Development of Mechanically Layered Haynesville-Bossier Shale-Gas Play*

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Abstract

The Haynesville shale is characterized by high TOC, good porosity, high gas saturation, low clay content and nanoDarcy permeabilities, all which makes for an exceptional shale gas reservoir. However, recent well IP's have been variable, and given the planned extensive development, it is necessary to de-risk some of the geologic variables to up-grade acreage and optimize well development plans. This was done through a two-part study covering the greater Sabine area of northwestern Louisiana, USA. The first part focused on defining the depositional environment, reservoir characteristics, and facies variation through inorganic element analysis, XRF, XRD, petrography, and biostratigraphic classification of macro- and nanofossils. The second focused on interpretation of present-day stresses and characterization of the natural fracture from core, image logs, and micro-seismic data. Both parts were then integrated to assist in sweet spot definition and well planning and optimization.

Results suggest that the Haynesville's reservoir properties (clay/calcite content, TOC, perm) are mappable showing trends that can roughly be correlate with IP rates. However, on a well-to-well basis, it is unclear what the contribution of a single property is (e.g., TOC or porosity) to productivity, and hence the predictability of future well rates or location. Similarly, fracture distribution shows mappable trends. These fractures are generally calcite cemented, and hence cannot directly contribute to well productivity unless reactivated during the stimulation. Vertically, fractures occur more extensively in the lower and upper Bossier than in the Haynesville and Mid-Bossier forming a mechanically layered system.

We show that mechanical layering combined with reservoir properties, complicates play development because the less fractured layers are richer in TOC than the highly fractured layers. Thus, while one could target a high TOC layer, the lack of fractures could hinder productivity. At the same time, the lack of natural fractures allows stimulated fracs to grow longer because the presence of natural fractures in the path of a stimulated frac dissipates its energy and produces shorter or segmented ones. A successful shale gas play development thus requires: 1) characterizing the competition between stimulated frac efficiency and value of natural fractures, or 2) realizing the balance between choosing the right reservoir properties, and reactivation of pre-existing fractures.

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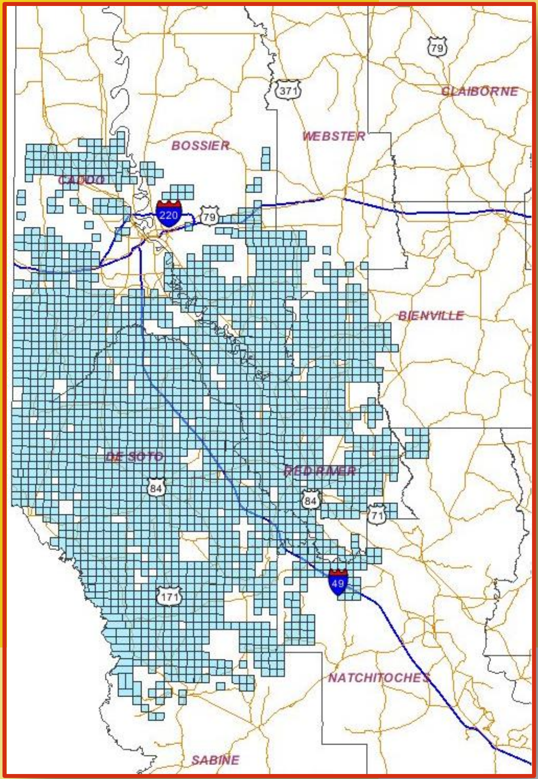

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Related Papers
Paul Smith
Tues 8:05, this room

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Reserves: Our use of the term "reserves" in this presentation means SEC proved oil and gas reserves for all 2009 and 2010 data, and includes both SEC proved oil and gas reserves and SEC proven mining reserves for 2008 data.
Resources: Our use of the term "resources" in this presentation includes quantities of oil and gas not yet classified as SEC proved oil and gas reserves or SEC proven mining reserves. Resources are consistent with the Society of Petroleum Engineers 2P and 2C definitions.
Organic: Our use of the term Organic includes SEC proved oil and gas reserves and SEC proven mining reserves (for 2008) excluding changes resulting from acquisitions, divestments and year-average pricing impact.
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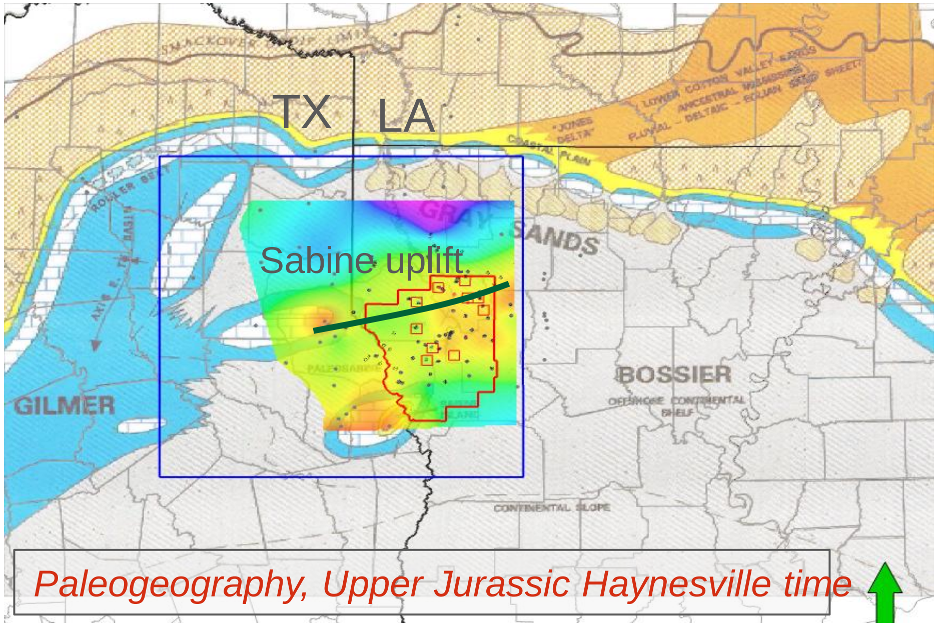
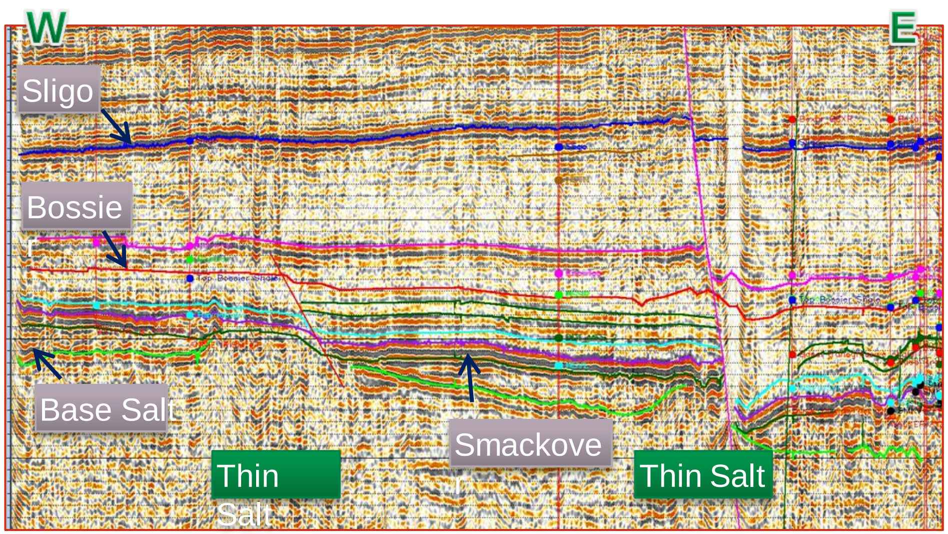
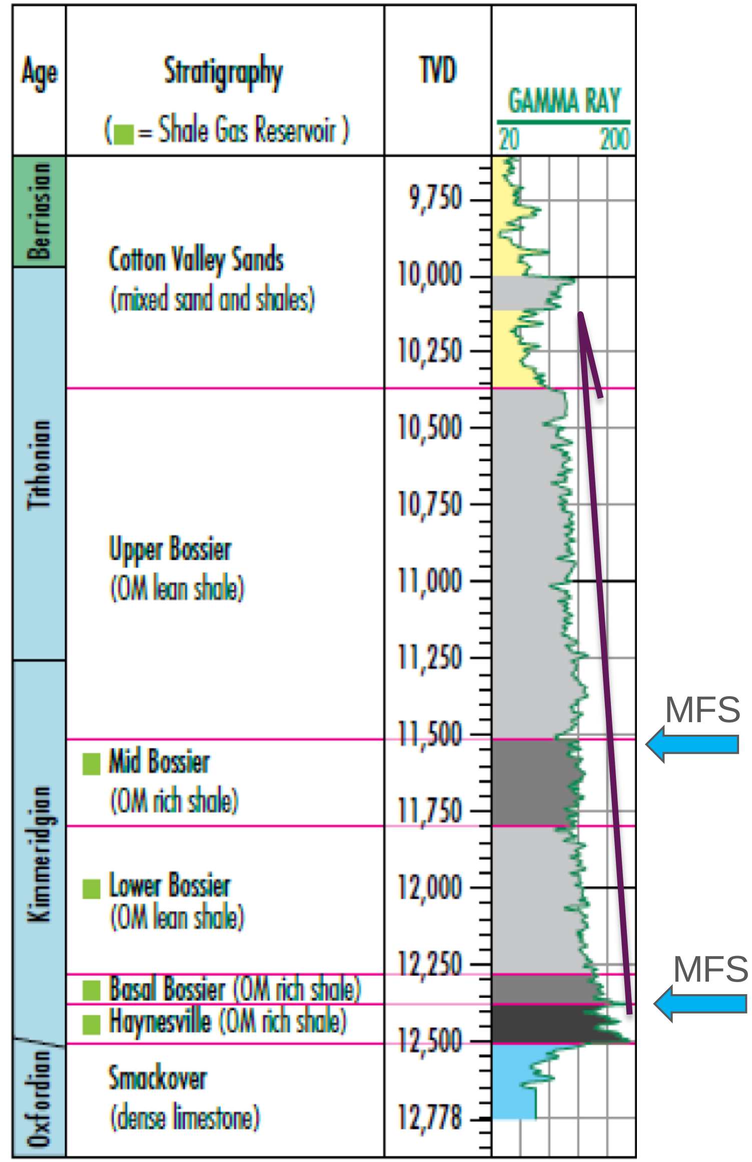
Haynesville-Bossier Regional Setting







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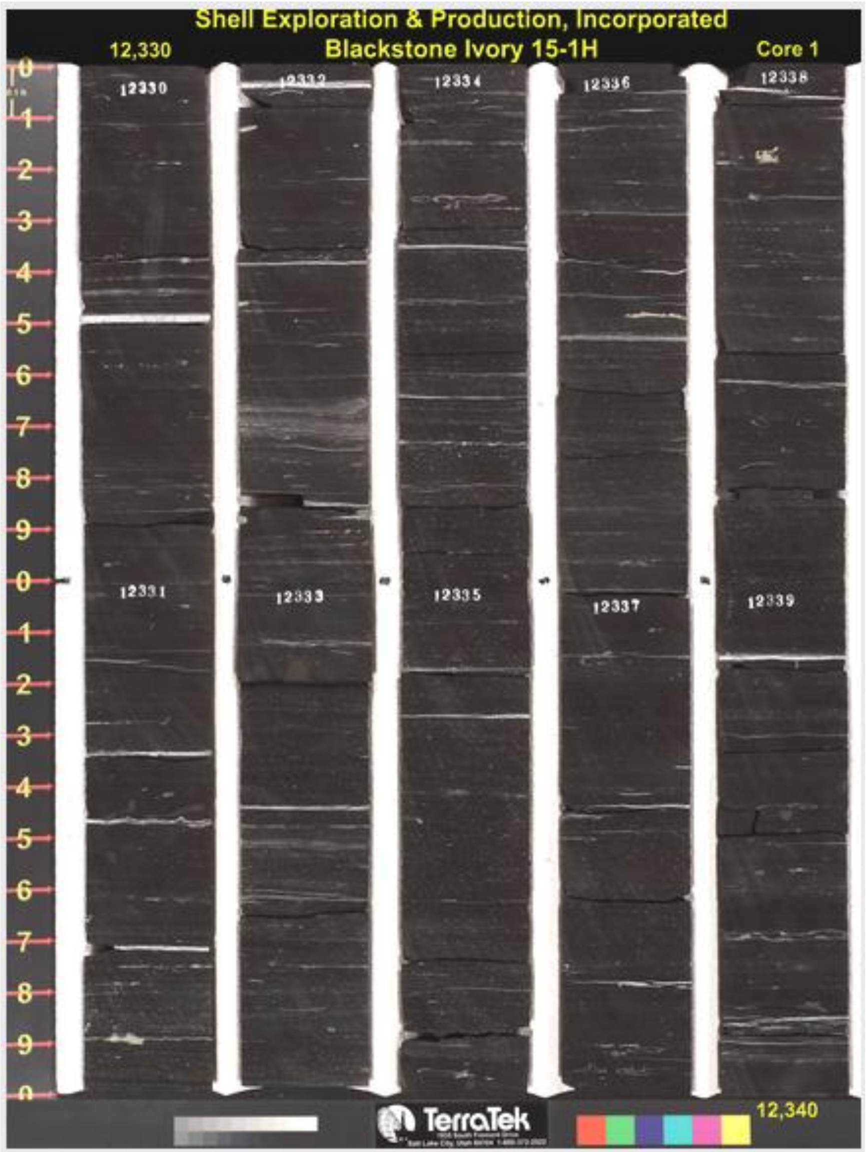
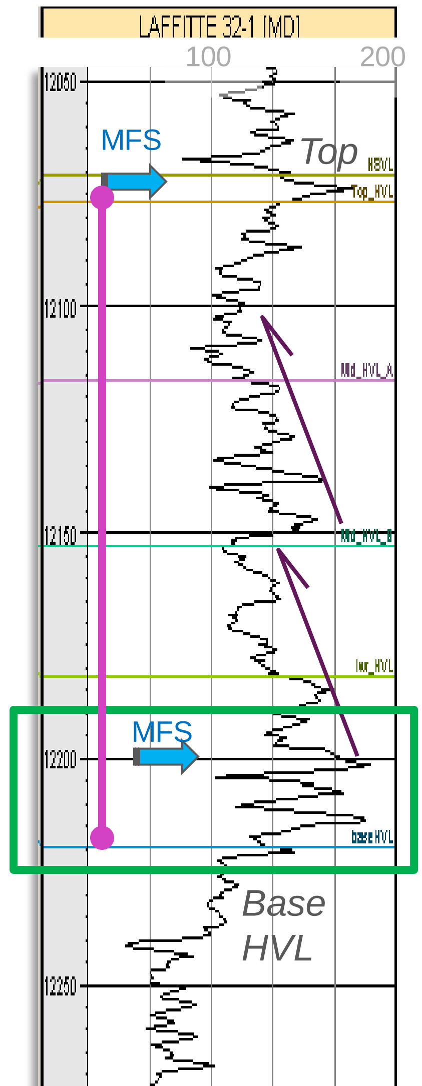
The Haynesville Shale

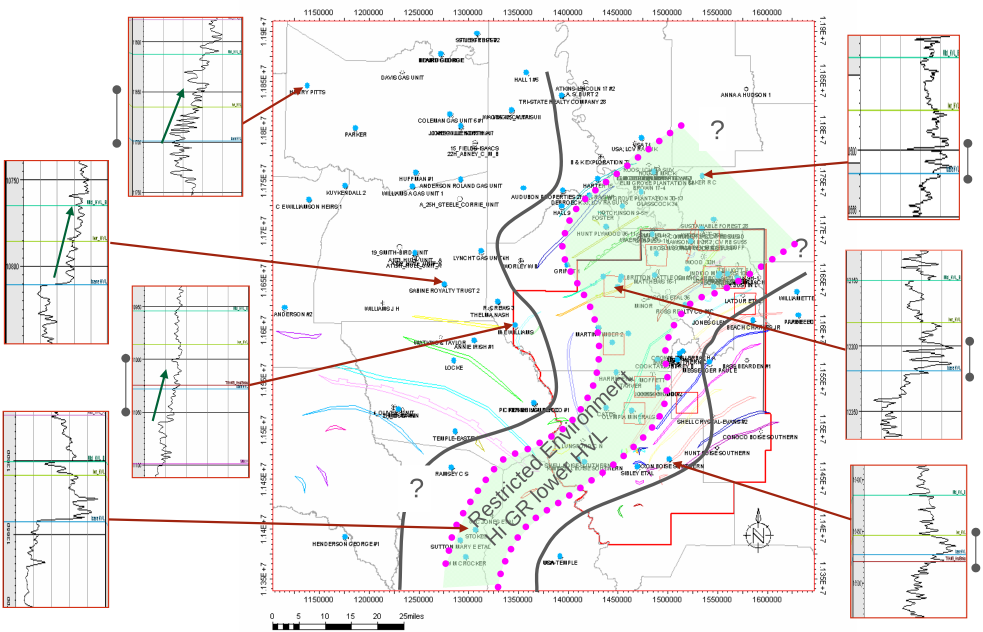


Haynesville Type log



- Haynesville: Monotonous dark shale with occasional silt and carbonate-rich shales.
- Vertically “coarsening“ upwards cycles.
- Highest GR at base, 40-50 ft.

Consistent Haynesville High GR in Area of Development



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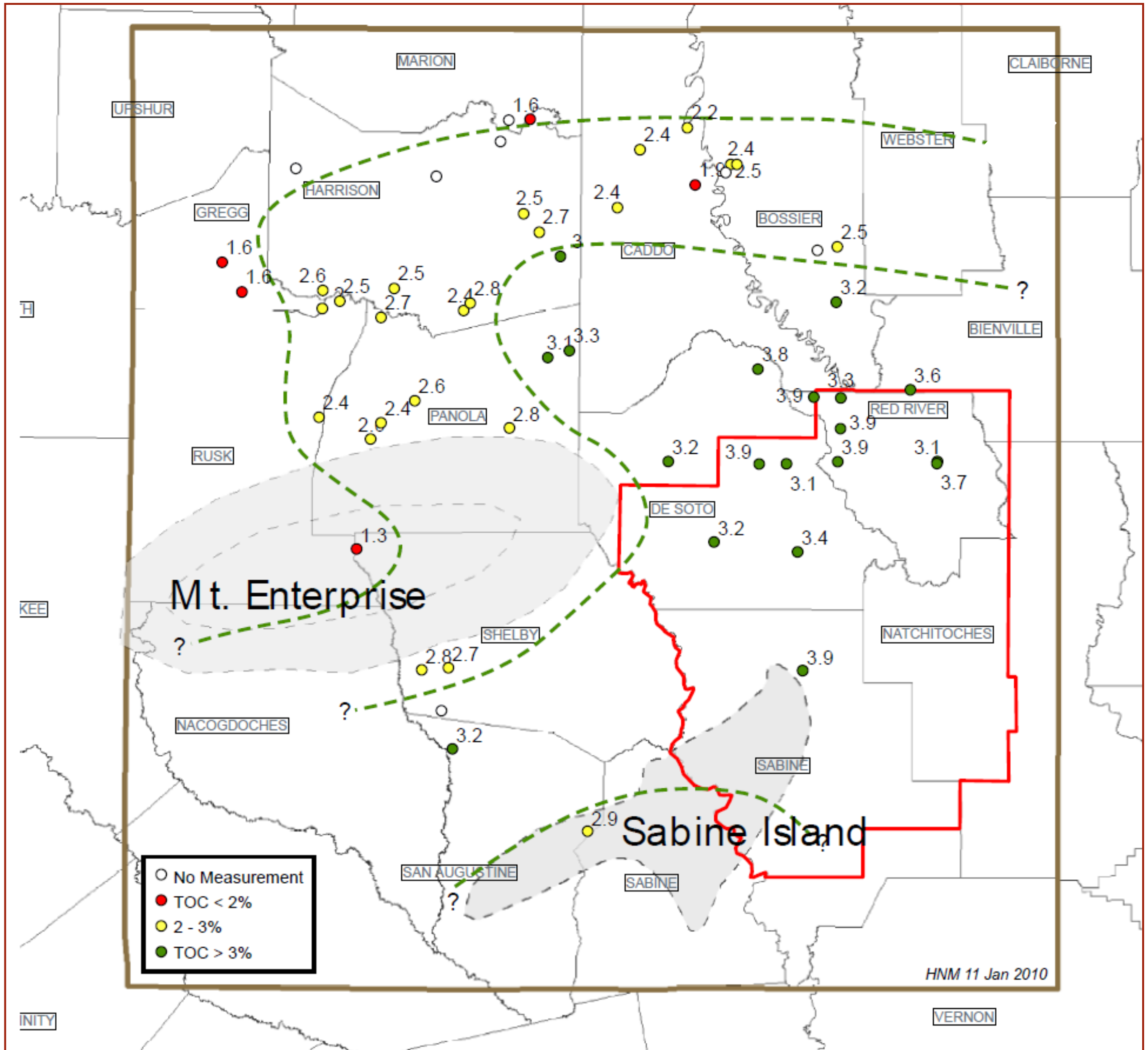
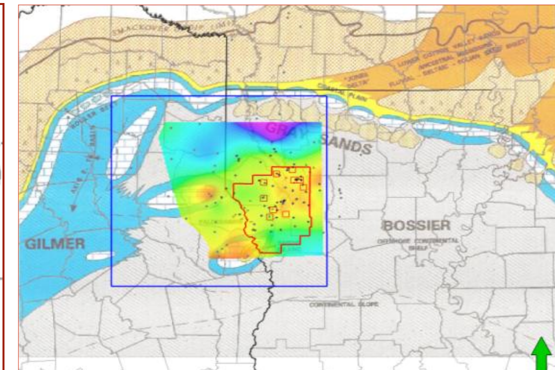
Presenter's notes: Well developed GR lower section is restricted to a corridor trending NE parallel to main fault system to the north and south.

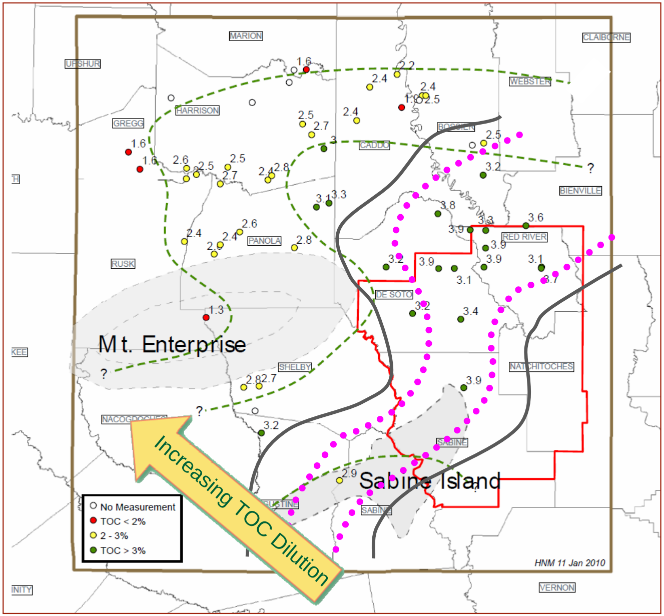
TOC Distribution

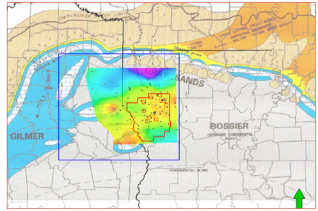




- TOC values decrease from SE to NW
- Indicates clastic source dilution of OM.
- High TOC values coincide with High GR of Lower Haynesville

TOC Distribution





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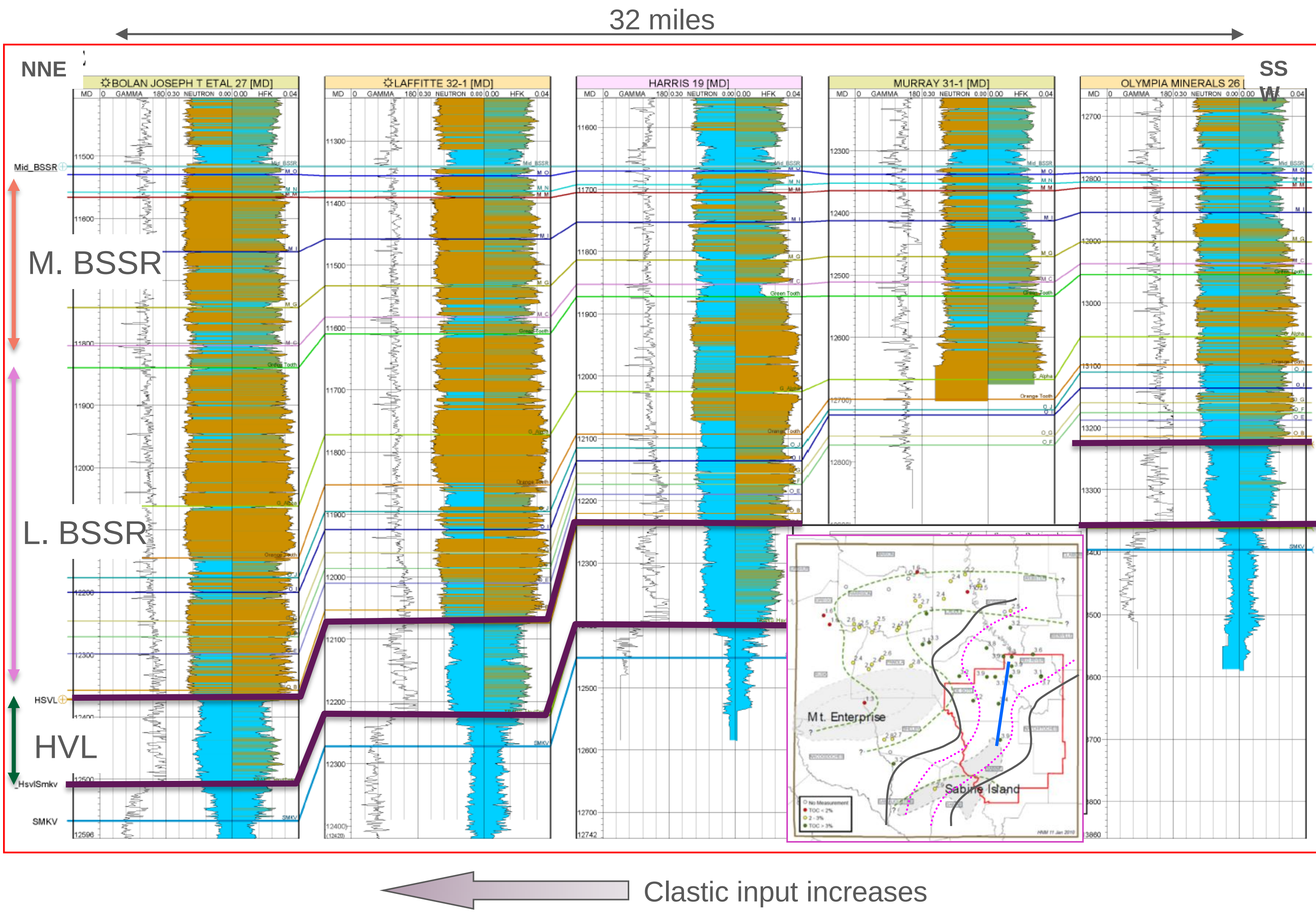
Presenter's notes: Present day TOC averages higher than 3% tend to exist and within the Shelby trough between the Sabine and Mt. Enterprise highs (outlined in grey). HSVL tends to thin over both paleo highs, implying that pre-existing basement topography could have effected the distribution and settling of terrigenous material within the Greater Sabine area. The highs undoubtedly disrupted water circulation patterns and settlement rates in the basin, potentially shielding the Shelby trough from being inundated by significant clay and contributing to the stagnant water conditions during early euxinic/anoxic HSVL times.

Detailed Stratigraphic Correlations



Clastic input increases

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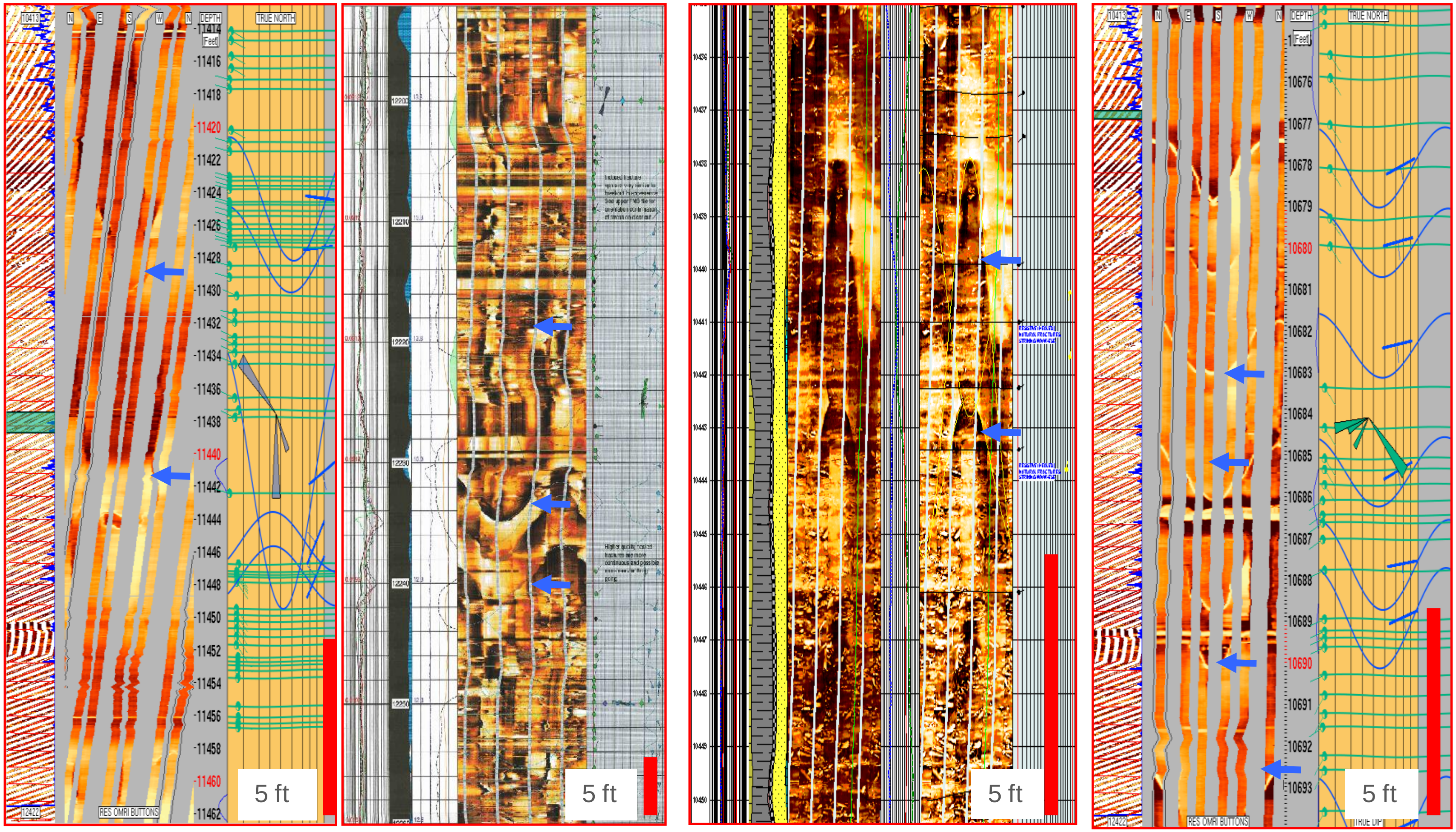
Fracture Observations: Bossier

Lower Bossier

Sustainable 24 | Adcock 2

Upper Bossier

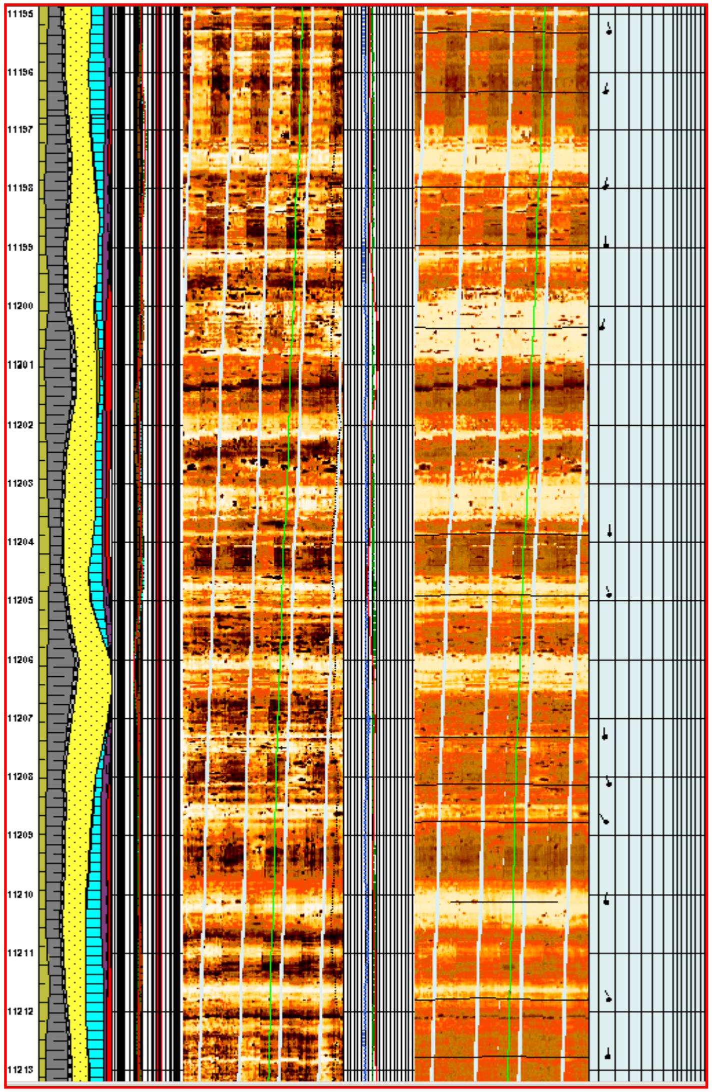
Hunt Plywood | Sustainable 24



- Tectonic fractures 5->10 ft high

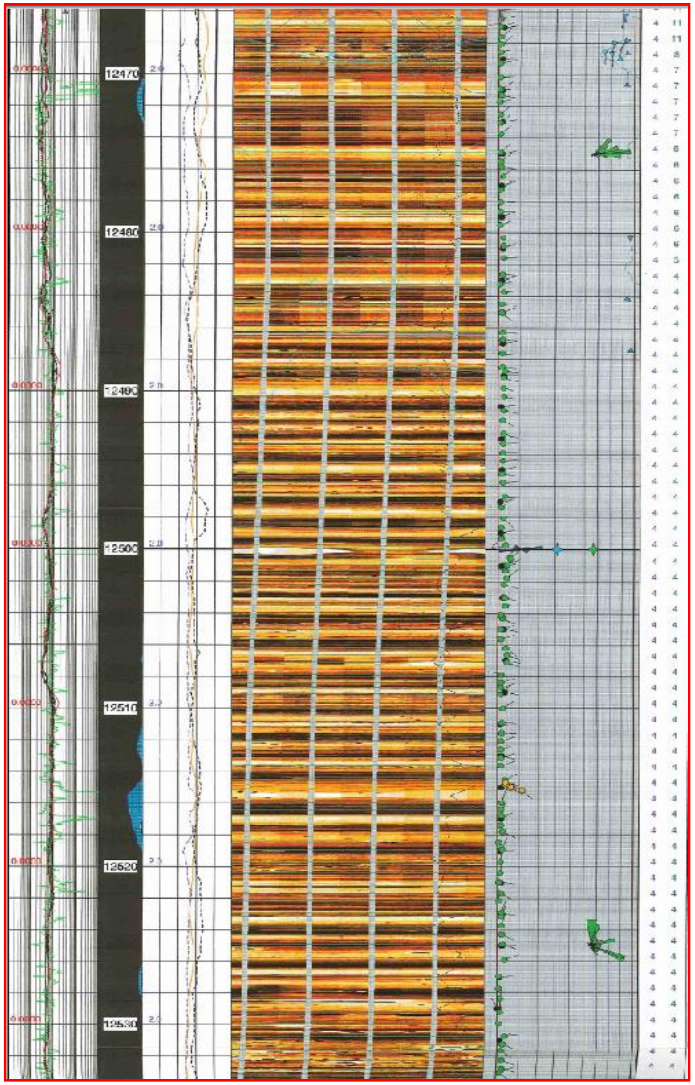
Fracture Observations (or Lack of): Haynesville

Elm Grove Plantation 63



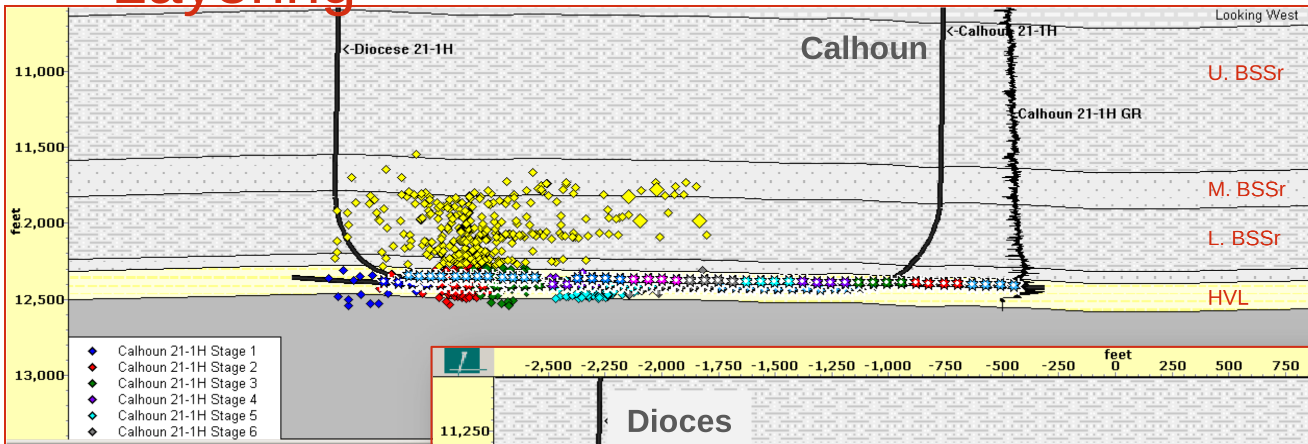
5 ft

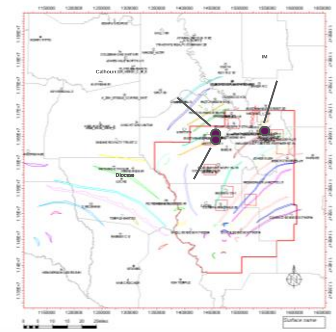
Adcock 2

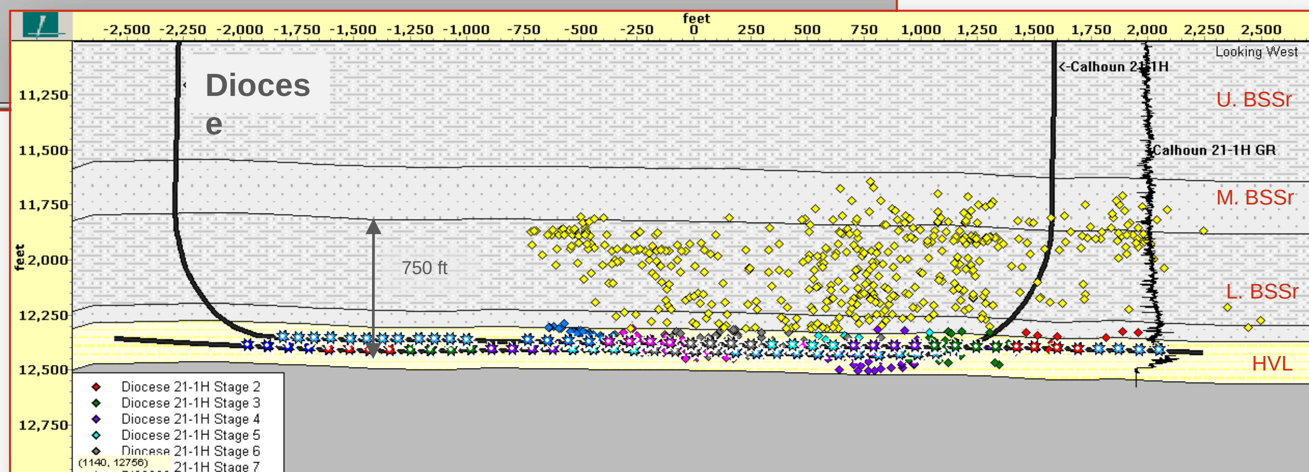


5 ft

Micro-seismic: Evidence of Fracturing & Mechanical Layering

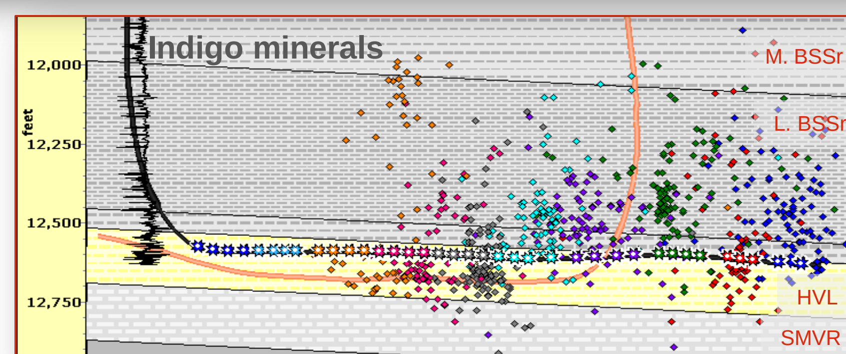






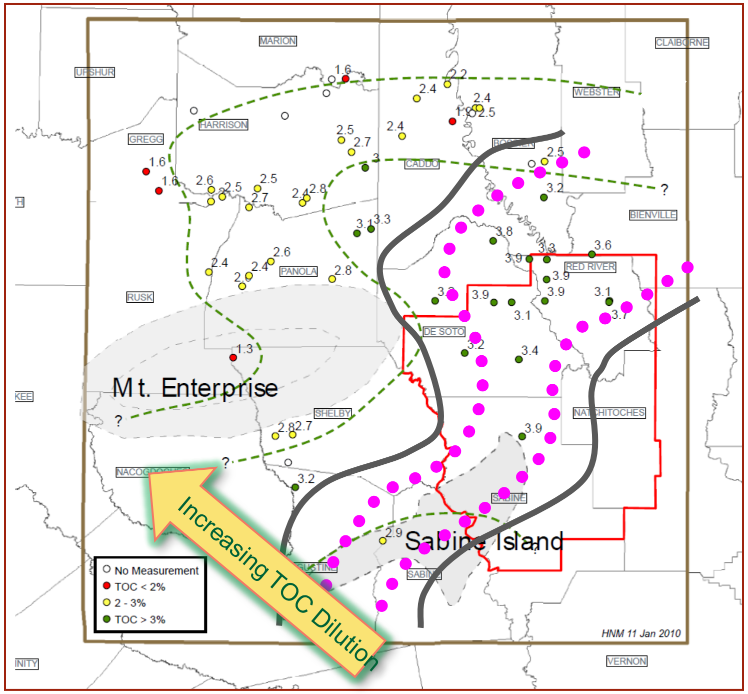
Event in L. Bossier

Events per Frac Stages



- > 60% of events in L. Bossier
- Events recorded 750’ high.
- M. BSSR is a Frac Barrier

Current Model and Understanding

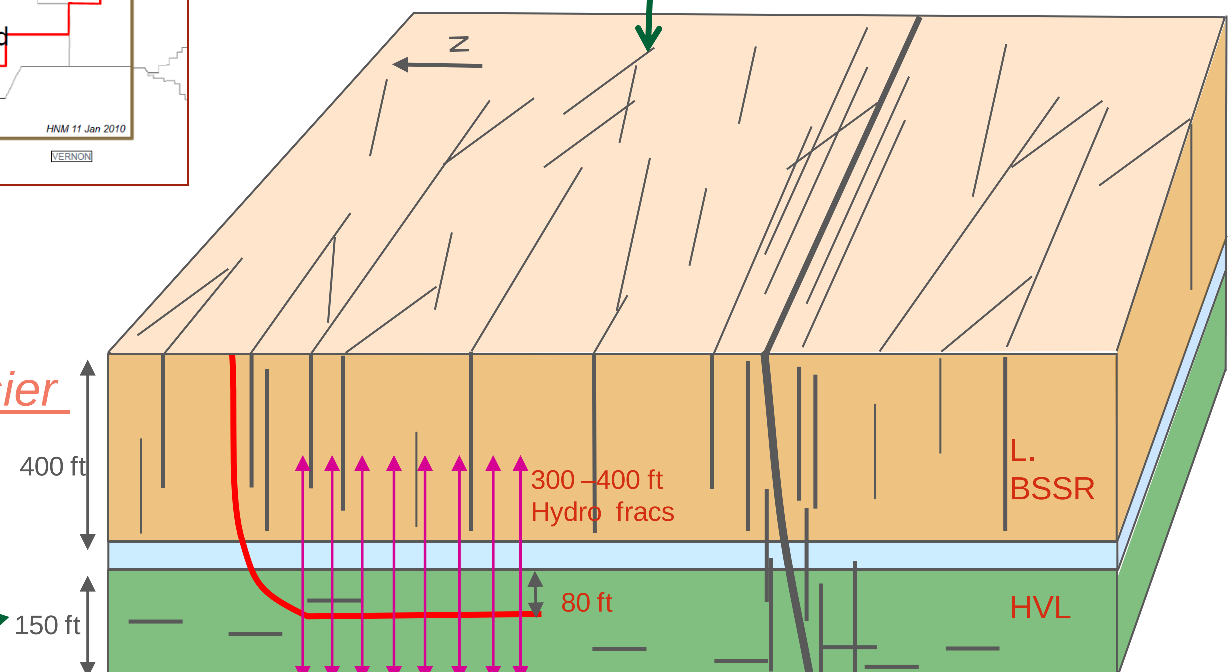


Upper & Lower Bossier

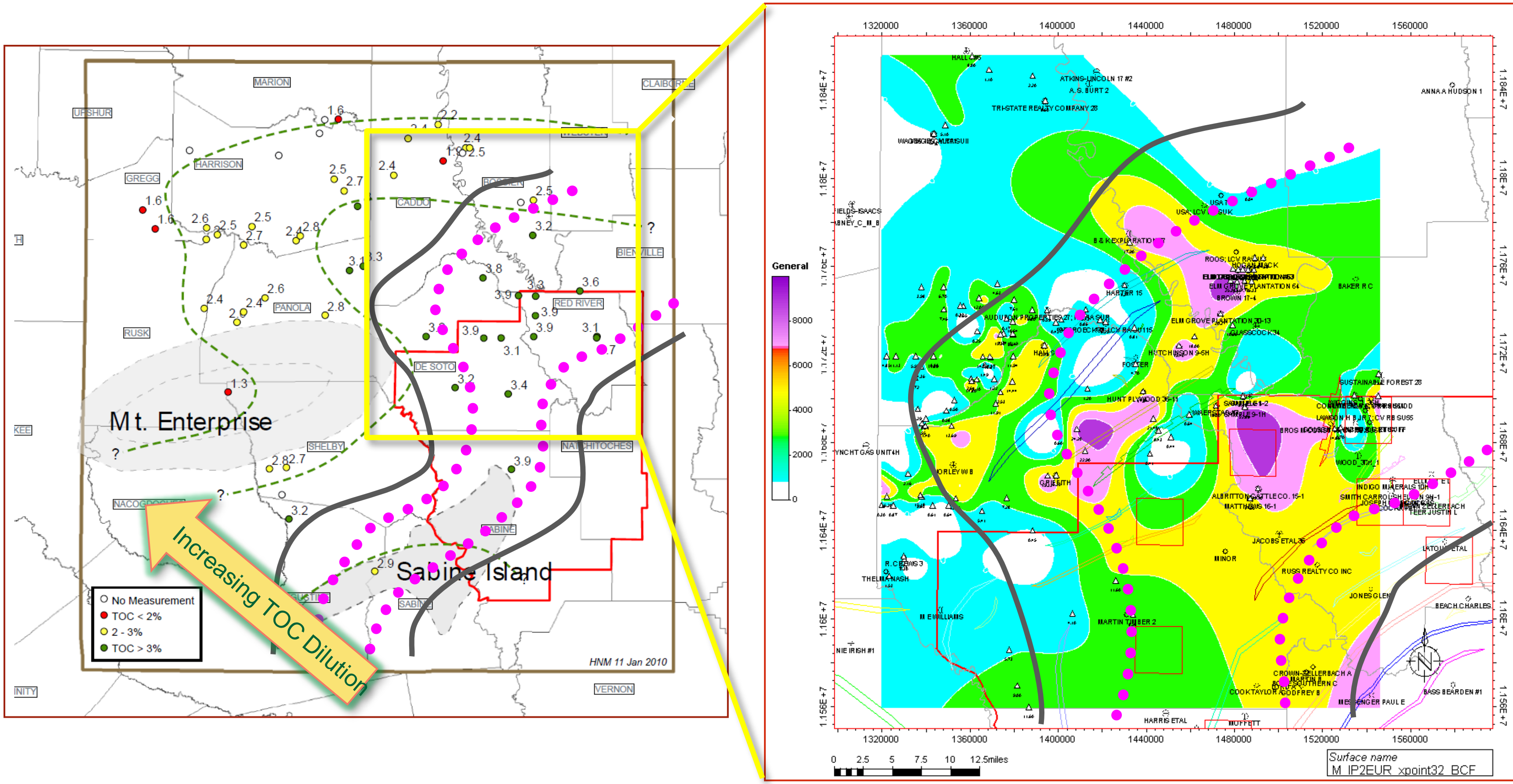
- High Fracture density
- Thick section (400 ft)
- Low TOC

Haynesville & Middle Bossier

- No or rare fractures
- Thinner section (150 ft)
- High TOC

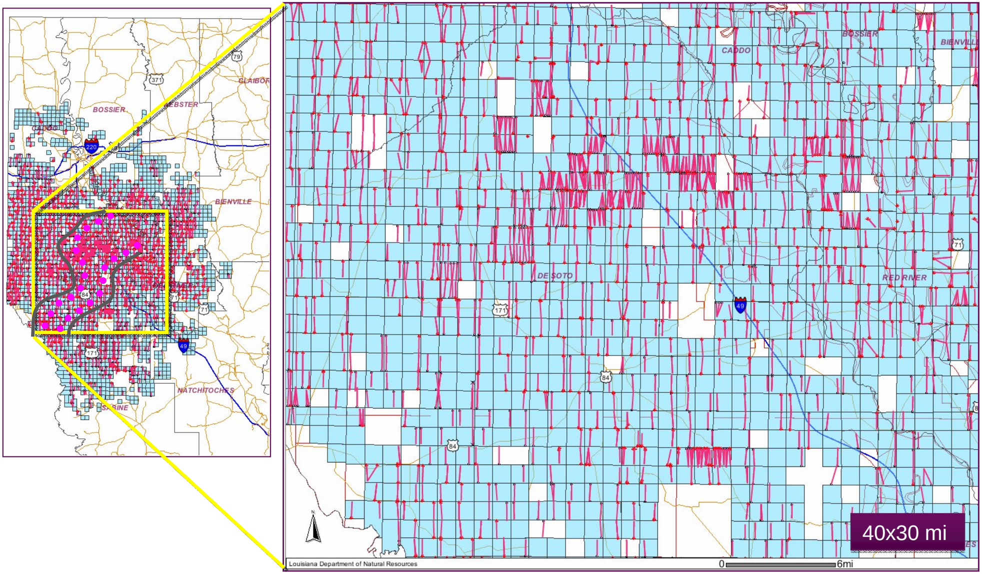


Comparison of Haynesville “Fair Way” With IPs



- From a play perspective, there is a good Correlation between IP and TOC / High GR member of the Haynesville.

How Much Detail To Predict Well by Well EUR?

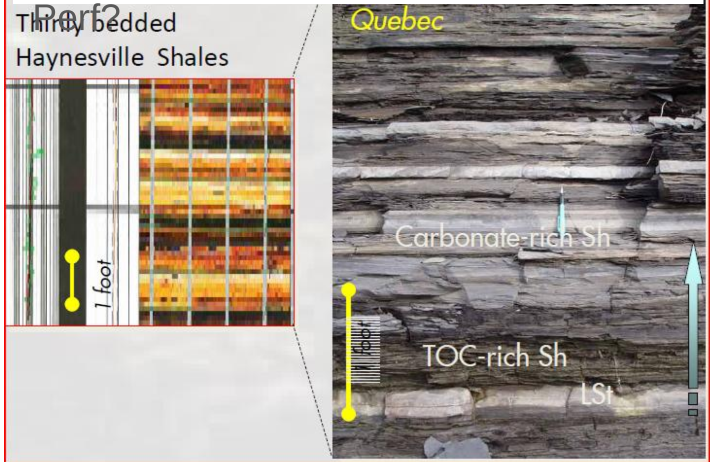


http://sonris.www.dnr.state.la.us/

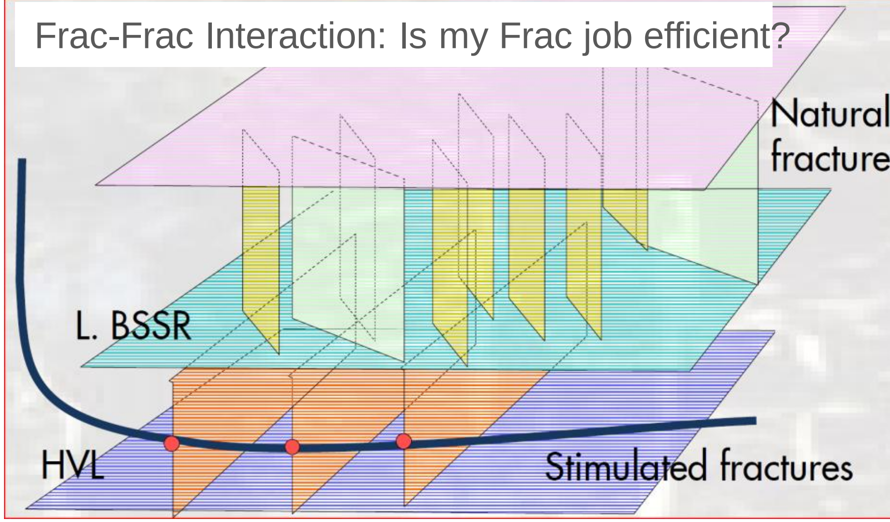
Presenter's notes: On this map, the blue squares represent the Haynesville Shale's proposed or adopted drilling and production units. Together, they cover 1.5 million acres. That is not including the Texas side. Considering a development spacing of 160 acres per well, that is nearly 90-95k wells, of which only 2000 are drilled.

Some Development Optimization Challenges…..

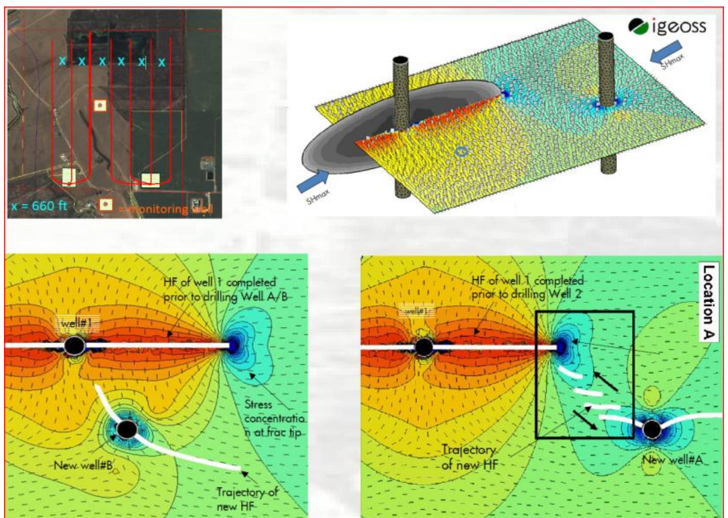
Compositional Variations: Where to Perf?

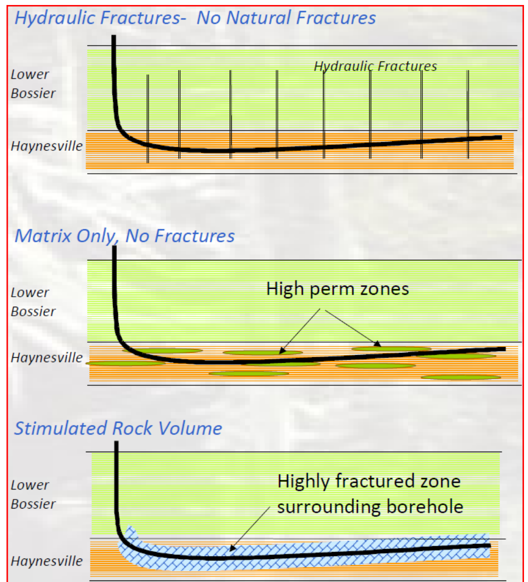


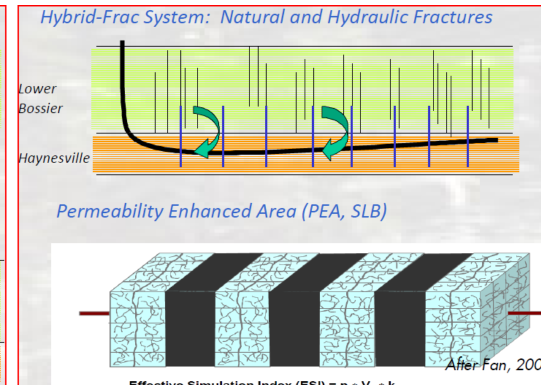
Frac-Frac Interaction: Is my Frac job efficient?



Local stresses: Well & frac optimization







Modeling Shales:
Simulation and EUR prediction
Where does the gas come from?