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

"TXLA"

DE-FE0026083

Tip Meckel, Ramon Trevino, & Susan Hovorka

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The University of Texas at Austin

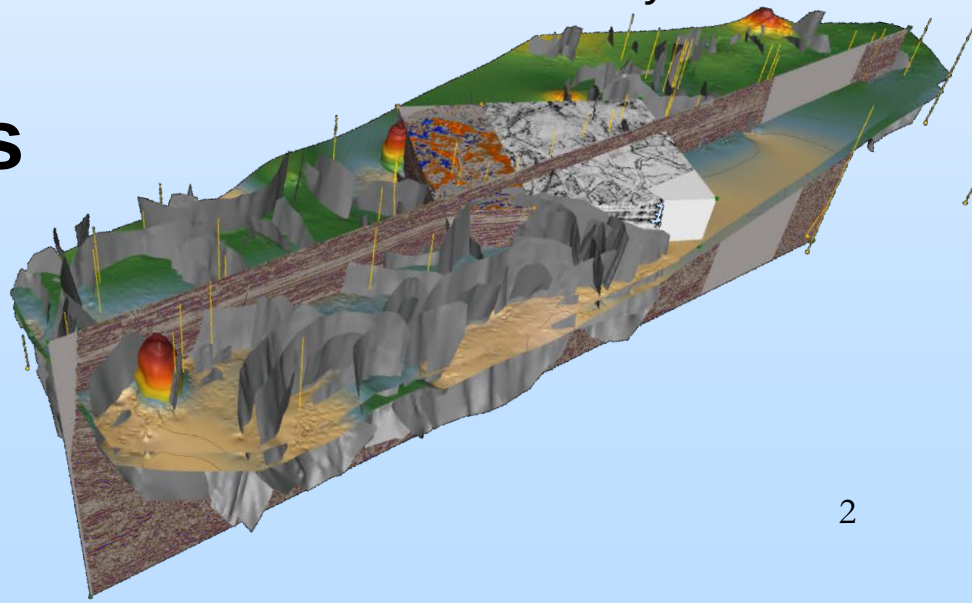
Gulf Coast Carbon Center

U.S. Department of Energy
National Energy Technology Laboratory
Addressing the Nation's Energy Needs Through Technology Innovation – 2019 Carbon Capture, Utilization, Storage, and Oil and Gas Technologies Integrated Review Meeting
August 26-30, 2019

Presentation Outline

- **Goals and Objectives**
- **Technical Status**
- **Project Accomplishments**
- **Lessons Learned**
- **Summary**
- **Acknowledgements**

Cover image: Petroleum Geoscience 25th Anniversary Edition



TXLA Goals & Objectives

Assess:

- Offshore 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

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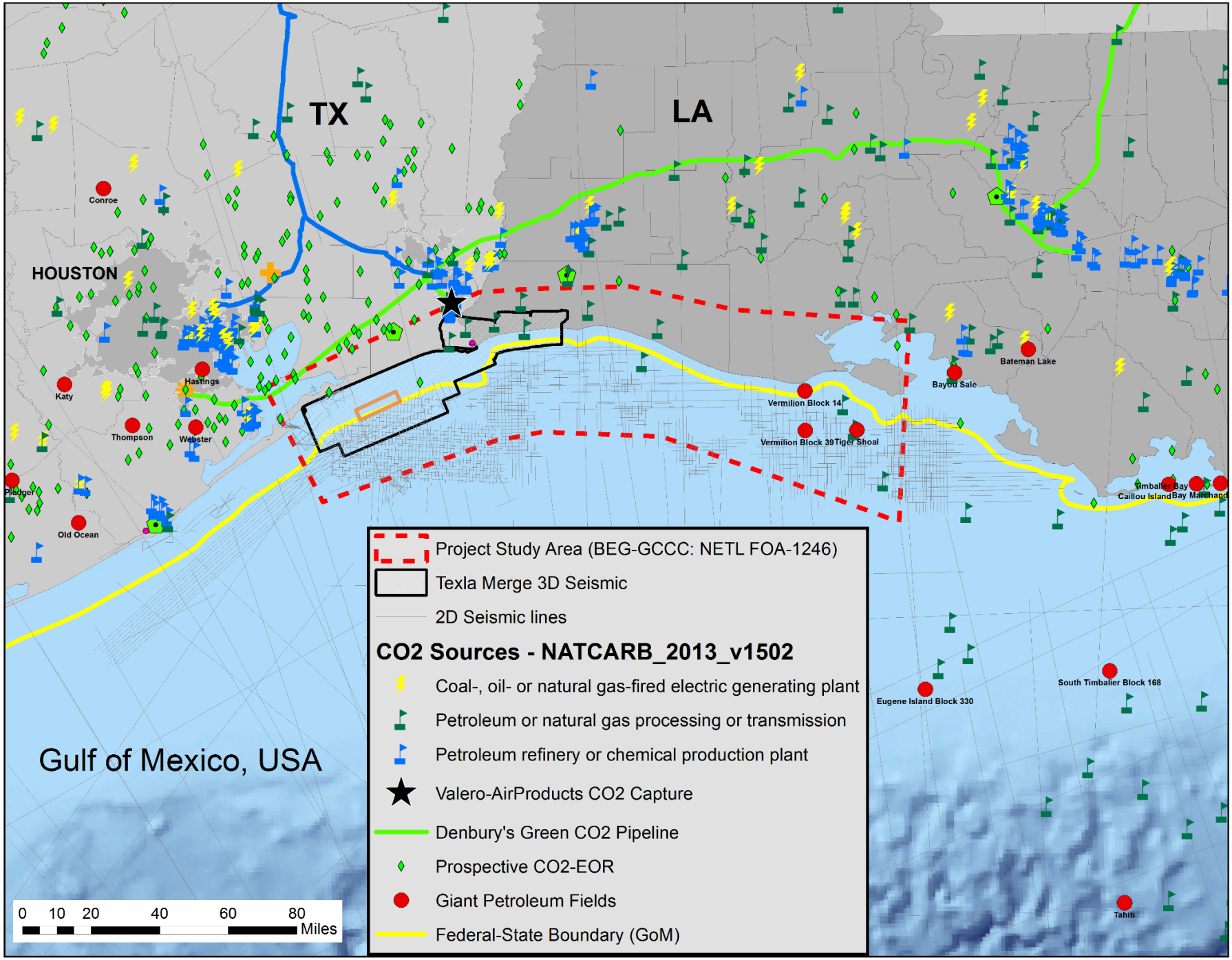
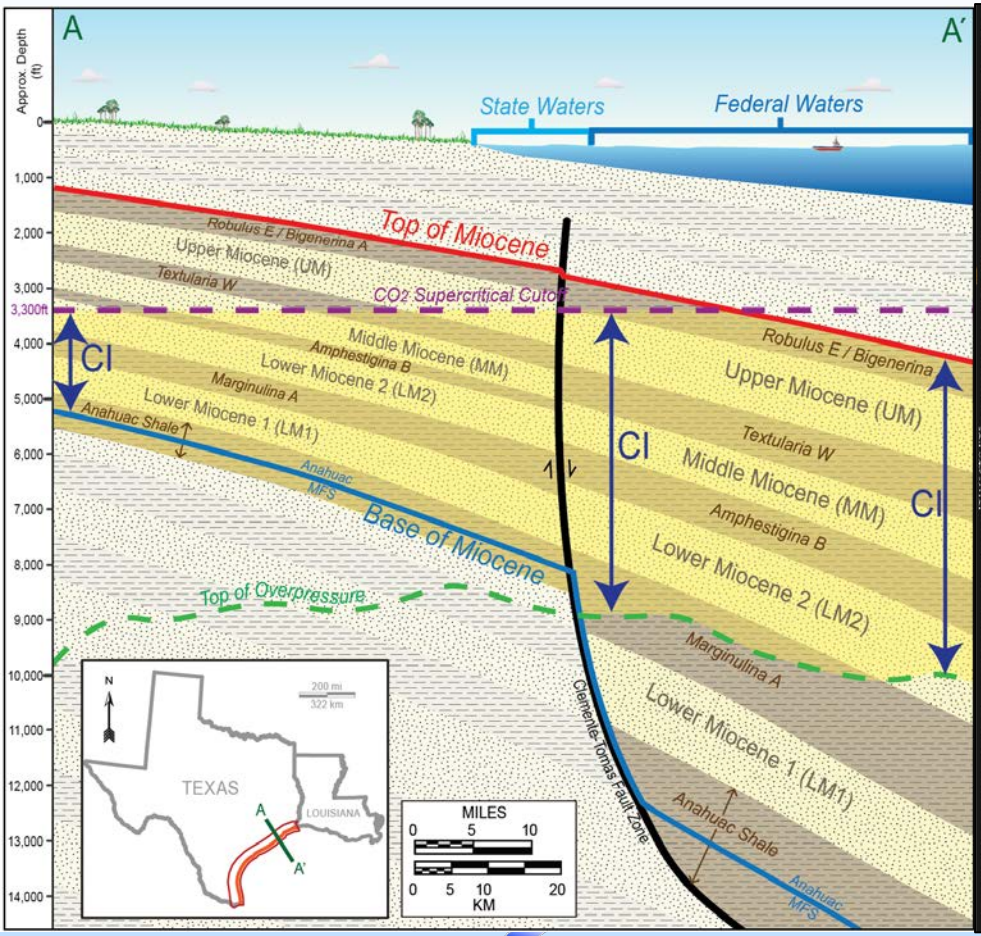
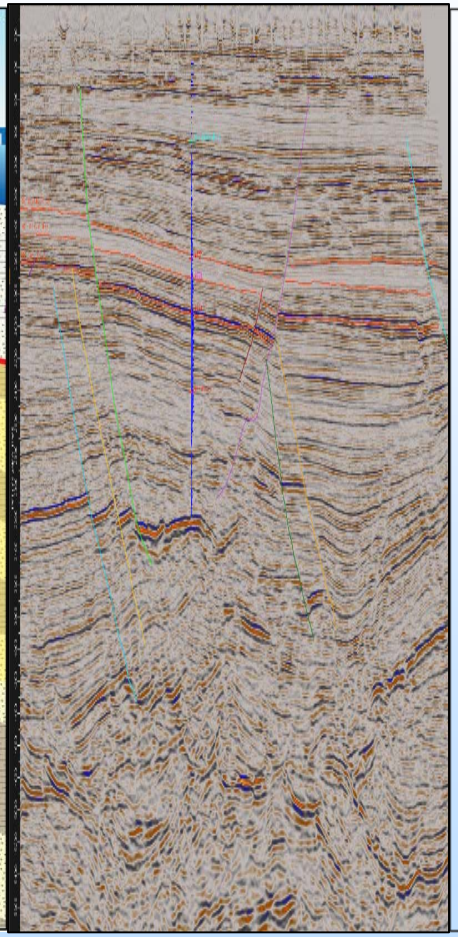
Technical Status

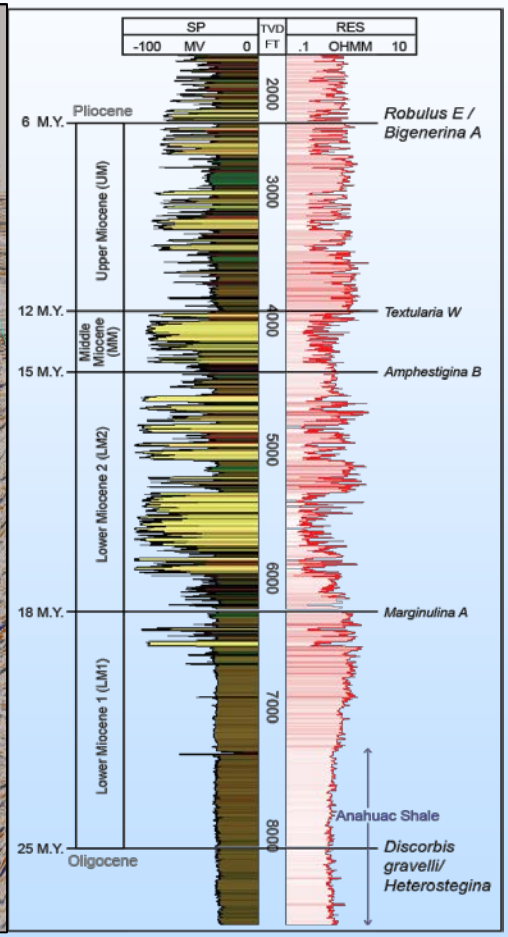
- **Project Overview**
- **Database Development**
  - **Interpretation**
- **Site Identification**
  - **Example – High Island 10-L Field**
  - **(HI 24-L presented last year)**


TX
LA
HOUSTON
Conroe
Katy
Hastings
Thompson
Webster
Pledger
Old Ocean
Bateman Lake
Bayou Sale
Vermilion Block 14
Vermilion Block 39
Tiger Shoal
Timbalier Bay
Caillou Island
Bay Marchand
Eugene Island Block 330
South Timbalier Block 168
Tahiti
Gulf of Mexico, USA
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)
0 10 20 40 60 80
Miles

Conceptual Overview







Subtask 2.1 – Database Development

Contents lists available at ScienceDirect

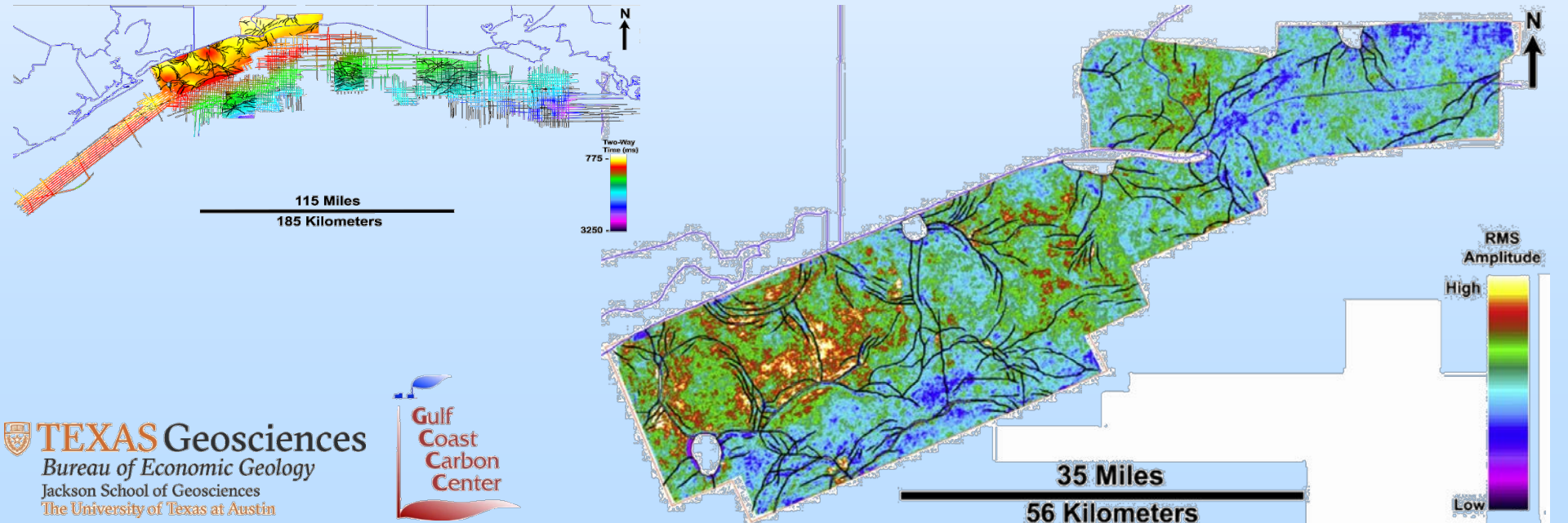
International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc

A seismic-based CO_2-sequestration regional assessment of the Miocene section, northern Gulf of Mexico, Texas and Louisiana

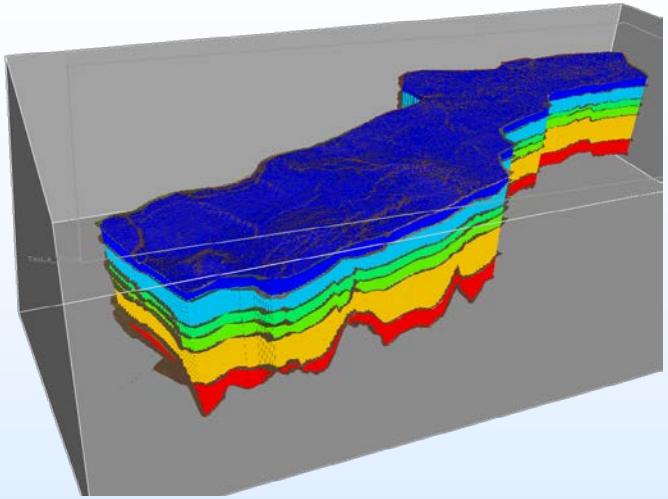
Michael V. DeAngelo*, Reynaldy Fifariz, Tip Meckel, Ramon H. Treviño

Gulf Coast Carbon Center, Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas, Austin, Texas, USA

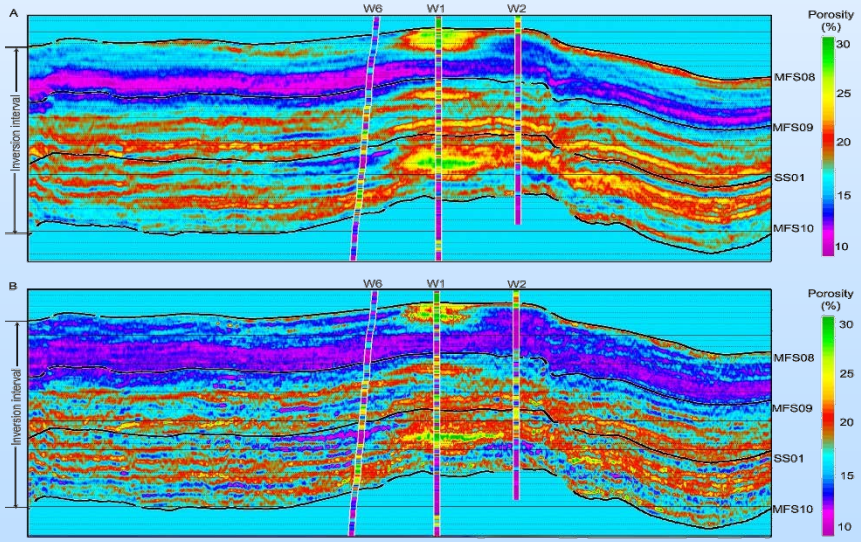


Subtask 3.1 – Regional Capacity Assessment

Regional framework over hundreds of square miles built using 7 depth-converted regional seismic horizons



Porosity prediction using multi-attribute analysis with limited well log data



Seismic profile showing porosity derived from the (A) linear regression and (B) PNN

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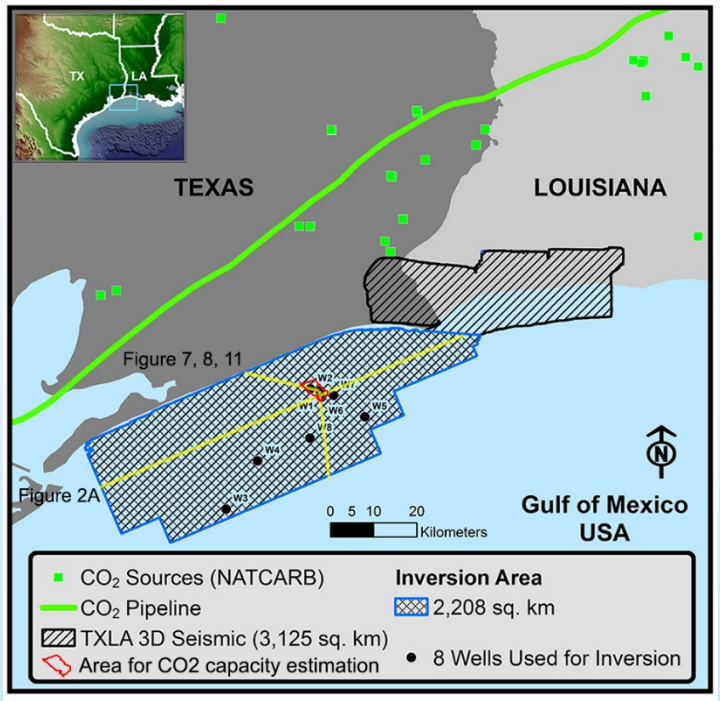
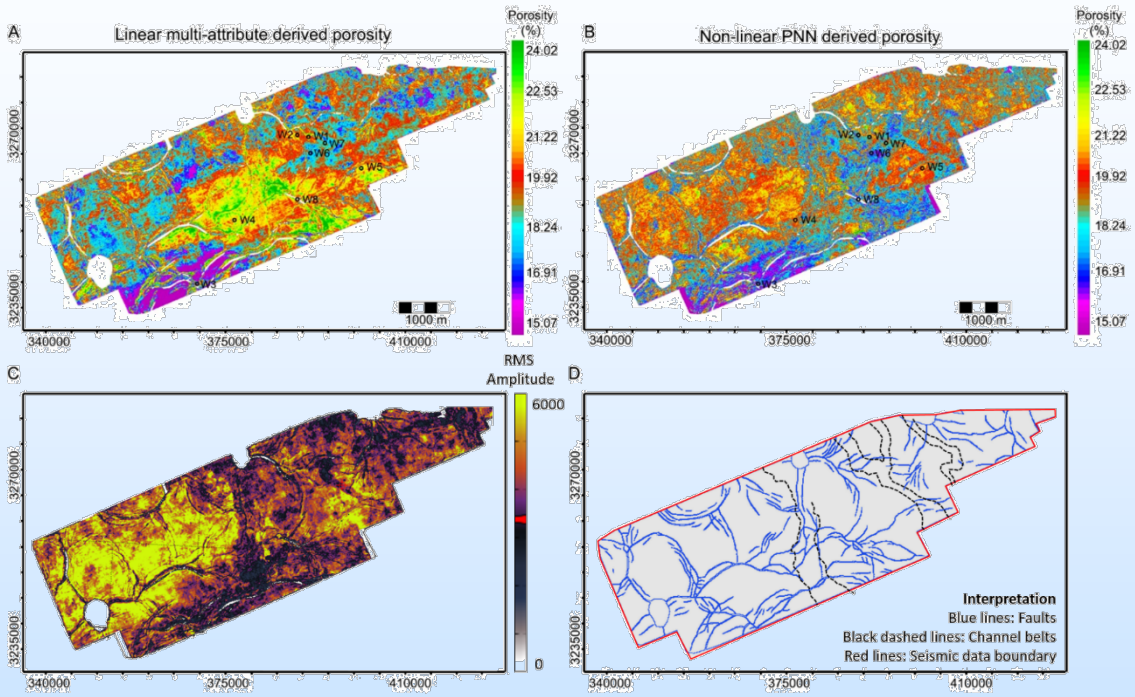
Seismic inversion for porosity volume

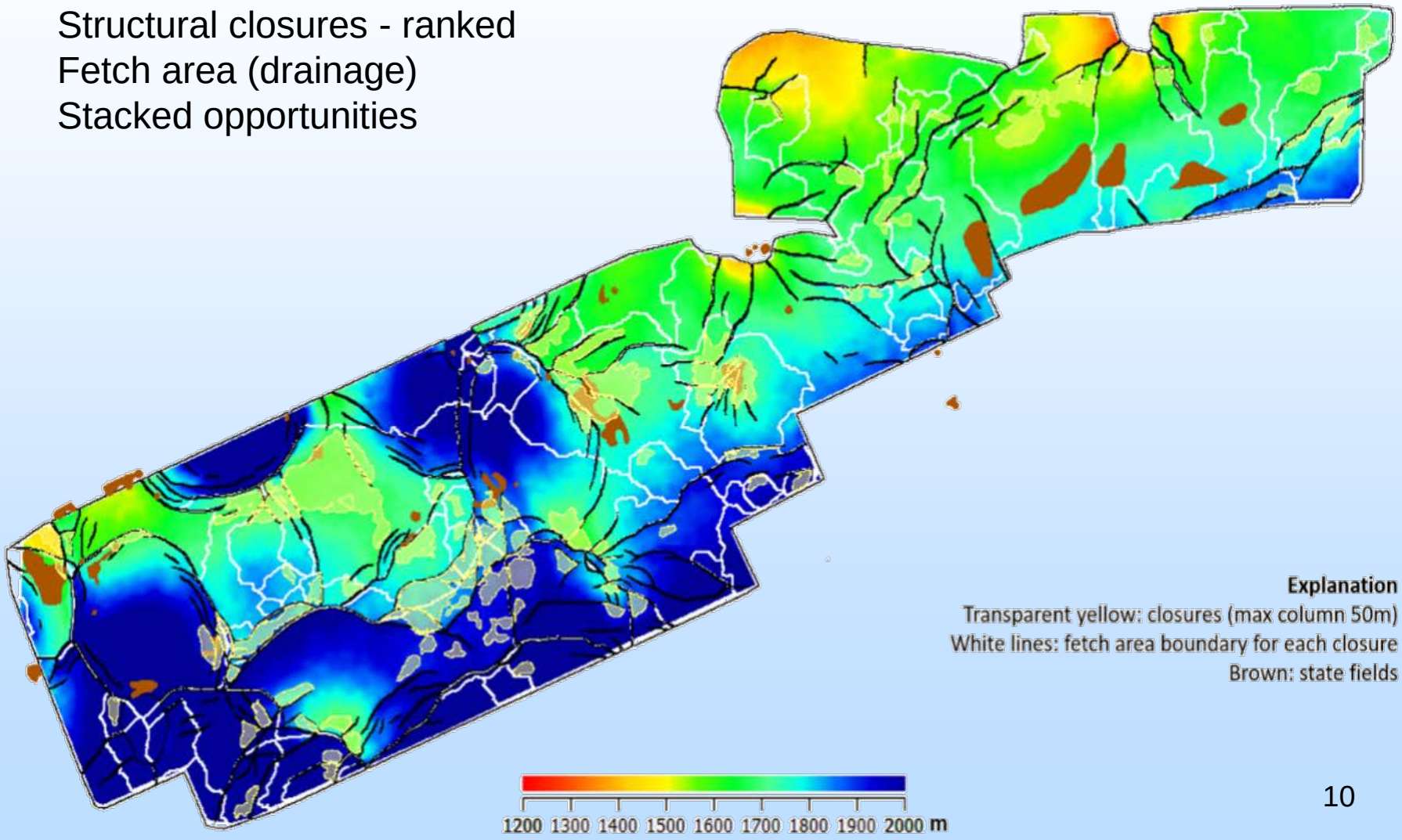




Feng et al., in preparation

Subtask 3.1 – Regional Capacity Assessment

Structural closures - ranked
Fetch area (drainage)
Stacked opportunities



Subtask 3.2 – Local Prospect Resource Assessment

- Perspectives from production data
  - Goudarzi et al., 2019, IJGGC

- Prospecting for 30 Mt site
  - Prior presentation of High Island site 24L
    - Izaak Ruiz, MSc Thesis
  - HI 10-L site CO_2 storage resources estimate
    - Omar Garcia, MSc Thesis

Perspectives from Production Data – Decline Curve Analysis

Contents lists available at ScienceDirect

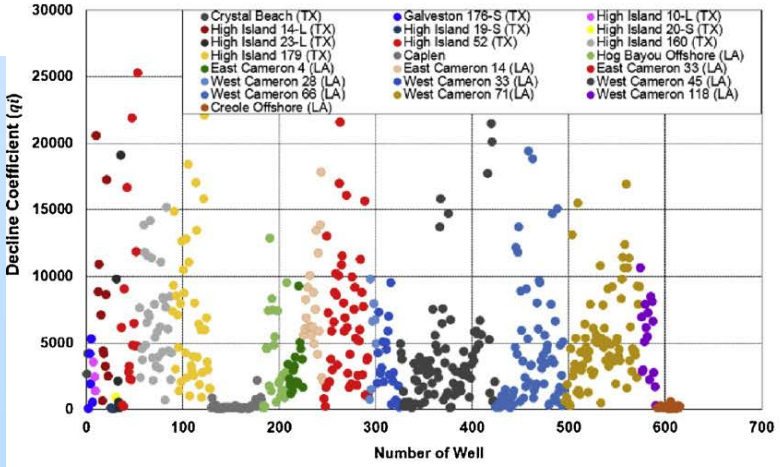
International Journal of Greenhouse Gas Control

journal homepage: www.elsevier.com/locate/ijggc

Statistical analysis of historic hydrocarbon production data from Gulf of Mexico oil and gas fields and application to dynamic capacity assessment in CO_2 storage

Ali Goudarzi*, Timothy A. Meckel, Seyyed A. Hosseini, Ramón H. Treviño

Bureau of Economic Geology, Jackson School of Geosciences, The University of Texas at Austin, USA



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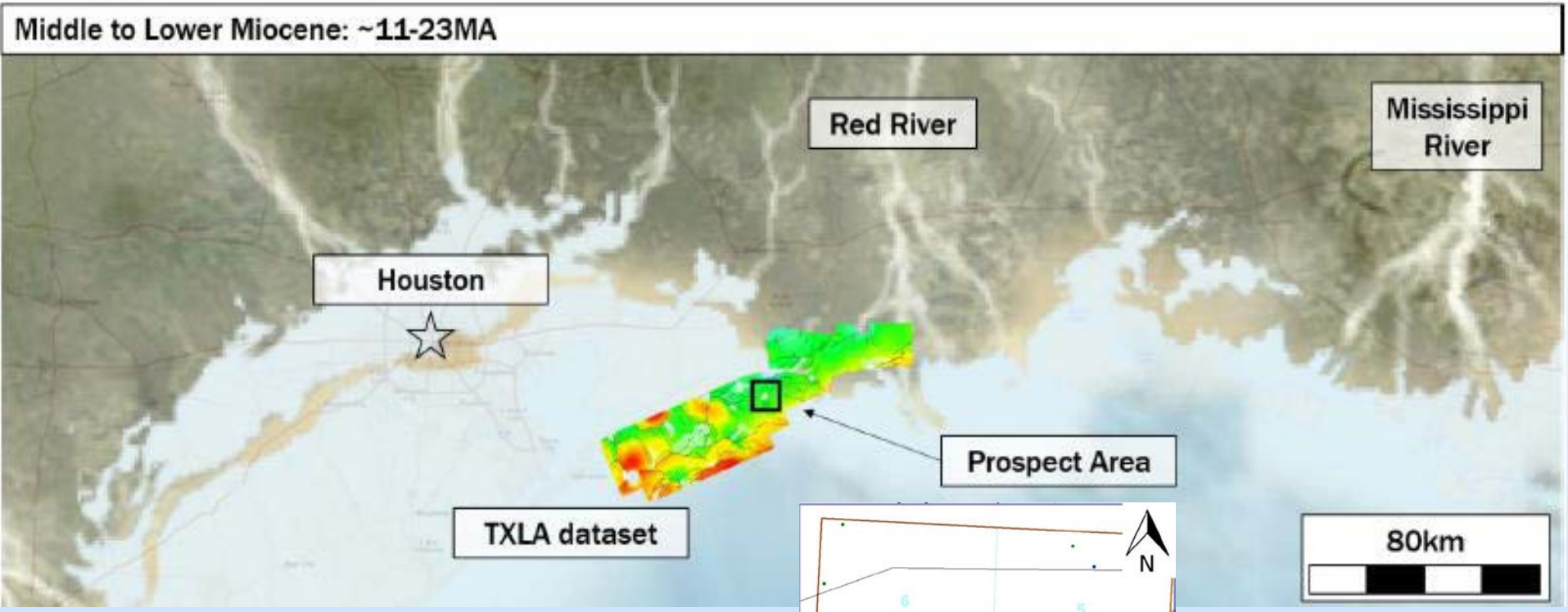
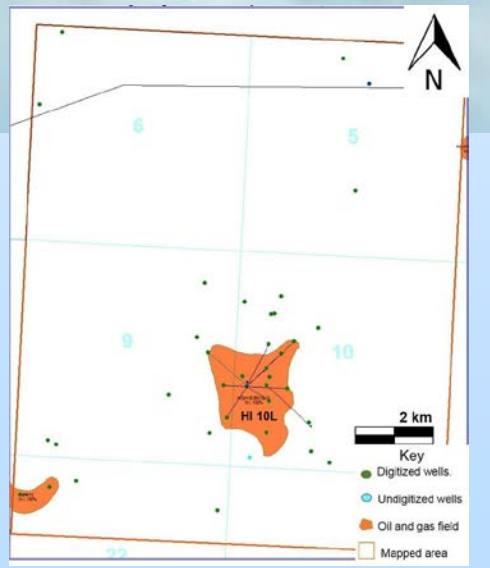
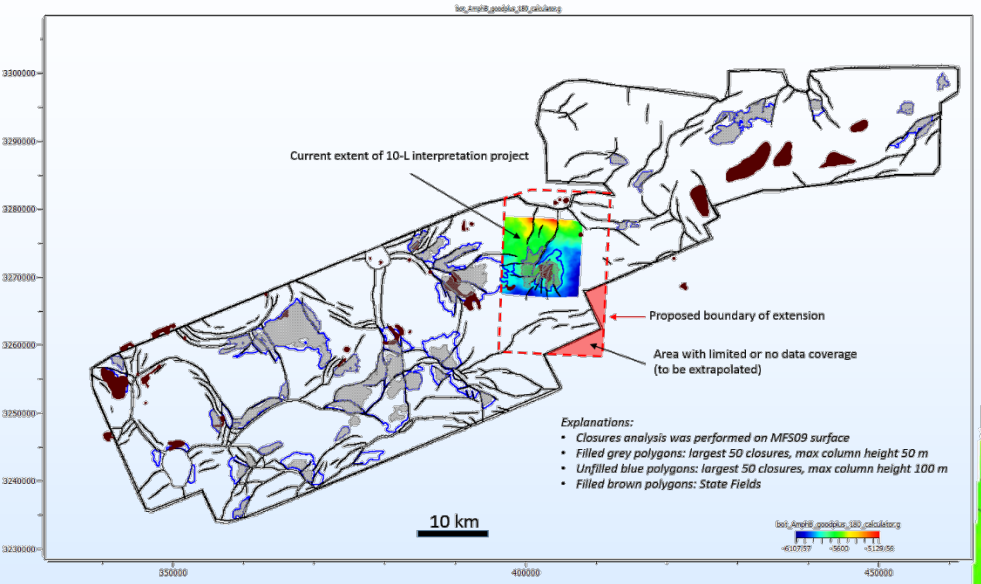
Prospecting – 30 MT Site
High Island 10-L field

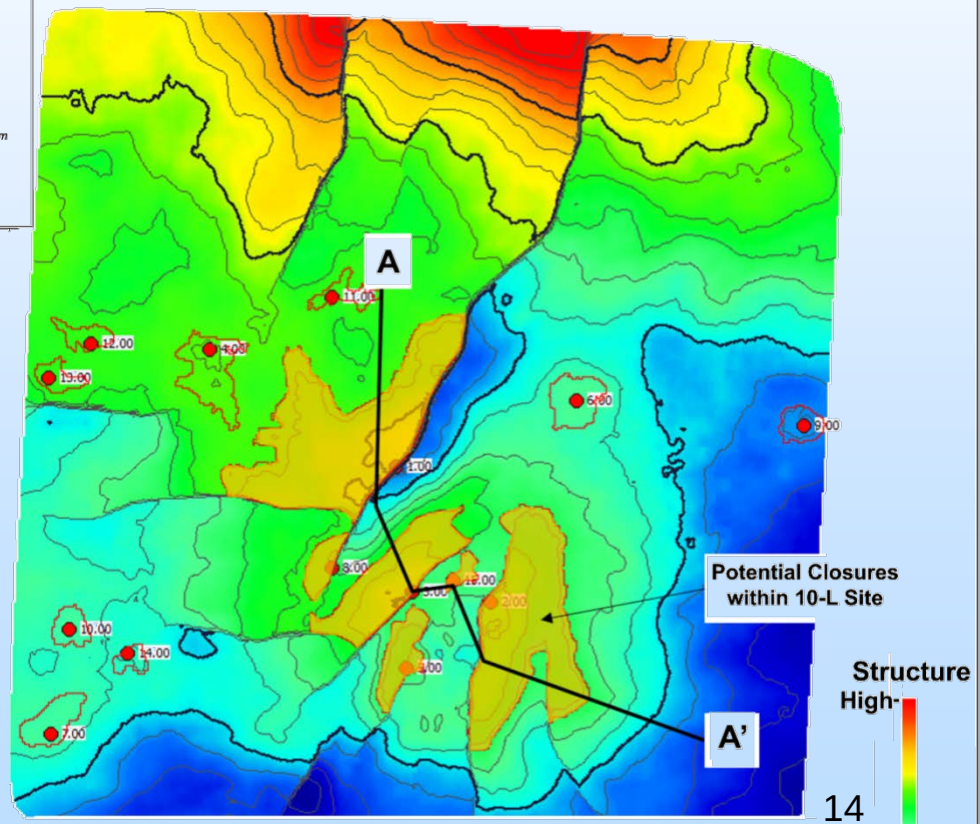


43 wells in area
3D seismic
Production history



High Island 10L field





Garcia, O., *Geologic characterization and modeling of the High Island 10-L field for CO_2 storage resource assessment in Texas State Waters, offshore Gulf of Mexico*, MS Thesis, UT-Austin, 123 p.

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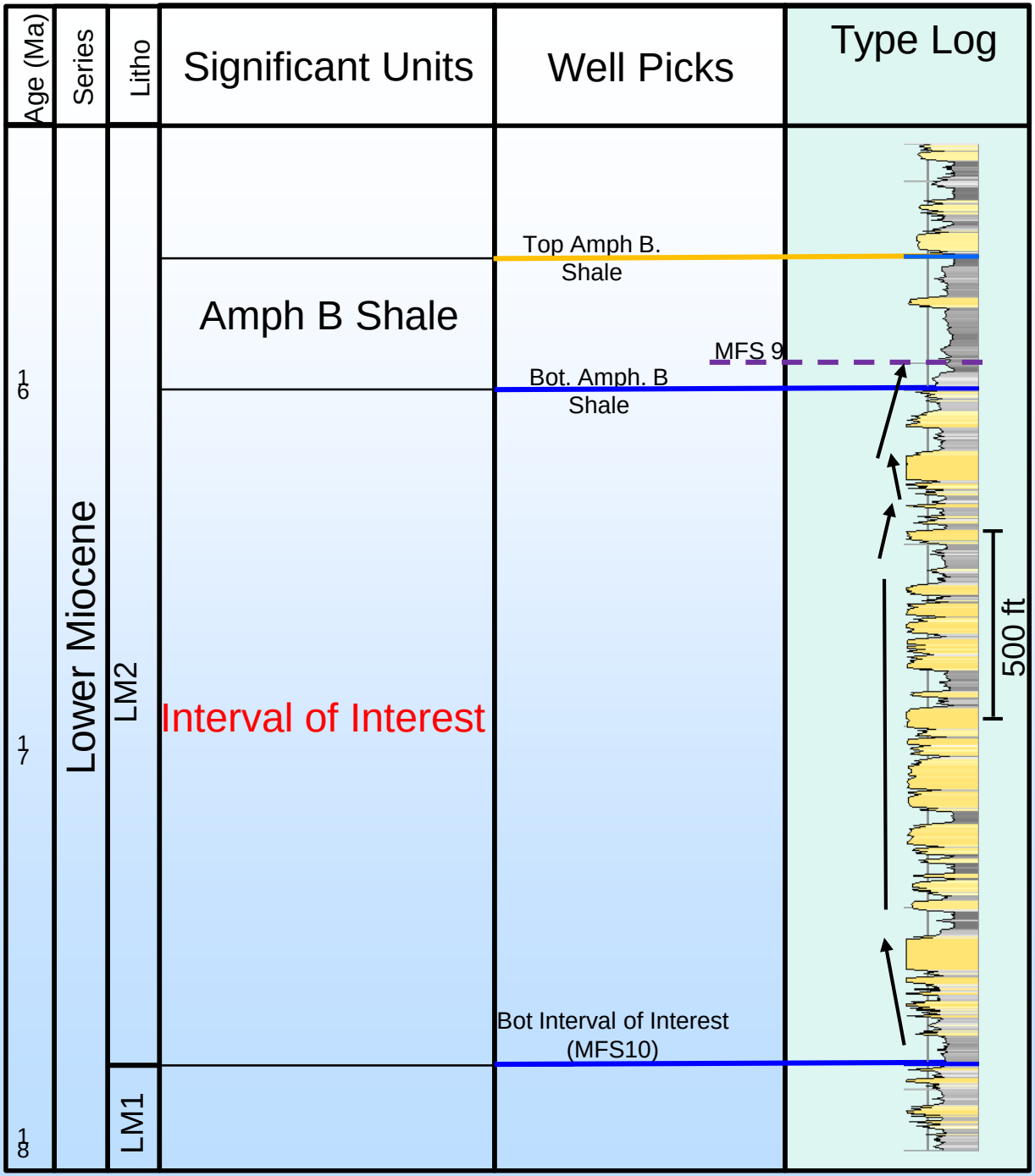
Play	Age	EOD	Year Disc.	Reservoir Depth (ft)	Area (acres)	HC Type	Pay (ft)	Drive	Trap	Porosity	Water Saturation	Oil Gas Ratio (MCf/STB)	Cumulative Oil (Mbbl)	Cumulative Gas (MMcf)
MM9 A.3A	Upper Middle Miocene	Aggradational Deltaic SS	1956	4,885	491	Oil, Gas	5	?	Rollover anticline, growth fault	29%	70.70%	246	51	0
MM4 R.1	Lower Middle Miocene	Retrogradational Deltaic SS	1980	6,101	2,506	Oil, Gas	8	WD	Rollover anticline, growth fault	31.30%	40.10%	229,657	828	7,212
MM4 A.1B	Lower Middle Miocene	Aggradational Deltaic SS	1982	6,952	166	Oil	5	?	Rollover anticline, growth fault	25%	57.70%	591	2	0
LM4 P.4	Middle Lower Miocene	Progradational Deltaic SS	1981	7,687	491	Oil, Gas	20	?	Rollover anticline, growth fault	29.20%	40.80%	128,501	109	2,650
LM2 P.1B	Middle Lower Miocene	Progradational Deltaic SS	1955	8,182	1,630	Gas	50	WD	Rollover anticline, growth fault	33.10%	35.60%	342,693	12	17,196

Table 1.1: Miocene play characteristics for High Island 10-L field. Data from Seni (1997).



Amph B = 360 ft
IOI = about 1700 ft

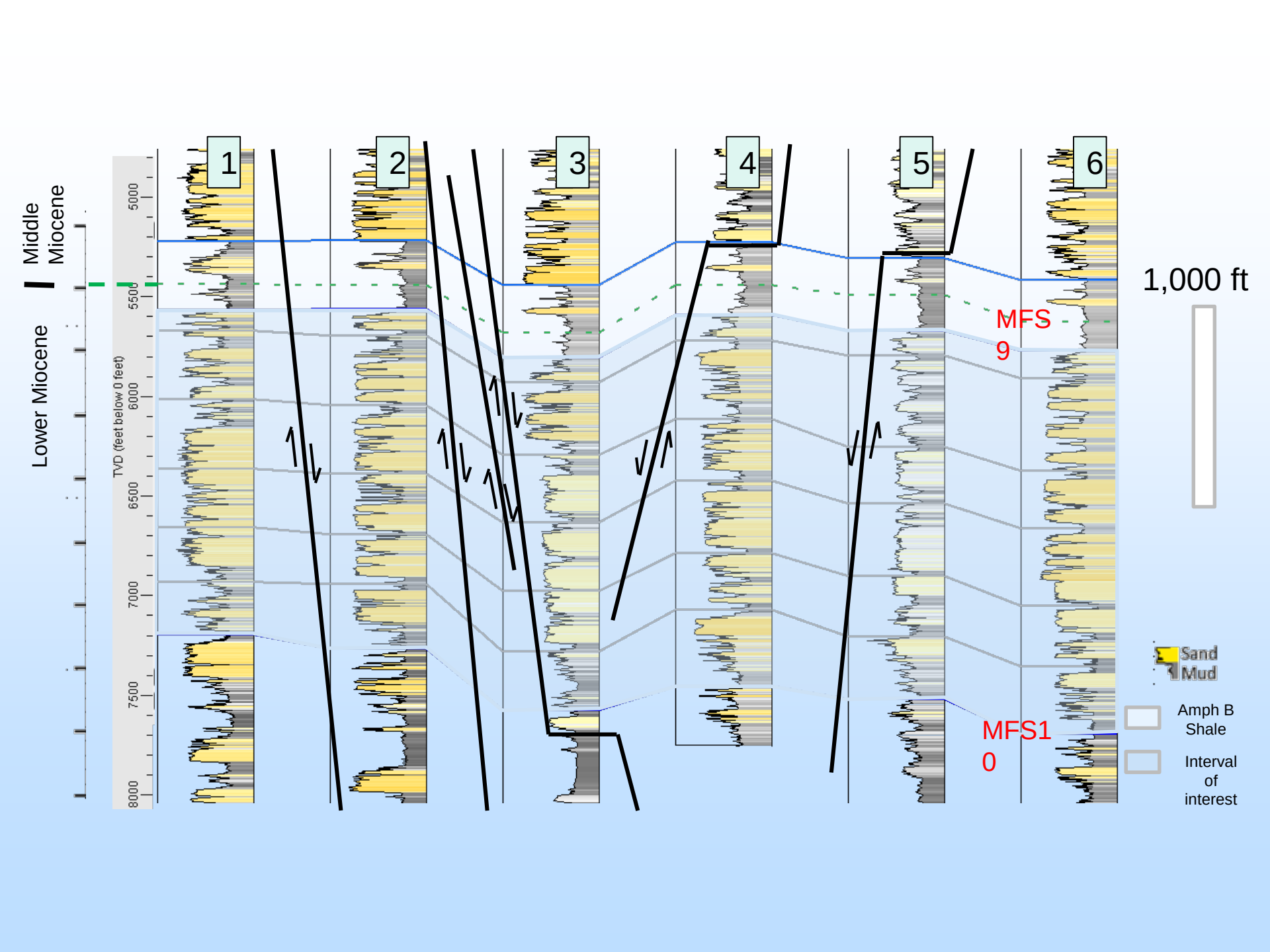
Sand
Mud

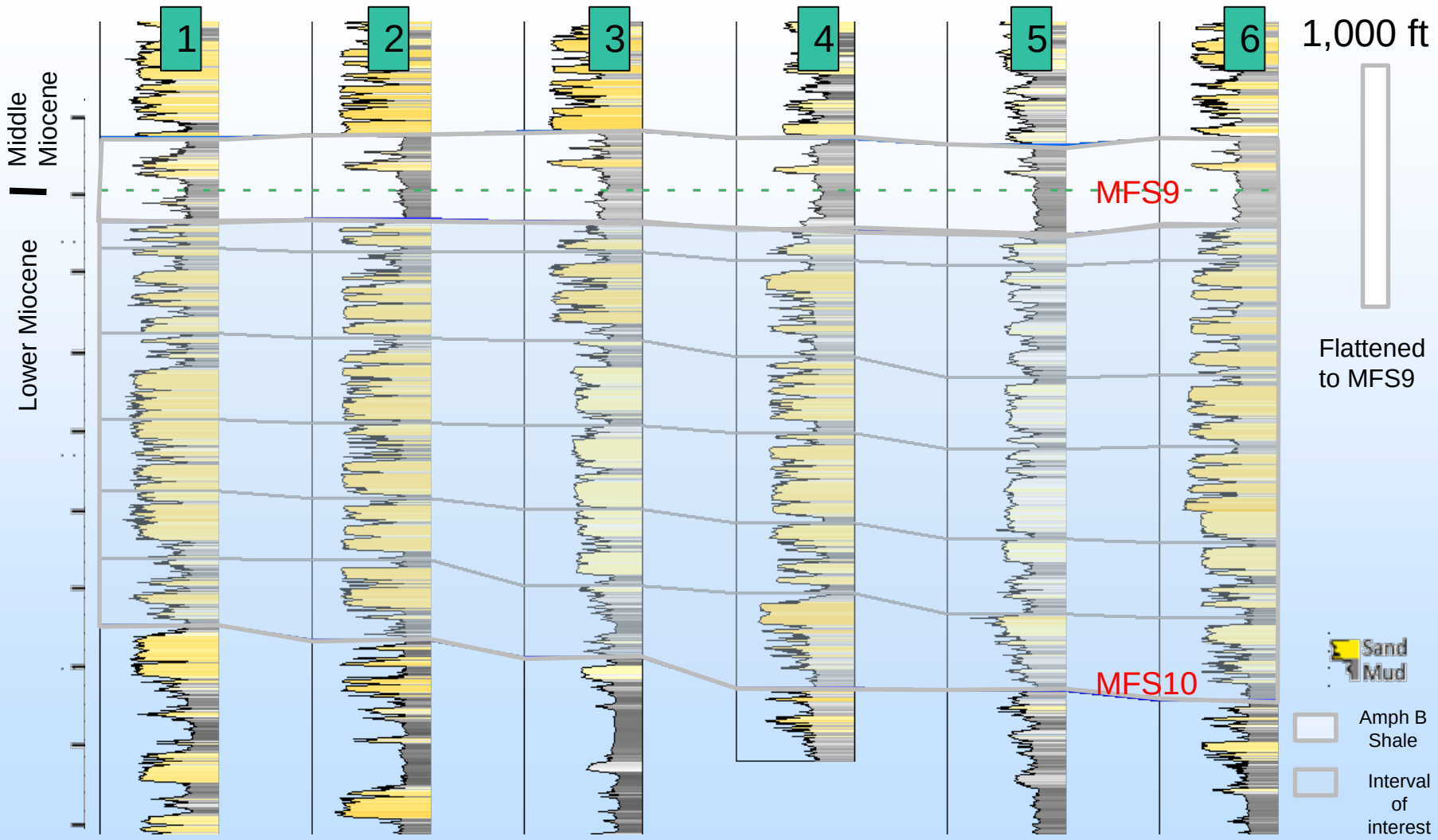
Stacking Patterns

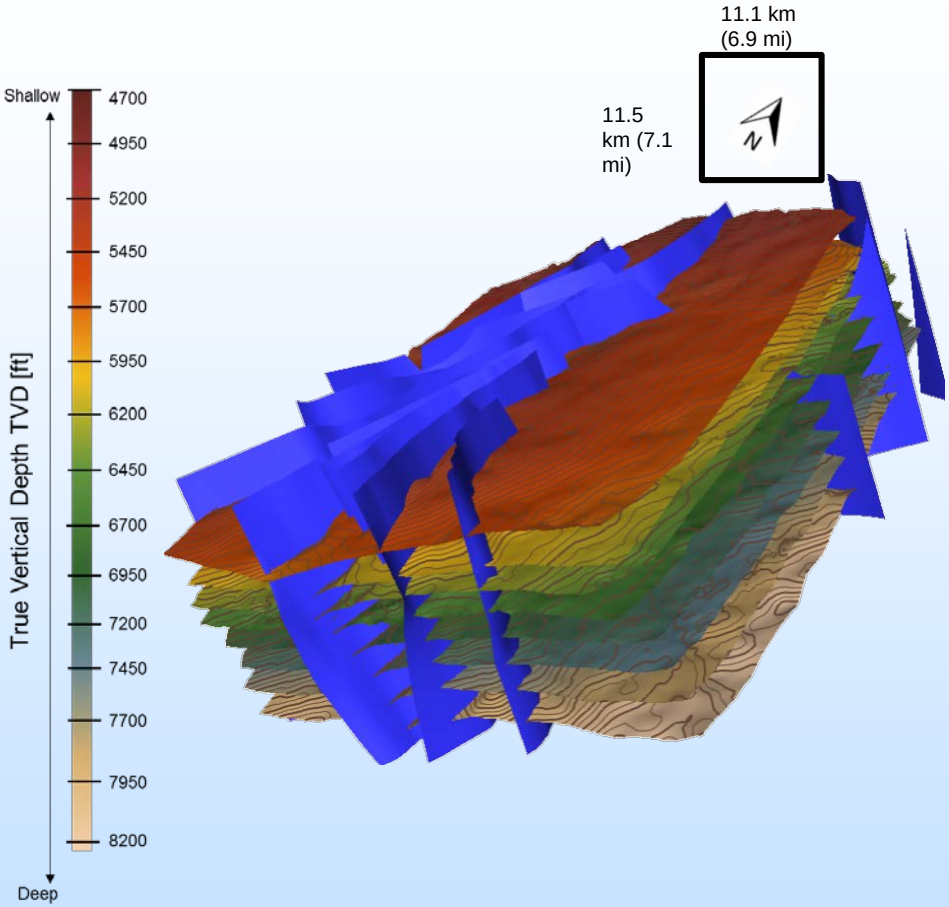
Retrogradational

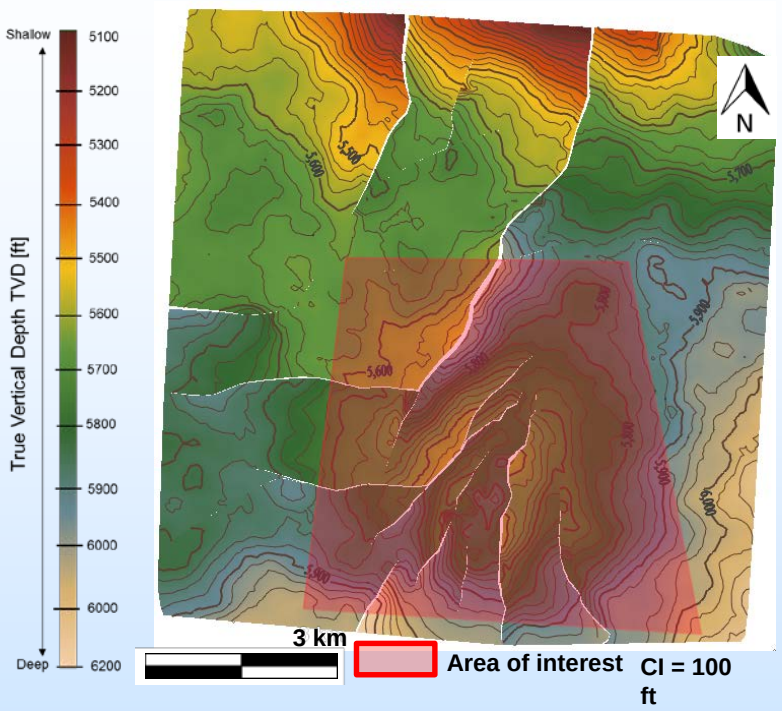
Aggradational

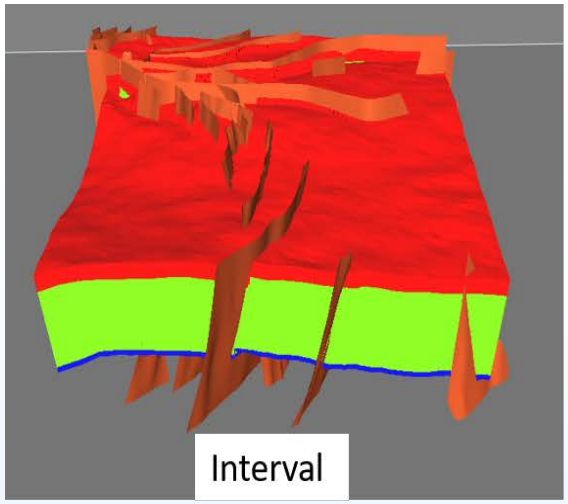
Progradational

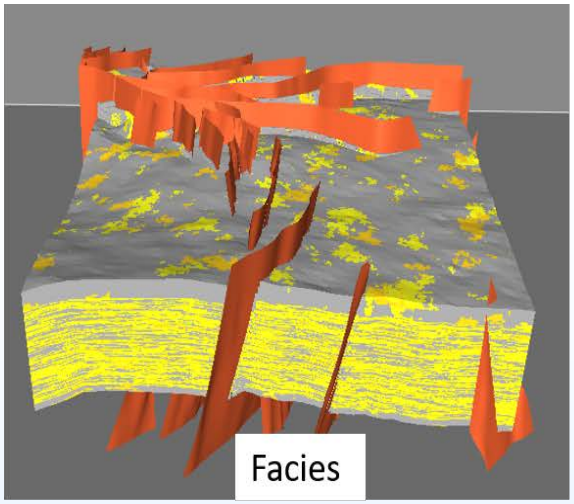

1
2
3
4
5
6
Middle Miocene
Lower Miocene
TVD (feet below 0 feet)
5000
5500
6000
6500
7000
7500
8000
MFS 9
MFS10
1,000 ft
Sand
Mud
Amph B Shale
Interval of interest

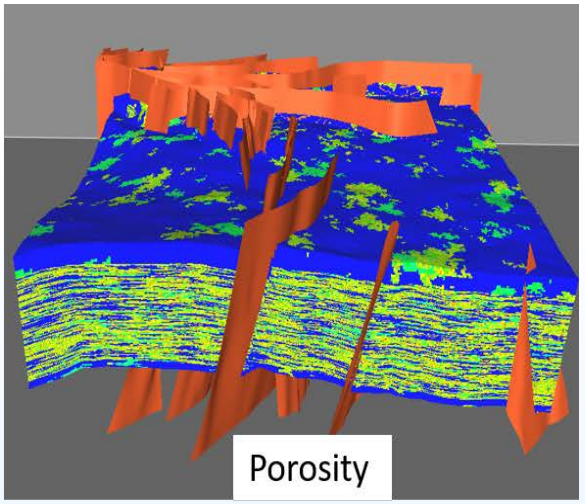

1
2
3
4
5
6
Middle Miocene
Lower Miocene
MFS9
MFS10
1,000 ft
Flattened to MFS9
Sand
Mud
Amph B Shale
Interval of interest


Shallow
4700
4950
5200
5450
5700
5950
6200
6450
6700
6950
7200
7450
7700
7950
8200
Deep
True Vertical Depth TVD [ft]
11.1 km
(6.9 mi)
11.5
km (7.1
mi)


Shallow
5100
5200
5300
5400
5500
5600
5700
5800
5900
6000
6000
6200
Deep
True Vertical Depth TVD [ft]
N
3 km
Area of interest
CI = 100
ft







	24-L			10-L		
	P10	P50	P90	P10	P50	P90
E_{saline} = Ev*Ed (Unspecified)	7.40%	14%	24%	7.40%	14%	24%
3D Model [Mt]	57	108	186	12	24	41
E_{saline} = Ev*Ed (Shallow shelf)	11%	23%	41%	11%	23%	41%
CO_2 SCREEN [Mt]	85	179	317	17	39	72

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Z Factor = 2.5

Recent Milestones

K. Quick-look report describing **CO_2 prospect categories** determined and analyzed in this work	11/30/2018
L. Quick-look report documenting the **static regional capacity estimates** determined in addition to **supporting data** including time/depth structure, porosity, isopach maps used for capacity calculations, as well as maps with capacity estimates gridded at appropriate resolution for the datasets used	12/31/2018
M. Complete a **summary sheet that describes the 30 Mt site(s)** identified	3/31/2019
N. Quick-look report documenting the results from the **EasiTool analyses** including capacity estimates, reservoir performance, summary statistics, and sensitivity analyses	Due 8/31/2019

Lessons Learned

- **Workflow for offshore storage resource characterization**
  - **Timeline, data, personnel, products**
- **Local resource assessment**
  - **Static capacity, historic production analysis, dynamic analytical.**
- **More seismic data than originally anticipated**
  - **Time to depth conversion requires careful implementation.**
- **Valuable synergy in continuity on topic**
  - **Rapid onboarding and moving up the learning curve.**

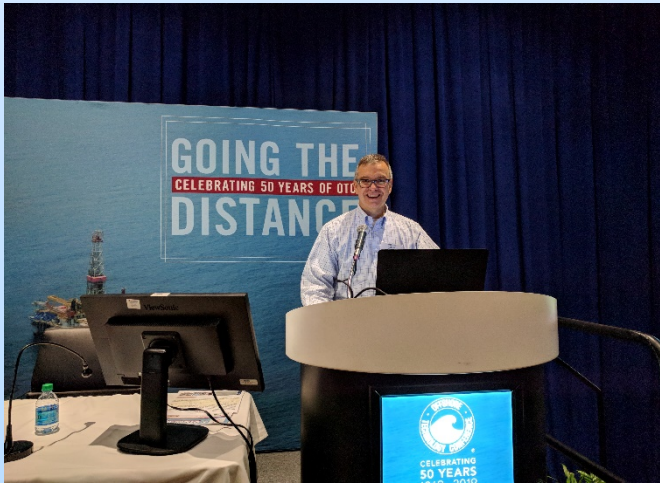
Synergy Opportunities

- Vanessa Nunez-Lopez: Austin Women in Oil & Gas seminar luncheon.
- Tip Meckel: Trondheim CCS Meetings (June, 2019, Norway); AAPG Annual Meeting (May, 2019, San Antonio).
- Reinaldo Sabbagh: received the Best Poster Award from the AAPG's Division of Environmental Geosciences (DEG) for 2018 ACE meeting. "*Pre-Injection Reservoir Characterization for CO_2 Storage in the Near Offshore Areas of the Texas Gulf of Mexico*".

Synergy Opportunities

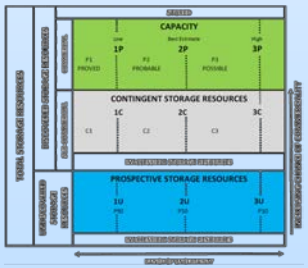
- April 15 and 16, 2019, Ramón Treviño attended a symposium and field trip of the American Beach and Shore Preservation Association (ASBPA), Texas Chapter: "Carbon Capture and Sequestration (Storage) – CCS: A Climate Change Mitigation Strategy for the Near-Offshore Northwestern Gulf of Mexico."
- On May 9, 2019 project co-PI, Ramón Treviño presented two talks, "What Offshore CCS Will Look Like in The Gulf of Mexico: Perspectives from Texas" and "Monitoring Stored CO_2 to Document Permanence" at the 50th annual Offshore Technology Conference in Houston.

ASBPA field trip, April 15, 2019, on the last stop of the field trip, Mustang Island, Texas.

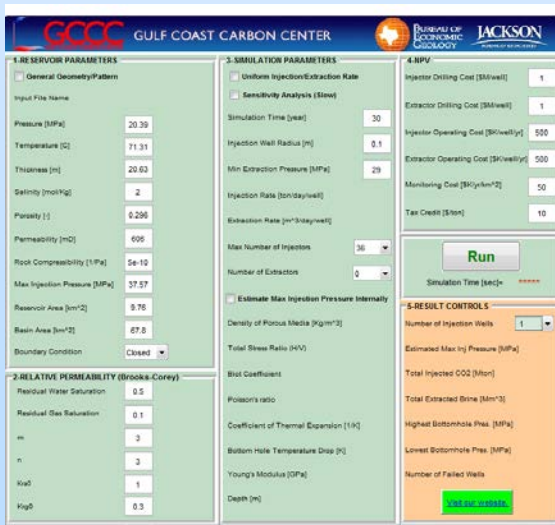


Project Summary

- **Key Findings**
  - Near offshore storage opportunities are vast, capable of storing 'Nationally-significant' CO_2 volumes
    - Regional structural and depositional framework
      - Depleted Oil & Gas Fields
      - Correlative Saline Formations
  - Individual sites have been assessed for site-specific aspects
    - Static storage capacity assessment
      - 2 Prospects (candidate sites)
    - Moving up SPE Resource Chart



- **Final Step**
  - Dynamic capacity assessment (EASiTool)



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Acknowledgements

- Jerry Carr (NETL PM)
- Ramon Trevino (GCCC project management)
- Mike DeAngelo (geophysicist)
- Iulia Olariu (geologist, regional well log correlation)
- Dallas Dunlap (geophysicist)
- Reynaldy Fifariz (PD, seismic interpretation)
- Izaak Ruiz (MSc Student)
- Omar Garcia (MSc student)

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Thank You

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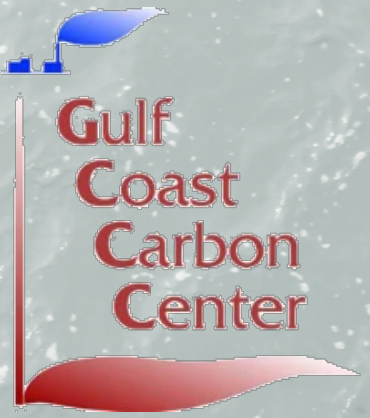


Appendix

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.

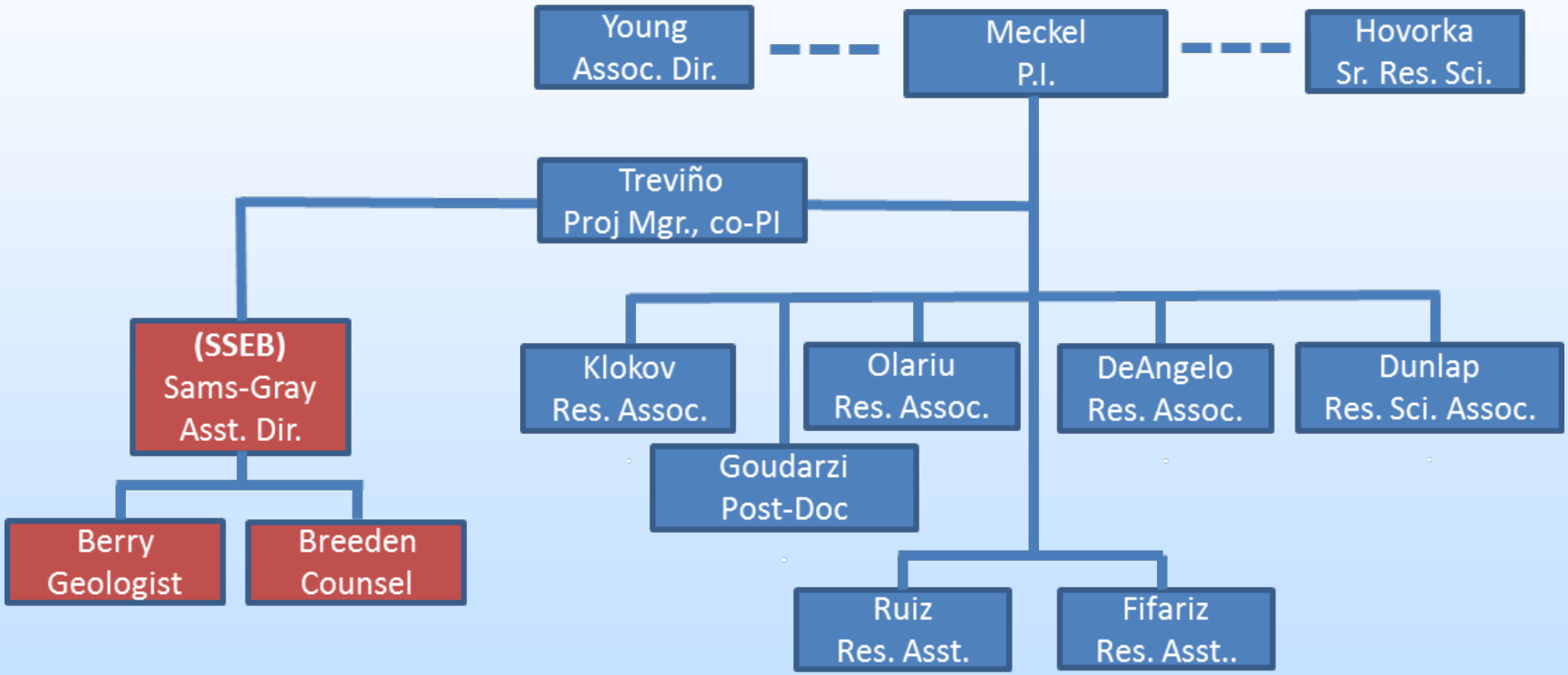
- BENEFITS STATEMENT: The methodology being developed is the assessment of offshore CO_2 storage resources in depleted hydrocarbon field settings or saline aquifers for offshore CO_2 storage applications. This approach will improve the current understanding of CO_2 storage potential for a large area 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

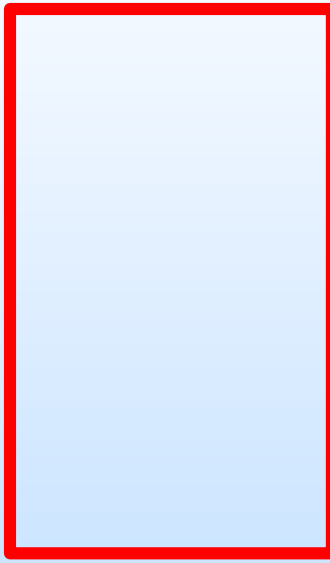
Goals and Objectives

- 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 depleted oil and natural gas reservoirs 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 **saline formations** 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 **engage the public and other stakeholders** for the region through outreach activities to apprise them of the study objectives and results.

Organization Chart



Gantt Chart



Recent Bibliography

- DeAngelo, M. V., Fifariz, R., Meckel, T., and Treviño, R. H., 2019, *A seismic-based CO_2-sequestration regional assessment of the Miocene section, northern Gulf of Mexico, Texas and Louisiana*: IJGGC, 81: 29-37, http://doi.org/10.1016/j.ijggc.2018.12.009.
- Goudarzi, A., T.A. Meckel, S.A. Hosseini, and R.T. Trevino, 2019, *Statistical analysis of historic production data from Gulf of Mexico oil and gas fields and application to dynamic capacity assessment in CO_2 storage*, IJGGC, 80: 96-102, https://doi.org/10.1016/j.ijggc.2018.11.014
- Ruiz, I., 2019, *Charcterization of the High Island 24L Field for modeling and estimating CO2 storage capacity in the offshore Texas State Waters, Gulf of Mexico*, MS Thesis, UT-Austin, 220 p.
- Garcia, O., *Geologic characterization and modeling of the High Island 10-L field for CO_2 storage resource assessment in Texas State Waters, offshore Gulf of MExico*, MS Thesis, UT-Austin, 123 p.

Bibliography

- Beckham, E., 2018, *CO_2 storage in deltaic environments of deposition: Integration of 3D modeling, outcrop analysis and subsurface application*, MS Thesis, UT-Austin, 220 p.
- Maciel, R.S., 2017, *Pre-injection reservoir characterization for CO_2 storage in the inner continental shelf of the Texas Gulf of Mexico – seismic inversion*, MS Thesis, UT-Austin, 90 p.