Offshore CO_2 Storage Resource Assessment of the Northern Gulf of Mexico (Upper Texas-Western Louisiana Coastal Areas)

"TXLA"

DE-FE0026083

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U.S. Department of Energy
National Energy Technology Laboratory
Mastering the Subsurface Through Technology Innovation, Partnerships and Collaboration:
Carbon Storage and Oil and Natural Gas Technologies Review Meeting
August 1-3, 2017

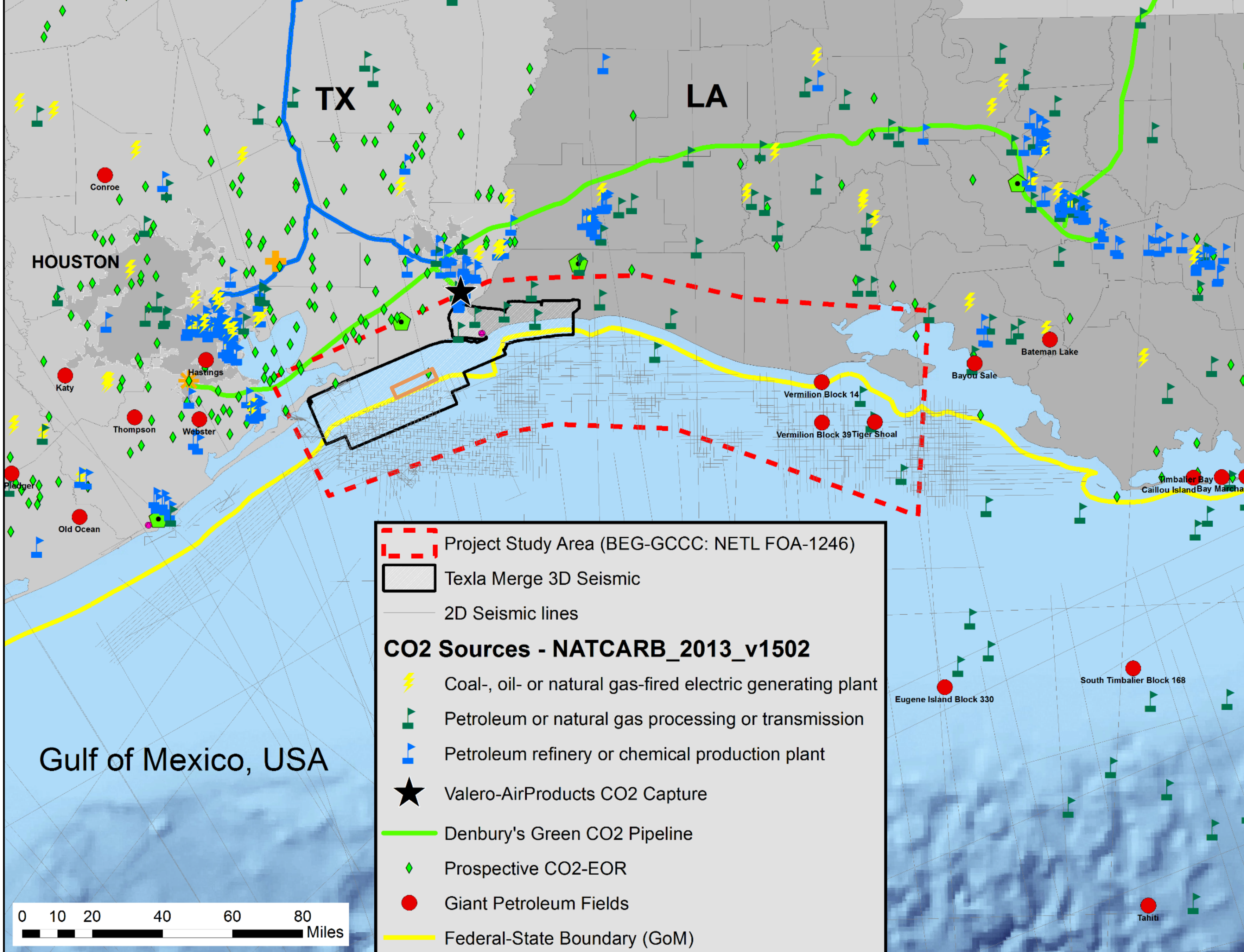
Presentation Outline

- Project Overview: Goals and Objectives
- Technical Status
- Accomplishments to Date
- Lessons Learned
- Summary
- Acknowledgements

TXLA Goals & Objectives

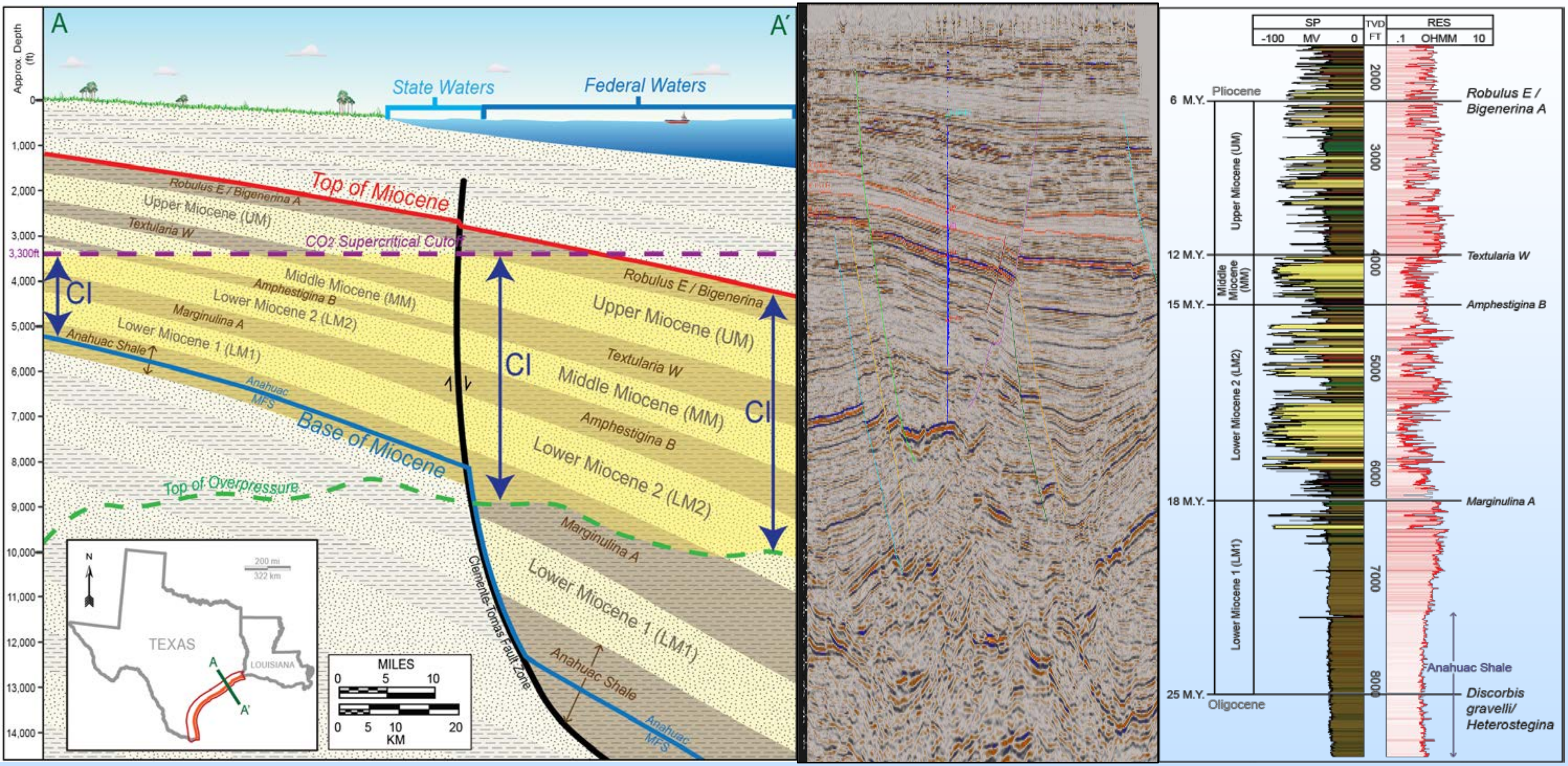
Assess:

- Depleted oil & natural gas reservoirs' storage capacity
- Saline formations' ability to store nationally-significant amounts of anthropogenic CO_2
- Identify at least one 30 MT site

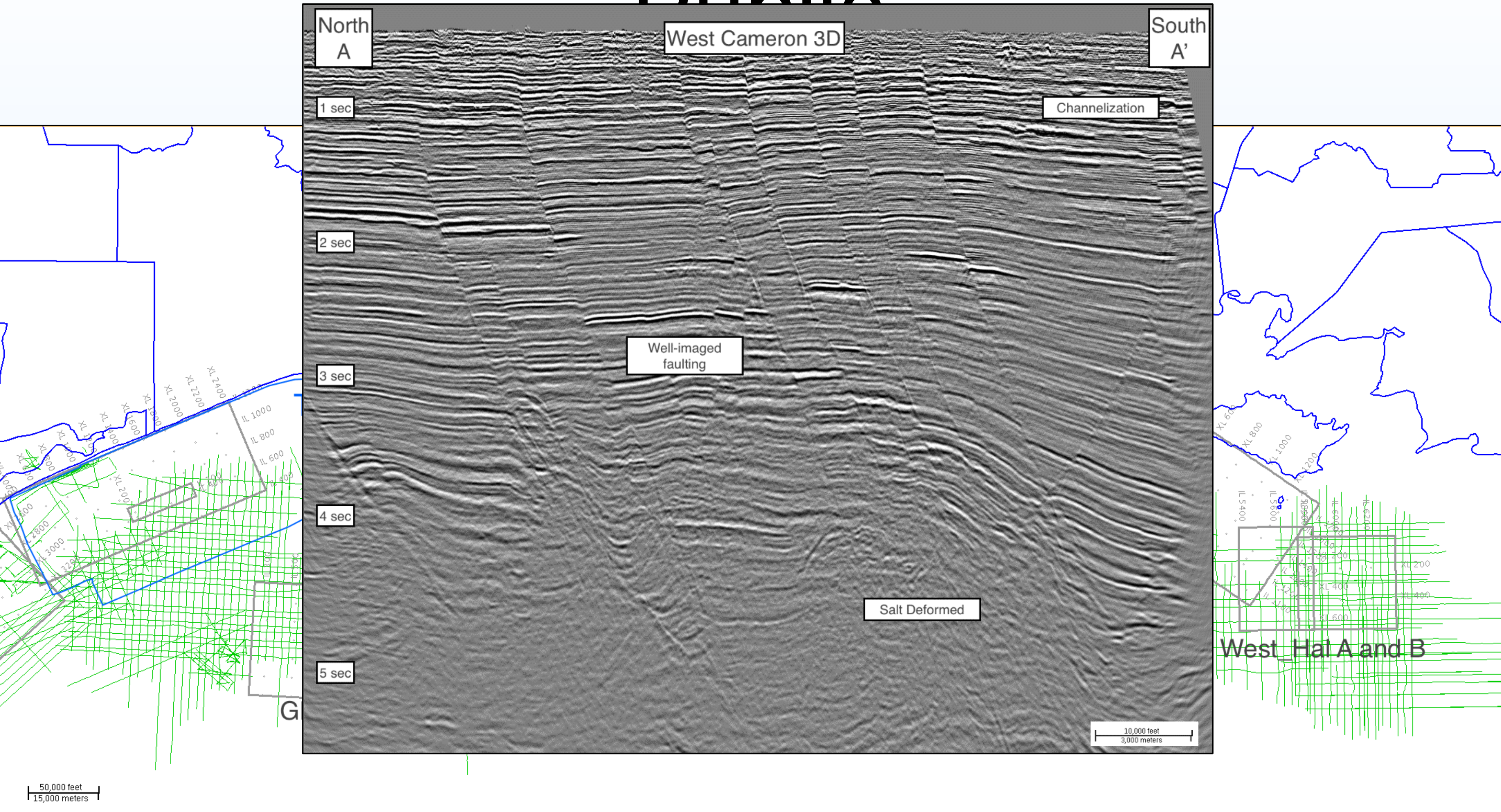


TX
LA
HOUSTON
Conroe
Katy
Hastings
Thompson
Webster
Pledger
Old Ocean
Vermilion Block 14
Vermilion Block 39
Tiger Shoal
Bayou Sale
Bateman Lake
Timbalier Bay
Caillou Island
Bay Marchand
Eugene Island Block 330
South Timbalier Block 168
Tahiti
Gulf of Mexico, USA
0 10 20 40 60 80 Miles
Project Study Area (BEG-GCCC: NETL FOA-1246)
Texla Merge 3D Seismic
2D Seismic lines
CO2 Sources - NATCARB_2013_v1502
Coal-, oil- or natural gas-fired electric generating plant
Petroleum or natural gas processing or transmission
Petroleum refinery or chemical production plant
Valero-AirProducts CO2 Capture
Denbury's Green CO2 Pipeline
Prospective CO2-EOR
Giant Petroleum Fields
Federal-State Boundary (GoM)

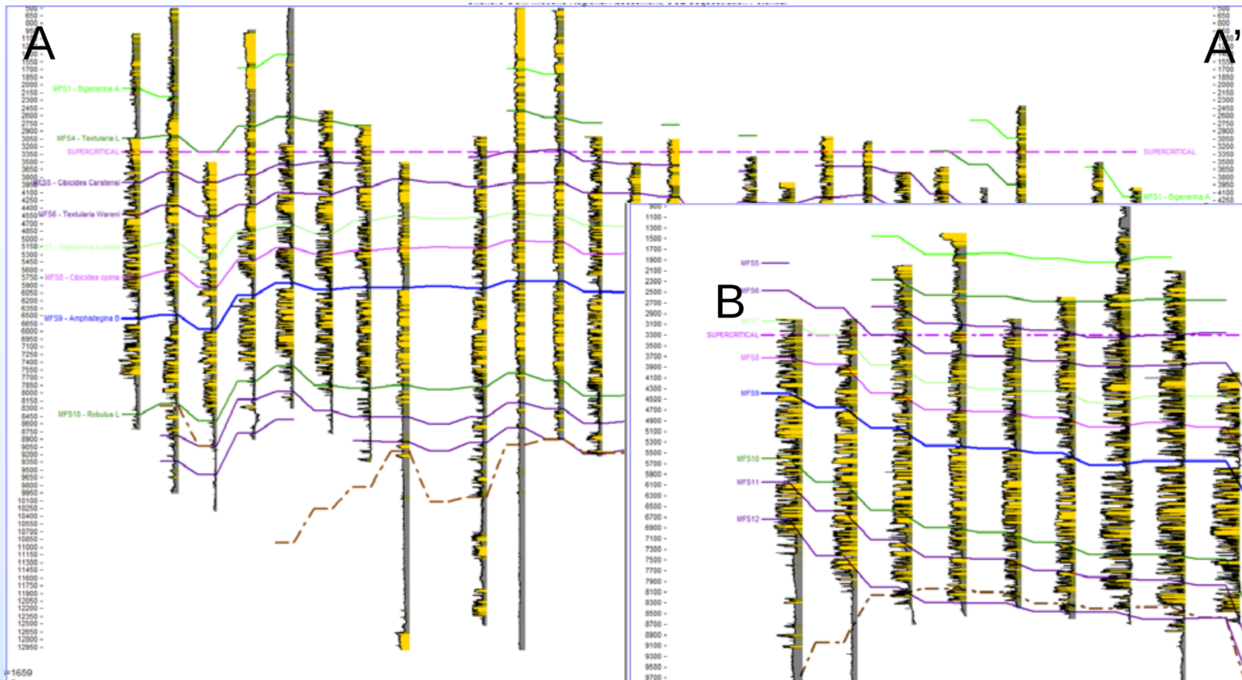
Conceptual Overview

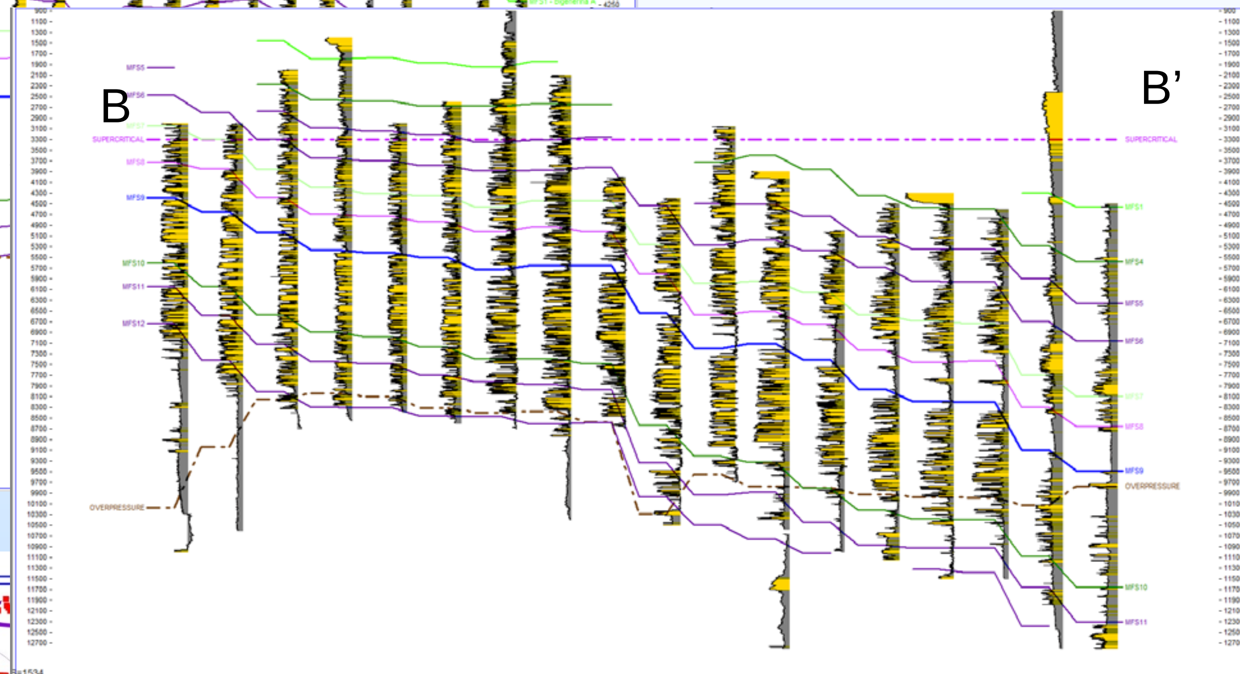


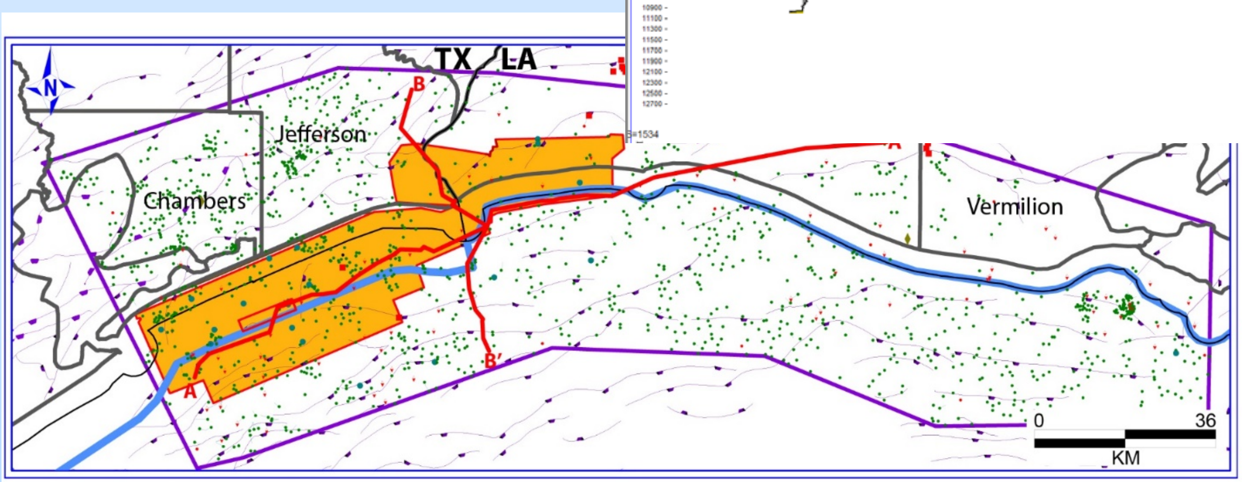
3Ds Recently Released to Public



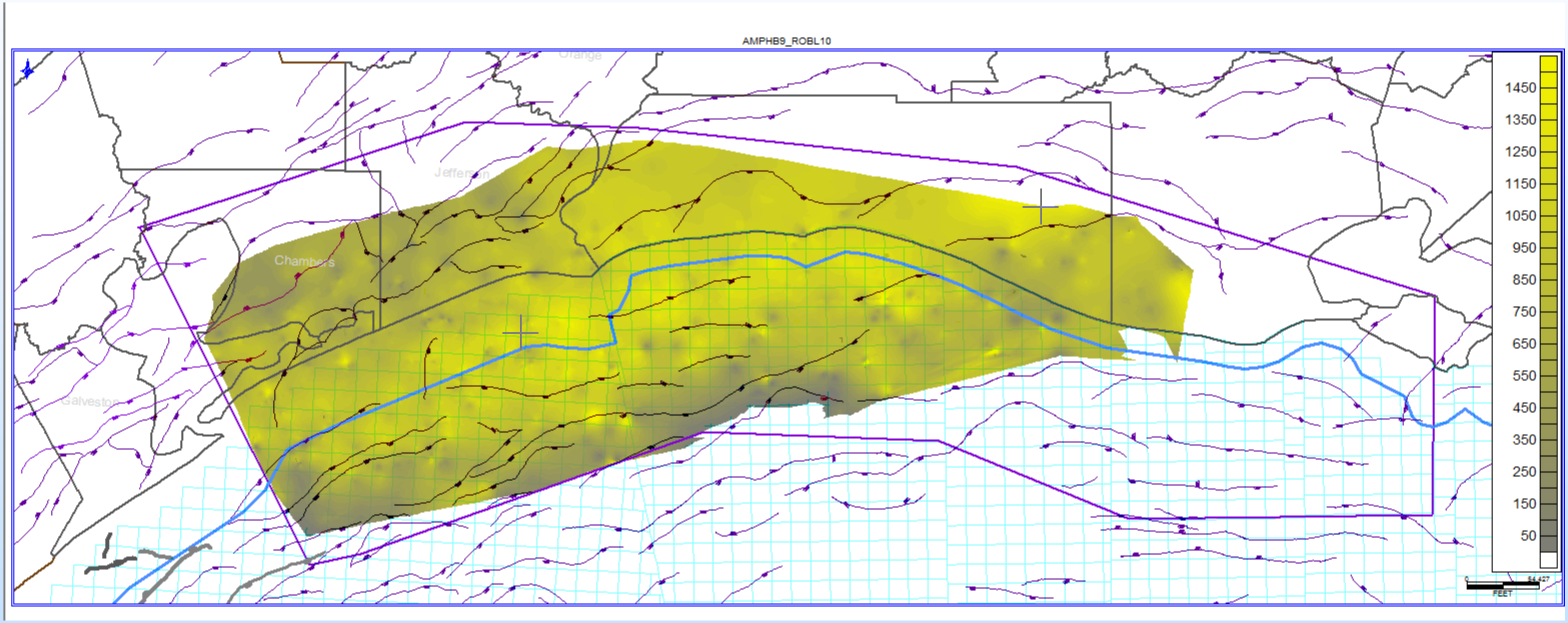
Regional Well Correlations



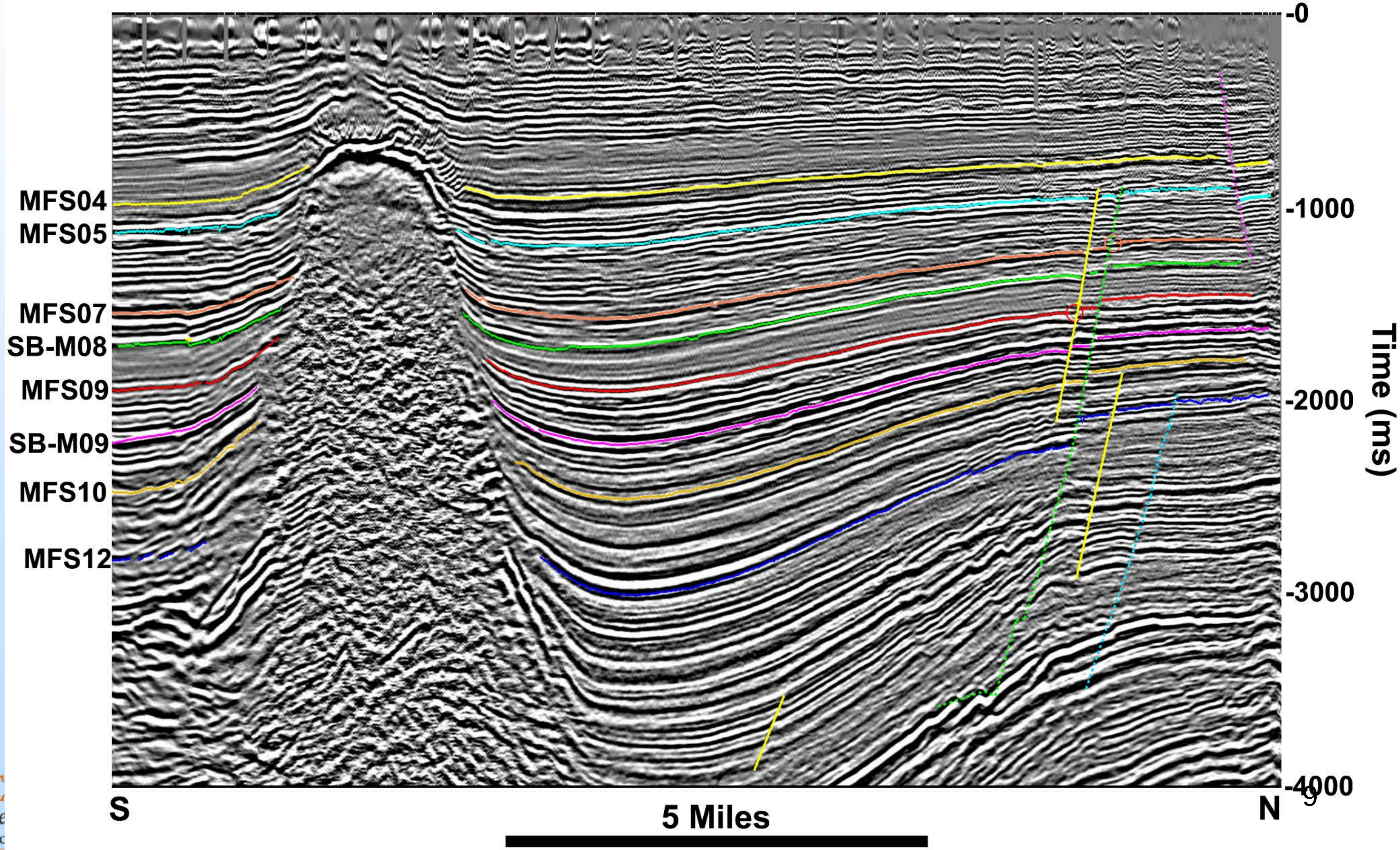




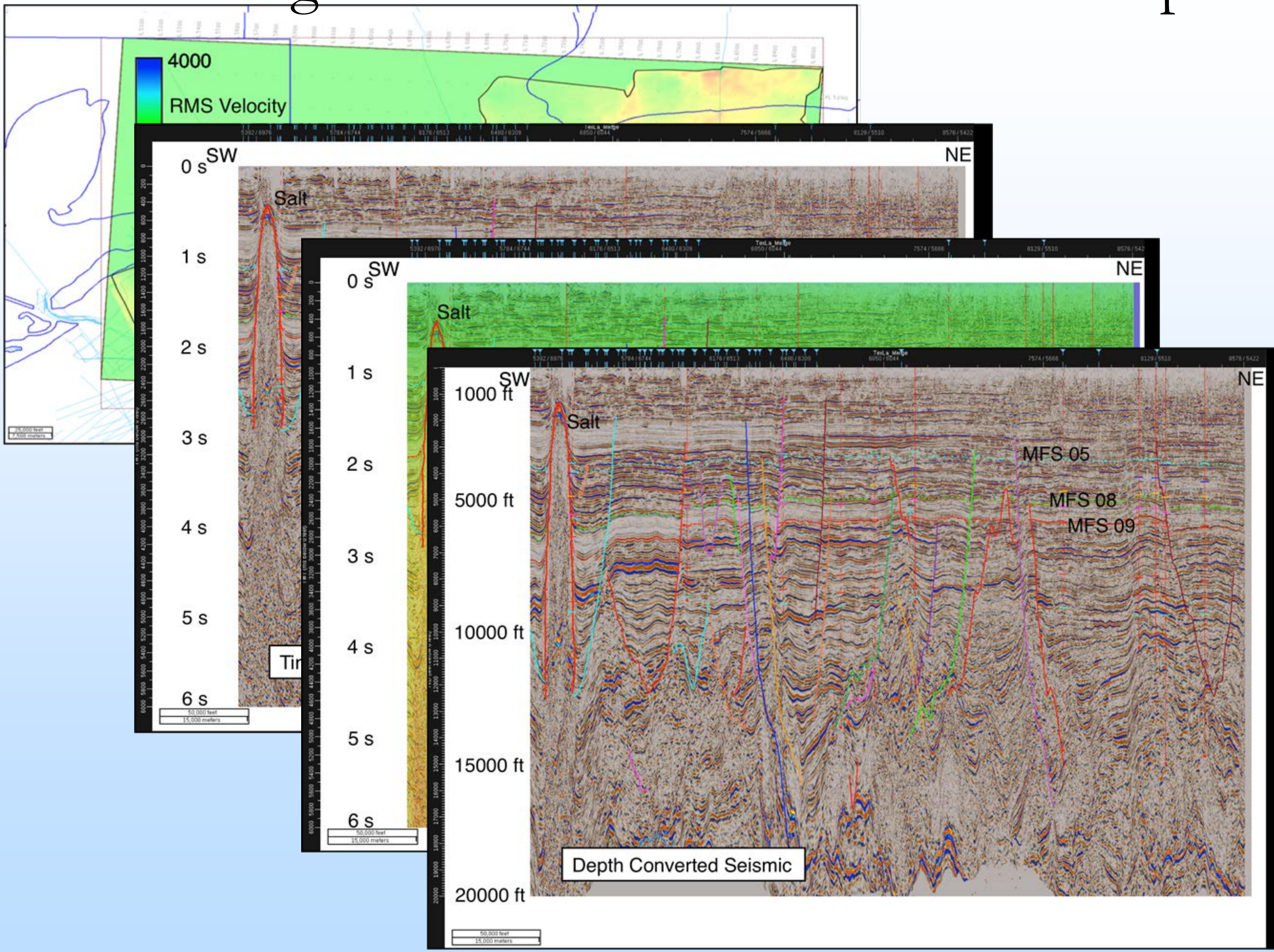
Net Sand Calculations for Static Capacity Estimates



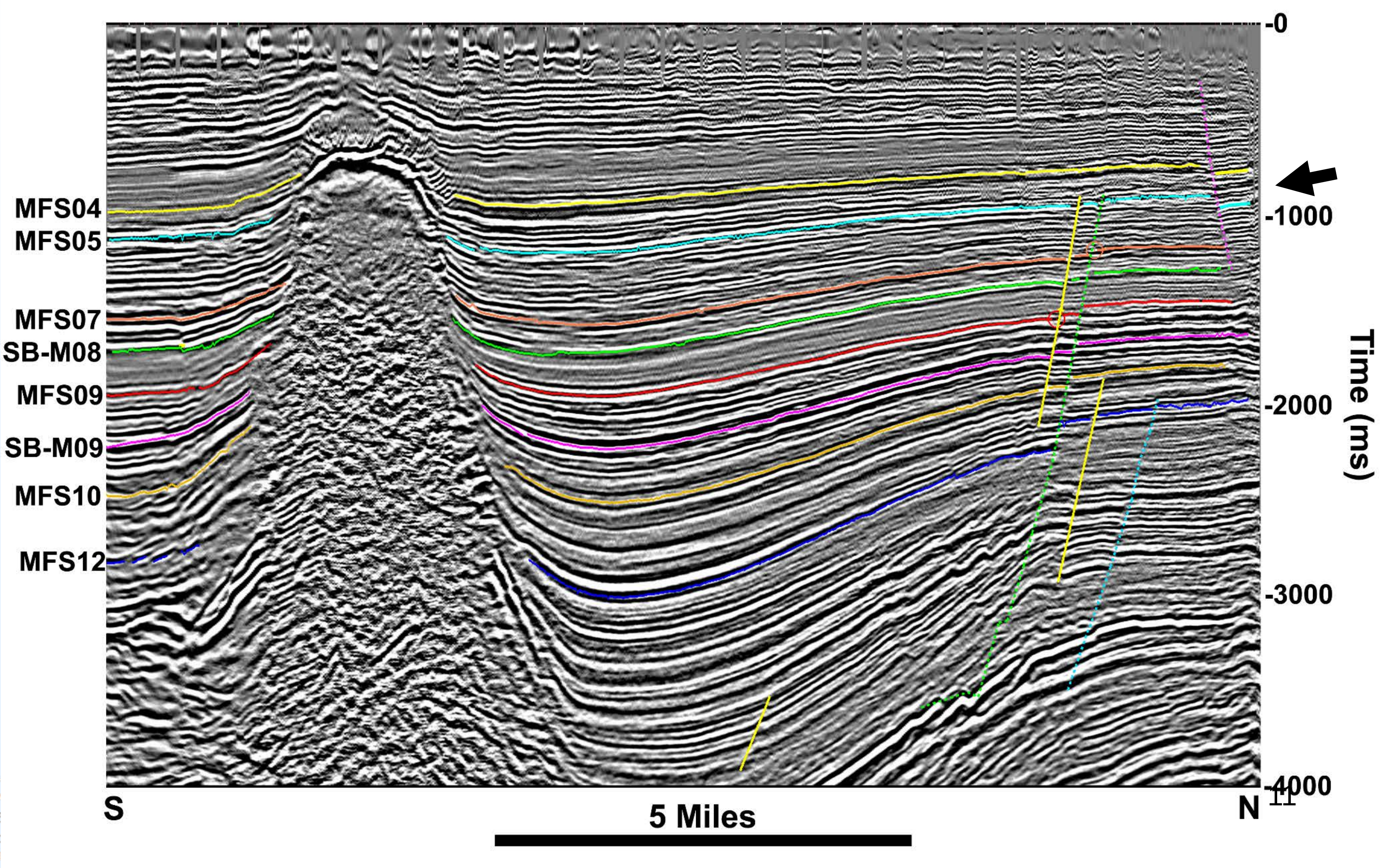
Transect – TexLa Merge 3D Interpreted Horizons



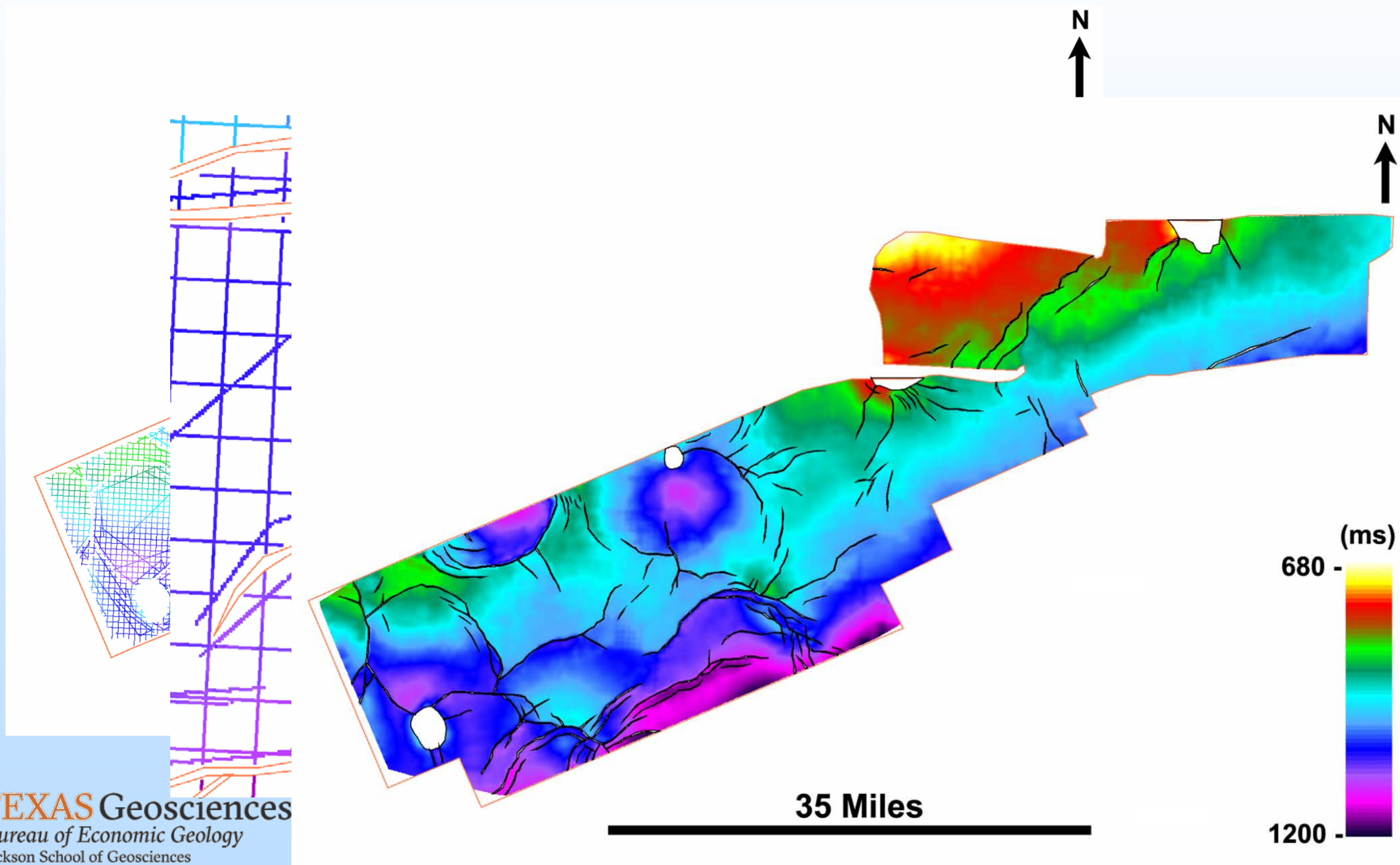
TexLA Merge 3D Converted from Time to Depth



Transect – TexLa Merge 3D Interpreted Horizons



Seismic Interpretation: Horizons & Faults



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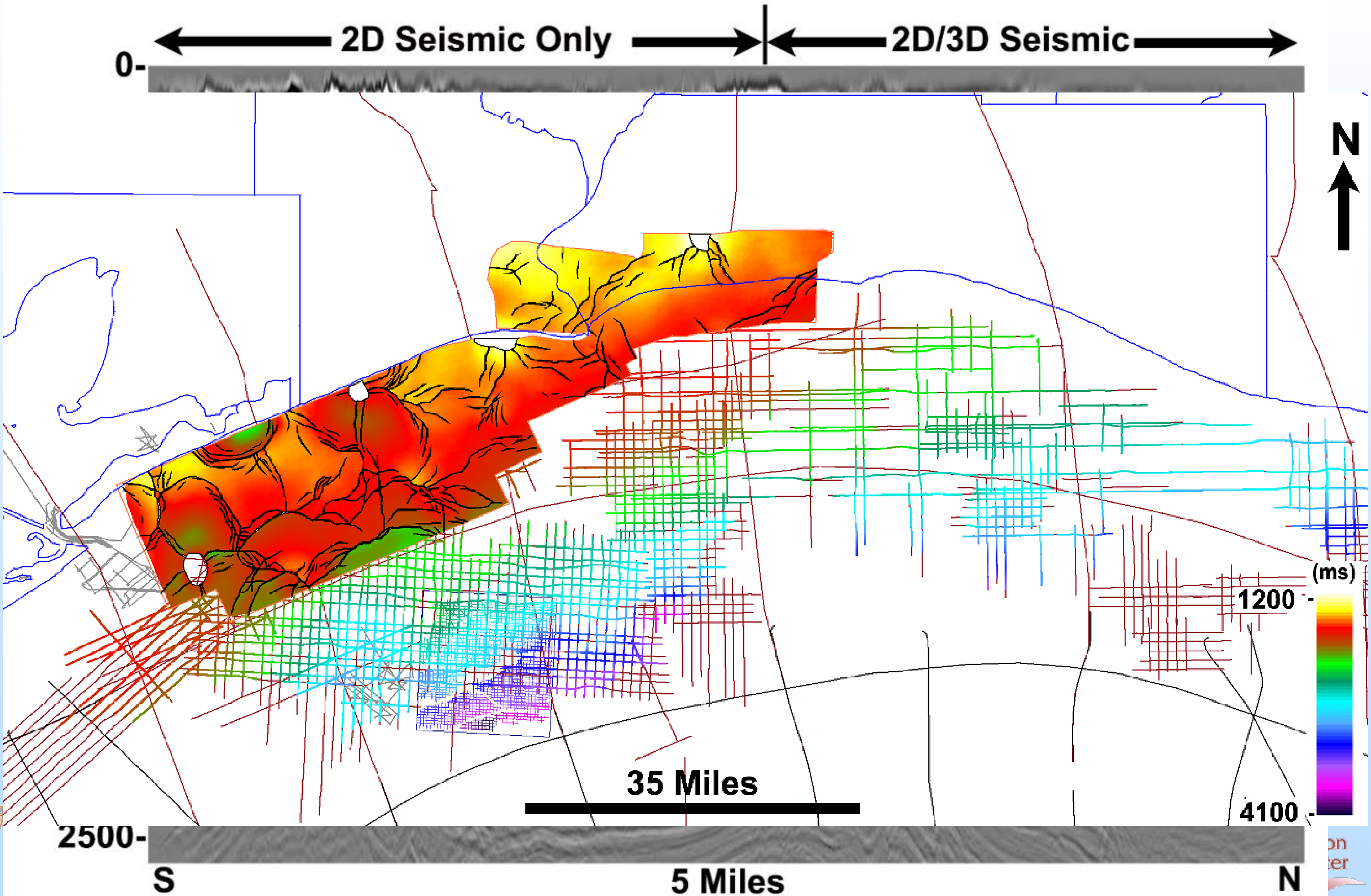
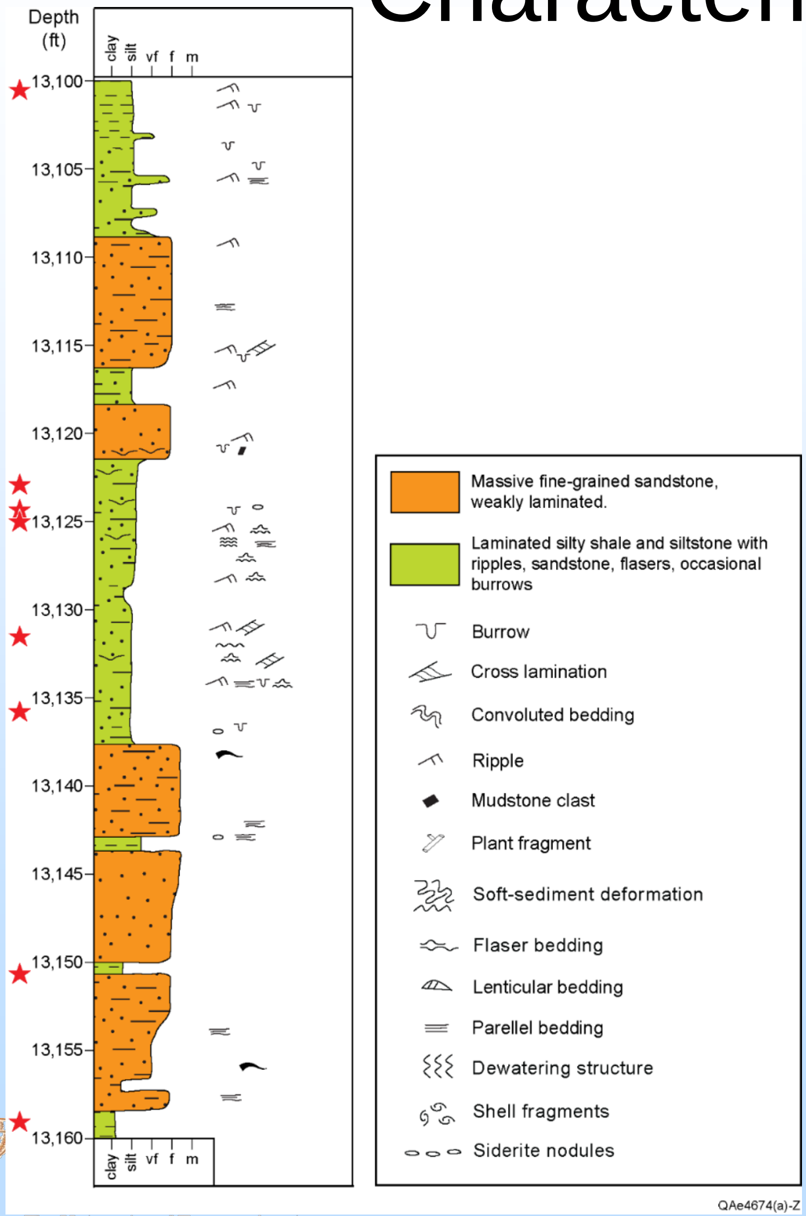
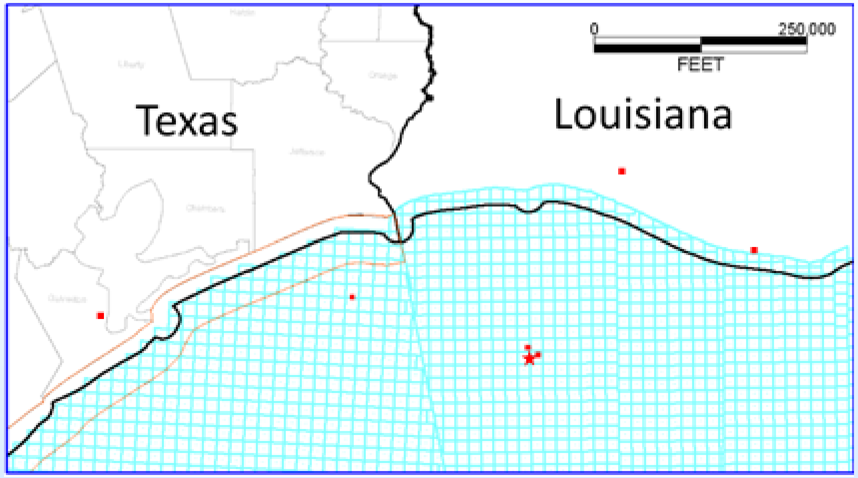
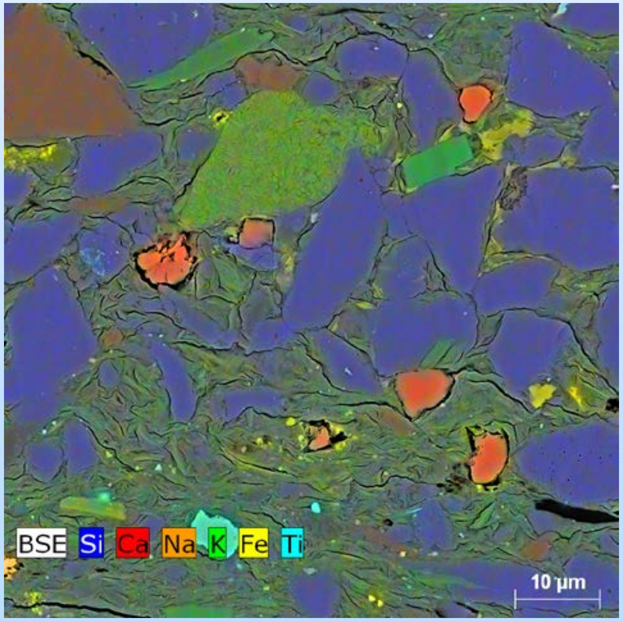
Extended to More Extensive 2D Seismic Grid



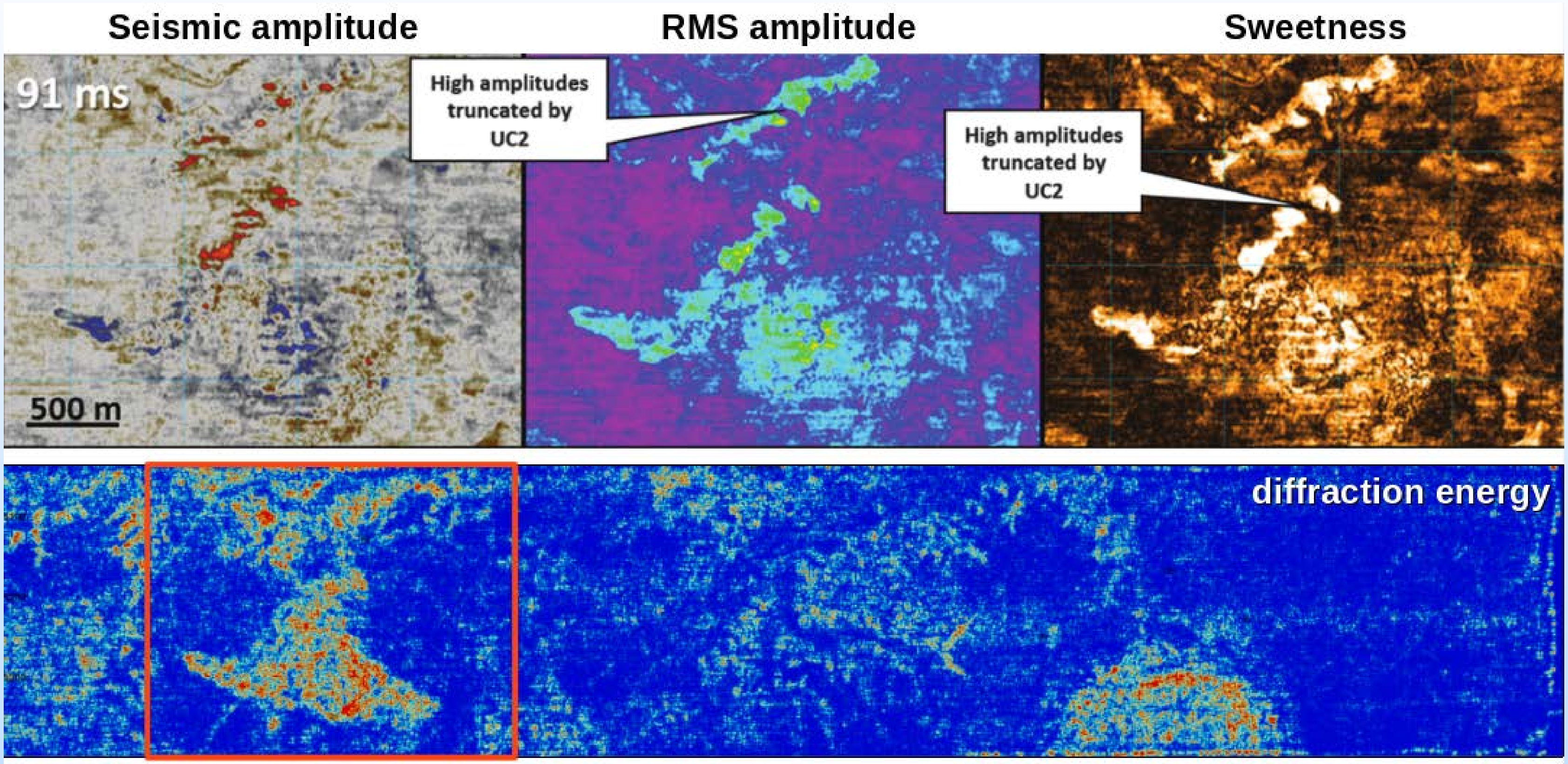
Assess Confining Zone (Seal) Interval Characteristics (Micro-Scale)







Assess Confining Zone (Seal) Interval Characteristics (Macro-Scale)



**Using UHR3D datasets*

Production Decline Analysis - 22 Offshore Oil & Gas fields: Dynamic Capacity Estimate (EASiTool)

$$CBP = V_o B_o + \frac{V_g}{5.615 E_g}$$

CBP = Cum. Bulk Production
V_o = total oil production (standard conditions),
B_o = oil formation volume factor,
V_g = total gas production (standard conditions)
E_g = gas expansion factor

$$\boldsymbol{Equivalent}\ Mass\ (CO_2) = CBP \times \rho_{CO_2}$$

Where ρ_{CO_2} represents CO_2 density at reservoir conditions of T_{res}, P_{res} (reservoir temperature and reservoir pressure, respectively)

Number of Field	Field	Reservoirs	CBP (bbl)	Equivalent Mass of CO_2 (Million Metric Tons)
1	Crystal Beach (TX)	7500	1.03E+05	0.012
		DISCORBIS B, LO.	4.63E+03	0.001
		S-1	8.86E+06	1.072
		7700	1.00E+03	0.000
2	Galveston 176-S (TX)	MIOCENE A-12, FB 2	8.20E+04	0.009
		MIOCENE D-1	2.46E+05	0.028
		MIOCENE S-2*	2.99E+03	0.000
		MIOCENE S-1	1.63E+06	0.185
3	High Island 10-L (TX)	6950 SD	2.00E+03	0.000
		BIG 3	5.10E+04	0.006
4	High Island 14-L (TX)	6700*	1.11E+06	0.119
		8700	8.50E+06	0.933
		10000*	6.24E+07	7.920
5	High Island 19-S (TX)	36-B SD.	1.28E+05	0.015
6	High Island 20-S (TX)	5800	7.00E+03	0.001
7	High Island 23-L (TX)	LH-10	1.49E+06	0.207
		LH-13	2.59E+06	0.350
8	High Island 52 (TX)	M26	4.30E+05	0.047
		M30	2.20E+05	0.024
		M48	1.71E+06	0.194
		M49/M50	5.80E+06	0.657
		M50	3.17E+07	4.098
9	High Island 160 (TX)	B	4.72E+07	5.361
		C	7.60E+07	8.614
10	High Island 179 (TX)	G SD	1.69E+07	1.812
		H8SD	1.45E+07	1.640
		I SD	1.82E+07	2.074
		J3SD	2.27E+06	0.267
		J4SD	7.78E+06	0.908
		N SD	1.66E+07	2.032
		60	7.60E+06	0.980
11	Caplen (TX)	FB-4, 2-B, UP	4.70E+04	0.003
		MIOCENE 4000	1.58E+03	0.000
		MIOCENE 4300	8.10E+04	0.006
		MIOCENE 4430	1.85E+05	0.015
		MIOCENE 4650	5.60E+04	0.005
		SIPH D, 7250 SD	4.73E+04	0.004
		FB-5, 10	7.19E+05	0.075
12	Hog Bayou Offshore (LA)	AMPHISTEGINA	2.24E+06	2.236
		DISCORBIS_SANDS	2.29E+05	0.229
		LIEBUSELLA_SANDS	4.00E+06	3.996
13	Creole Offshore	CREOLE_SAND	3.16E+04	0.032
14	East Cameron 4 (LA)	12300_SAND	5.24E+04	0.052
15	East Cameron 14 (LA)	DB-1	3.65E+07	4.201
		DB-2	3.54E+07	4.189
		M11-3	6.77E+05	0.086
16	East Cameron 33 (LA)	CR54#6	1.05E+06	0.111
		NA	1.36E+07	1.499
		12900	6.51E+06	0.825
		MA1#10	7.31E+04	0.009
		NQ	3.10E+07	3.403
17	West Cameron 28 (LA)	14000	9.77E+05	0.131
		14300	1.09E+07	1.481
		15100	5.69E+05	0.078
18	West Cameron 33 (LA)	AMPH	5.43E+04	0.006
		CRIS	3.58E+04	0.004
		DIS B1	1.67E+07	1.795
		DIS B2	1.86E+07	2.014
19	West Cameron 45 (LA)	AMP5	9.52E+05	0.099
		AMP6	2.57E+05	0.027
		AMPH11	8.08E+05	0.082
		AMPH13	1.27E+06	0.131
		AMPH14	5.90E+05	0.065
		DISB1	1.50E+07	1.614
		DISB2	1.17E+07	1.203
		DISB5	4.80E+06	0.503
		E4	3.14E+06	0.334
		E8/E9/F9	1.96E+07	2.147
		E9/F4	2.66E+07	2.913
		F6	1.44E+08	15.384
20	West Cameron 66 (LA)	IR	3.83E+04	0.004
		IT	5.21E+07	5.935
		JA	2.28E+07	2.652
		LJ	6.76E+07	7.797
		MB	6.82E+04	0.008
		12700	3.01E+04	0.004
		T	8.01E+06	1.138
		TO	0.00E+00	0.000
21	West Cameron 71 (LA)	30	2.07E+07	2.151
		3034	1.63E+07	1.743
		31	7.14E+06	0.742
		35	2.22E+06	0.242
		39	3.85E+07	4.082
		44	8.15E+07	8.855
		46	1.22E+08	12.928
		47	5.82E+06	0.618
		51	7.11E+07	7.556
		90	1.03E+08	13.920
		94	1.90E+07	2.480
		MA10	7.81E+07	10.737
		MA2529	5.31E+06	0.702
		MA40	5.47E+06	0.747
22	West Cameron 118 (LA)	7150	2.71E+07	2.668
		9150	8.33E+06	0.879
		DISCB1	1.55E+04	0.002
		MO-8	9.95E+05	0.116

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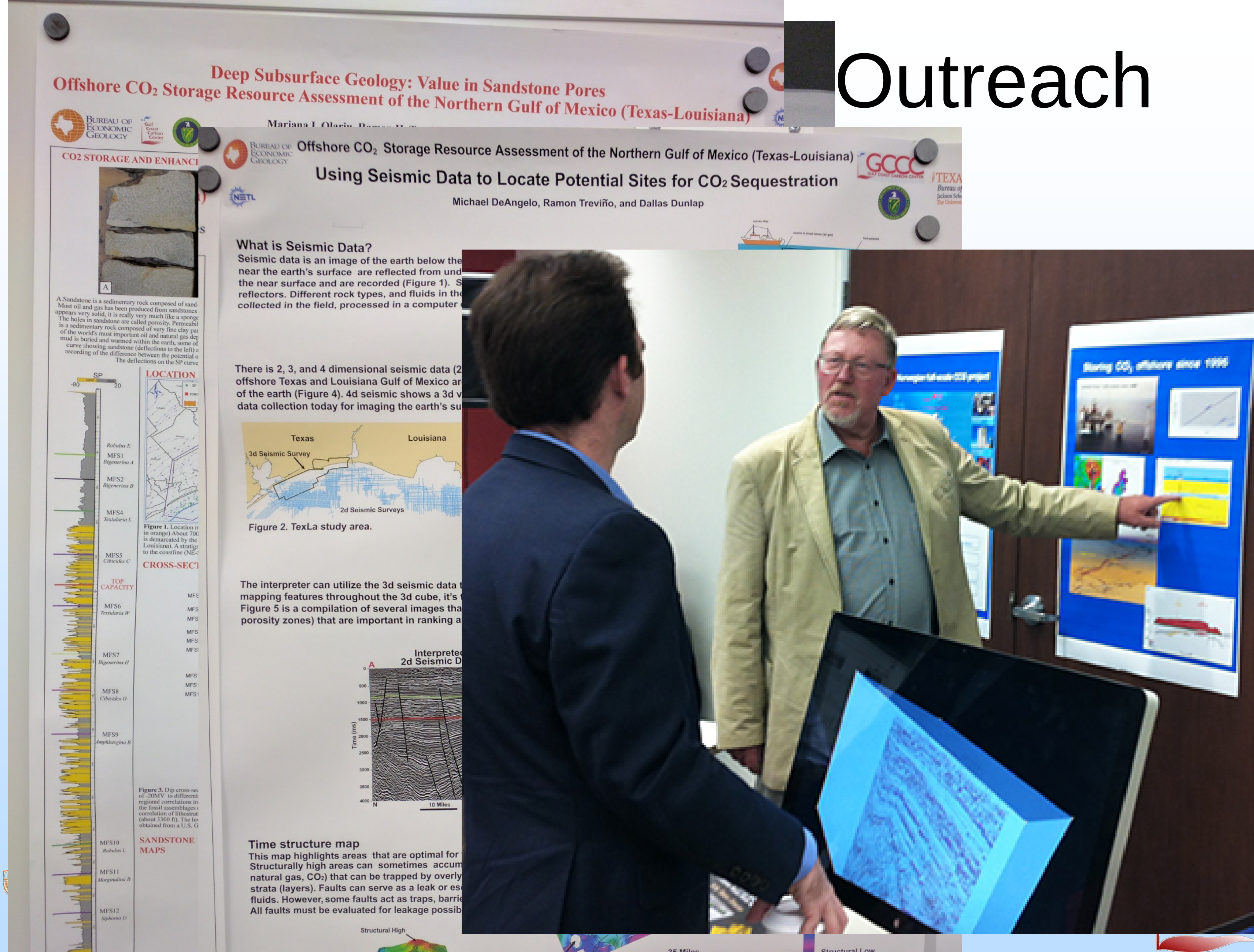
Outreach



Deep Subsurface Geology: Value in Sandstone Pores
Offshore CO2 Storage Resource Assessment of the Northern Gulf of Mexico (Texas-Louisiana)
Bureau of Economic Geology
CO2 STORAGE AND ENHANC
LOCATION
CROSS-SECT
SANDSTONE MAPS
Offshore CO2 Storage Resource Assessment of the Northern Gulf of Mexico (Texas-Louisiana)
Using Seismic Data to Locate Potential Sites for CO2 Sequestration
Michael DeAngelo, Ramon Treviño, and Dallas Dunlap
What is Seismic Data?
Texas
Louisiana
3d Seismic Survey
2d Seismic Surveys
Figure 2. TexLa study area.
Time structure map
Storing CO2 offshore since 1996

Accomplishments to Date

- Correlated ~2000 wells
- Interpreted 8 major seismic horizons
  - Sequence boundaries or maximum flooding surfaces
  - Converted seismic to depth
- Analyzed Confining zone (micro & macro)
- Analyzed 500 wells' production data (22 fields)
  - Calculate equivalent mass of injected CO2
- Local and regional outreach

Lessons Learned

- Plenty of well data!
  - well logs, production data,
- More seismic data than originally anticipated
  - …and probably more released soon
- Lack of rock material (cores) for interval of interest
  - Only two whole cores identified / analyzed
- Unanticipated research difficulties
  - Key research staff member recently barred from project
    - *international political affairs*

Synergy Opportunities

- PI Meckel is participant on Battelle's mid-Atlantic Assessment Project (AAP).
  - Monthly phone conferences
- Trevino TXLA presentation SECARB (Atlanta)
  - L. Cummings (AAP); J. Pashin, J. Knapp (SOSRA)
  - SSEB (SOSRA Prime) hosts meeting
- International Workshop on Offshore Geologic CO_2 Storage (June, 2017, Beaumont, TX)
  - Neeraj Gupta (AAP); J. Knapp, J. Pashin (SOSRA)
- SSEB (SOSRA prime): Outreach on TXLA

Project Summary

- Key Findings
  - Large amount of potential reservoir rock
    - Oil & Gas Fields
    - Saline
  - Confining zone adequate
    - Micro-scale: positive results
    - Macro-scale: seismic diffraction energy with UHR3D
      - potential new tool
- Next Steps
  - Regional static storage capacity assessment
  - Identify Leads & Prospects (candidates)
  - Dynamic capacity assessment (EASiTool)

Acknowledgements

- Jerry Carr (NETL PM)
- Tip Meckel (PI)
- Mike DeAngelo (geophysicist)
- Dallas Dunlap (geophysicist)
- Iulia Olariu (geologist)
- Alexander Klokov (geophysicist
- Ali Goudarzi (engineer)
- Reinaldo Sabbagh (GRA)

Appendix

– These slides will not be discussed during the presentation, but are mandatory.

Benefit to the Program

- **Goal (3) of the Carbon Storage Program**: "*Support industry's ability to predict CO_2 storage capacity in geologic formations to within ±30 percent*" by **assessing potential regional storage formations** in State and Federally regulated offshore areas of the United States.
- **Goal (4) of the Carbon Storage Program**: "*Develop Best Practice Manuals for monitoring, verification, accounting (MVA), and assessment; site screening, selection, and initial characterization; public outreach; well management activities; and risk analysis and simulation*" by **producing information that will be useful for inclusion** in DOE Best Practices Manuals.

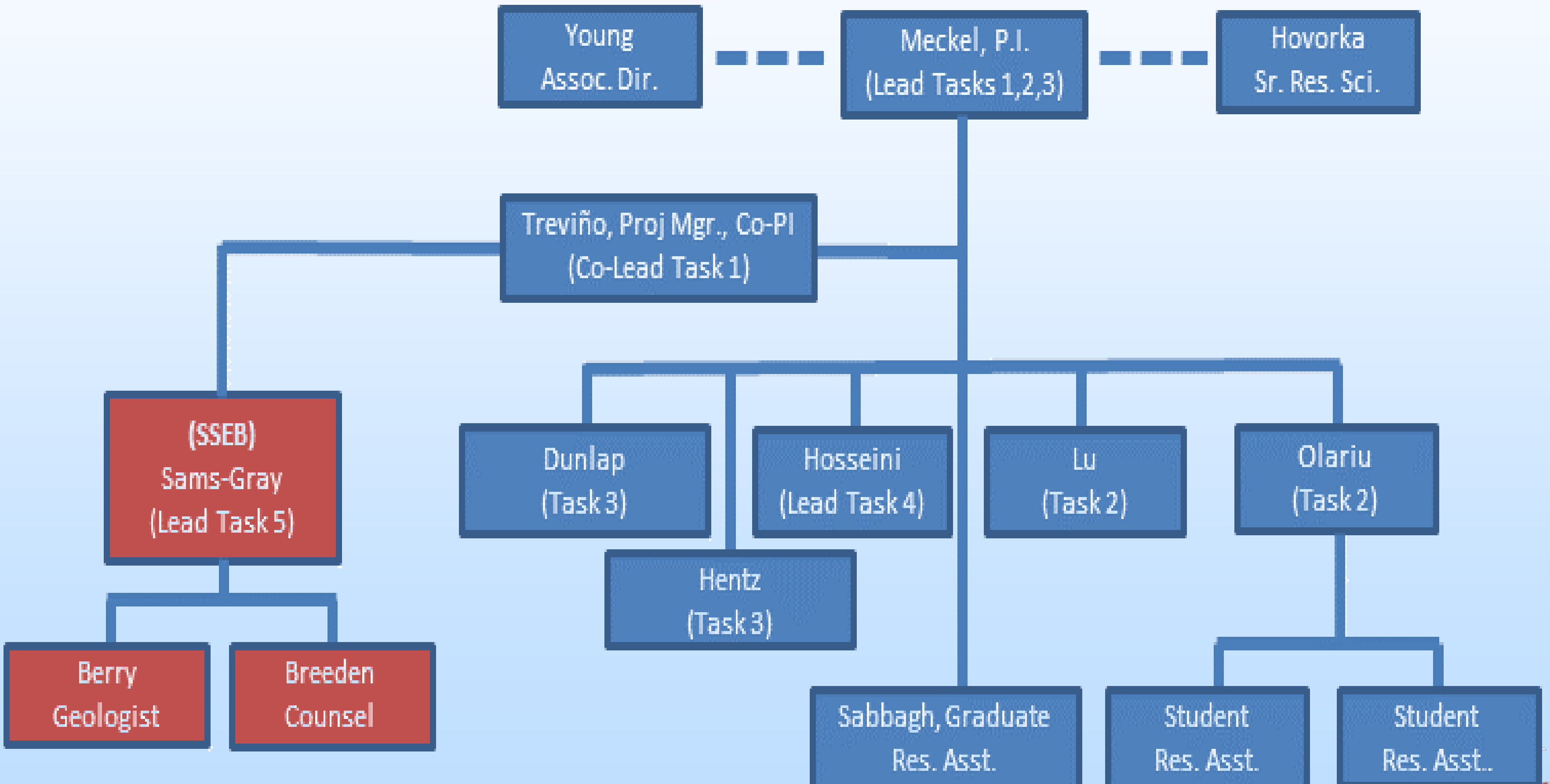
- BENEFITS STATEMENT: The methodology being developed is the assessment of offshore CO_2 storage resources in depleted hydrocarbon field settings or saline aquifers for offshore CO_2 storage applications. This approach will improve the current understanding of CO_2 storage potential for a large area of the Gulf of Mexico adjacent to significant industrial emissions sources. This projects supports Goals 3 & 4 of the Carbon Storage Program Plan by assessing potential regional storage formations in state and/or federally regulated portions of the Gulf of Mexico. The study will also produce information that will be useful for inclusion in DOE Best Practices Manuals, thus supporting Goal 4.

Project Overview

Goals and Objectives

- The objective of this study is to conduct an offshore carbon storage resource assessment of the Gulf of Mexico, Texas – Louisiana study area. This will be completed by:
  - Assessing the CO_2 storage **capacity of <u>depleted oil and natural gas reservoirs</u> utilizing existing data** (well logs, records and sample descriptions from existing or plugged/abandoned wells, available seismic surveys, existing core samples, and other available geologic and laboratory data) from **historical hydrocarbon industry activities in the heavily explored portions of the inner continental shelf** portions of the Texas and Louisiana Gulf of Mexico coastal areas; and
  - Assessing the ability and capacity of **<u>saline formations</u>** in the region to safely and permanently store nationally-significant amounts of anthropogenic CO_2 using existing data. Additionally, **the study will identify at least one specific site with potential to store at least 30 million tons of CO_2 which could be considered further for a commercial or integrated demonstration project in the future**.
  - The project will also **<u>engage the public and other stakeholders</u>** for the region through outreach activities to apprise them of the study objectives and results.

Organization Chart



Gantt Chart

Bibliography

– List peer reviewed publications generated from the project per the format of the examples below.

- Klokov, A., R. H. Treviño, and T. A. Meckel, 2017, Diffraction imaging for seal evaluation using ultra high resolution 3D seismic data: Marine and Petroleum Geology, v. 82, p. 85-96.