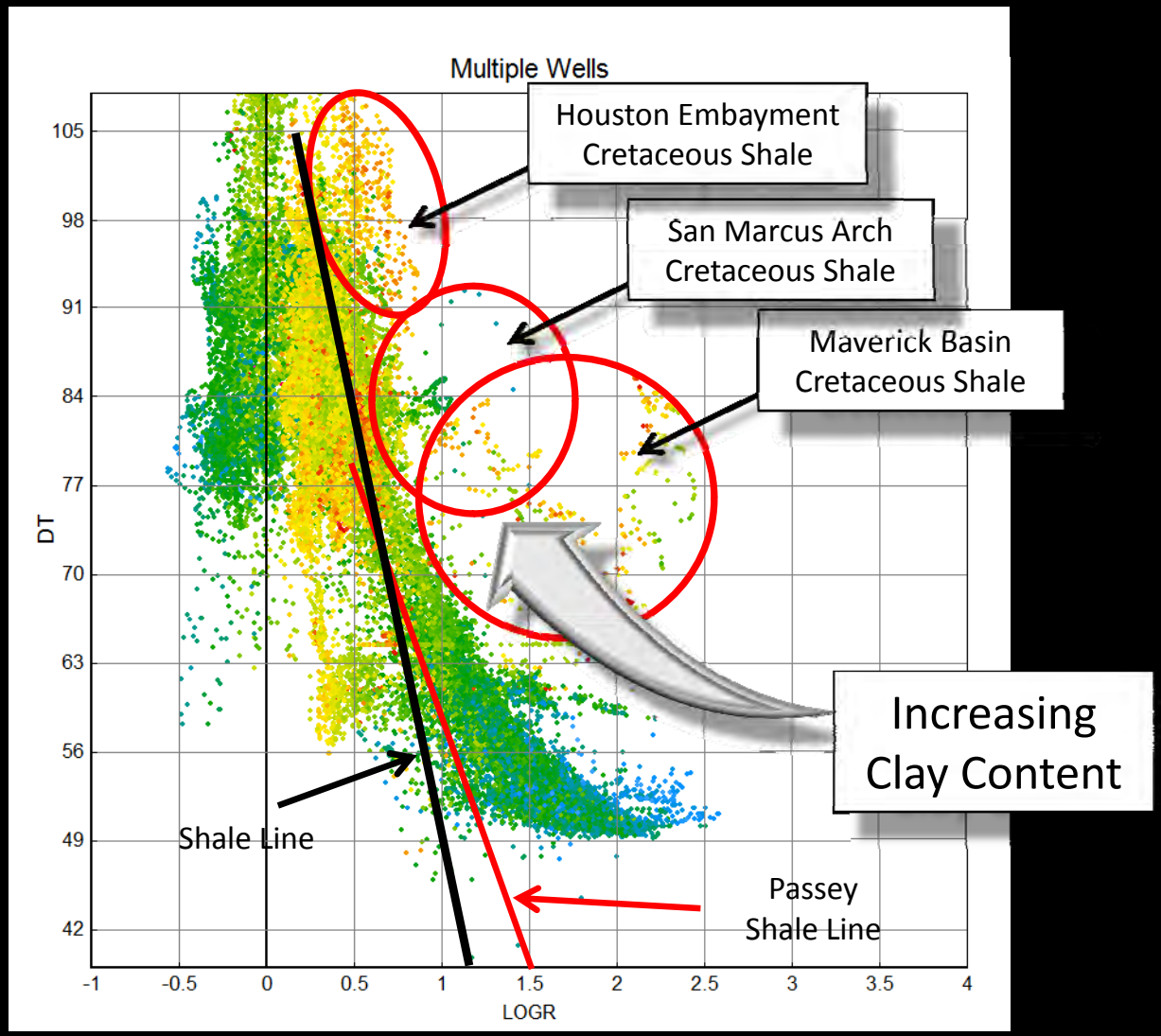

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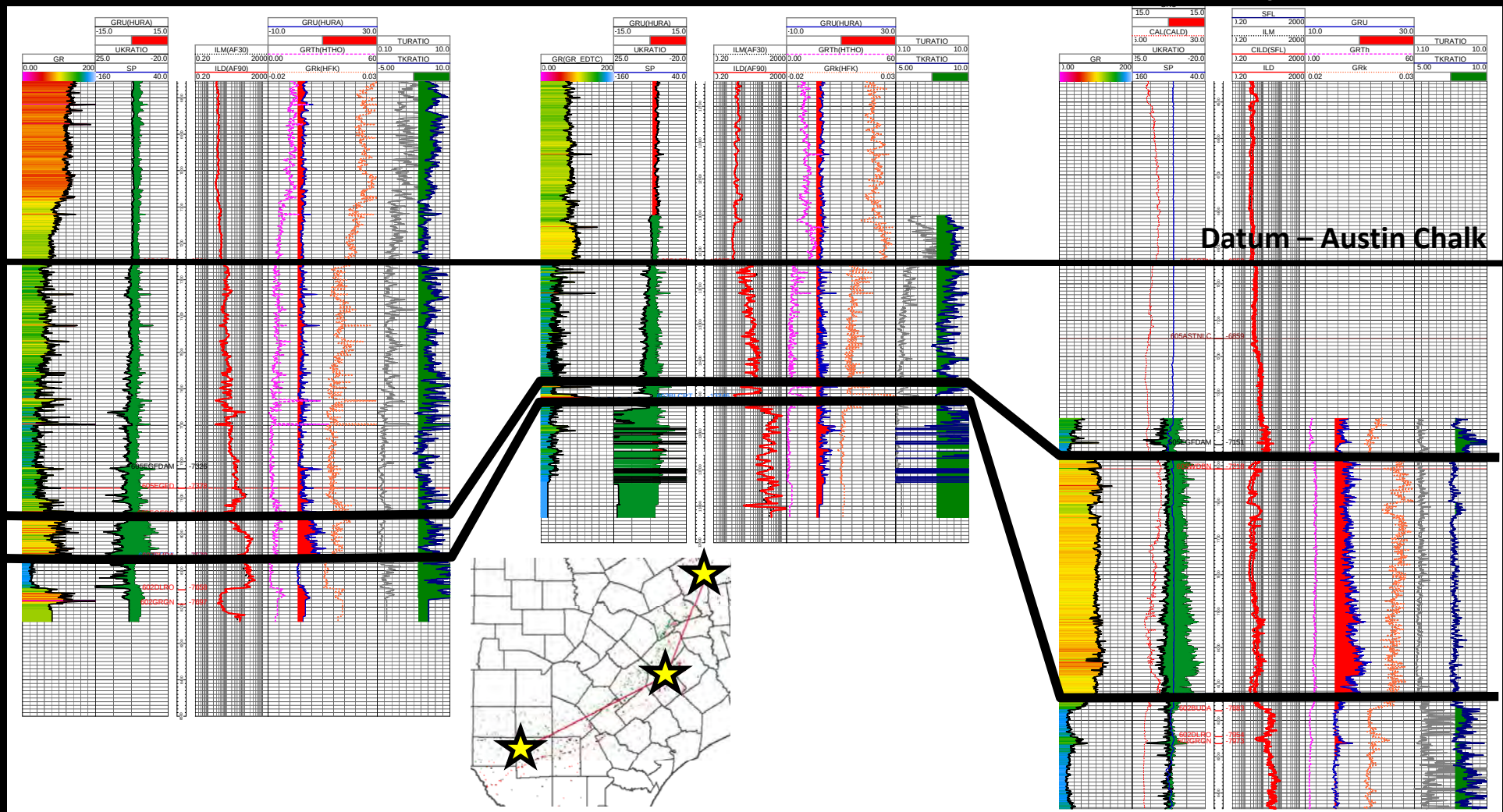

4/12/2011

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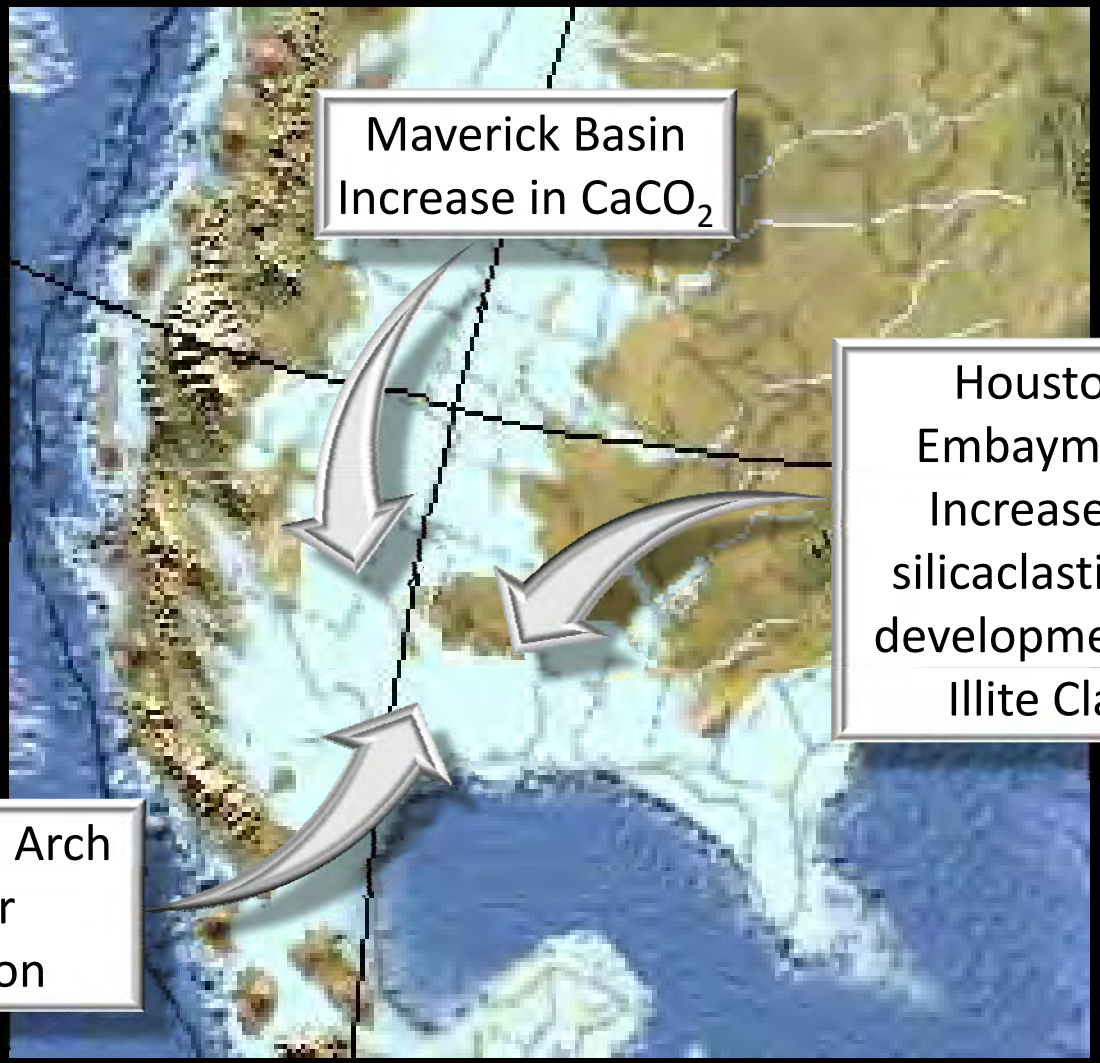
Middle Cretaceous Deposition

~ 5000 km at Equator
Middle Cretaceous (90 M a)*



*From Ron Blakey Department of Geology
Northern Arizona University

Conclusions

- The Upper Cretaceous Shale section is deposited in three distinct environments.
- Each of these areas have different lithological impacts on the type of formations deposited.
- The eastern portion (Houston Embayment) has a higher concentration of illite clay resulting in lower resistivity readings.
- The eastern portion has good indications, base on the Uranium concentrations that there is abundant organic material present.
- “Eagle Ford” does not equal “Eagle Ford”.


Thank You