

^{AV}Preliminary Investigation of the Thermal Maturity of Pearsall Formation Shales in the Maverick Basin, South Texas*

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Abstract

The Aptian Pearsall Formation, a regionally occurring limestone and shale package of 500-600 ft maximum thickness, is being evaluated as part of an ongoing U.S. Geological Survey assessment of undiscovered hydrocarbon resources in onshore Lower Cretaceous strata of the northern Gulf of Mexico. Pearsall Formation units are, in ascending stratigraphic order, the Pine Island Shale, James Limestone, and Bexar Shale members. Currently, Pearsall shales are an active exploration target for independent oil and gas operators in the Maverick basin area of south Texas. Favorable initial gas flow rates from frac-treated horizontal Pearsall wells have been reported; however, to our knowledge there are no public data that document thermal maturity, organic richness, or other reservoir characteristics applicable to unconventional resource characterization.

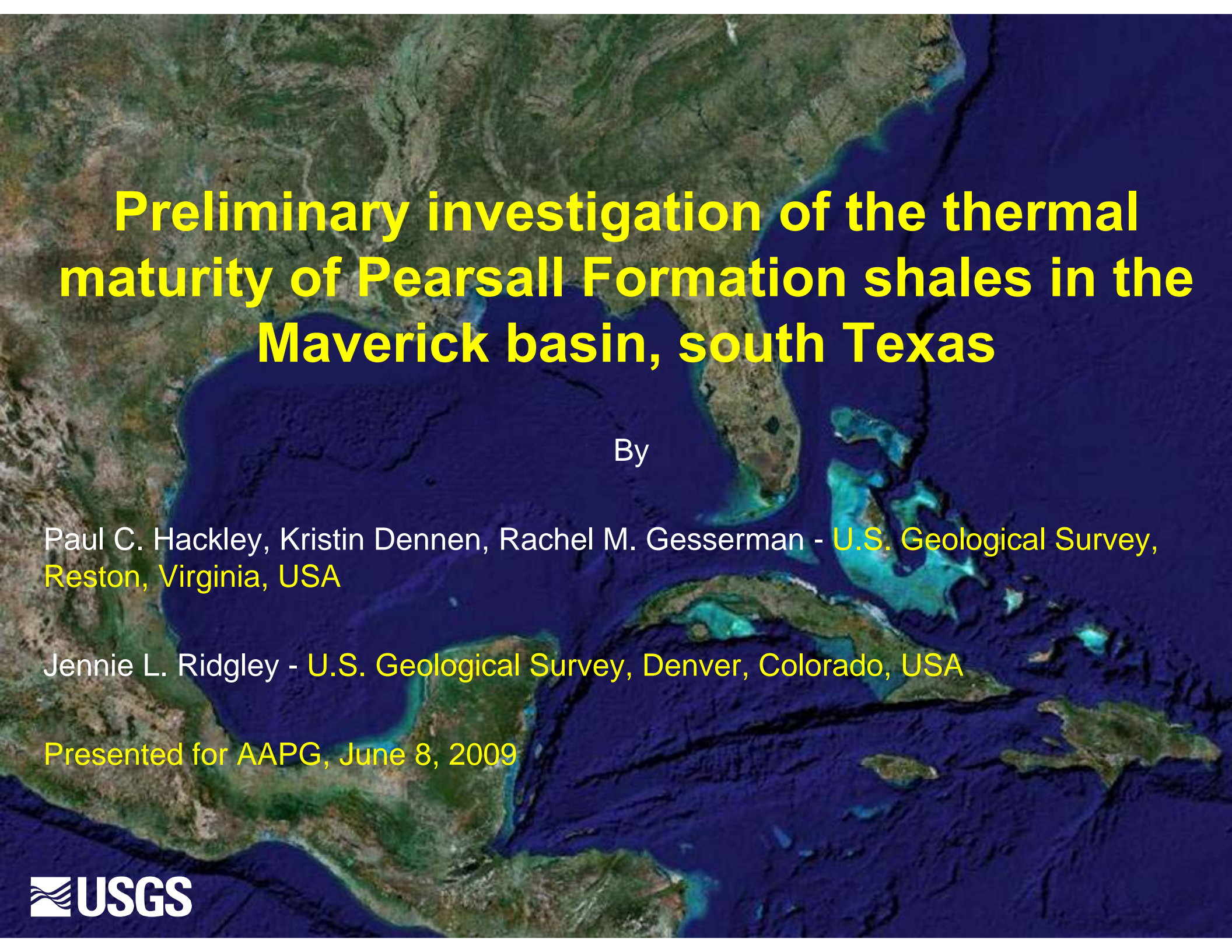
Spontaneous potential-resistivity logs for twenty-six conventional wells in the Maverick basin were evaluated to correlate the stratigraphic positions of Pearsall Formation units. Cuttings and core available from these wells were sampled and prepared for petrographic, geochemical, and other analyses. Samples also were collected from Pearsall equivalent outcrops in western Travis County, Texas, on the San Marcos Arch (the Pearsall does not outcrop in the Maverick Basin).

Evaluation of a preliminary dataset derived from samples of core and cuttings from twelve wells in Maverick County (5100-9000 ft), cuttings from two wells in McMullen County (12,300-15,100 ft), and core from Bee County (15,900 ft) indicates low average total organic carbon (TOC) content of 0.80 wt.% (n=81) for Pearsall calcareous shale and mudstones from the Pine Island and Bexar Shales. The TOC content ranges between 0.17 and 2.97 wt.%. Rock-Eval pyrolysis typically yielded broad or low temperature S2 peaks; therefore, Tmax and calculated Ro values are considered unreliable. Measured Ro values for a sample subset range from 1.5 to 2.3% (n=14), indicating that the samples are in the gas window. Low HI values and petrographic analyses indicate that gas-prone Type III organic matter dominates. Measured Ro values for overlying Upper Cretaceous Austin-Eagle Ford Group source rocks which range from 0.84 to 1.42% (n=7) further support our conclusion that Pearsall shales in the Maverick Basin are mature with respect to gas generation.

References

Blakley, 2005, Paleogeography and geologic evolution of North America: Early Cretaceous--115 Ma:
<http://jan.ucc.nau.edu/~rcb7/namK115.jpg> (accessed June 22, 2009)

Loucks, R.G., 2002, Controls on reservoir quality in platform-interior limestones around the Gulf of Mexico: example from the Lower Cretaceous Pearsall Formation in South Texas: Gulf Coast Association of Geological Societies Transactions, v. 52, p. 659–672.



Preliminary investigation of the thermal maturity of Pearsall Formation shales in the Maverick basin, south Texas

By

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Assessment Review Committee

- **Ron Charpentier**
- **Tim Klett**
- **Rich Pollastro**
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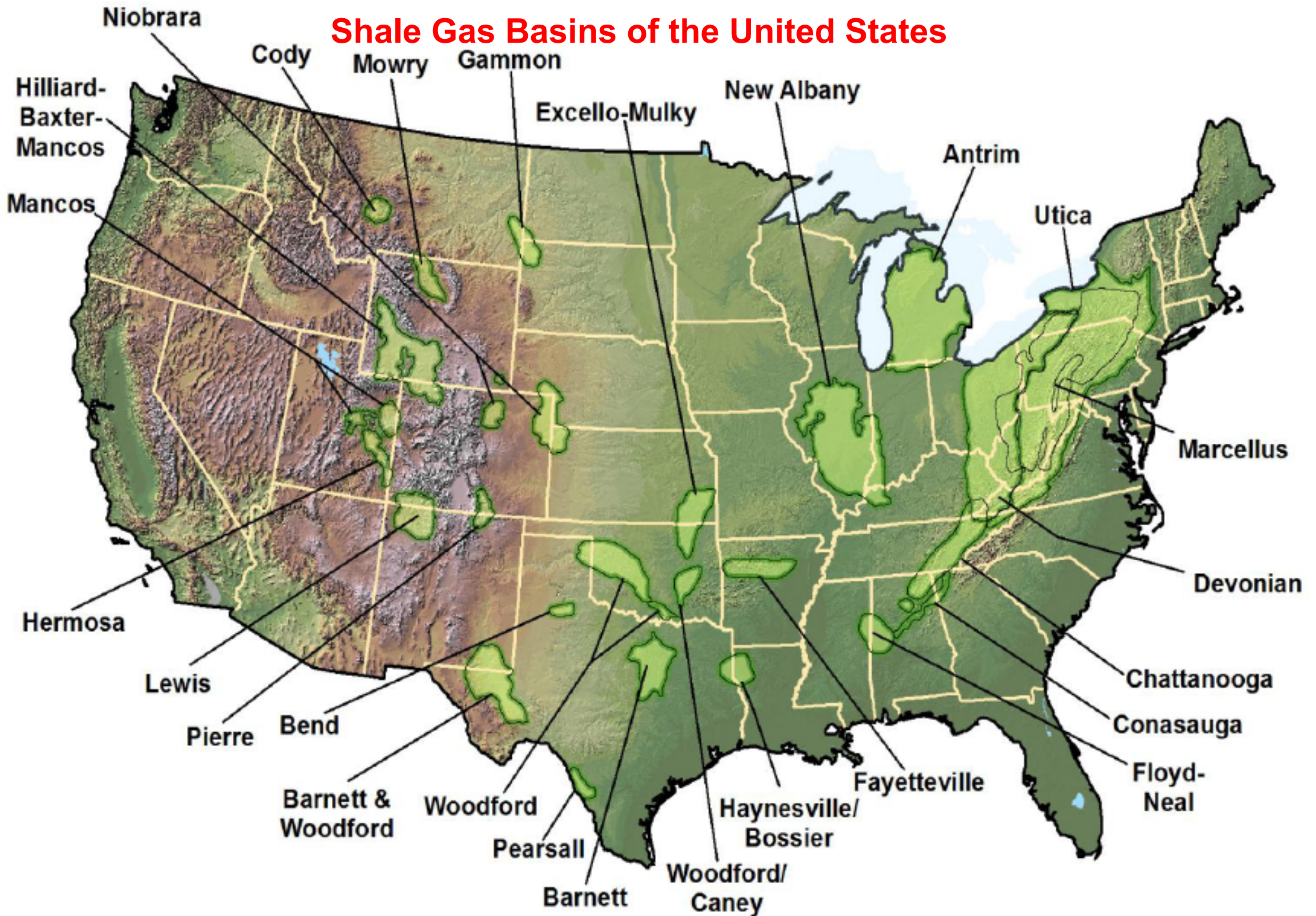
TBEG – Core Research Center

- **James Donnelly**

Outline

- Purpose of Pearsall investigation
- Geology
 - Lower K – Pearsall Formation stratigraphy
 - Maverick Basin carbonate environment
- Methodology: log study, sampling
- Data: TOC, Rock-Eval, vitrinite reflectance
- Conclusions and future directions

Shale Gas Basins of the United States



Purpose of Pearsall Investigation

- Industry reports indicate Pearsall Formation is an important future gas shale resource play in Maverick Basin area.
- Should USGS consider the Pearsall as an unconventional assessment unit in the current Gulf Coast assessment of undiscovered oil and gas resources? **YES.**
- Therefore, data are needed to characterize the reservoir: What is the regional distribution and thickness? **TOC? Thermal maturity?** Mineralogy? Porosity-permeability?

Geology

Geology: Stratigraphy

PERIOD	EPOCH	AGE	GROUP OR FORMATION	GAS	OIL	POT. SOURCE ROCK		
						Shale	Coal	
QUAT.	Holo.							
	Plei.	Calabrian	Undifferentiated	▲	●			
TERTIARY	NEOGENE	Piacenzian	Undifferentiated	▲	●			
		Zanclean						
		MIOCENE	Messinian	Fleming Fm.	▲	●		
			Tortonian					
	Serravallian							
	Langhian							
	PALEOGENE	OLIGOCENE	Chattian	Anahuac Fm. Catahoula Fm. Frio Fm.	▲	●		
			Rupelian	Vicksburg Grp.	▲		■	
		EOCENE	Priabonian	Jackson Grp.		●	■	★
			Bartonian	Claiborne Grp.	▲	●	■	★
Lutetian								
Ypresian			Wilcox Grp.	▲	●	■	★	
PAL.	Thanetian	Midway Grp.	▲		■			
	Selandian							
		Danian						
CRETACEOUS	UPPER	Maastrichtian	Wabigoon (Olmos-Escondido)	▲	●		★	
		Campanian	Taylor (Anacacho/ San Miguel/ Ozan/Annona)	▲	●	■		
		Santonian	Austin/Tokio/ Eutaw	▲	●	■		
		Coniacian						
	LOWER	Turonian	Eagle Ford Fm. Woodbine/Tuscaloosa	▲	●	■	★	
		Cenomanian	Washita (Buda)	▲				
			Fredricksburg (Edwards/Paluxy)	▲	●			
			Glen Rose (Rodessa)	▲	●	■		
		Albian	Pearsall Fm.	▲	●	■	?	
		Aptian	Sligo (Pettet)					
Barremian	Hosston (Travis Peak)	▲	●	■	★			
Hauterivian								
Valanginian								
Berriasian	Cotton							
JURASSIC	UPPER	Tithonian	Valley	▲		■		
		Kimmeridgian	Haynesville/ Gilmer	▲	●	■		
		Oxfordian	Smackover Norphlet	▲	●	■	★	
	MID.	Calloviaian	Louann Salt Wenger					
		Bathonian						
L.	Hettangian							
TRIA.	UP.	Rhaetian	Eagle Mills			■		
	Norian							
	Carnian							

Gulf Tertiary Assessment complete

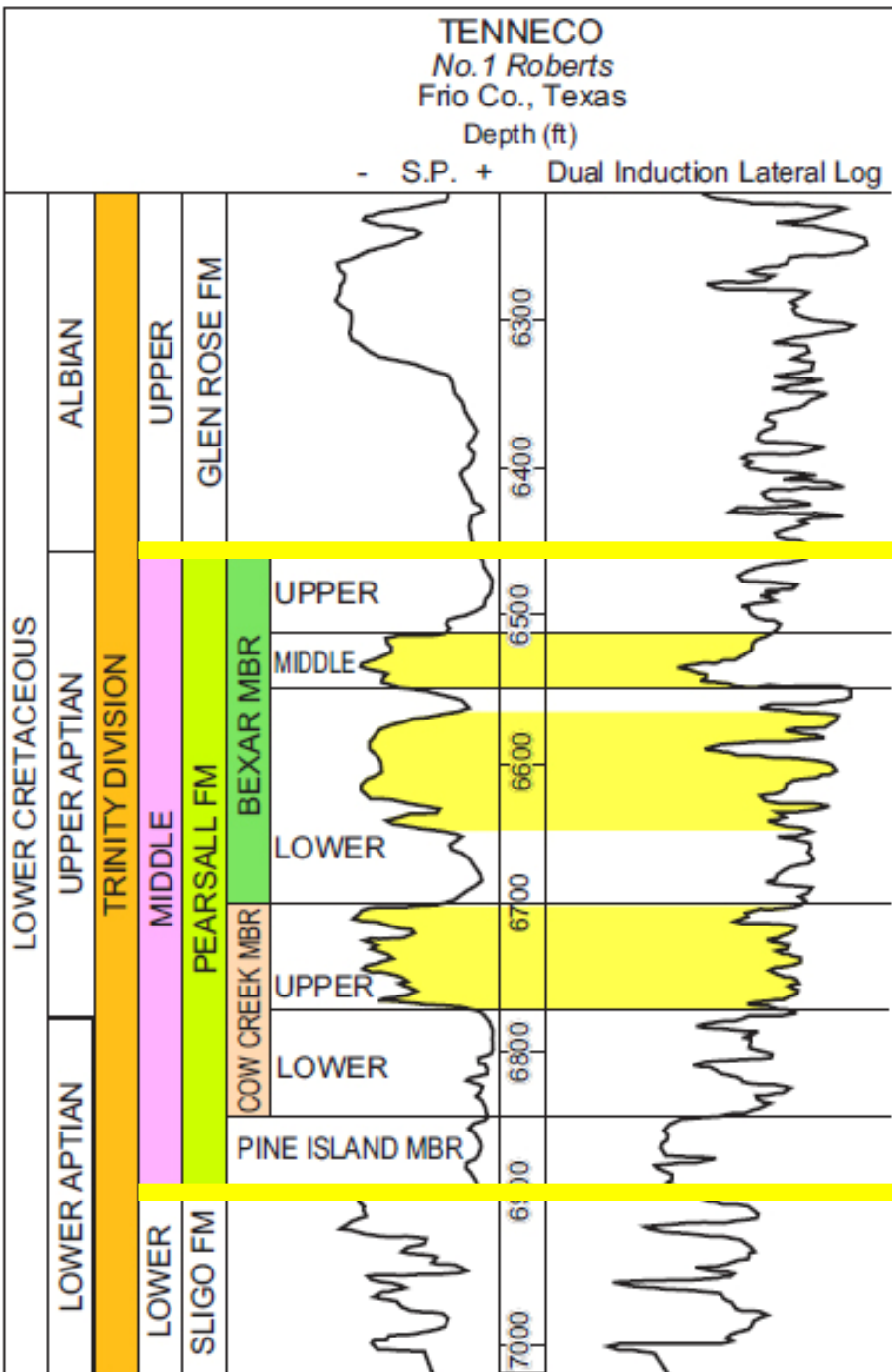
Important source rock

Important source rock

Important source rock

Pearsall Fm.

Geology: Stratigraphy

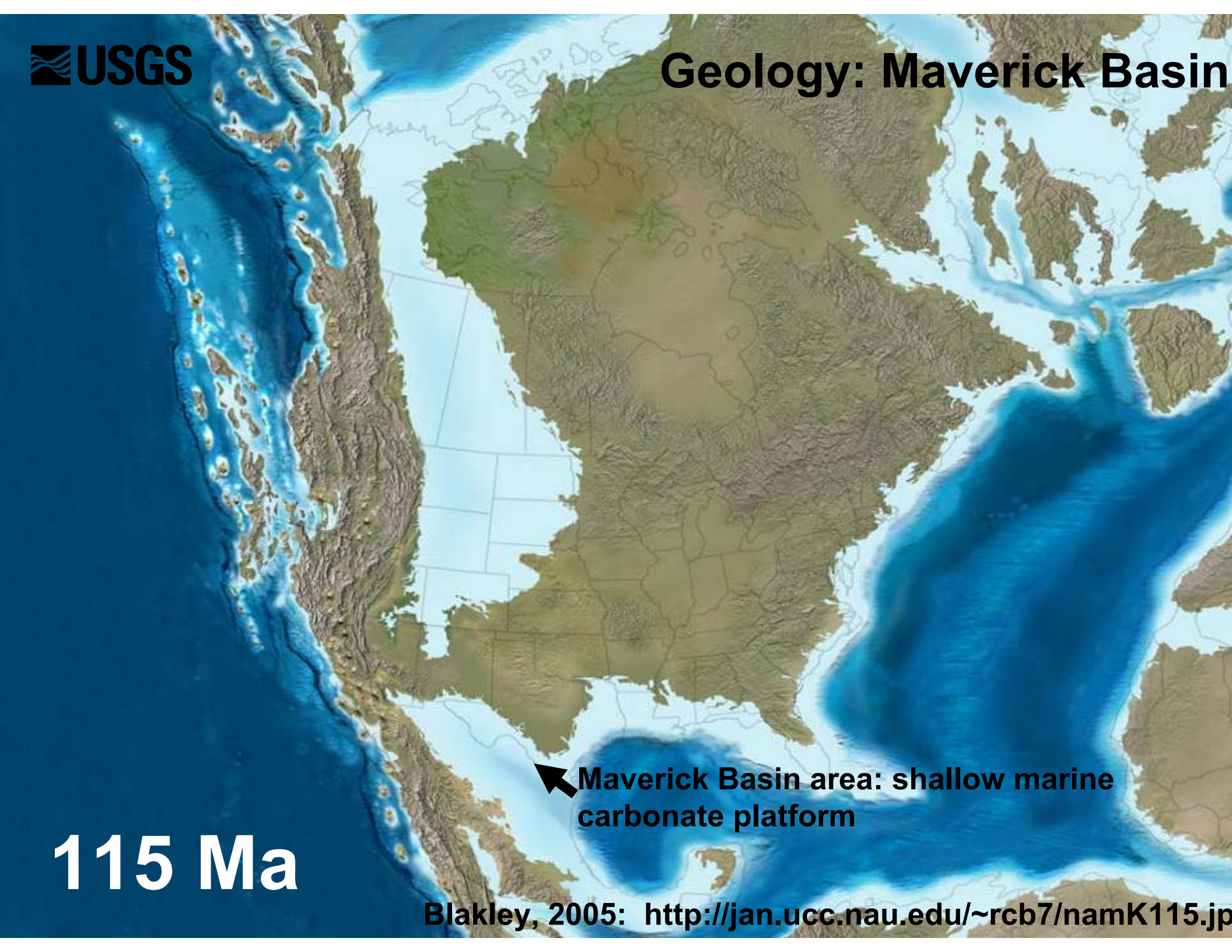


← ~112.5 Ma

- Pearsall is regional in extent
- Contains three members
 - Bexar Shale
 - Cow Creek/James Limestone
 - Pine Island Shale

← ~118 Ma

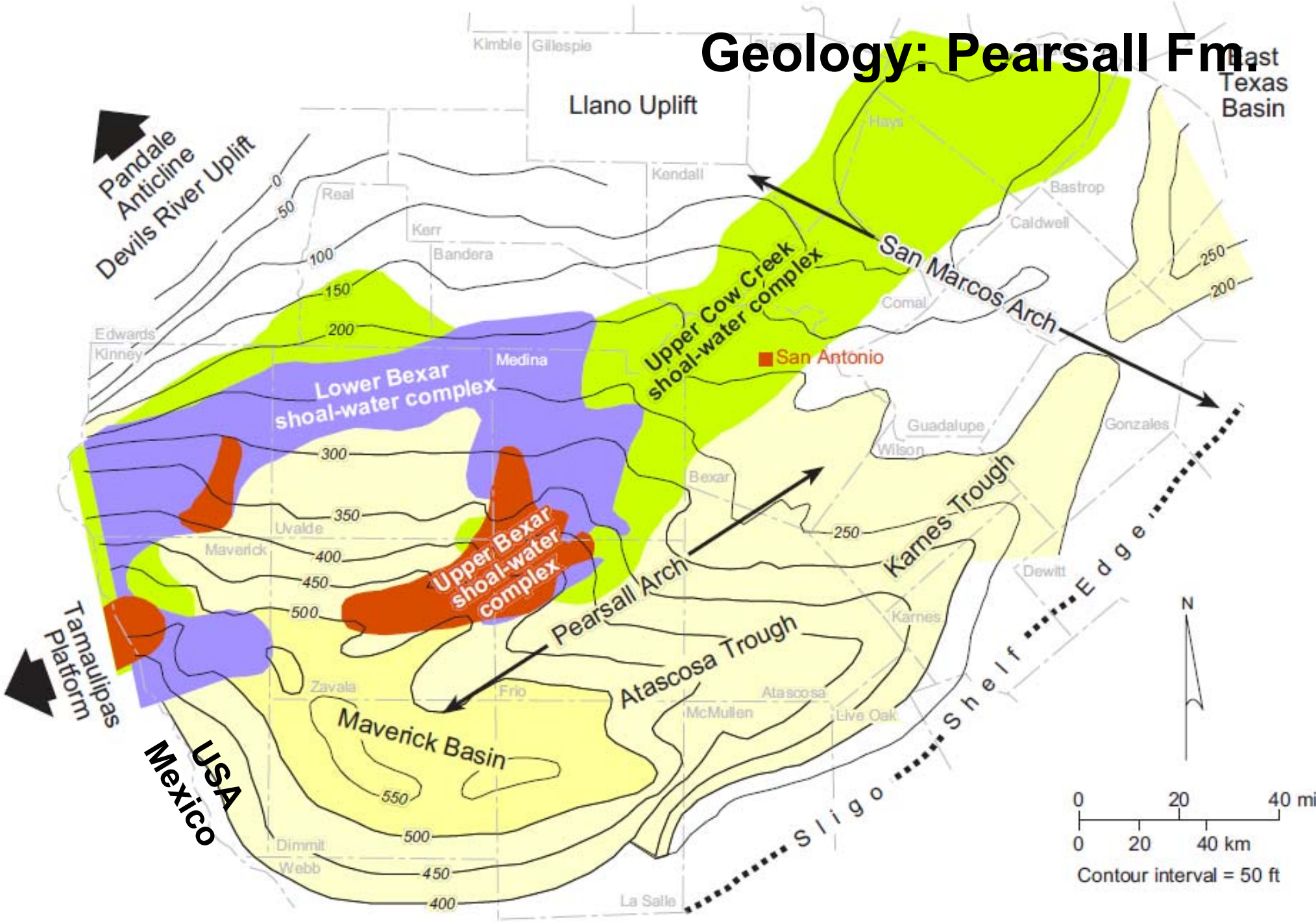
Loucks, 2002



115 Ma

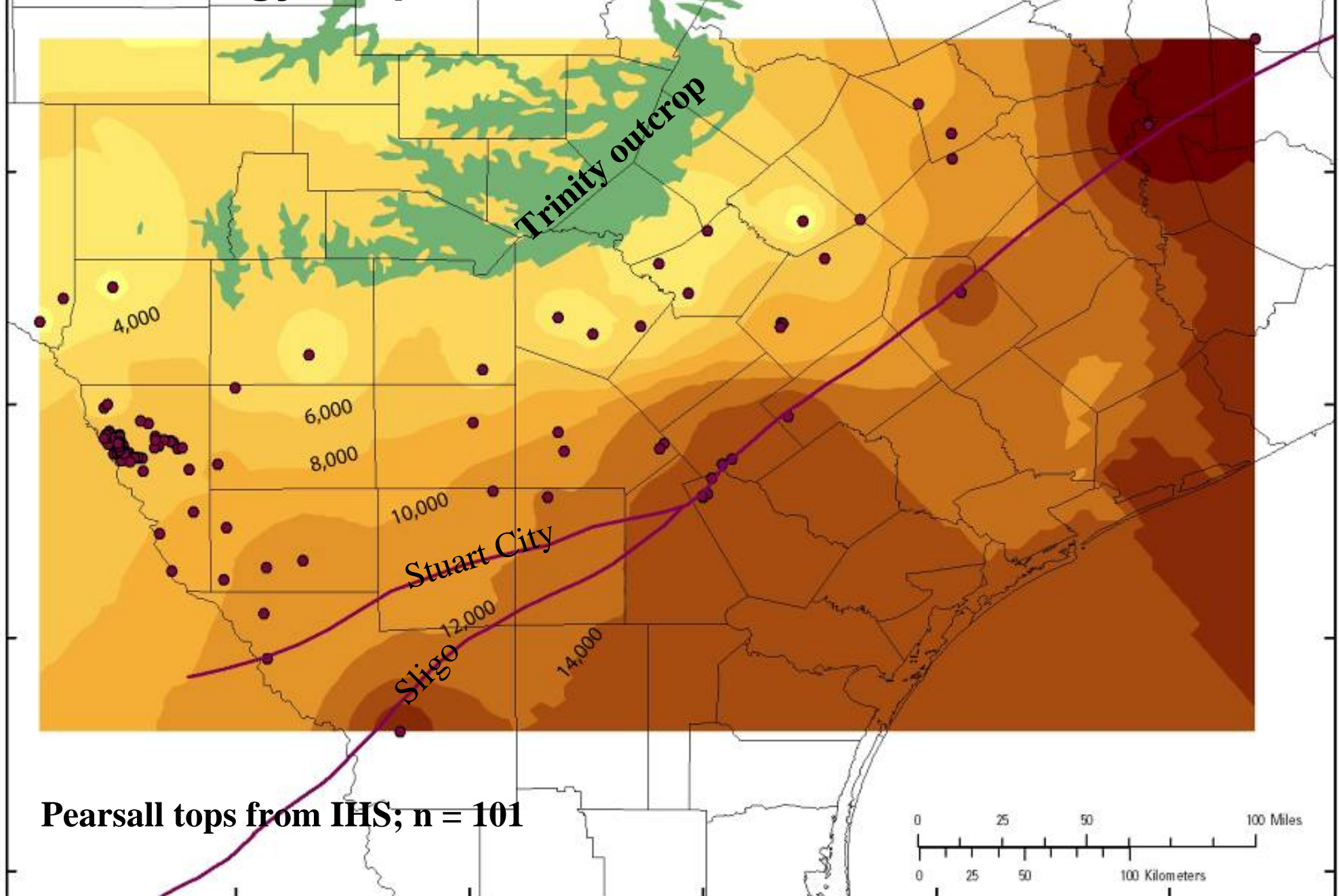
↖ **Maverick Basin area: shallow marine carbonate platform**

Geology: Pearsall Fm.



Methodology

Methodology: Depth to Pearsall, south and central Texas



Pearsall tops from IHS; n = 101



Methodology: Sample availability

Twenty-four wells in south Texas containing Pearsall interval identified in holdings of TBEG from online IGOR

The screenshot shows a web browser window displaying the 'BUREAU OF ECONOMIC GEOLOGY' website. The page title is 'Integrated Log And Core Database (IGOR)'. Below the header, there is a search form with the following fields and options:

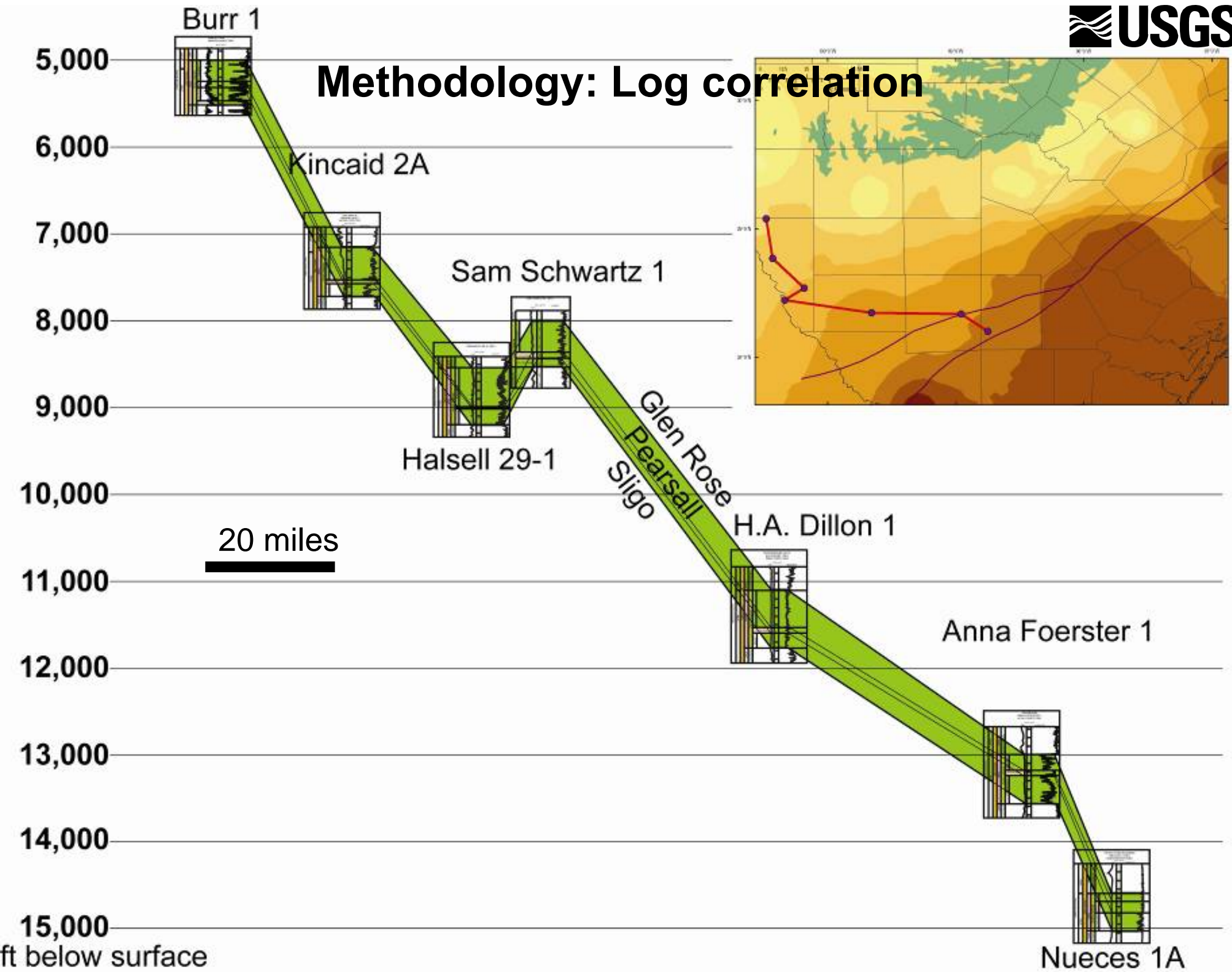
- Country:** USA (dropdown menu)
- State/Province:** No Preference (dropdown menu)
- County/Parish:** No Preference (dropdown menu)
- API:** contains (dropdown menu) [text input field]
- Operator:** contains (dropdown menu) [text input field]
- Lessee:** contains (dropdown menu) [text input field]
- Field:** contains (dropdown menu) [text input field]
- Sample Category:** No Preference, Core, Cuttings, Other (dropdown menu)

Below the search form, there are sorting options:

- How would you like your search results sorted?**
- First Sort By:** County/Parish (dropdown menu) with radio buttons for Ascending and Descending.
- Then Sort By:** API (dropdown menu) with radio buttons for Ascending and Descending.

Core and cuttings (2 pallets) shipped to USGS, VA, for collection of Pearsall sample material

Methodology: Log correlation



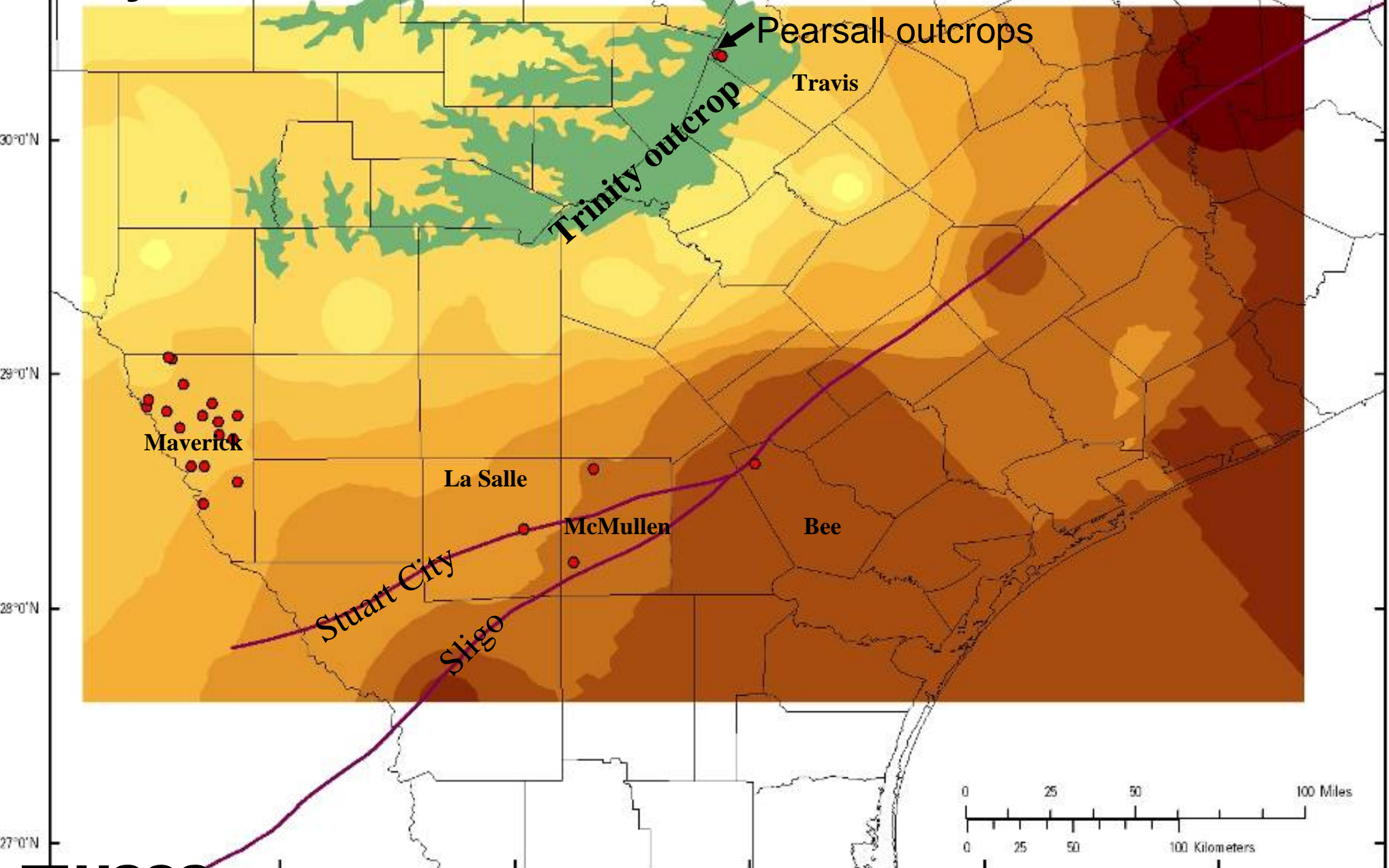
Methodology: Sampling

Core and cuttings described, photographed, and sub-sampled ($n = 100\text{s}$) for thermal maturity (vitrinite reflectance, Rock-Eval), TOC, petrography, XRD, ICP-MS, porosity-permeability, others...



100°0'W 99°0'W 98°0'W 97°0'W 96°0'W

Methodology: Sample distribution - Pearsall samples from twenty-four wells, south and central Texas

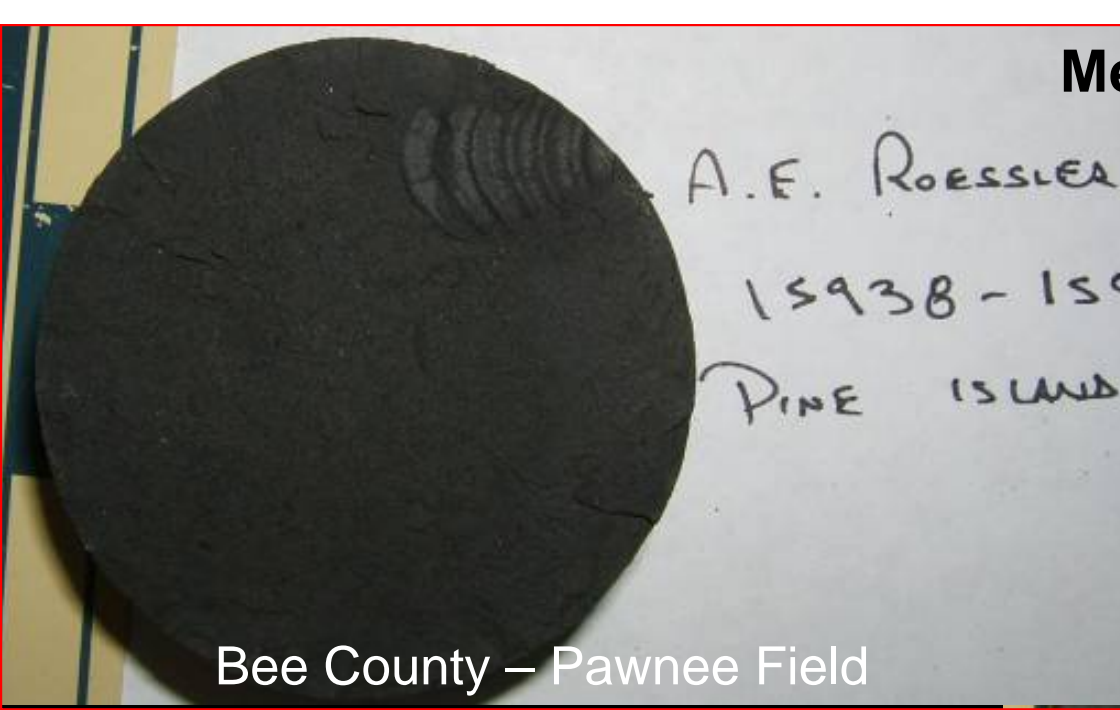


Cow Creek Limestone at Hamilton Pool

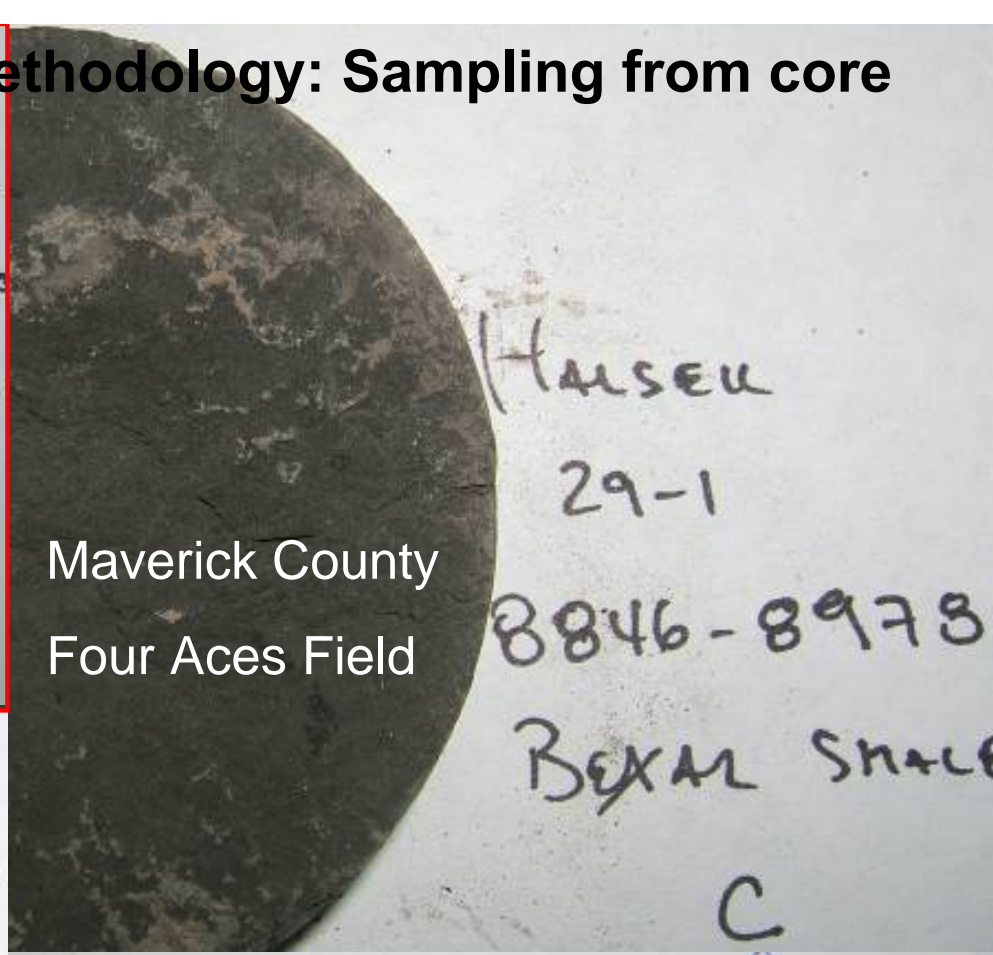
Methodology: Sampling from outcrop



Methodology: Sampling from core



Bee County – Pawnee Field



Maverick County
Four Aces Field



Maverick County
Kincaid-Winn Field



Maverick County – Los Cuatros Field

Core samples from 4 wells

6,400-16,000 ft



Methodology: Sampling from cuttings

5260
70

Burr No. 1 5,260-5,270'

Burr No. 1 5,260-5,270'

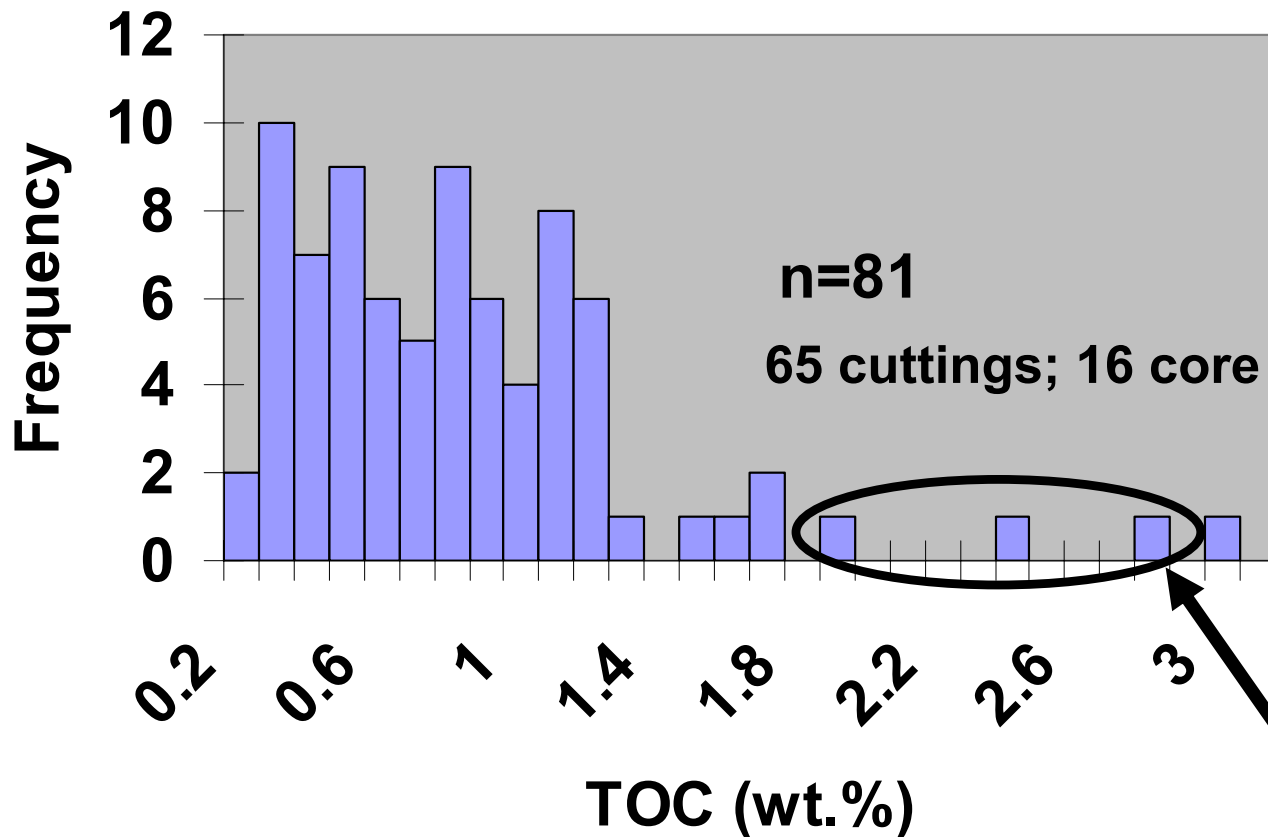
Burr No. 1
Maverick Co.



Preliminary Data

TOTAL ORGANIC CARBON

Pearsall TOC



Low average TOC = 0.8%

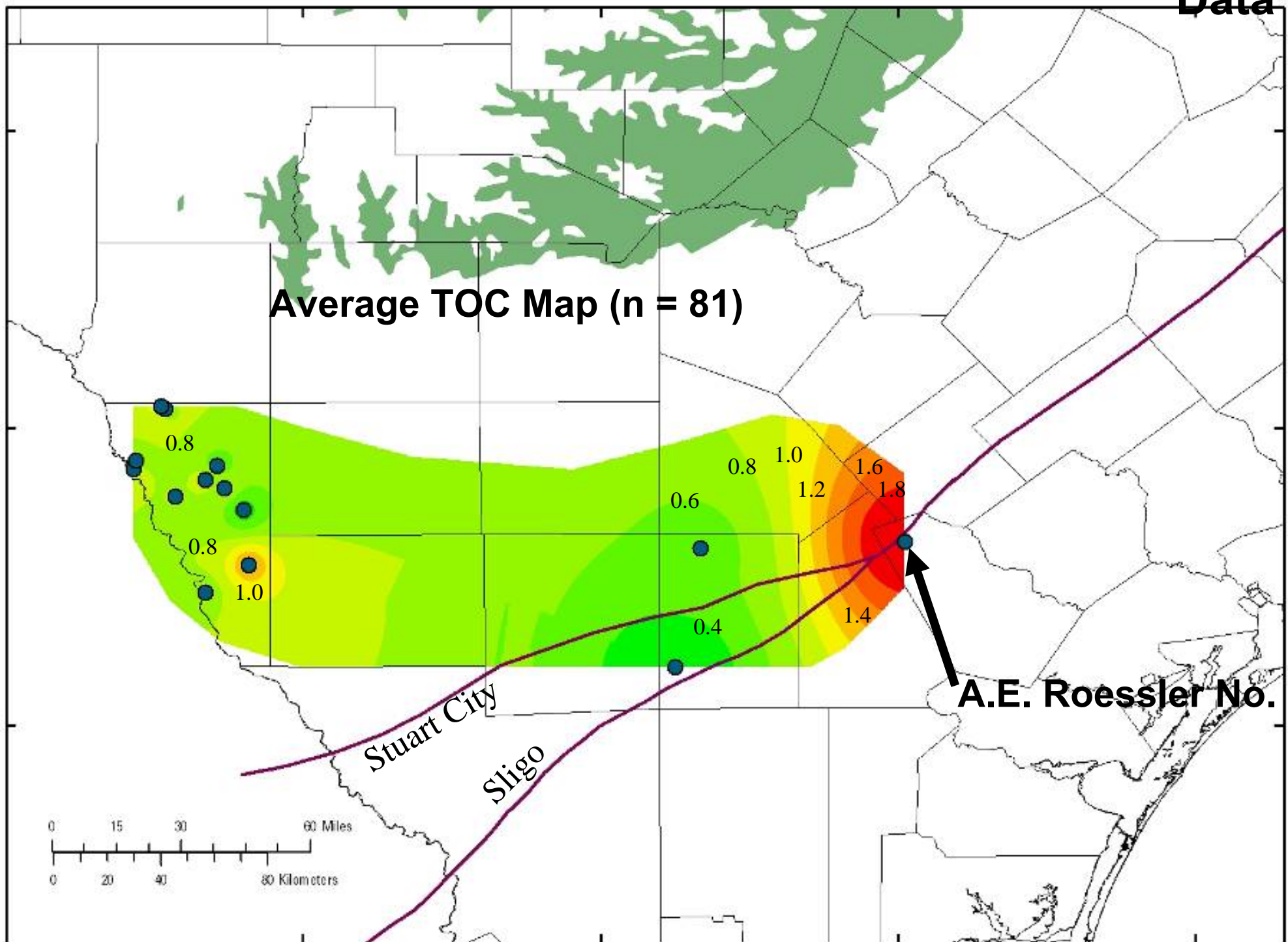
Bexar (0.79%) and Pine Island (0.81%) shales have very similar TOC content

Average core = 1.2%

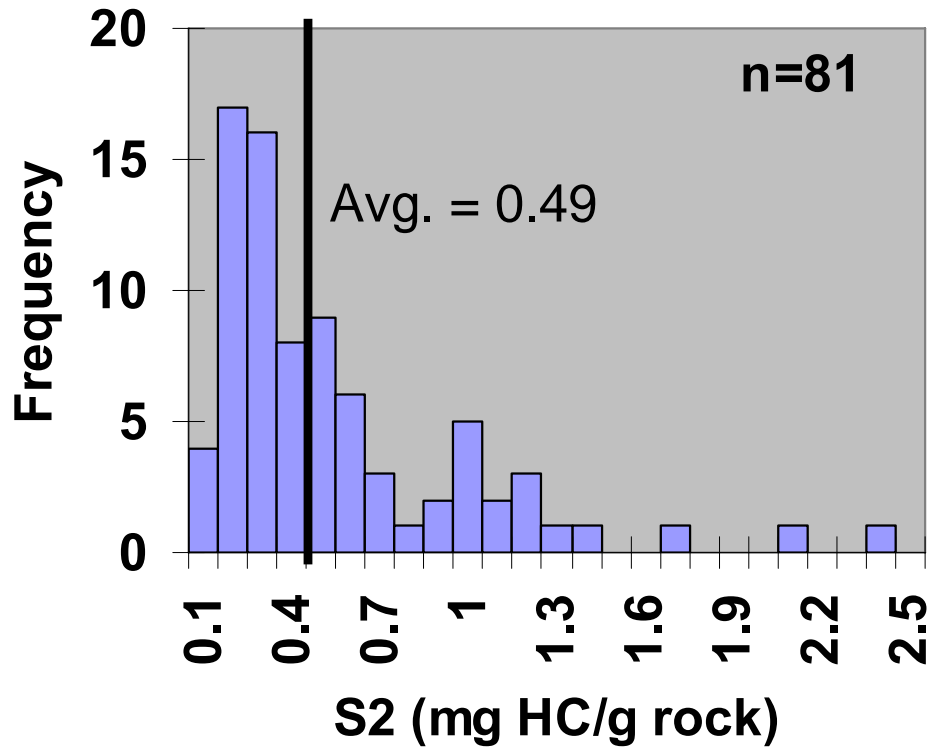
Average cuttings = 0.7%

A.E. Roessler No. 1

Average TOC Map (n = 81)



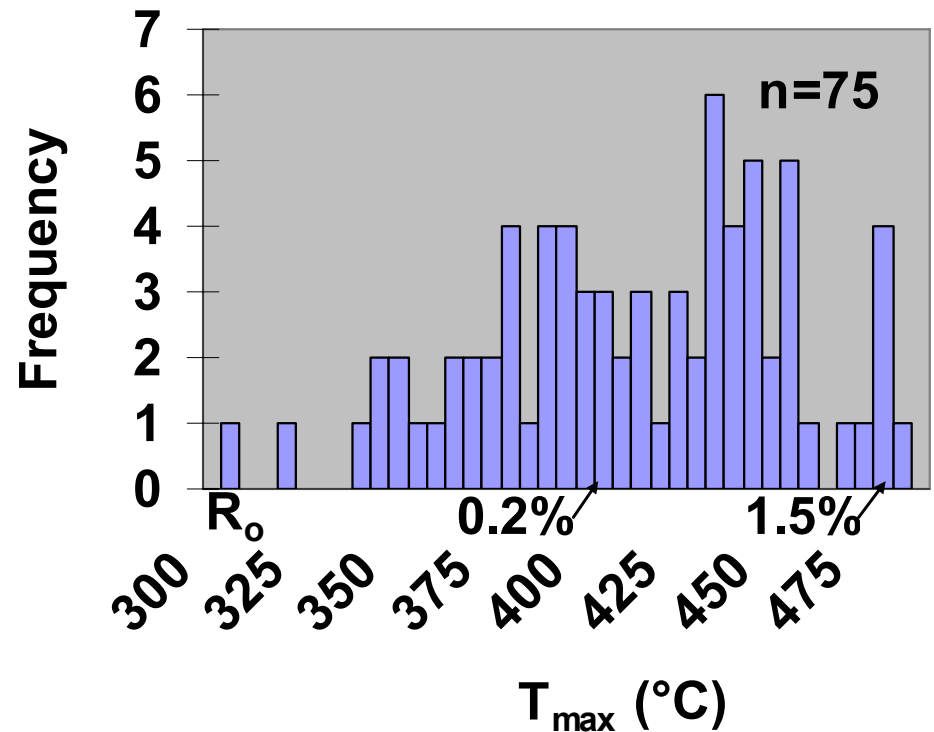
S2 values for Pearsall



Poor S2 peaks → T_{max} not a reliable measure of thermal maturity

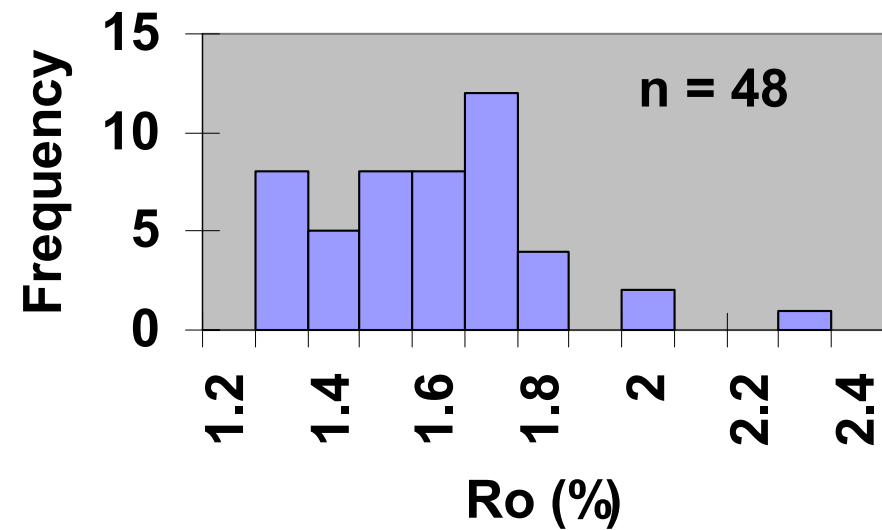
→ Calculated R_o is meaningless

T_{max} values for Pearsall



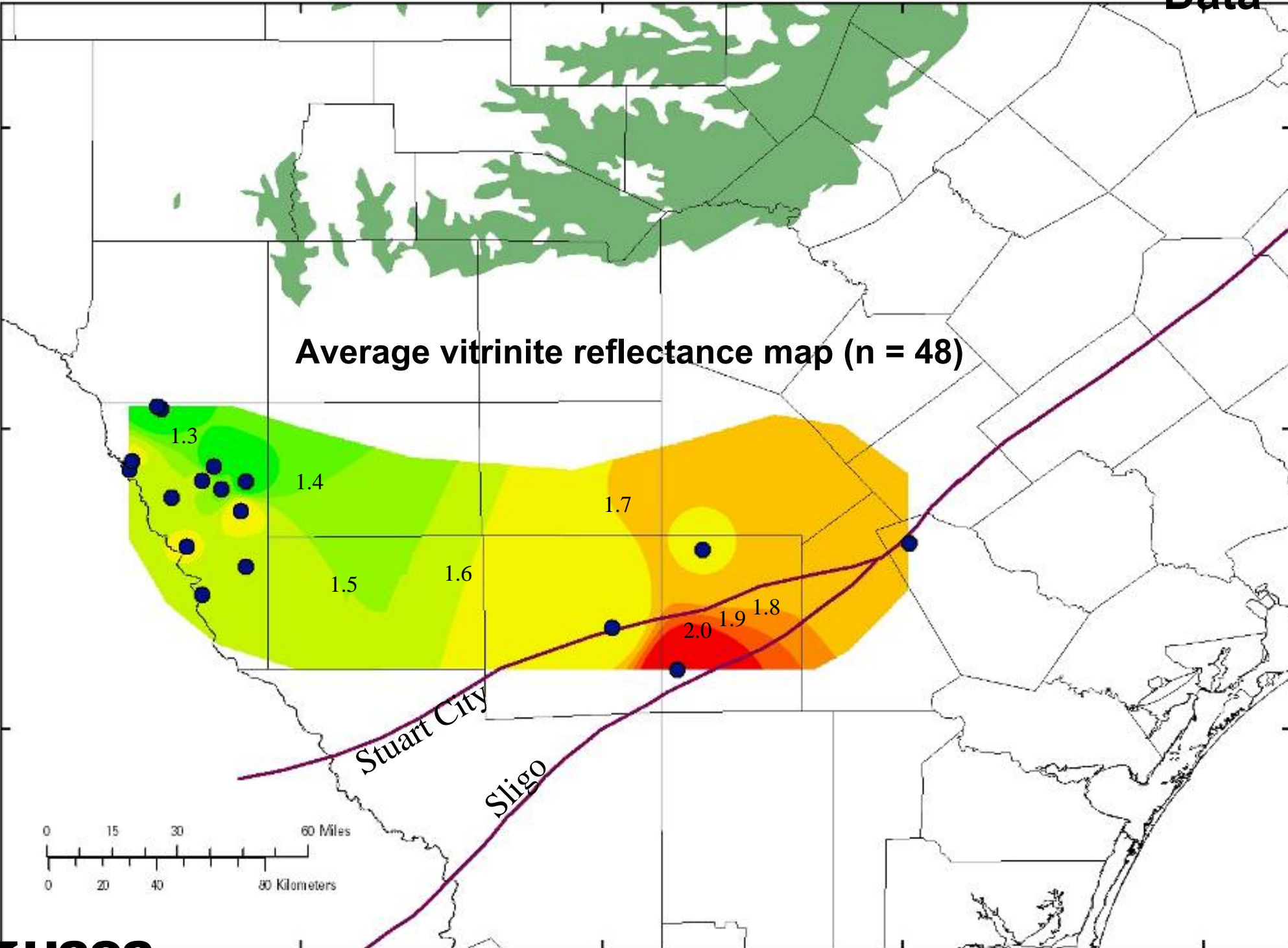
48 Pearsall samples analyzed for vitrinite reflectance to-date

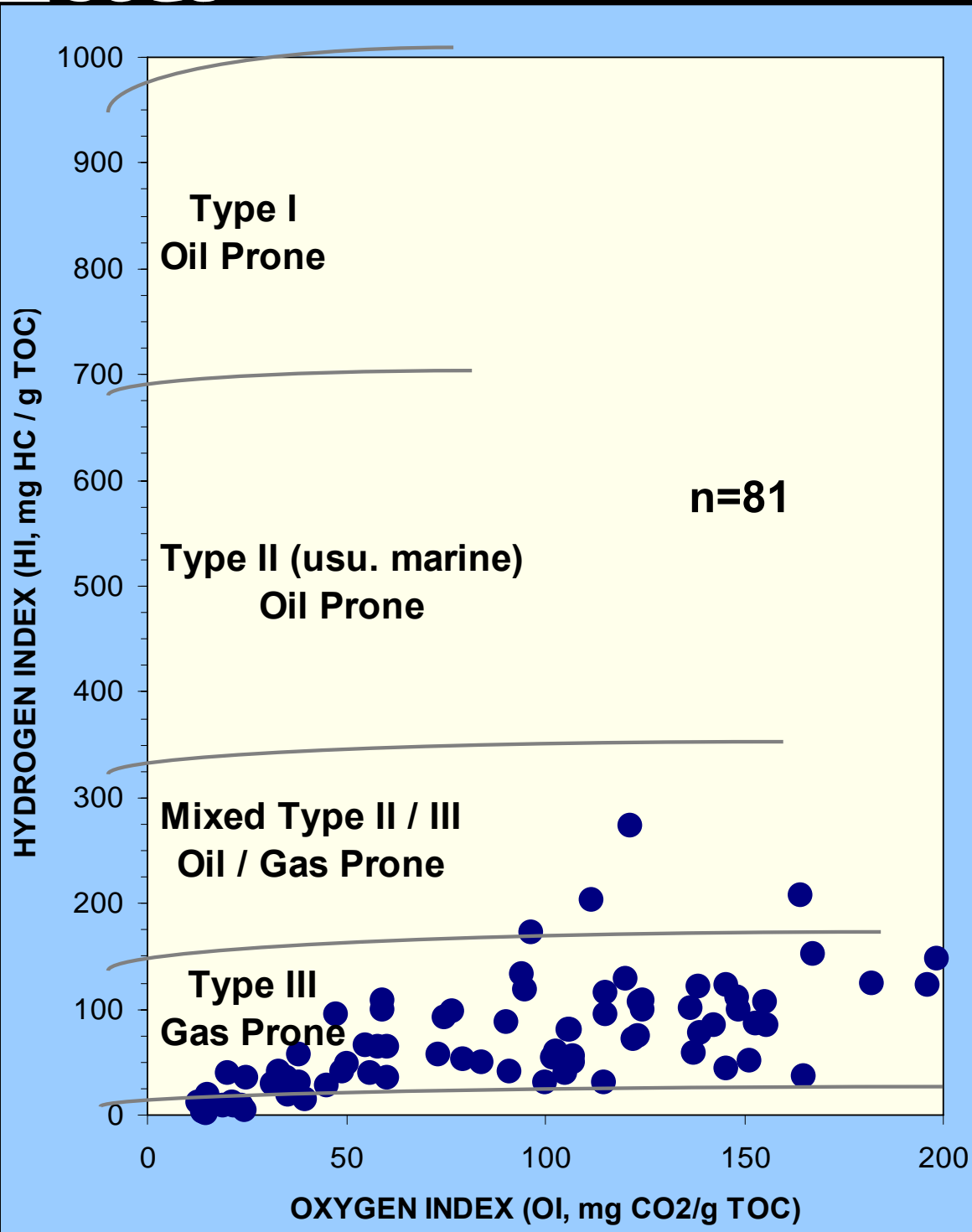
Pearsall measured vitrinite reflectance



Pearsall is in dry gas window

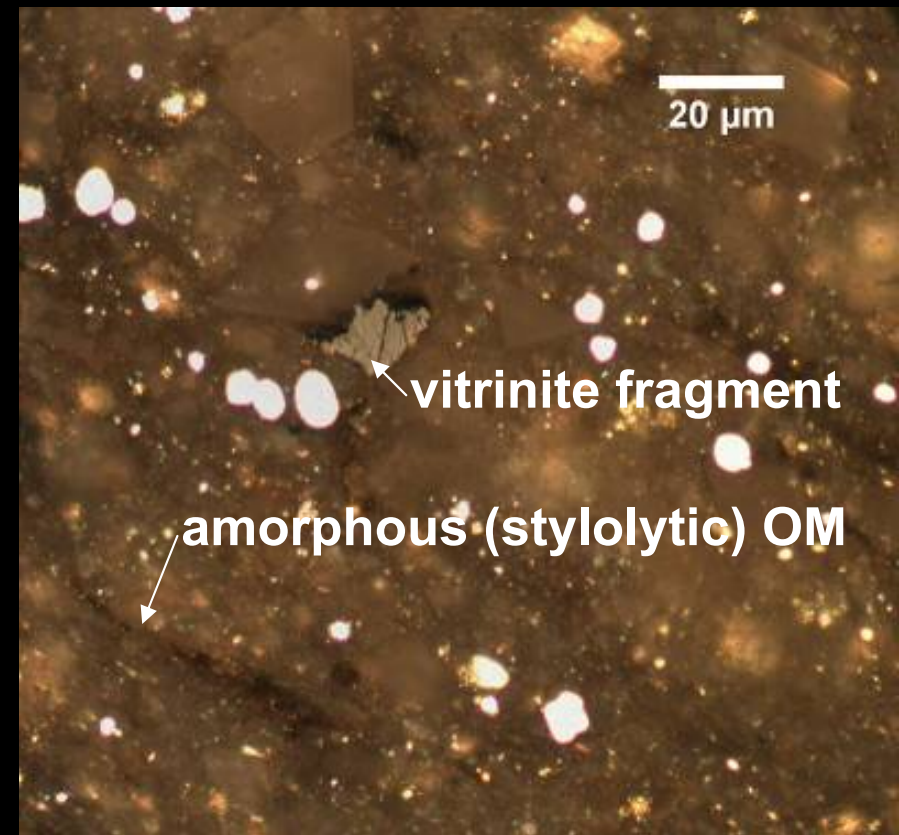
Average vitrinite reflectance map (n = 48)





ROCK-EVAL PYROLYSIS - PETROGRAPHY

Organic matter mainly is Type III with some Type II



Conclusions and Future Directions

CONCLUSIONS

- Pearsall is in dry gas window in south Texas Maverick Basin area
- Pearsall contains low average TOC content of 0.8%
- Bexar Shale & Pine Island Shale members very similar in TOC content
- Rock-Eval T_{max} not reliable for thermal maturity
- Organic material mostly is Type III – terrestrial, with minor Type II
- Some deep (>15,000 ft) shelf-edge Pearsall shows promising TOC content in core

FUTURE DIRECTIONS

- More thermal maturity data are needed in south Texas - collaboration with an industry partner?
- Evaluation of incoming data – thin section petrography, XRD, ICP-MS, petrophysics
- Expansion of the study to the eastern part of the Gulf Basin?