Status for Offshore CCUS in the Gulf of Mexico

Seyyed Hosseini

Tip Meckel, Ramon Trevino, Susan Hovorka

The University of Texas at Austin

Bureau of Economic Geology

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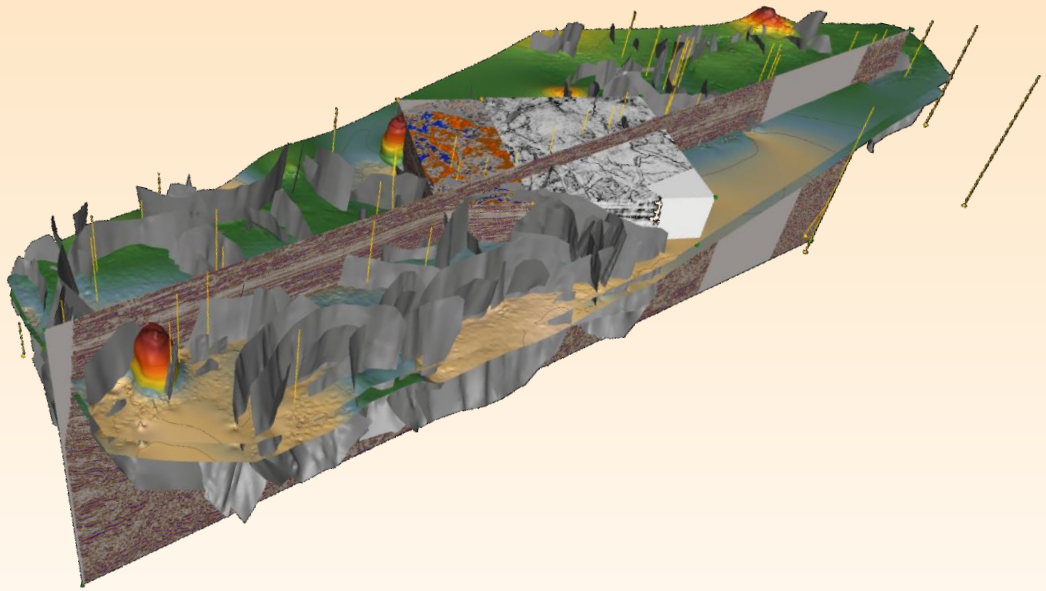

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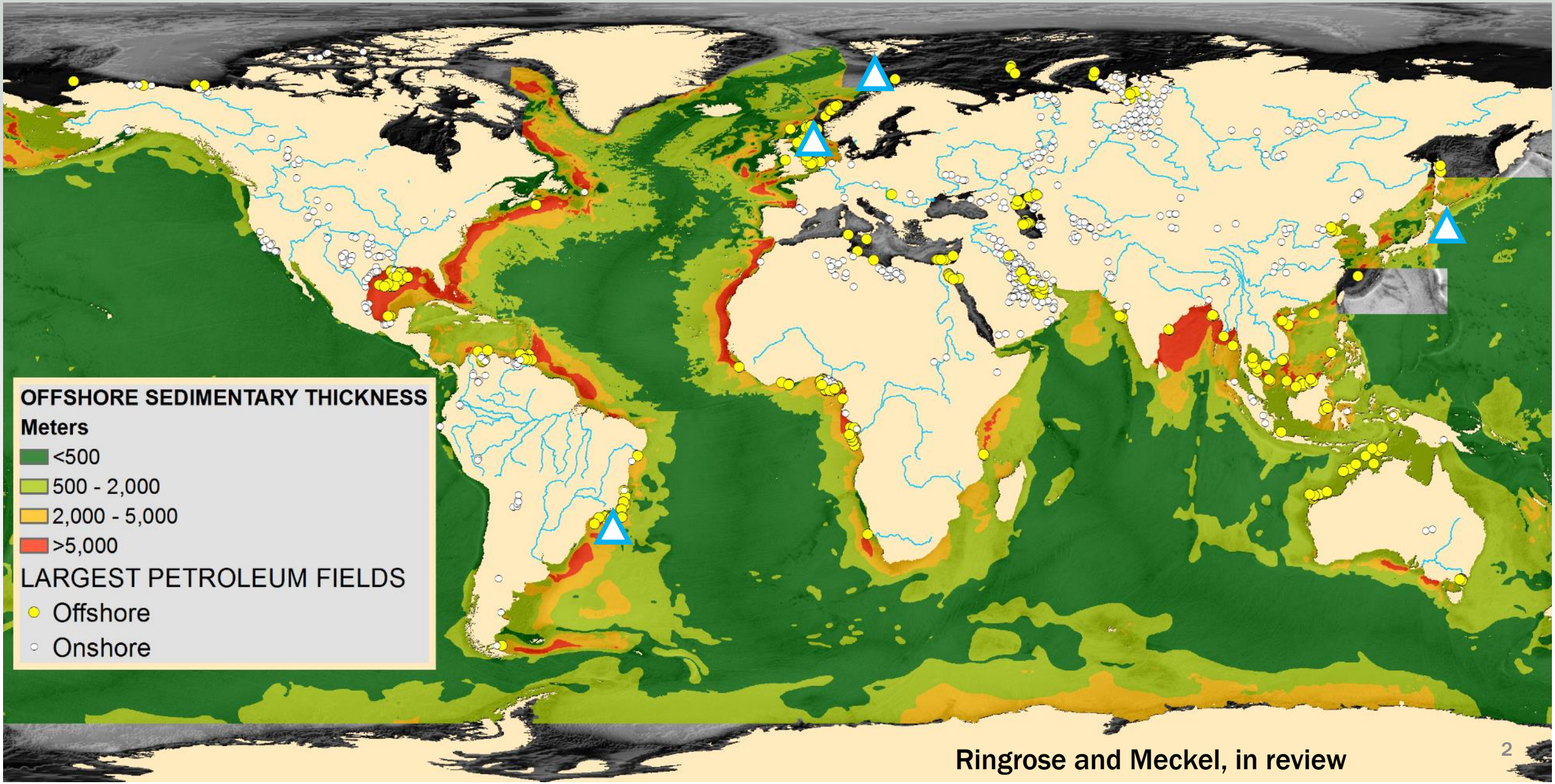
Offshore continental margins are the most promising for near-term Gigatonne-scale storage



Ringrose and Meckel, in review

TOPICS

- What is the maturity of CCS in the northern Gulf Coast?
  - Many prior projects (research/demo, industrial).
  - Existing capture and pipeline transport infrastructure.
  - Current 45Q Tax Credits make CCUS very attractive
- Prior and current work to mature near offshore storage
  - Summary of prior geologic storage assessments since 2009.
    - Texas Offshore Atlas publication.
  - **NETL**: Two active Offshore partnerships; Screening & Identification Study
- Examples of Miocene-age reservoir capacity estimates and basin storage implications for meeting 2050 targets.

Regional Gulf Coast setting for rapid large-scale carbon management in U.S. heavy industry

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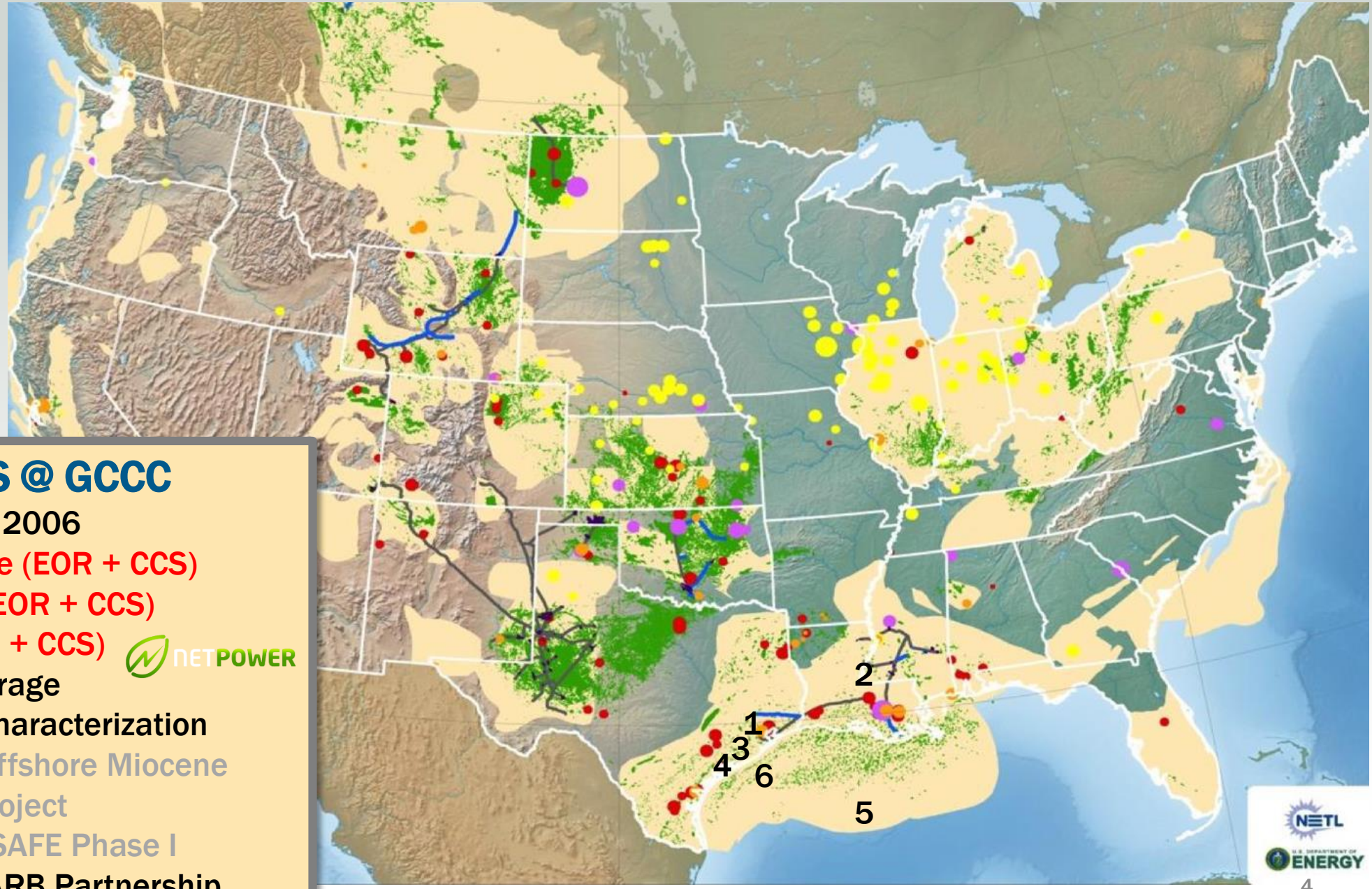

Gulf Coast CCS @ GCCC

1) Frio Saline tests 2004 & 2006
2) Cranfield stacked storage (EOR + CCS)
3) Air Products - Hastings (EOR + CCS)
4) NRG – West Ranch (EOR + CCS)
5) BOEM BPM Offshore Storage
6) Offshore GoM Storage Characterization
   - A. 2009-2014 Texas Offshore Miocene
   - B. 2015-2018 TXLA Project
   - C. 2016-2018 CarbonSAFE Phase I
   - D. 2018–2023 GoMCARB Partnership

NETPOWER

NETL

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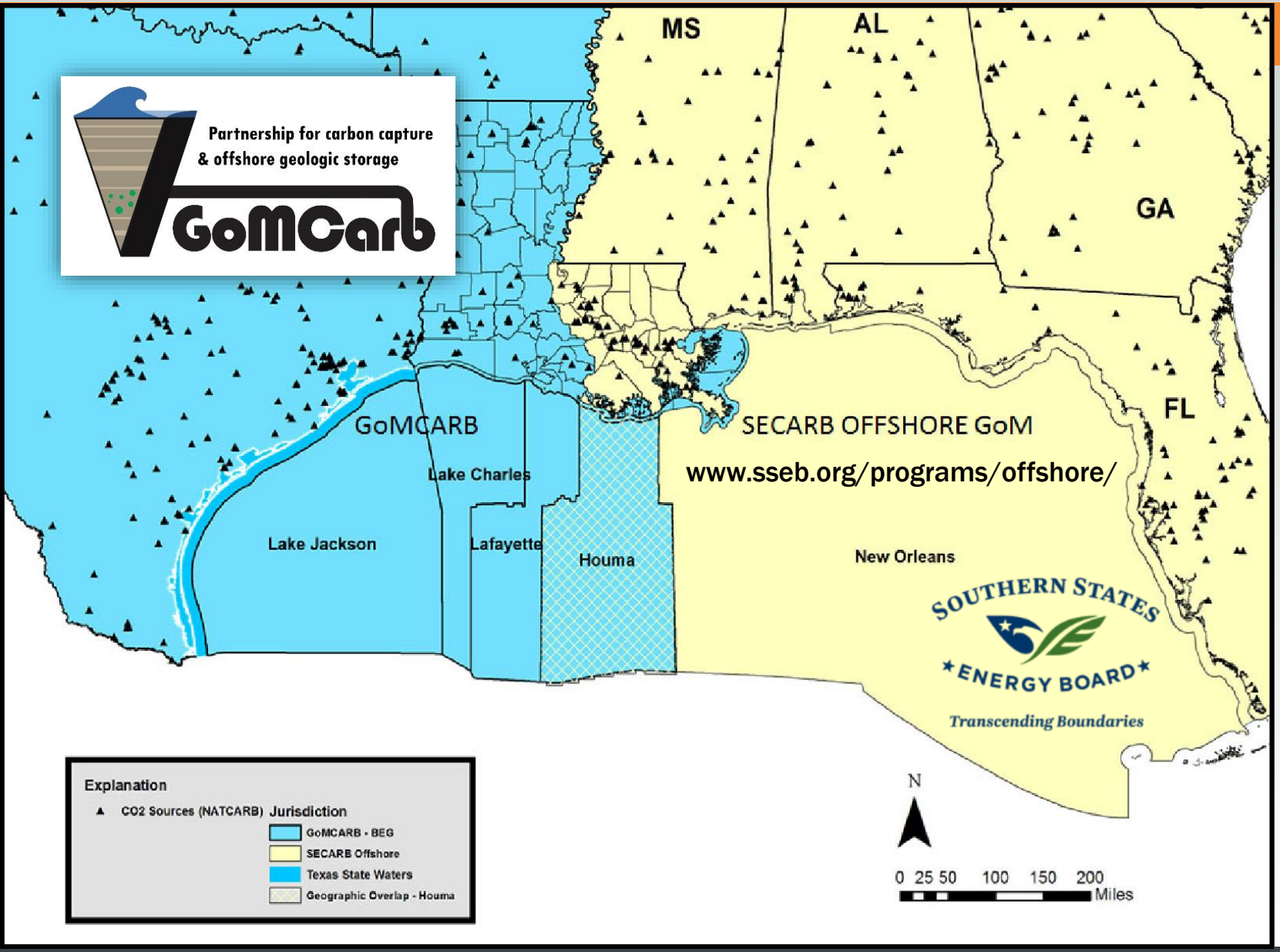


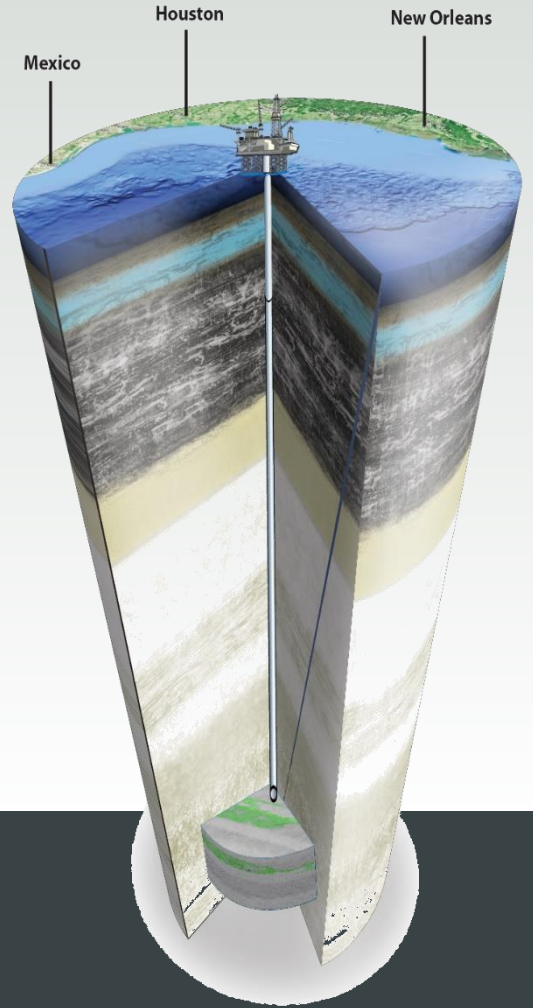
[A) Offshore Storage Resources]

[B) Risk Assessment, Simulation, Modeling]

[C) Monitoring, Verification, Assessment]

[D) Infrastructure, Operations, Permitting]

[E) Outreach]



www.beg.utexas.edu/gccc/research/gomcarb

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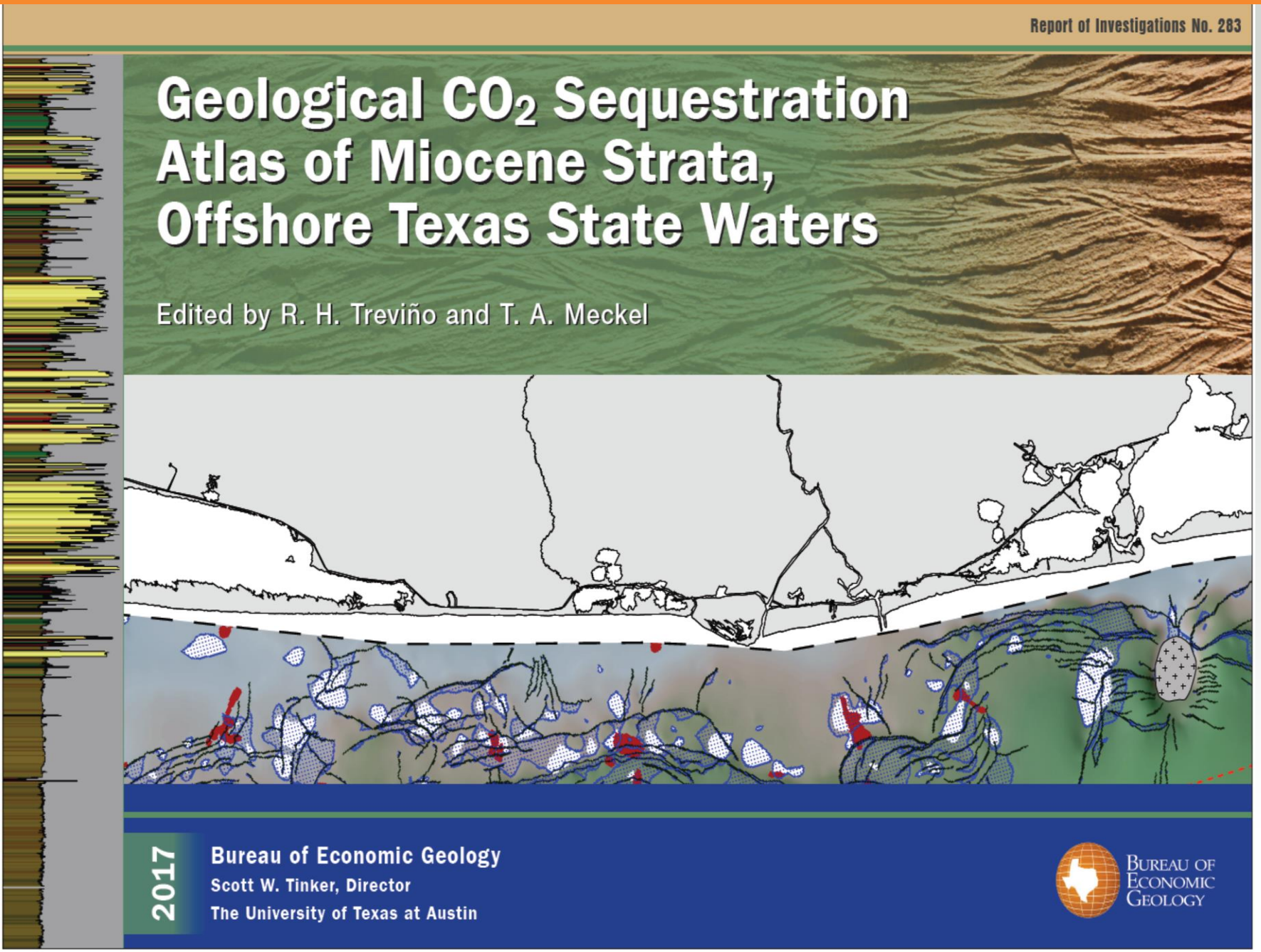
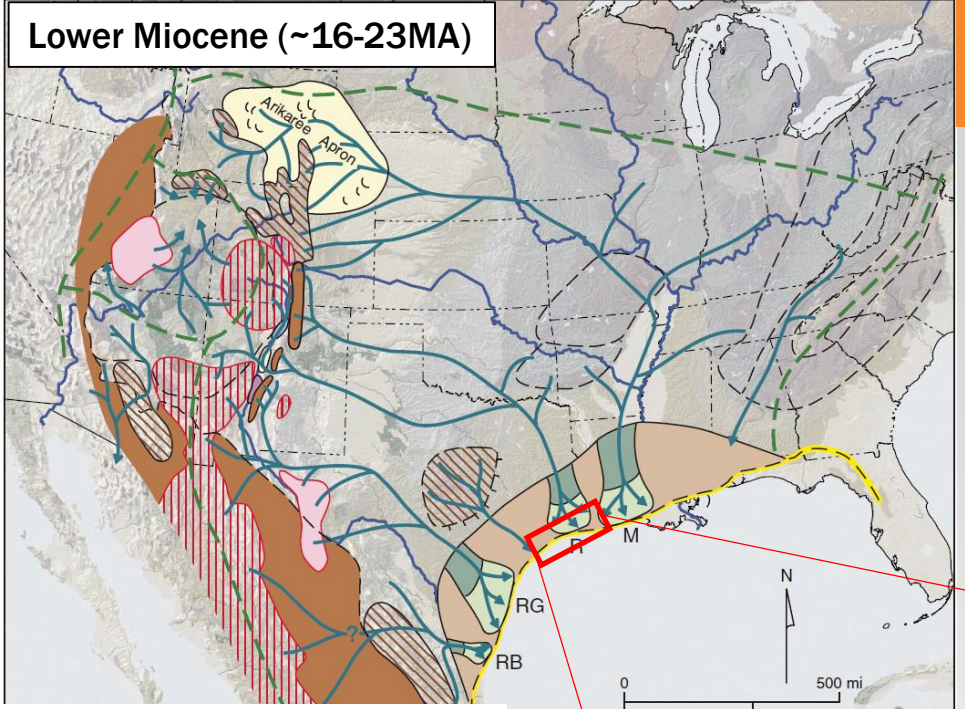
2017 Comprehensive Study of CO_2 Storage in Texas State Waters



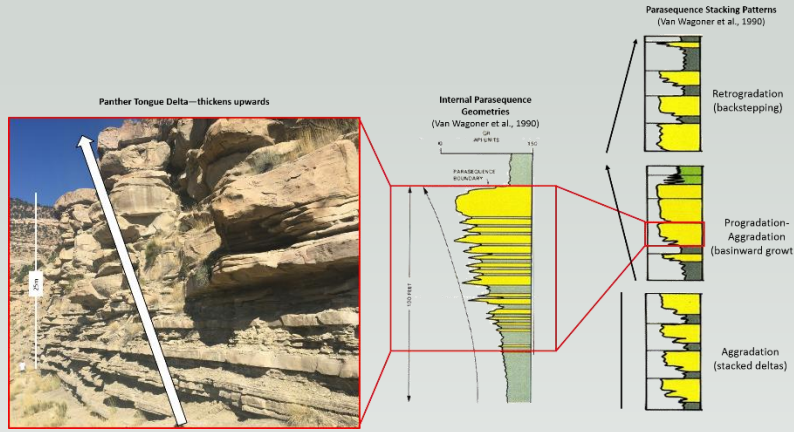
1. **Regional Geology** of the Gulf of Mexico and the Miocene Section of the Texas Near-offshore Waters
2. Implications of Miocene **Petroleum Systems** for Geologic CO_2 Storage beneath Texas Offshore Lands
3. Evaluation of Lower Miocene **Confining Units** for CO_2 Storage, Offshore Texas State Waters, Northern Gulf of Mexico, USA
4. Capillary Aspects of **Fault-Seal Capacity** for CO_2 Storage, Lower Miocene, Gulf of Mexico
5. **Regional CO_2 Static Capacity Estimate**, Offshore Saline Aquifers, Texas State Waters
6. **Field-scale Example** of Potential CO_2 Sequestration Site in Miocene Sandstone Reservoirs, Brazos Block 440-L Field
7. **Estimating CO_2 Storage Capacity** in Saline Aquifer Using 3D Flow Models, Lower Miocene, Texas Gulf of Mexico
8. Appendix A: **Regional Cross Sections**, Miocene Strata of Offshore Texas State Waters

GOM Paleogeography



(map from Galloway et al., 2011)

- Dominant environment: Coastal-Deltaic, shallow marine
- Red River merging with Mississippi River

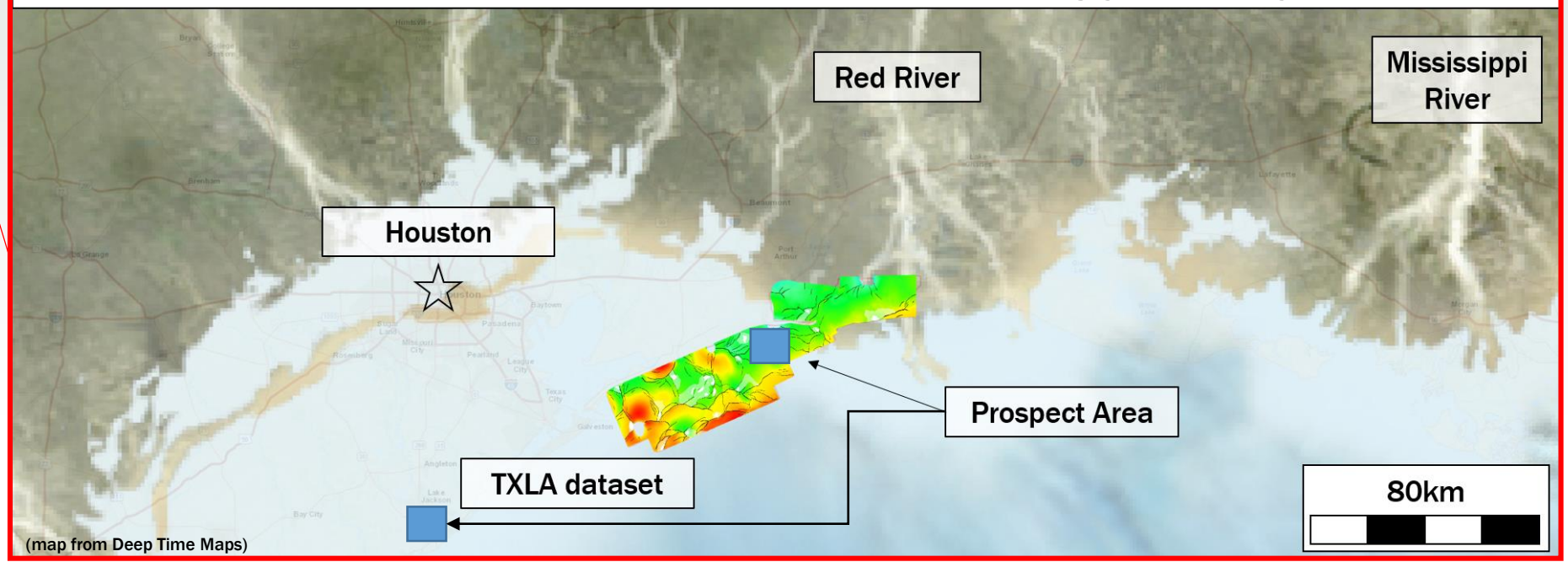


Receiving Basin Elements

Depositional coastal plain
Fluvial axes
Deltaic depocenters
Max. progradational shoreline

Middle to Lower Miocene: ~11-23MA

SCHEMATIC!



(map from Deep Time Maps)

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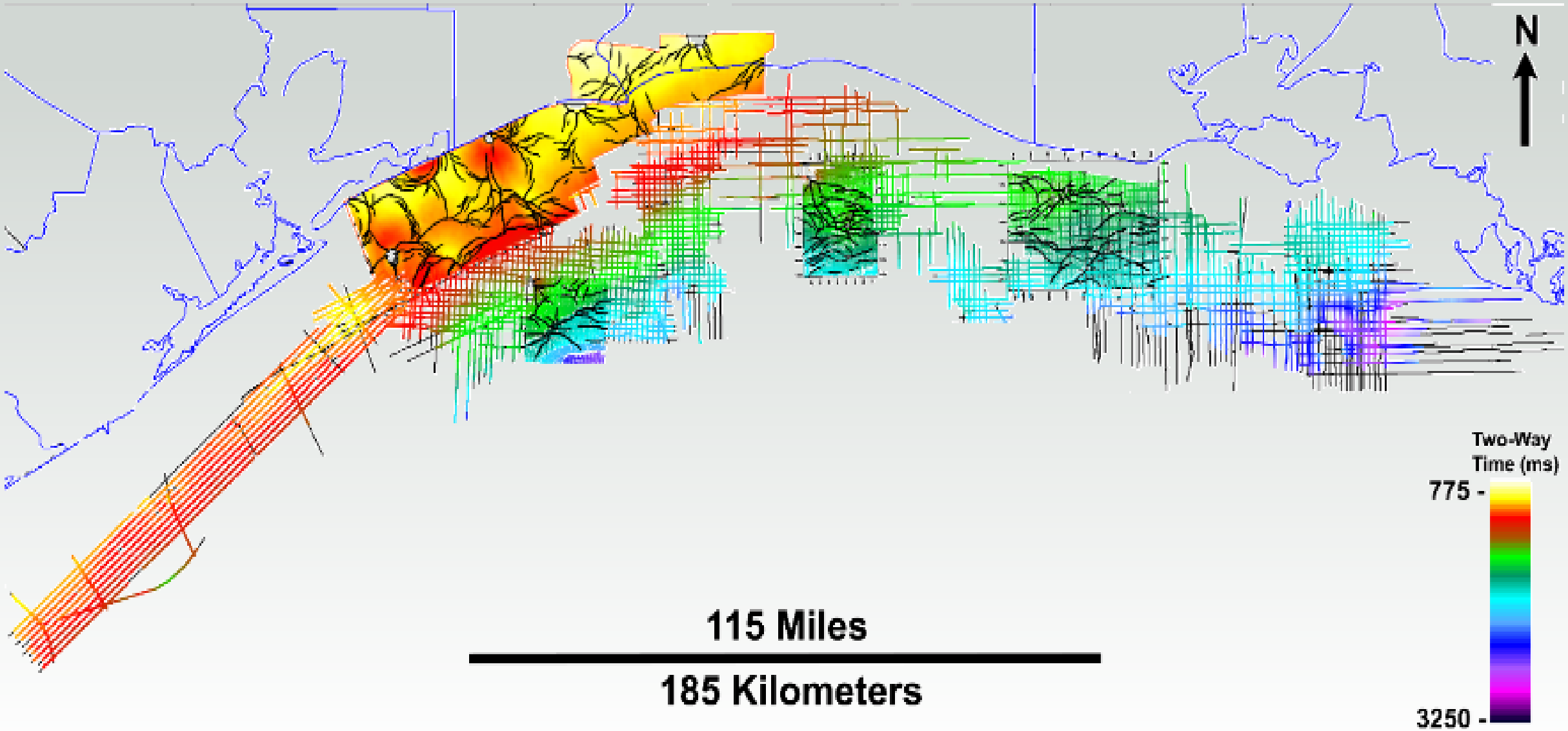
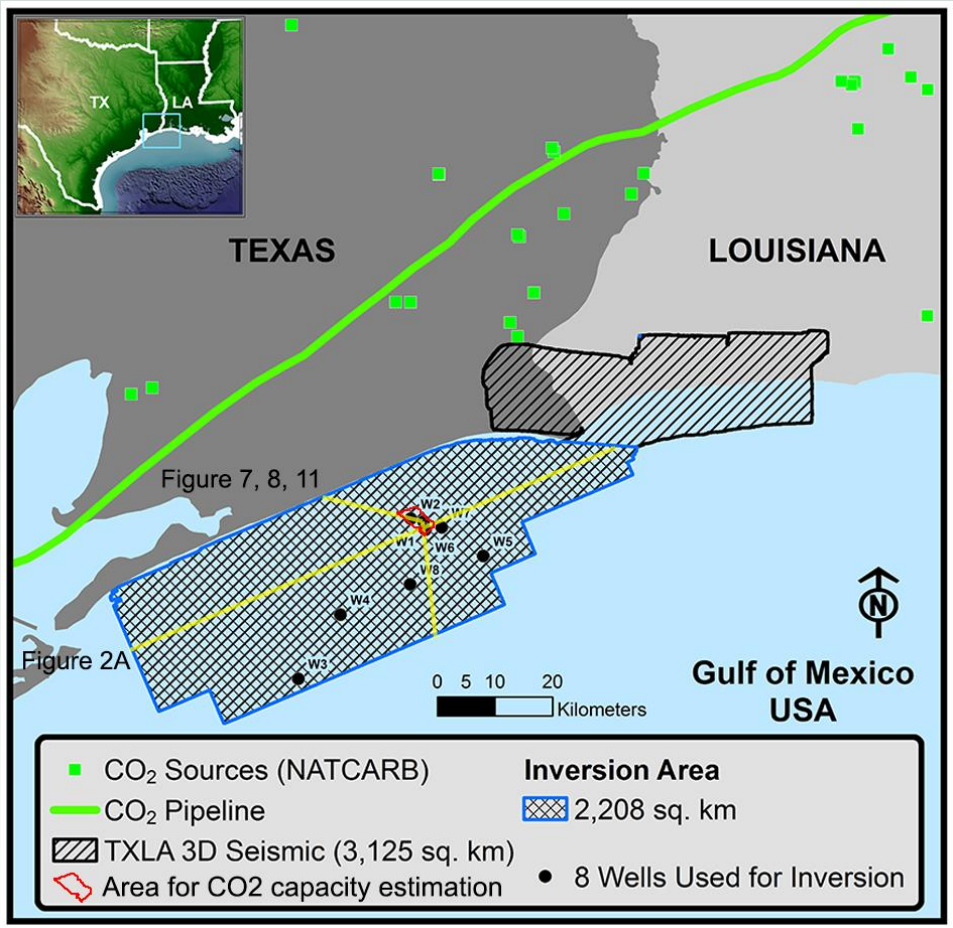
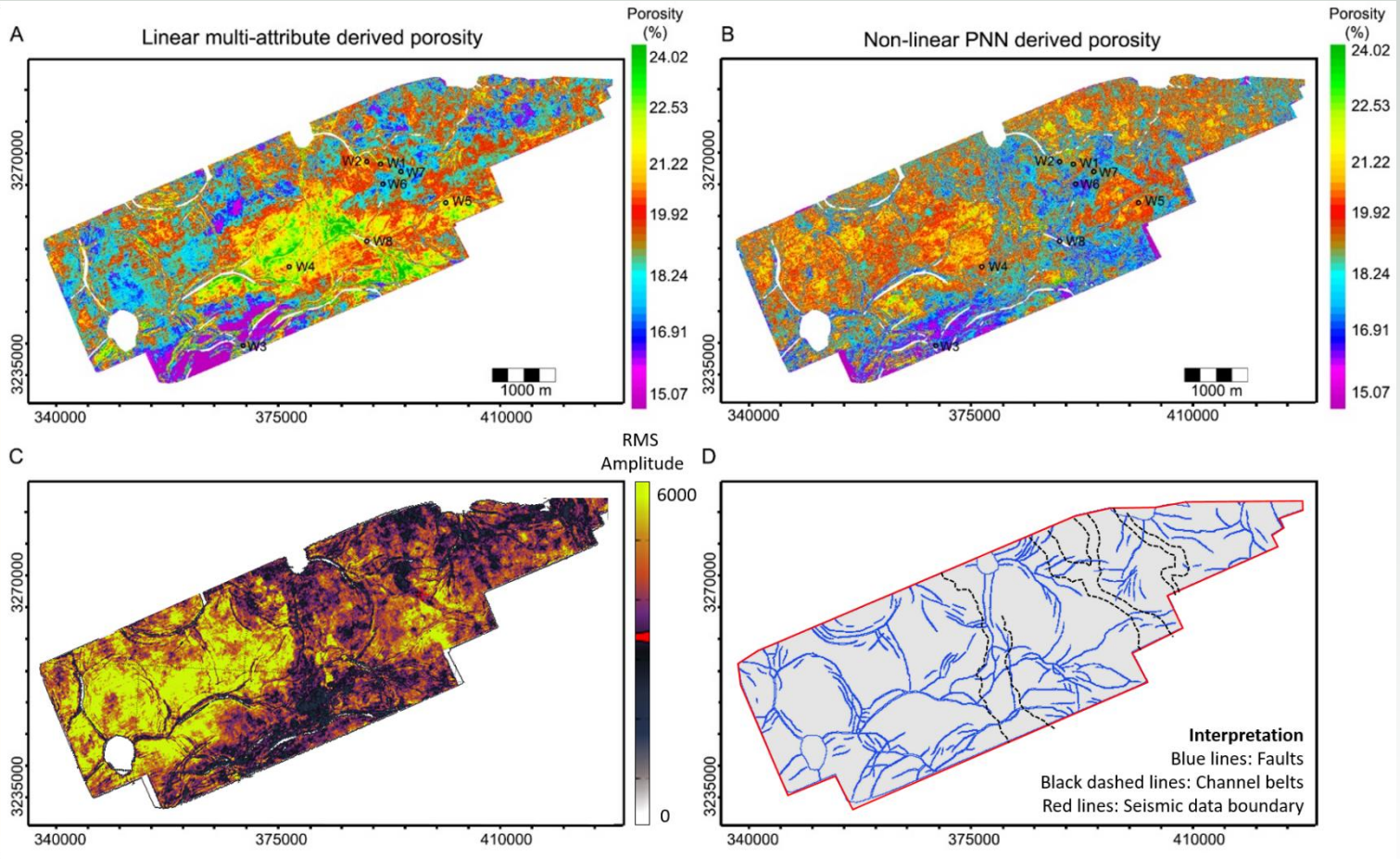

N
Two-Way
Time (ms)
775 -
3250 -
115 Miles
185 Kilometers

Seismic inversion for porosity volume





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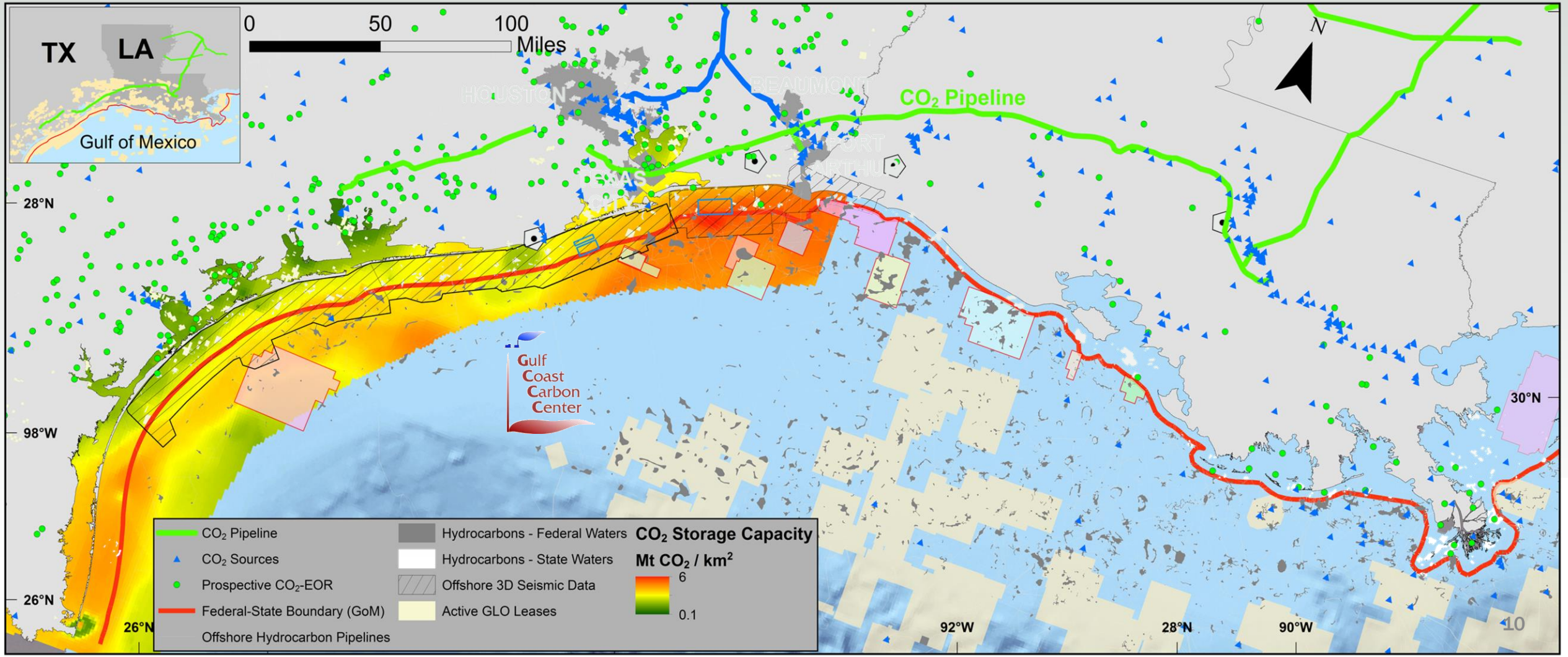
Static Regional Capacity

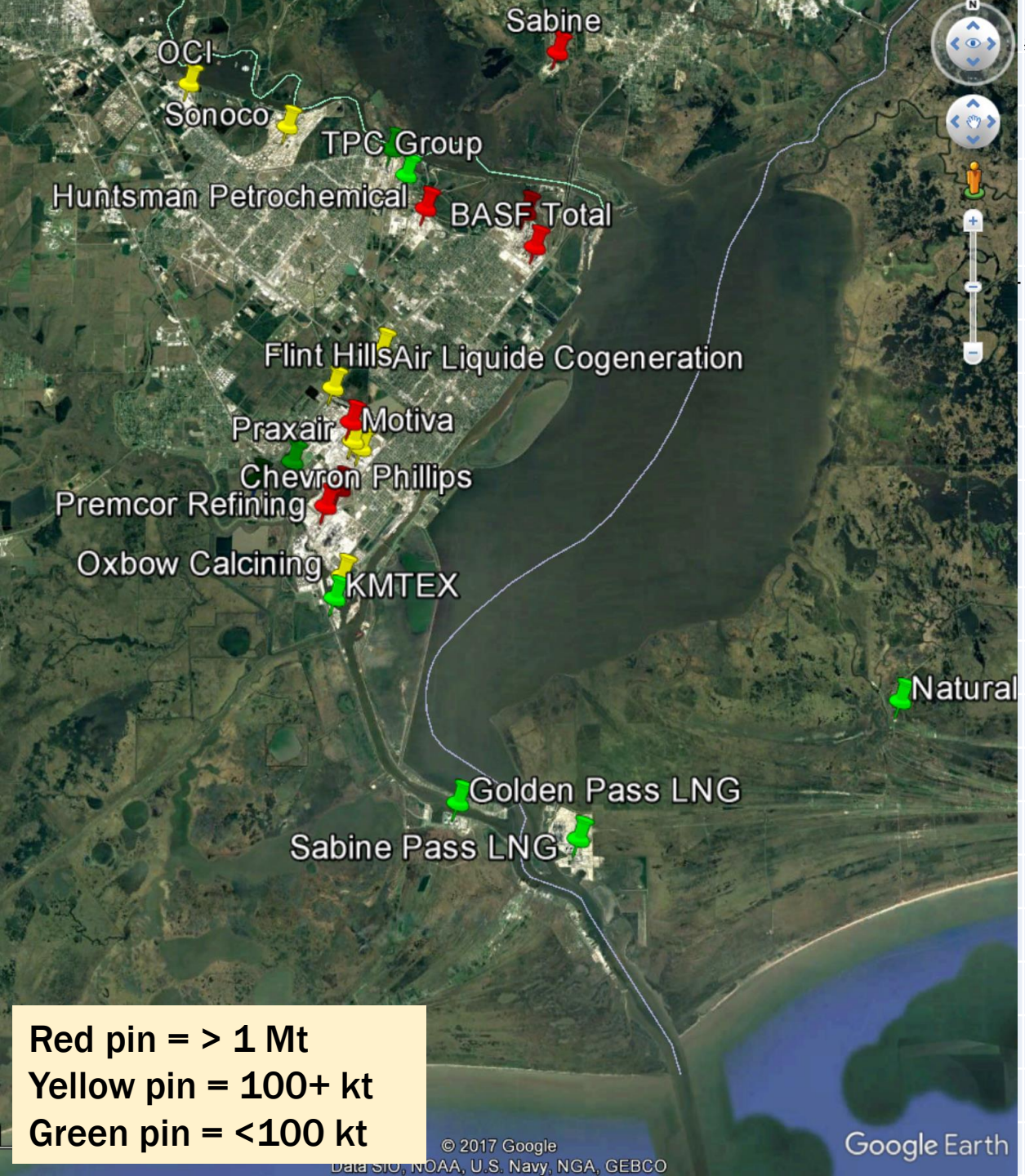
- NETL Methodology
- 40,000 sq. km.

- 3,300 logs
  - Tops, net sand, porosity

- 172 Gt CO_2 storage total TX State Waters



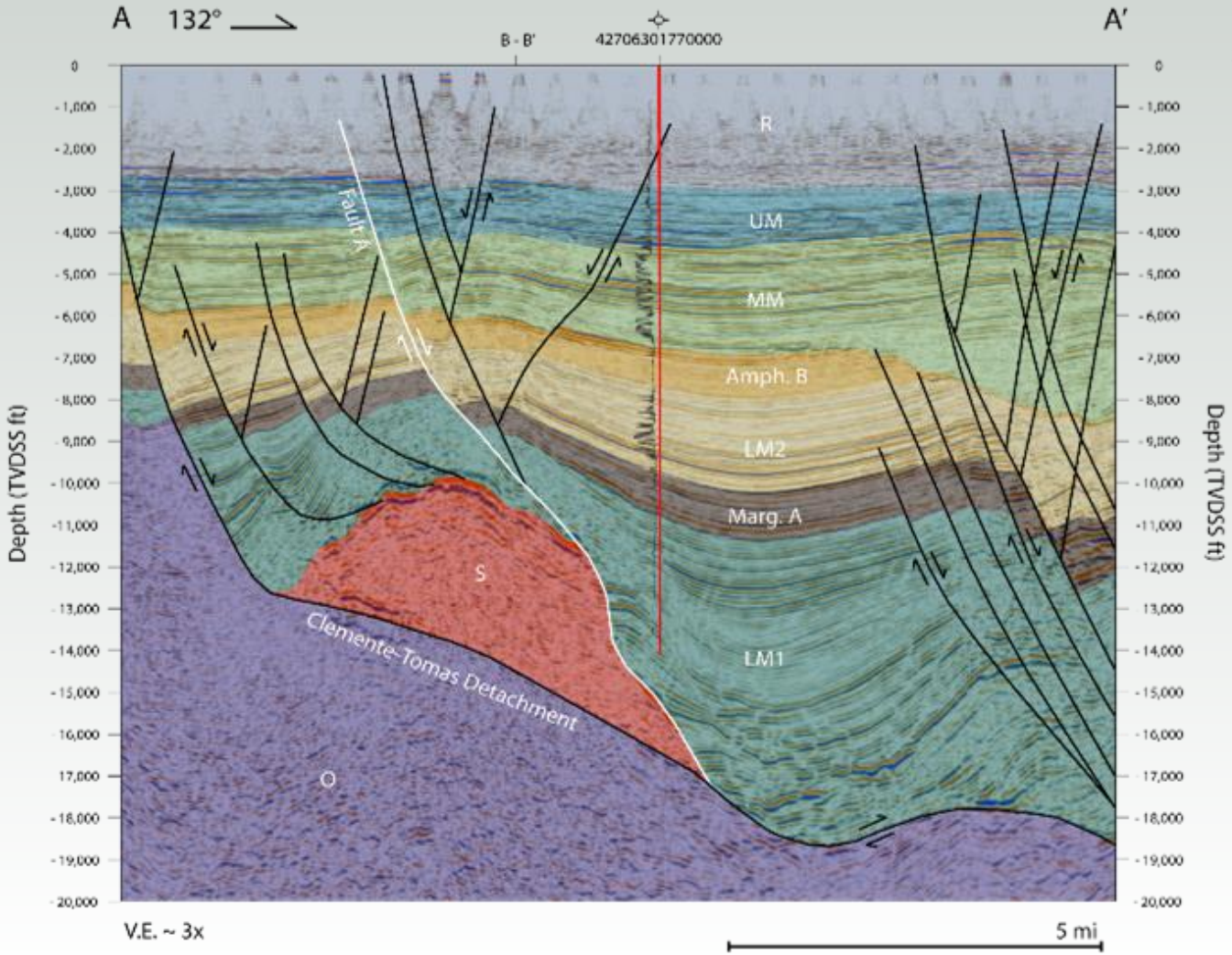
3 Texas GoM CO_2 Hubs: La Porte, Texas City, Port Arthur



SOURCE_TYPE_COMMON	EPA_SUBPART_CATEGORY	CO2_TONNE
REFINERIES/CHEMICAL	Stationary Combustion	4,590,601
REFINERIES/CHEMICAL	Stationary Combustion	2,463,770
REFINERIES/CHEMICAL	Stationary Combustion	2,359,646
ELECTRICITY	Electricity Generation	2,326,263
REFINERIES/CHEMICAL	Stationary Combustion	1,975,996
REFINERIES/CHEMICAL	Stationary Combustion	1,487,779
REFINERIES/CHEMICAL	Stationary Combustion	1,405,838
REFINERIES/CHEMICAL	Hydrogen Production	781,428
REFINERIES/CHEMICAL	Petrochemical Production	630,161
REFINERIES/CHEMICAL	Stationary Combustion	615,150
REFINERIES/CHEMICAL	Stationary Combustion	263,337
REFINERIES/CHEMICAL	Stationary Combustion	244,469
REFINERIES/CHEMICAL	Stationary Combustion	206,246
REFINERIES/CHEMICAL	Stationary Combustion	78,489
REFINERIES/CHEMICAL	Stationary Combustion	59,440
PETROLEUM/NATURAL GAS	Petroleum and Natural Gas Systems	57,182
REFINERIES/CHEMICAL	Stationary Combustion	38,727
PETROLEUM/NATURAL GAS	Petroleum and Natural Gas Systems	30,766
REFINERIES/CHEMICAL	Stationary Combustion	25,179
PETROLEUM/NATURAL GAS	Stationary Combustion	16,762
PETROLEUM/NATURAL GAS	Stationary Combustion	1,129

Port Arthur Hub, Phase I
~20 Mta total
17 Mta, 7 sources

Typical large growth fault setting on inner shelf – Dip Section

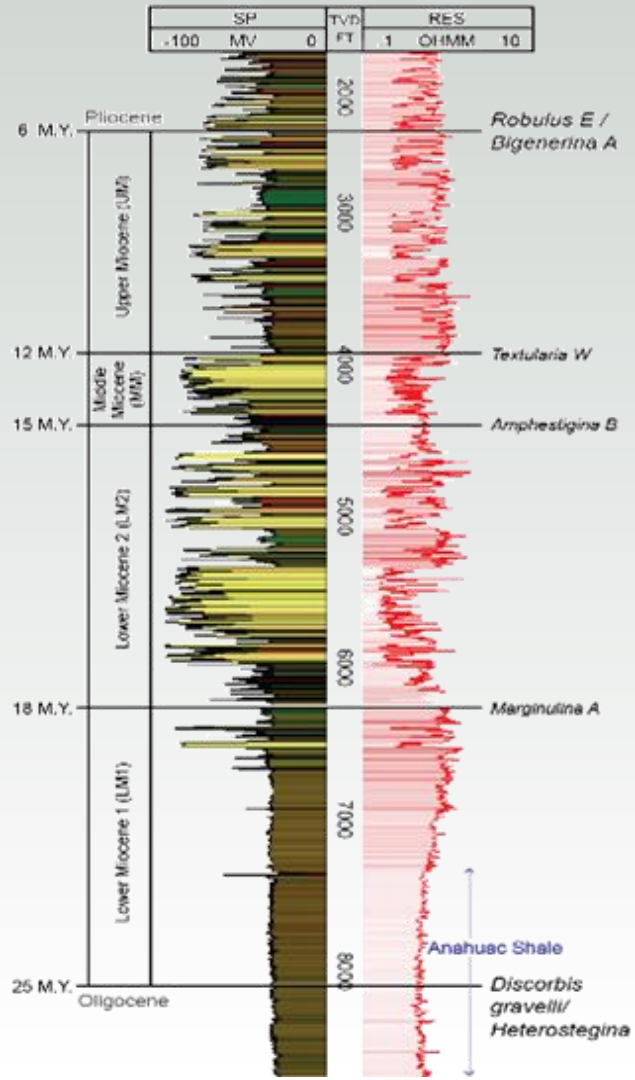


Key to Geologic Features and Symbols

R	Recent through Pliocene Siliciclastics
UM	Upper Miocene Siliciclastics
MM	Middle Miocene Siliciclastics
Amph. B	*Amphestegina chipolensis* Shale
LM2	Lower Miocene 2 Siliciclastics
Marg. A	*Marginulina ascensionesis* Shale
LM1	Lower Miocene 1 Siliciclastics
O	Oligocene Anahuac Shale and Older
S	Jurassic Allochthonous Louann Salt
	Faults

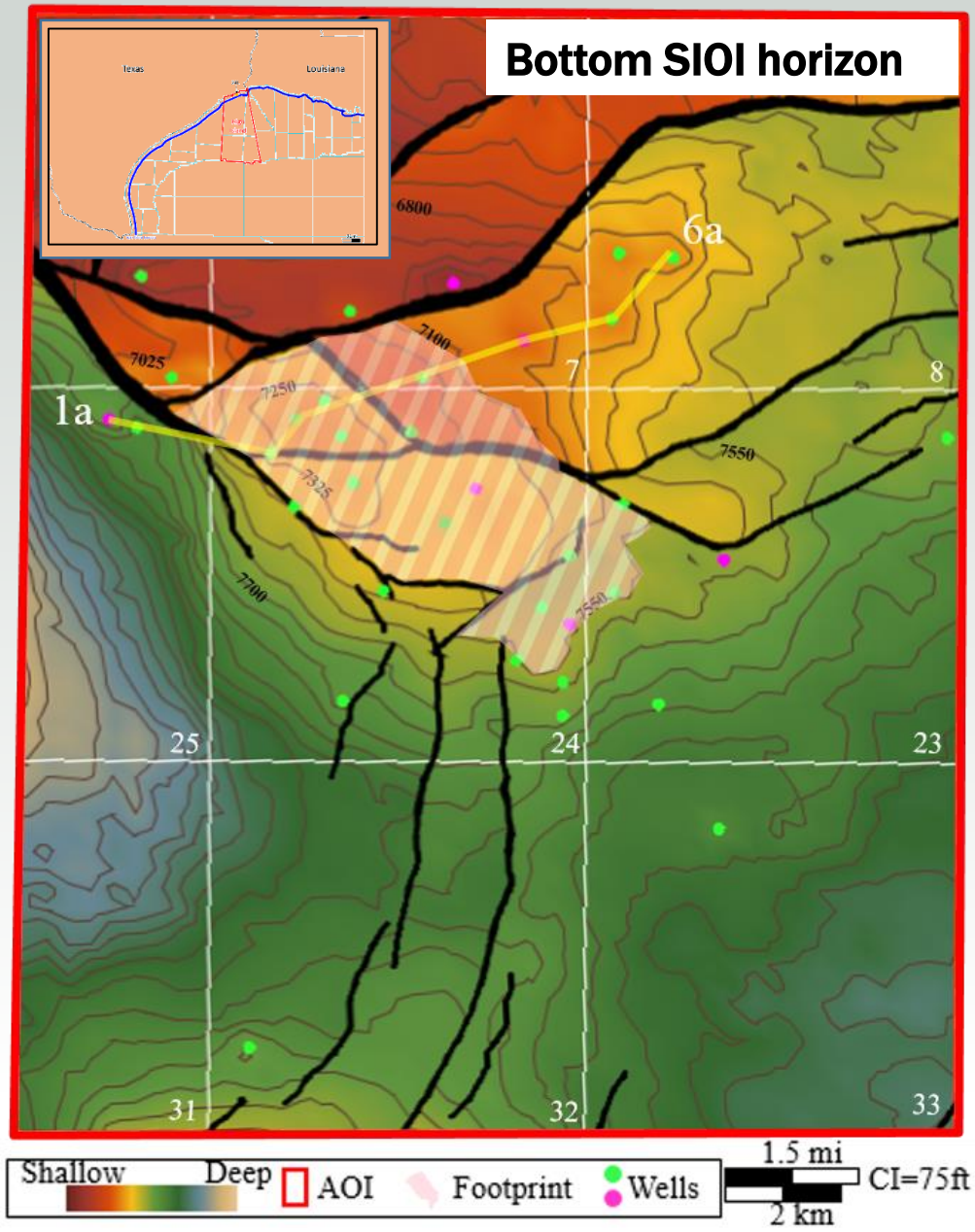
OBS Amplitude + -

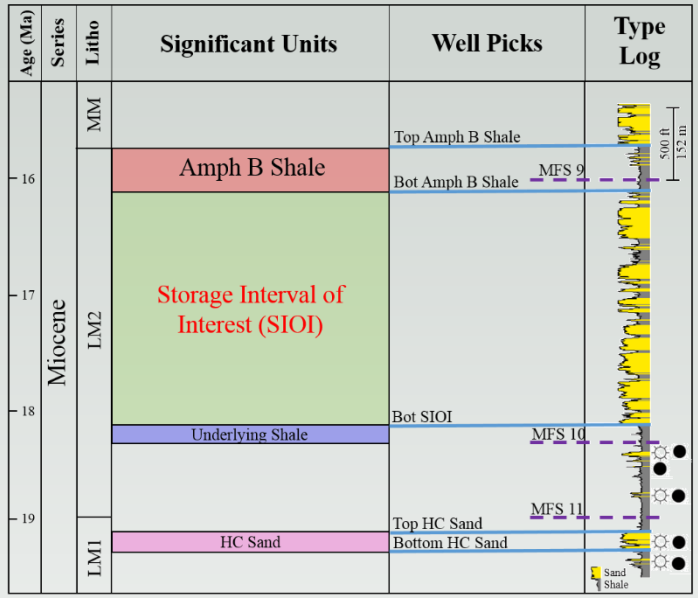
SP Log - +

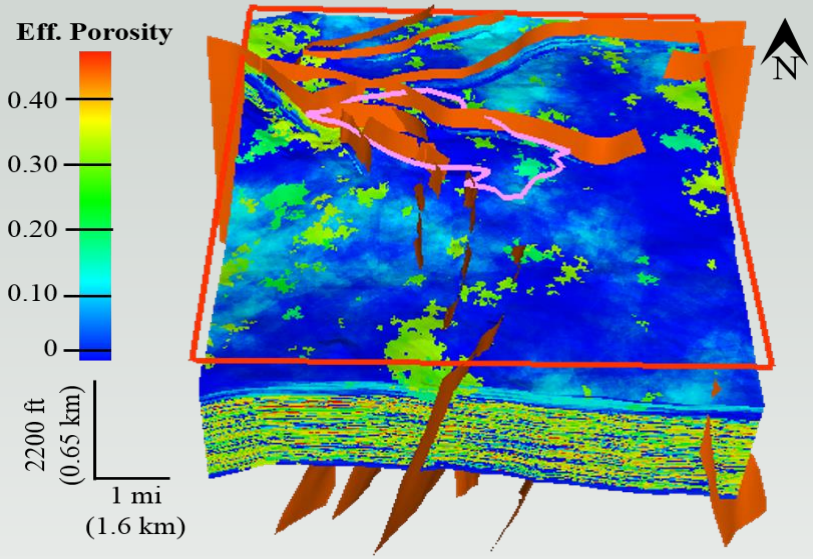


Osmond, 2016

High Island 24-L Field – Southeast Texas



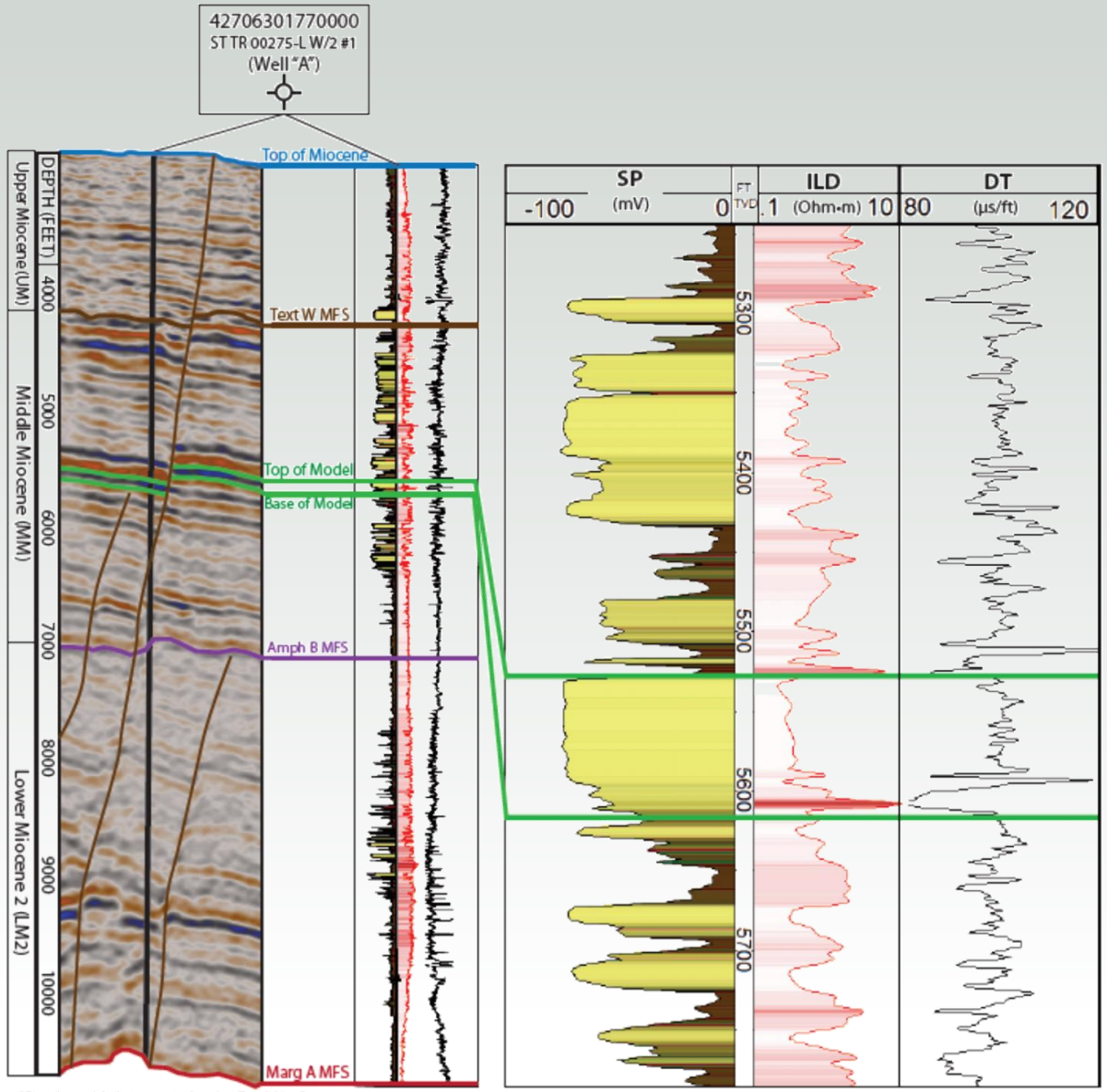




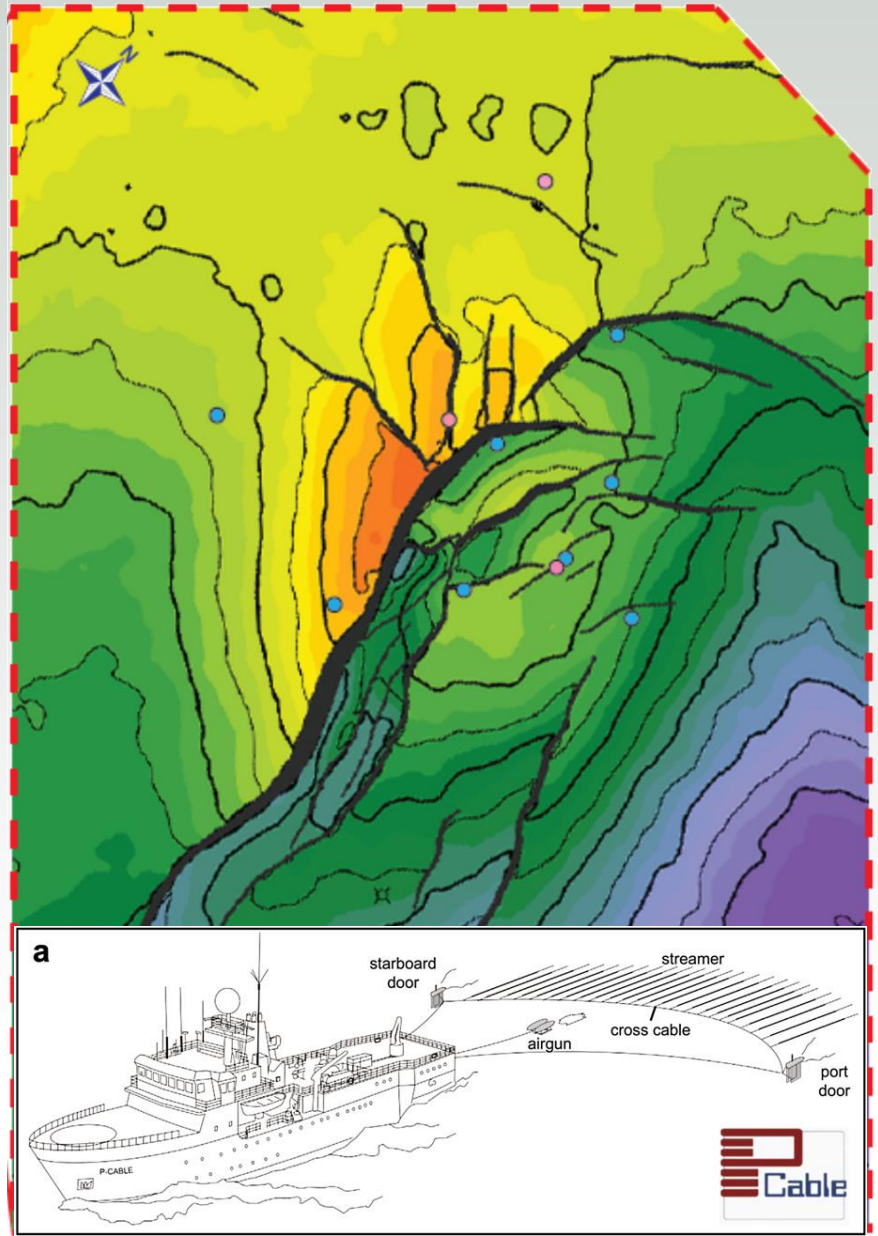
STATIC VOLUMETRIC CALCULATIONS

	P10	P50	P90
$E_{saline} = E_v E_d$	7.4%	14%	24%
SIOI: NETL CO2 Screen (Mt)	63	120	206
SIOI: 3-D Eff. Porosity Model (Mt)	57	108	185
HC Sand: 3-D Constant Avg. Eff. Porosity Model (Mt)	6	12	20

Reservoir Performance – Nonproductive Setting (San Luis Pass)



*Stratigraphic interpretation by David L. Carr
**Seismic data owned or controlled by Seismic Exchange, Inc.; interpretation is that of Kerstan Wallace



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RESERVOIR PERFORMANCE

Approximately 5 Mt in 90’ sand, unless completely open flow boundaries

Cumulative Injection Results for 27 dynamic 3D flow simulations

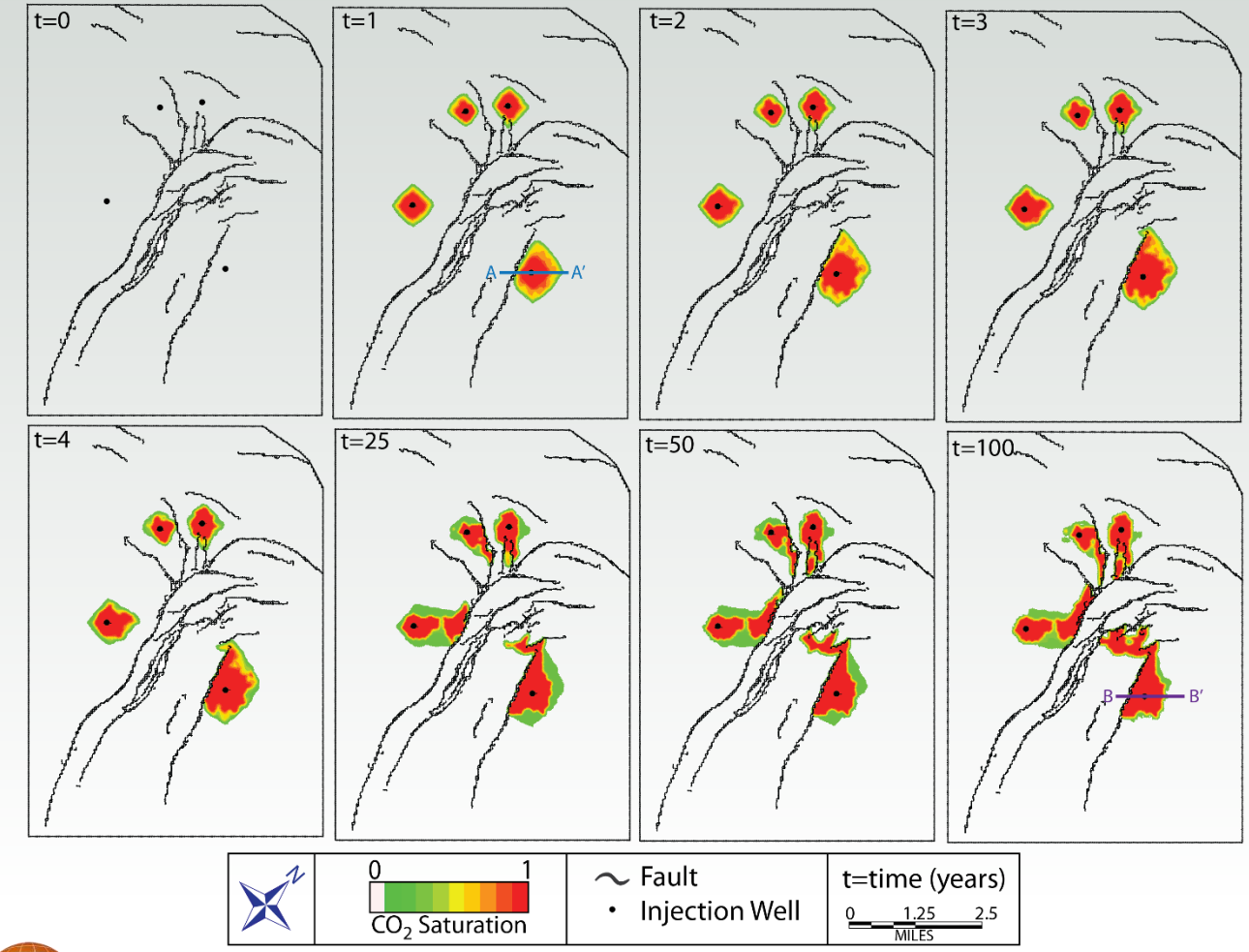
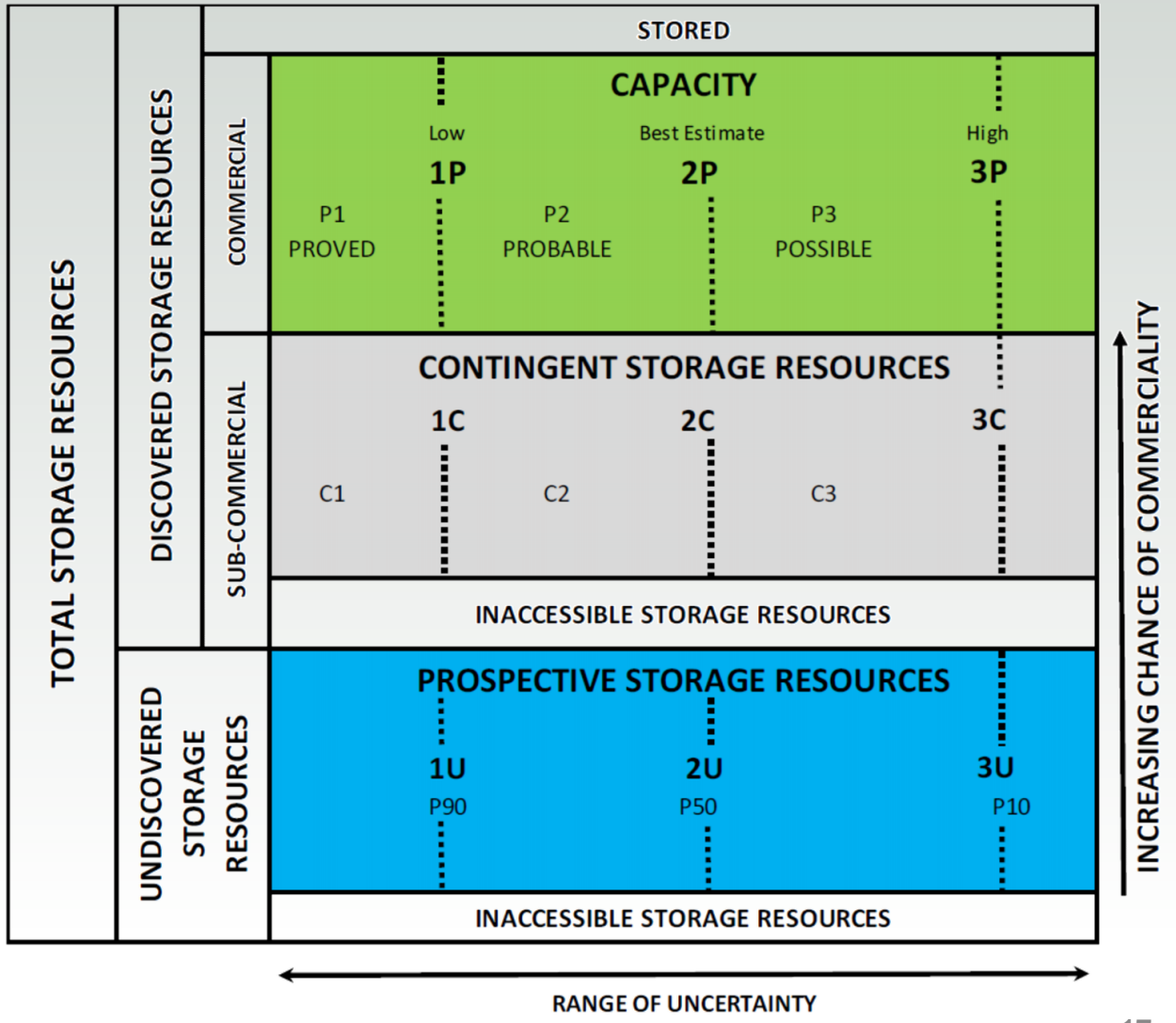


Table 7.2. Cumulative injection results for 27 model cases of dynamic 3D flow model

3D Flow Model Injected-Mass Results (Mt)			
	Homogeneous	Statistic-Based Heterogeneous	Seismically Derived Heterogeneous
Base case	5.4	5.3	4.5
High-quality reservoir	6.9	6.8	5.7
Low-quality reservoir	3.7	3.5	3.1
Open boundaries	*116.2*	*114.4*	*64.0*
Open faults	5.6	5.3	4.6
1 well	6.0	5.7	5.0
15 wells	5.4	5.2	4.8
Optimized array	5.4	5.3	4.9
Constant-rate injection	4.8	5.1	4.5

SPE Storage Resources Management System (SRMS)

- Uniformity, clarity, familiarity
- Bookable storage
- Similar to PRMS
  - SRMS exists
  - https://www.spe.org/industry/CO2-storage-resources-management-system.php
  - Guidelines currently being drafted
  - Training workshops to come.



SUMMARY

- The global offshore continental margins represent the best near-term opportunity for Gigatonne-scale CCS.
  - Gulf of Mexico is ideal geologically and geographically.
  - National resource of consequence.
  - **Research needs**: understand hub development and scaling, impact of Gt-scale pressure perturbation, fault performance.
- ::
- GoM ready to apply and expand upon the many successful examples.
  - North Sea, Japan, Brazil
  - CC(U)S perspectives benefit from knowing prior petroleum history: capacity, seal, reservoir performance, well development.
- Offshore CCS can deliver needed scales on needed time frames.
- CO_2 storage can be a bookable resource for reassuring investors and evaluating project economics.

Acknowledgements / Thank You / Questions

We gratefully acknowledge:

- **Seismic Exchange, Inc.**, for access to regional 3D seismic data.
- **Halliburton** for integrated Decionspace Desktop software license.

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