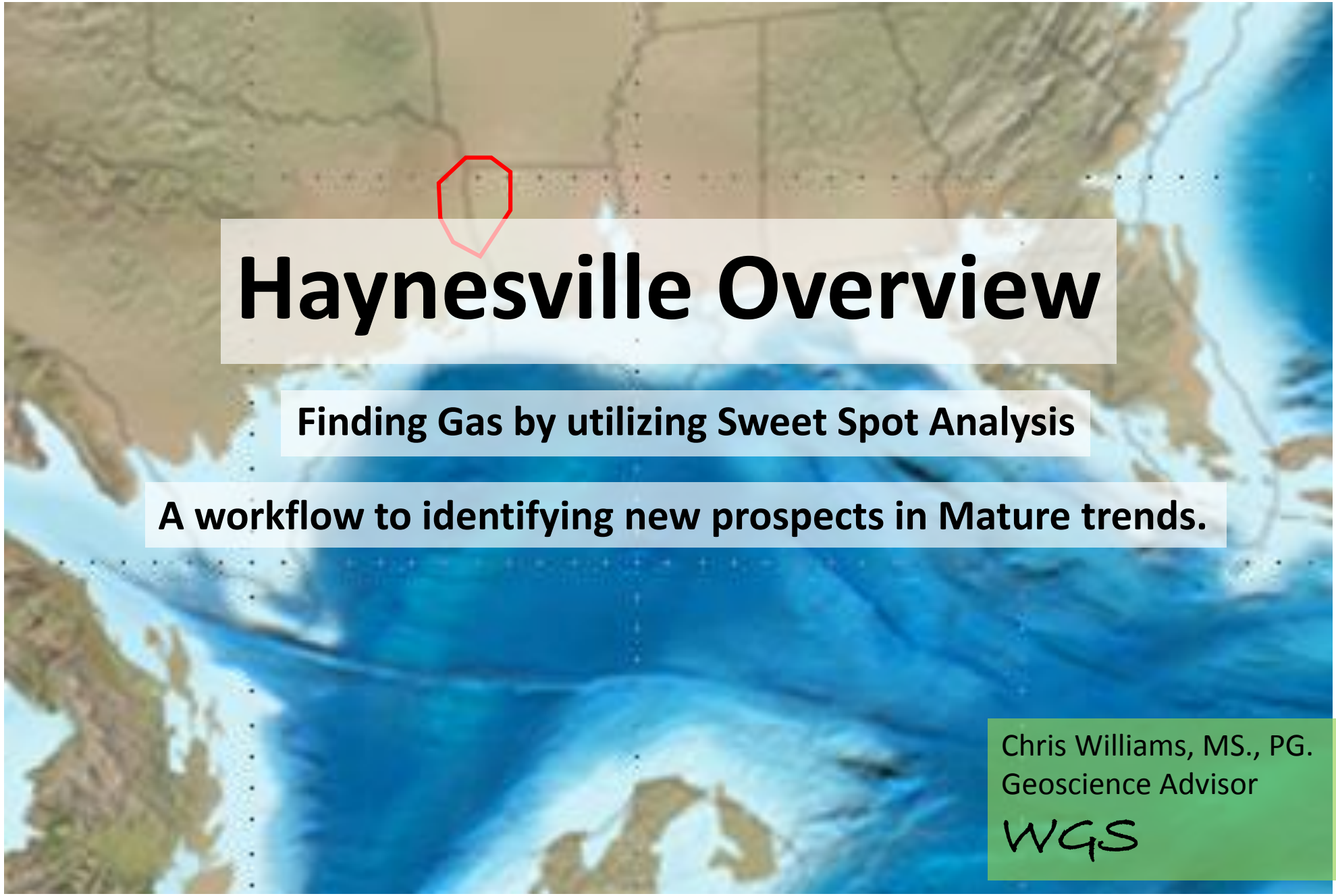


Haynesville Overview

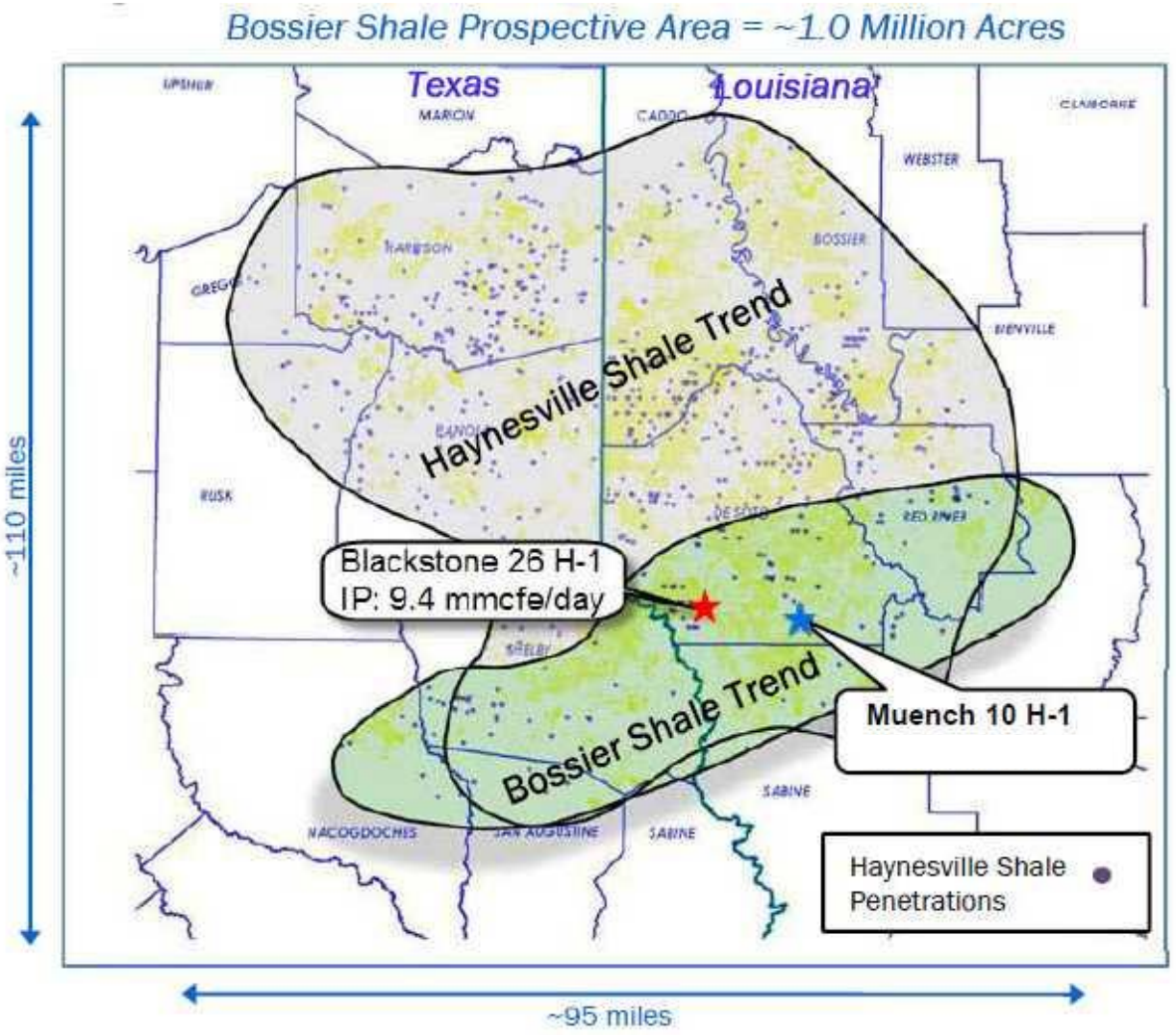
Finding Gas by utilizing Sweet Spot Analysis

A workflow to identifying new prospects in Mature trends.

Chris Williams, MS., PG.
Geoscience Advisor
WGS

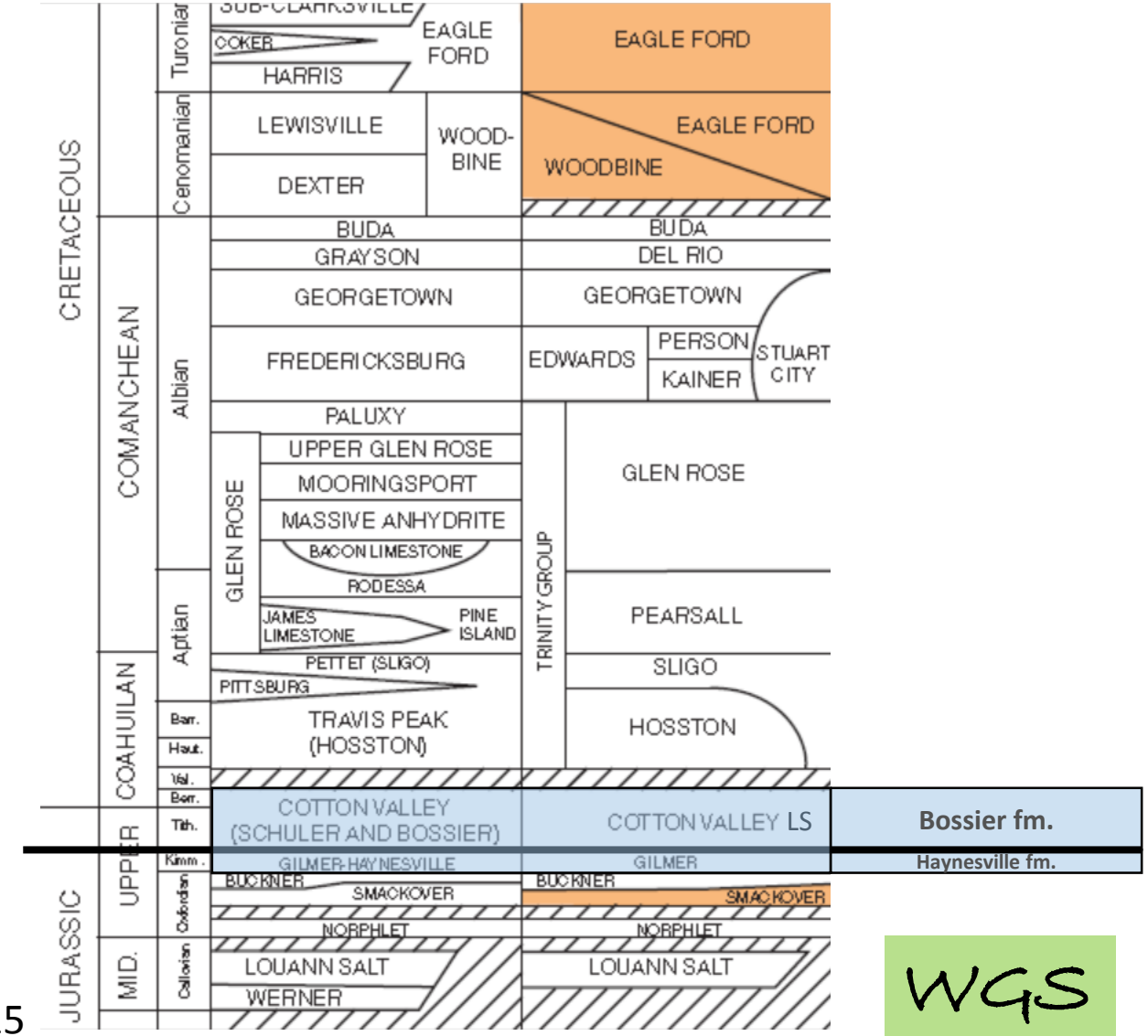
Haynesville Overview

Overview Study Area



Stratigraphic Column

Jurassic Period - Oxfordian – Kimmeridgian Age (163.5 – 152.1 MYA)



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Haynesville Overview

Haynesville Shale Characteristics

	Haynesville Shale	Bossier Shale
Depth TVD	10,500’ – 13,500’	500’ – 800’ shallower than Haynesville
MD (horizontals)	14,500 – 18,000’	
Thickness (net)	150’ – 350’	175’ - 325’
Total Organic Carbon (TOC)	2% - 5%	2% - 5%
Ave. Porosity (log)	8% - 10%	8% - 10%
Gradient (Psi/Ft)	0.84	0.84
Water Saturation	15% - 20%	15% - 20%
Gas in place/bcfe/section	150 – 250	150 – 200
Anticipated recover factor	25% - 30%	25% - 30%
Estimated Ultimate Recovery	3 to 12 Bcf per well	

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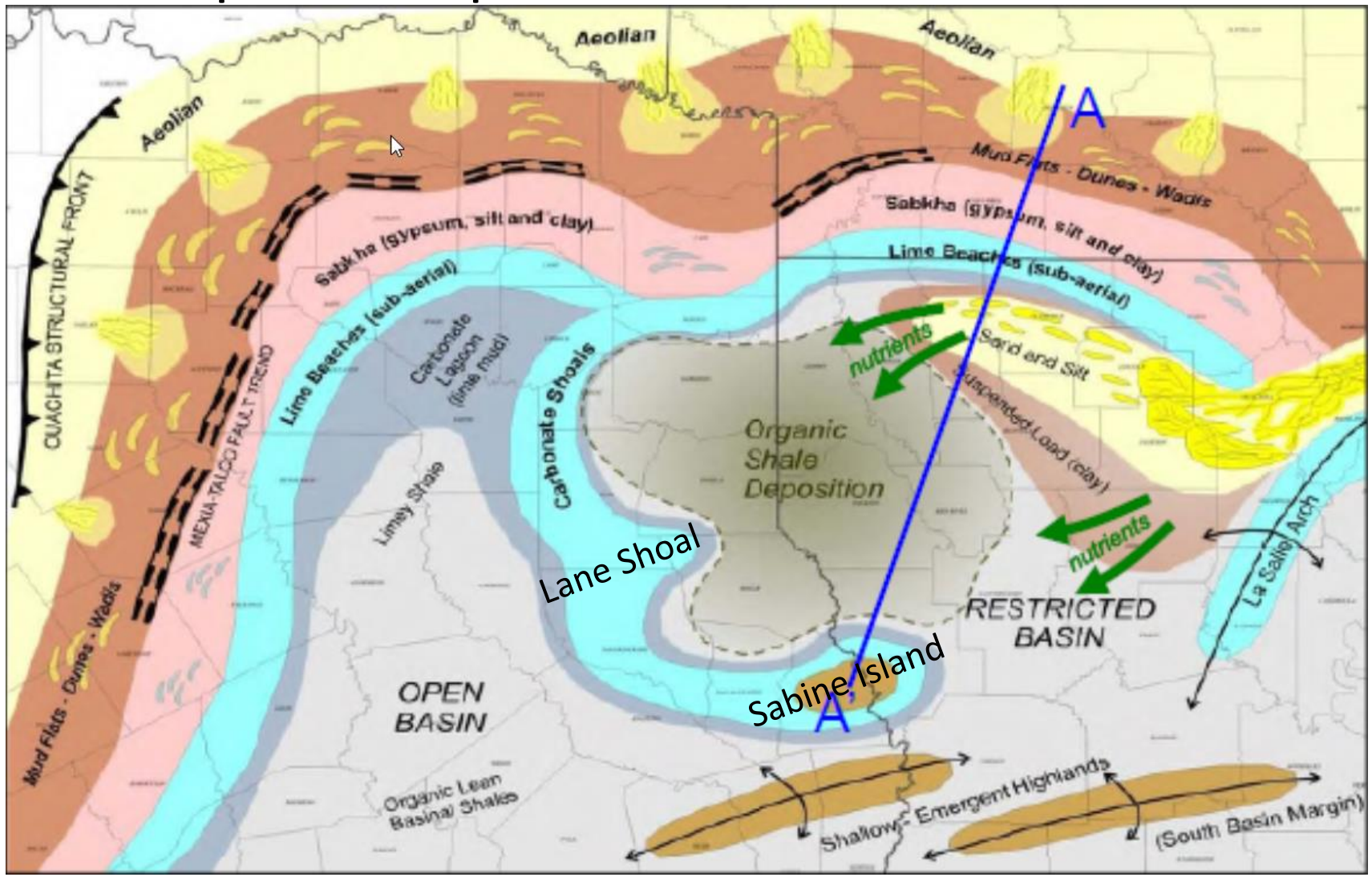
Haynesville Overview

Haynesville – Bossier Shale Depositional Map



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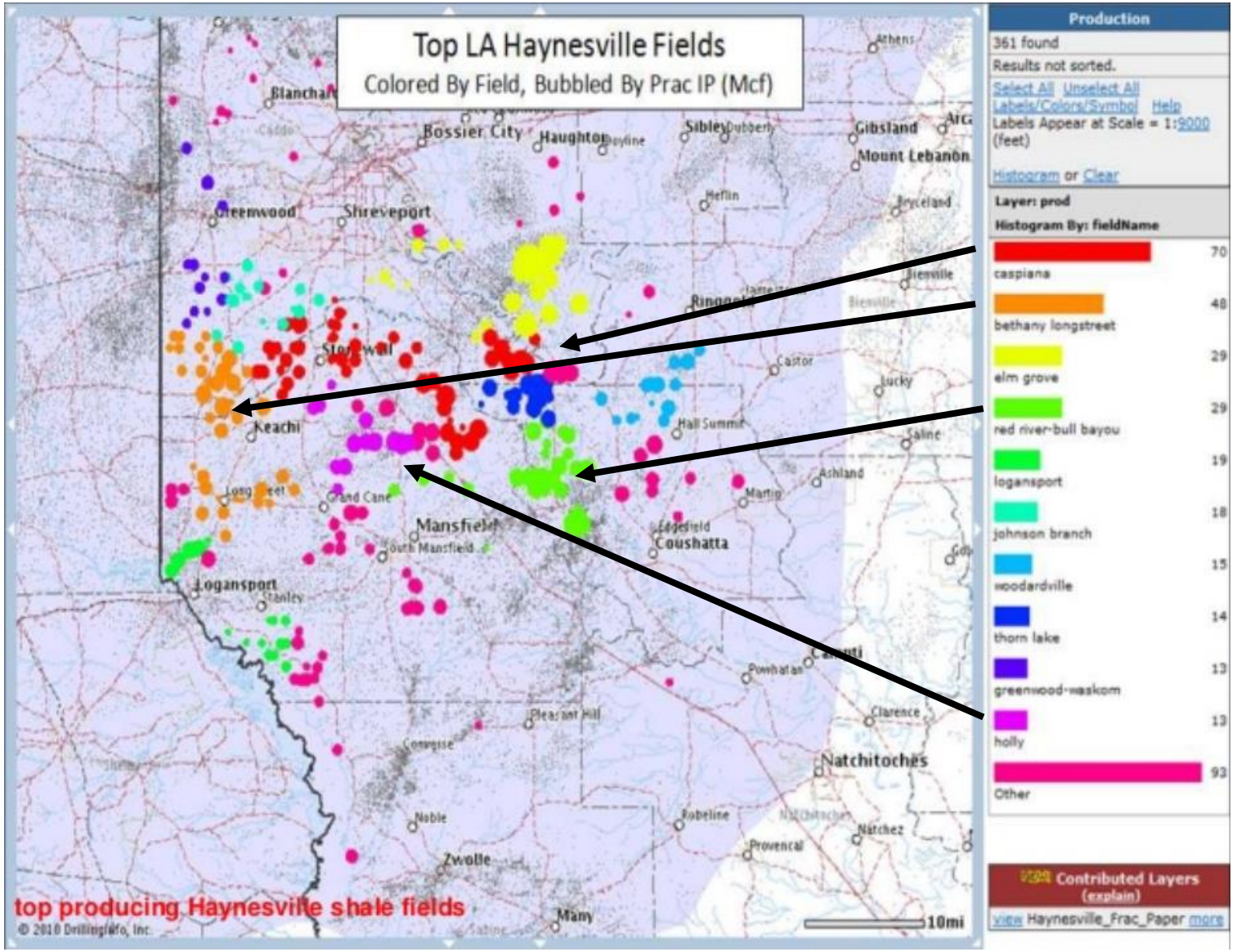
Haynesville Overview

Top Haynesville Fields in Louisiana

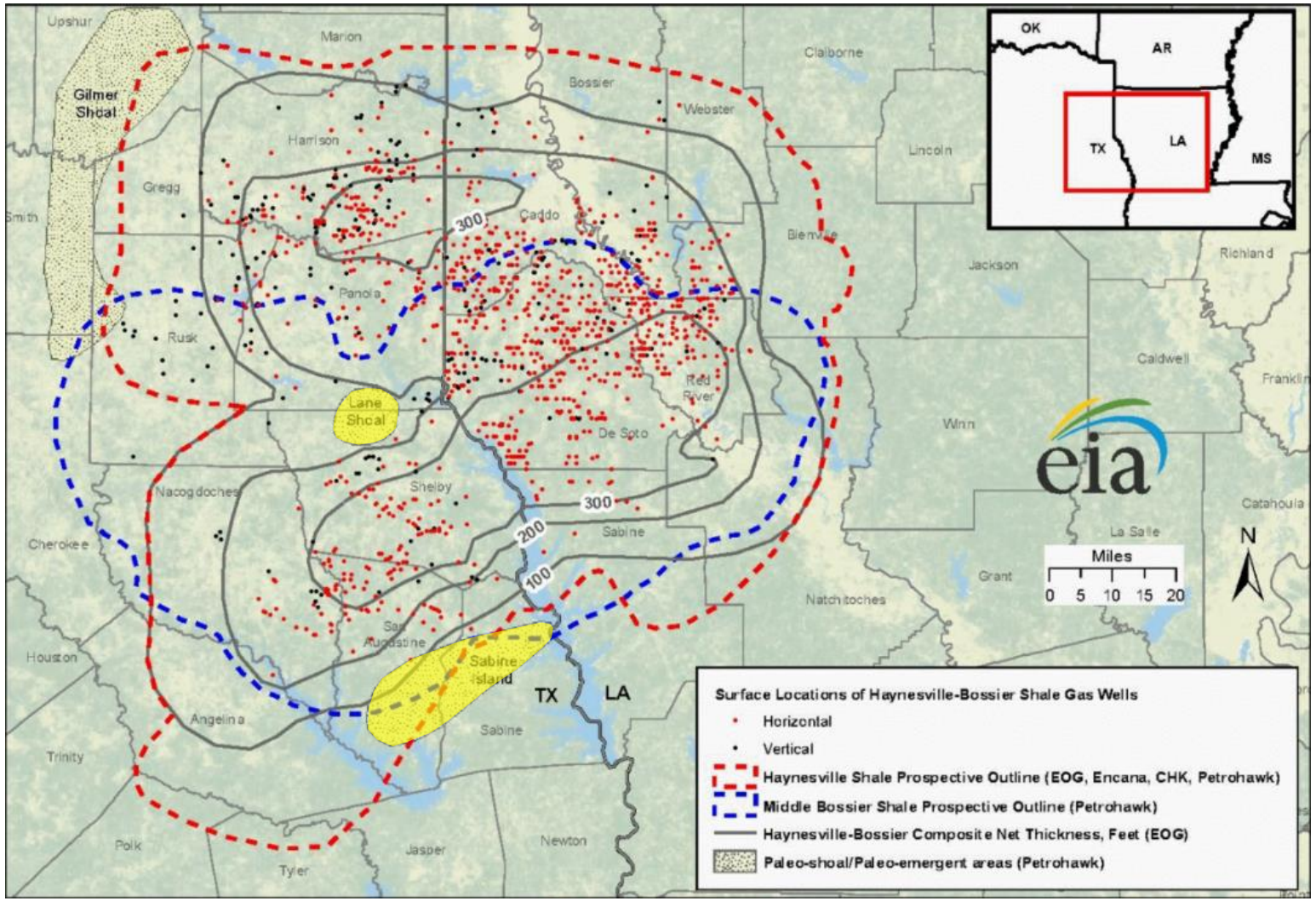


DrillingInfo, 2010

- Caspiana
- Bethany Longstreet
- Elm Grove
- Red River – Bull Bayou
- Logansport
- Johnson Branch
- Woodardville
- Thorn Lake
- Greenwood – Vaskom
- Holly

Haynesville Overview

Haynesville – Bossier Shale Thickness Map



Haynesville Basin Outline
Thickness 150’ – 350’

Bossier Basin Outline
Thickness 175’ - 325’

Paleo Shoals (Lane Shoal and Sabine Island) controlling local depositional patterns

Energy Information Administration based on data from HPDI, TX Railroad Commission, LA Dept. of Natural Resources, Operators. May 26, 2011

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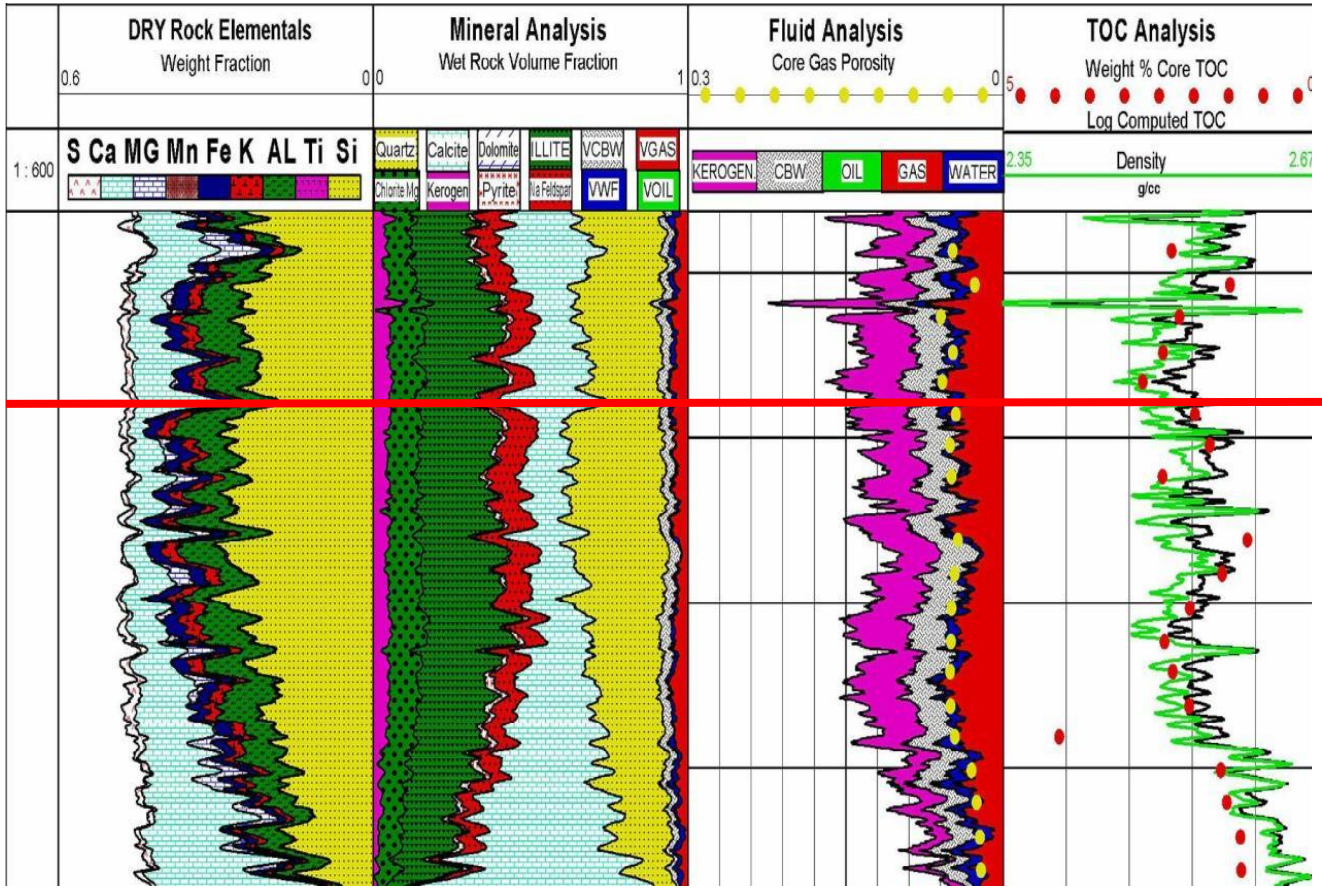
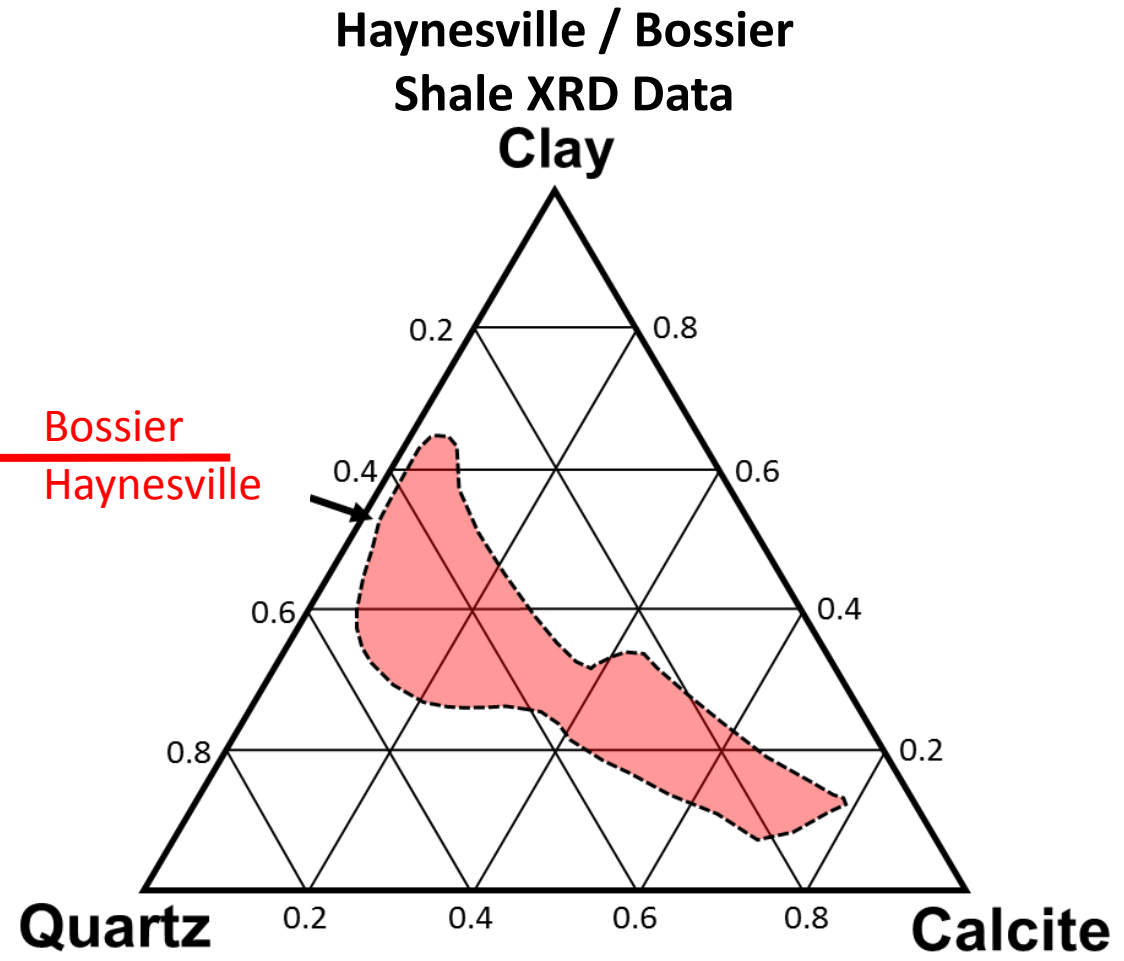
Haynesville Overview

Geochemical Composition



Bossier

Haynesville

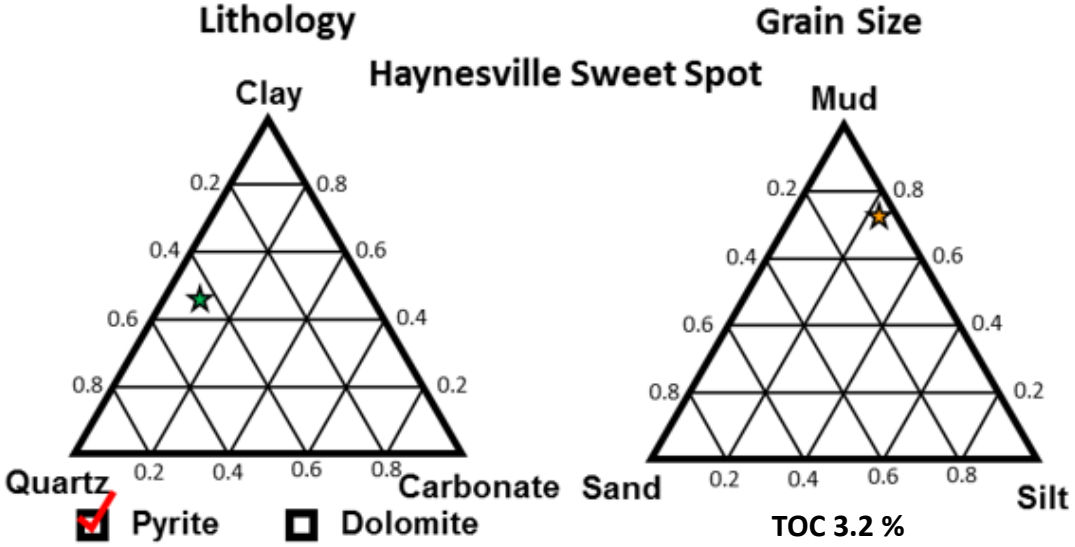


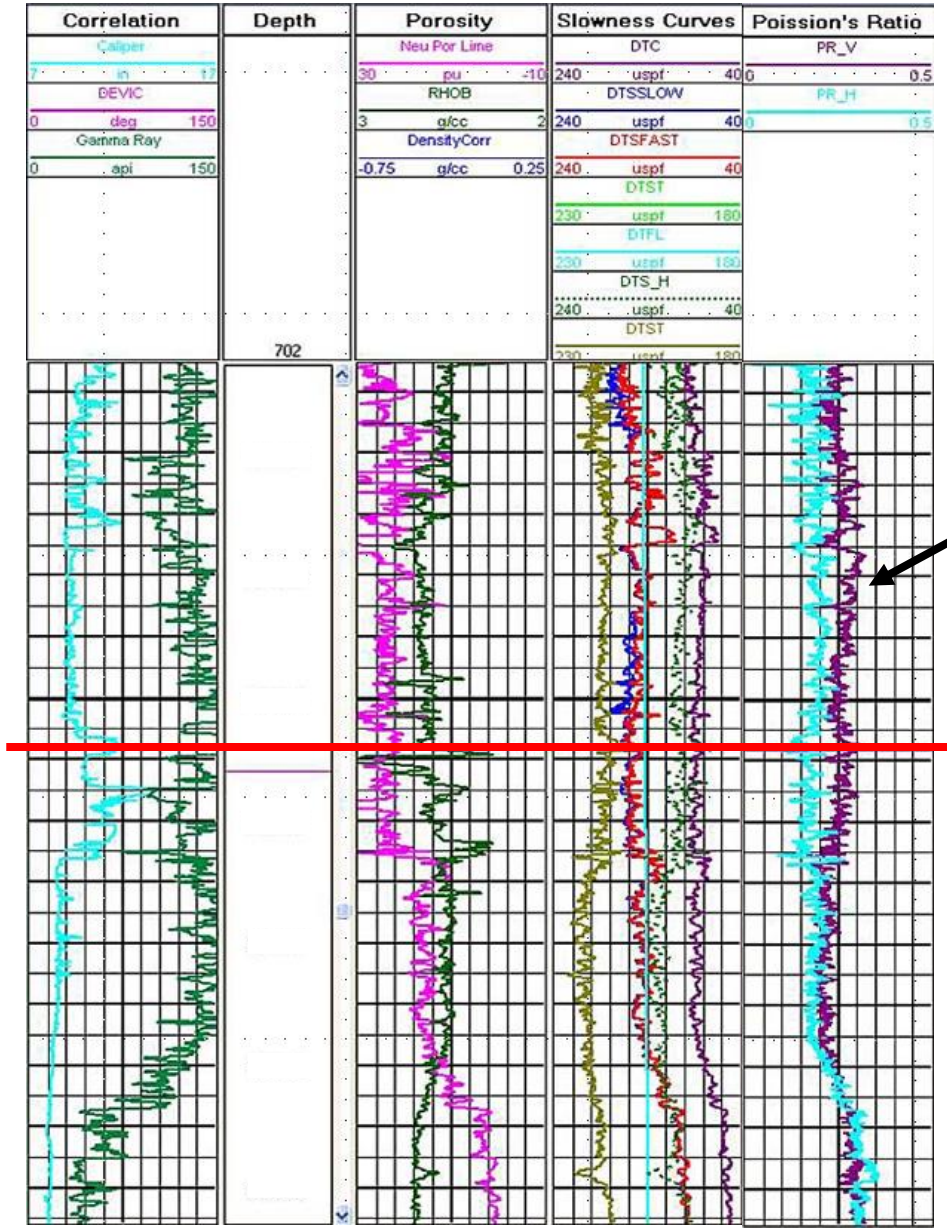
University of Utah, Energy & Geoscience Institute Study, 2015

Haynesville Overview

Key "Sweet Spot" Factors *

1) Micro-Fracturing
2) >3% Total Organic Content
3) 50% Silica Content
4) 10% Carbonate Content
5) Porosity





Anisotropy Effects

Bossier - Haynesville Shale Interface

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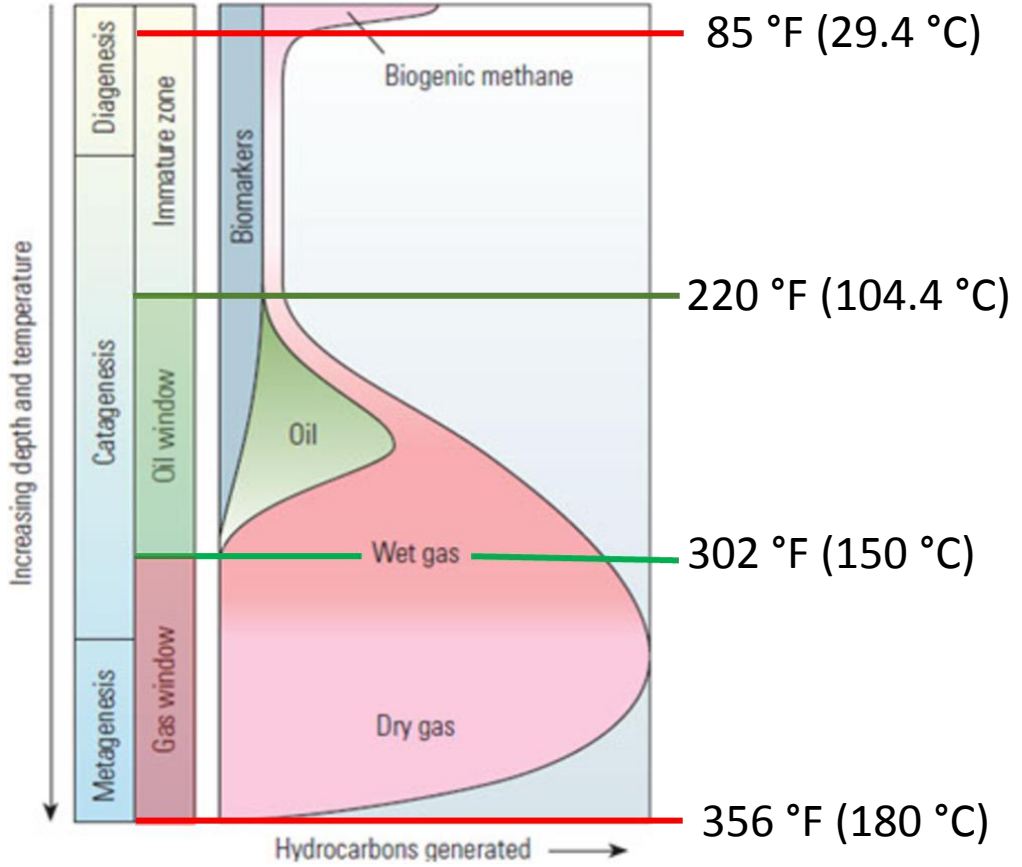
* Beneficial Properties to Map

- Thermal maturity
- Total organic content
- Clay content percentage (and type)
- Bedding thickness
- Porosity
- Concentration of natural fractures (and orientation)
- Brittleness factor
- Fracture initiation pressure (lower the better)
- Water saturation

Thermal Transformation of Kerogen



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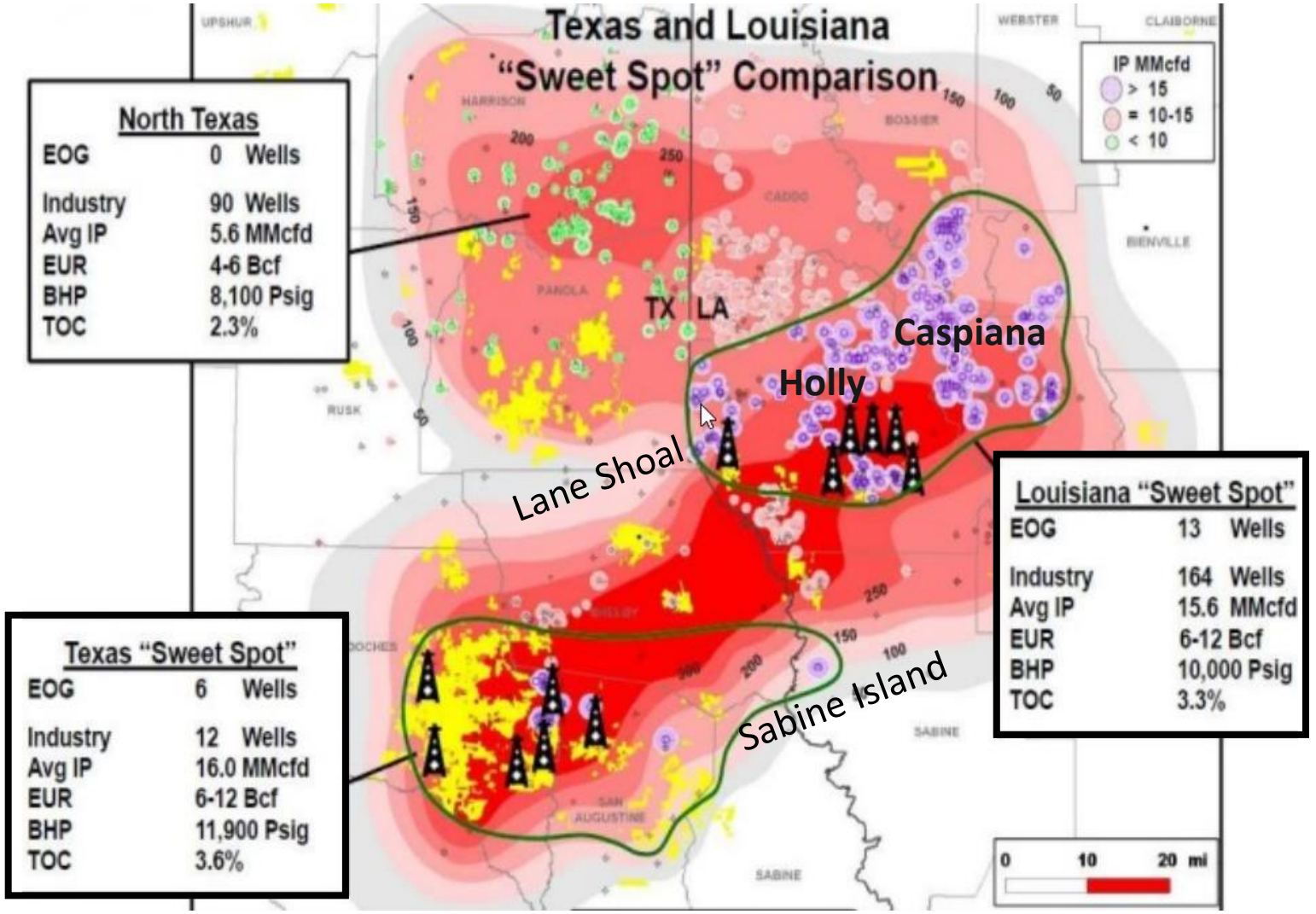
Haynesville Overview

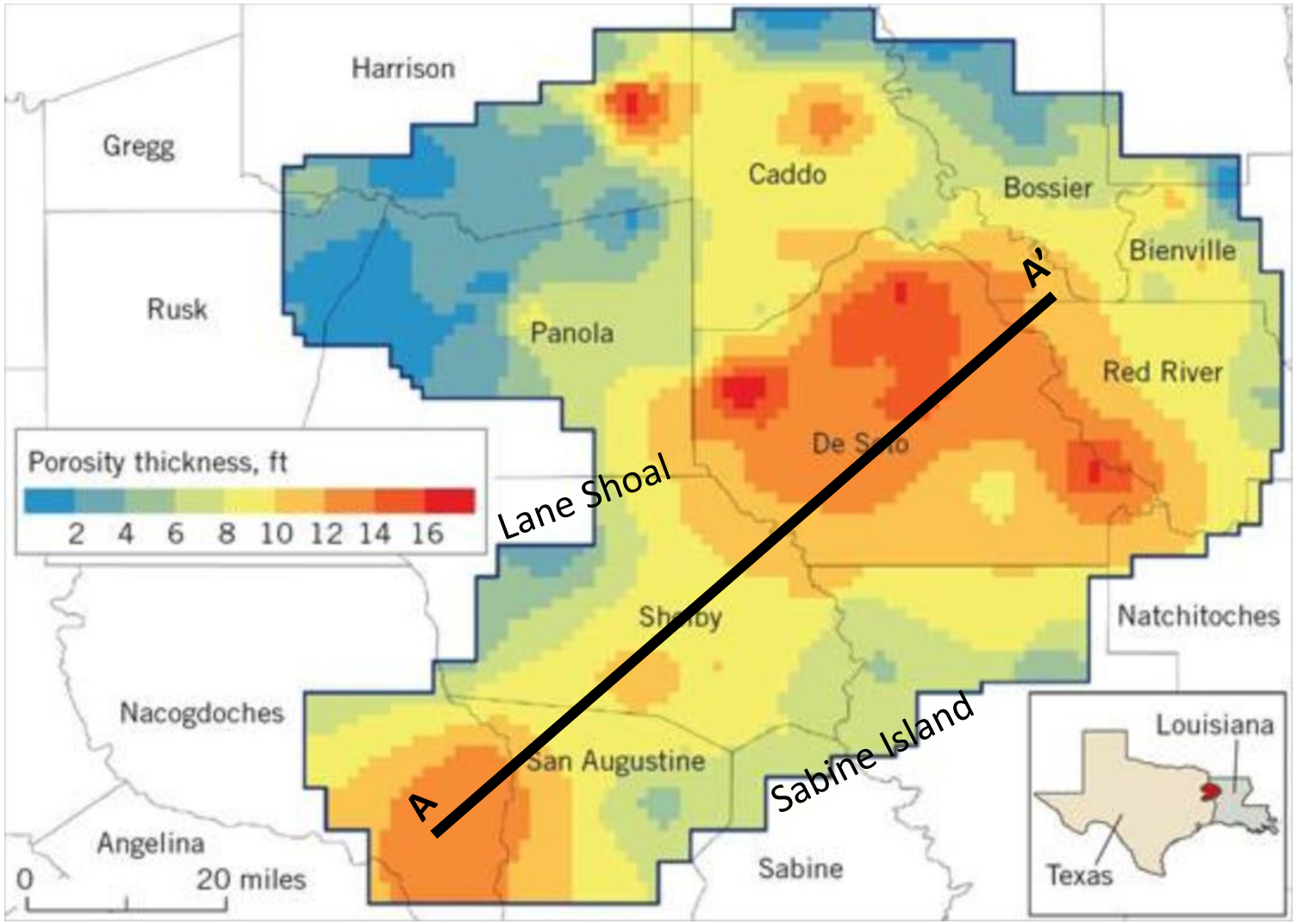
Haynesville Shale “Sweet Spot” Comparison



DrillingInfo, 2010

Haynesville Overview

Geomodeled Porosity, Thickness Map



Bureau of Economic Geology, University of Texas, Austin.

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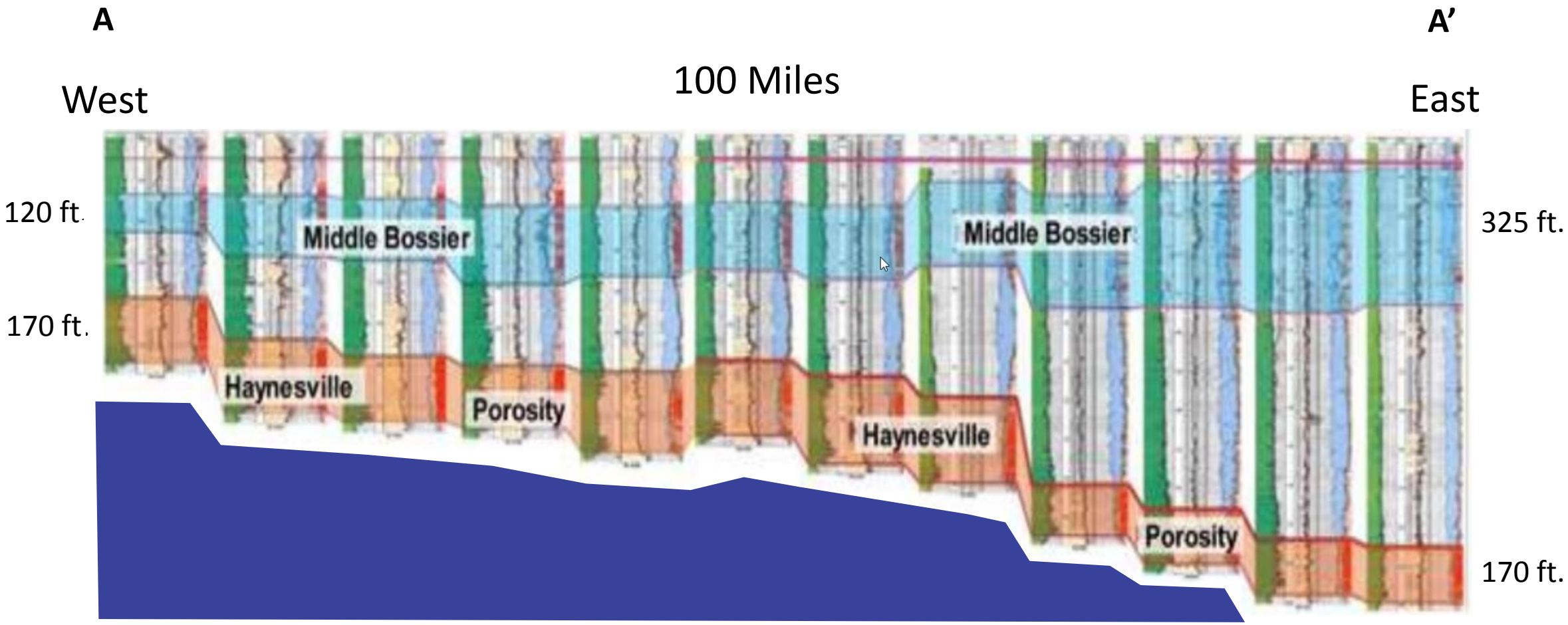
Haynesville Overview

Haynesville Bossier Shales - Depth and Thickness Cross-section



Bureau of Economic Geology, University of Texas, Austin.

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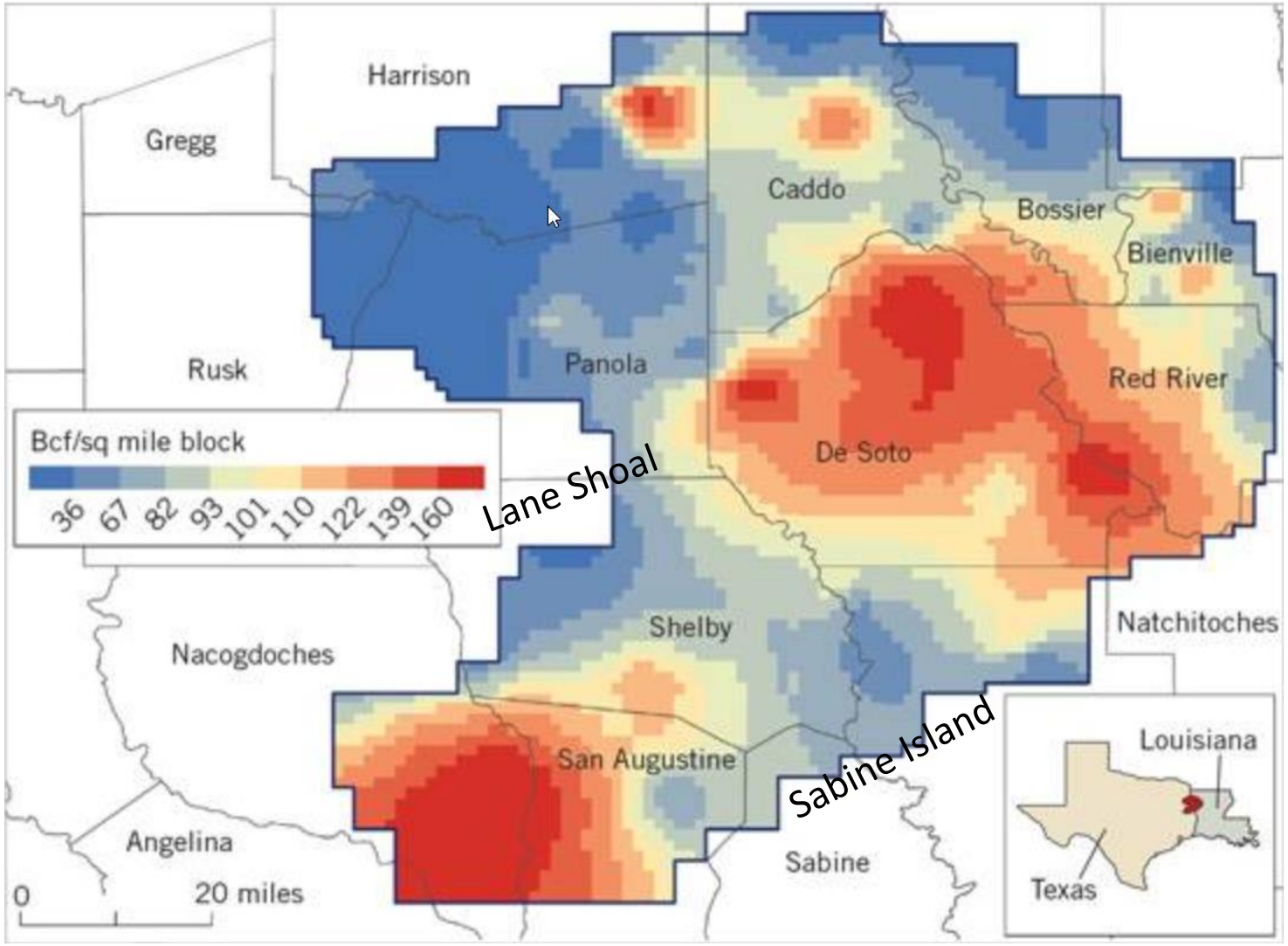
Haynesville Overview

Geomodeled Estimated Ultimate Recovery (EUR)



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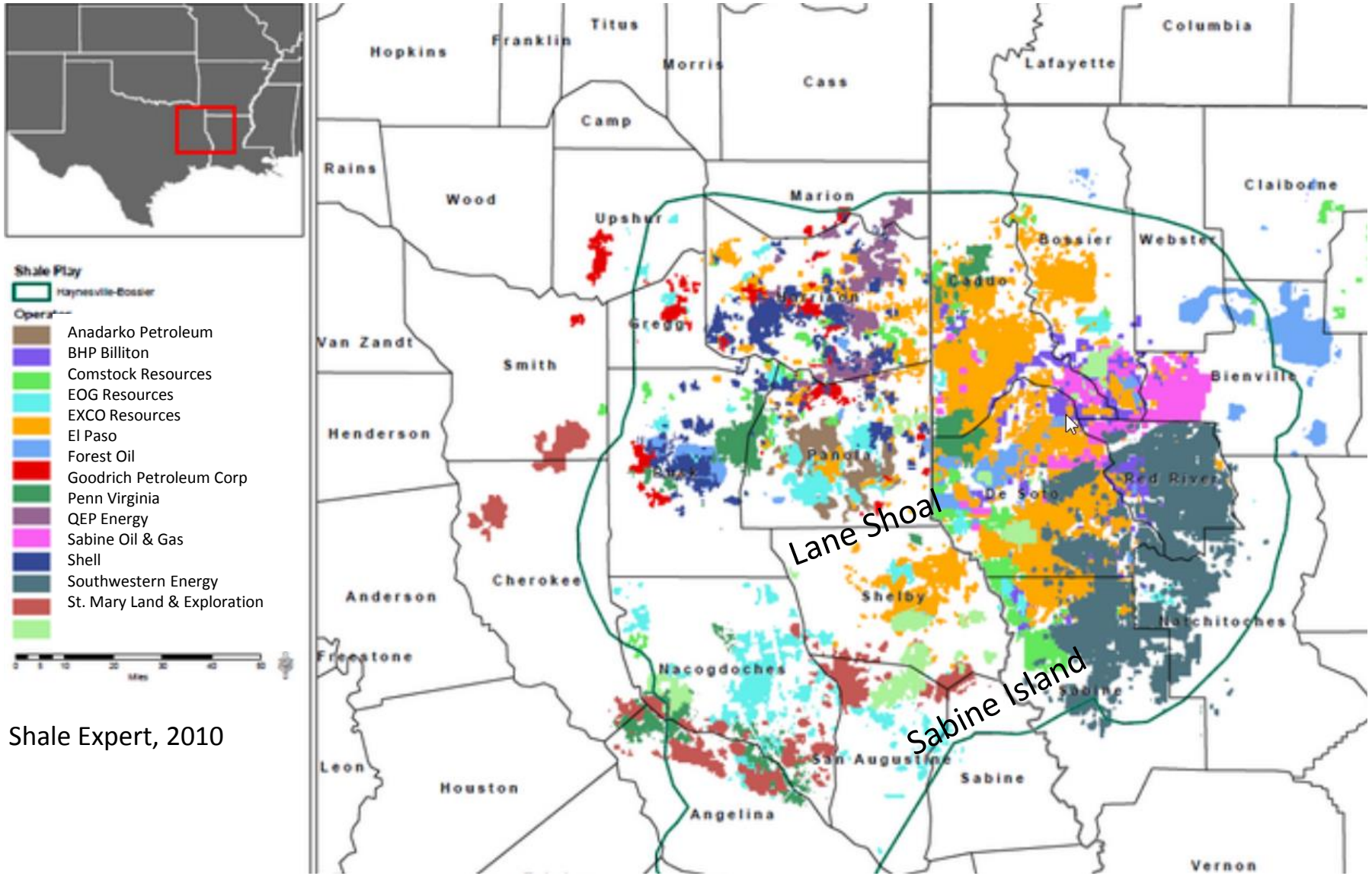
Haynesville Overview

Haynesville Shale, Players Lease Comparison



Shale Expert, 2010

Chris Williams, MS., PG.
Geoscience Advisor
WGS