Approaches to evaluations: Inner-shelf deltaic example GoM

High-level Summary

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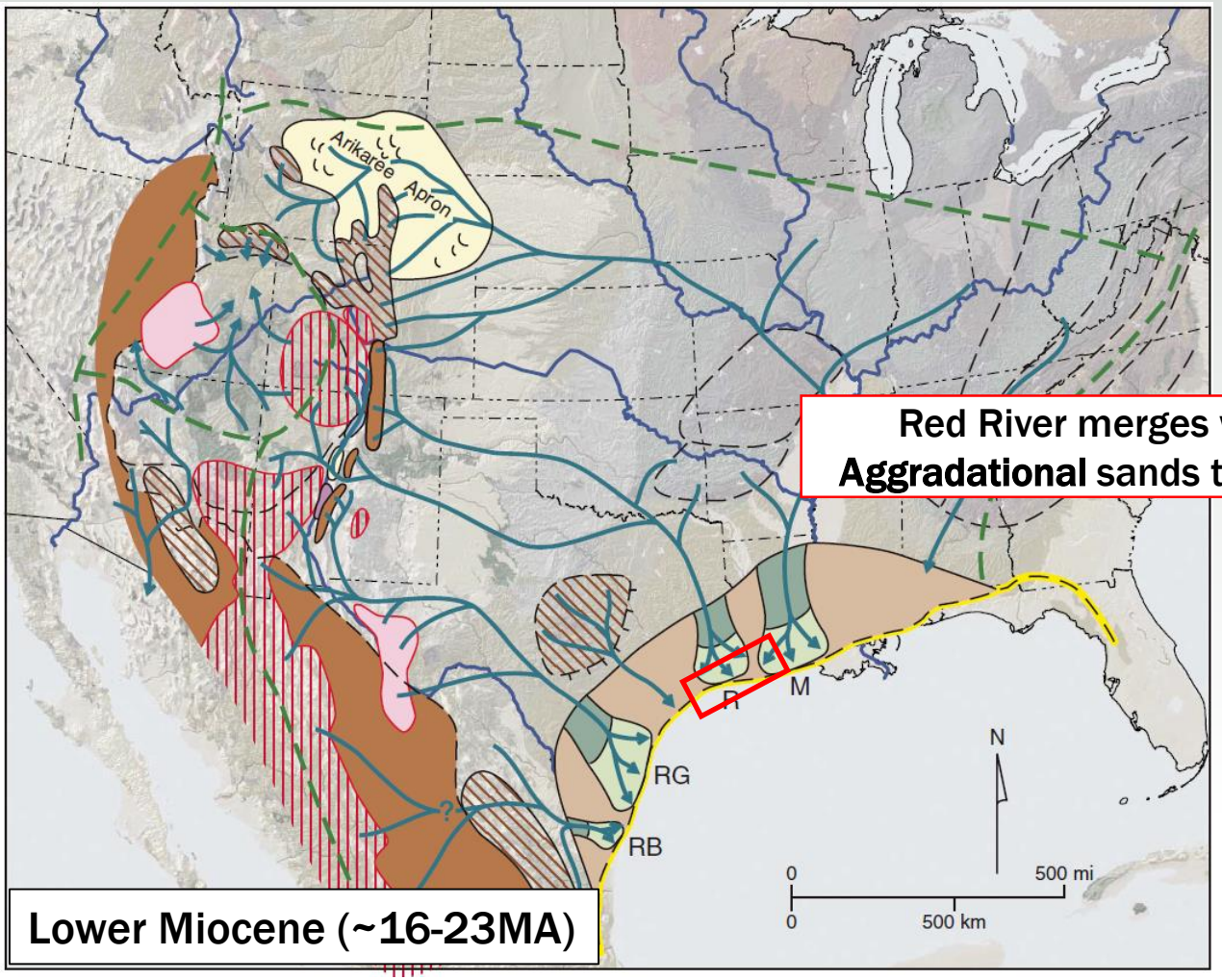
Paleogeography

- Dominant environment: **Deltaic**

Galloway et al. (2011)



Lower Miocene (~16-23MA)

Paleogeographic Map Explanation

(maps from Galloway et al., 2011)

Drainage Basin Elements

- Mountain glaciers
- Relict or moderate relief upland
- High-relief upland
- Subsiding alluvial basin
- Bypass alluvial basin
- Lacustrine basin
- Eolian basin fill or aggradational erg
- Aggradational fluvial fan/apron
- Drainage divide
- Fluvial channel systems
- Bedrock canyons

Igneous Features and Provinces

- Active volcanic center
- Caldera complex
- Relict volcanic complex
- Airborne volcanic ash

Receiving Basin Elements

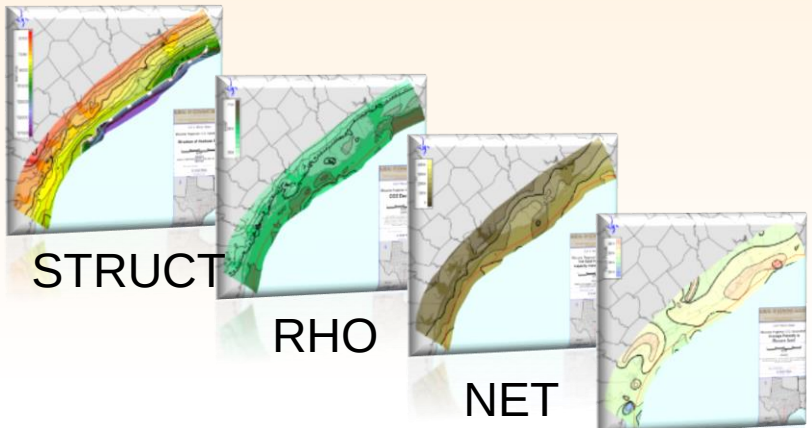
- Depositional coastal plain
- Fluvial axes
- Deltaic depocenters
- Max. progradational shoreline

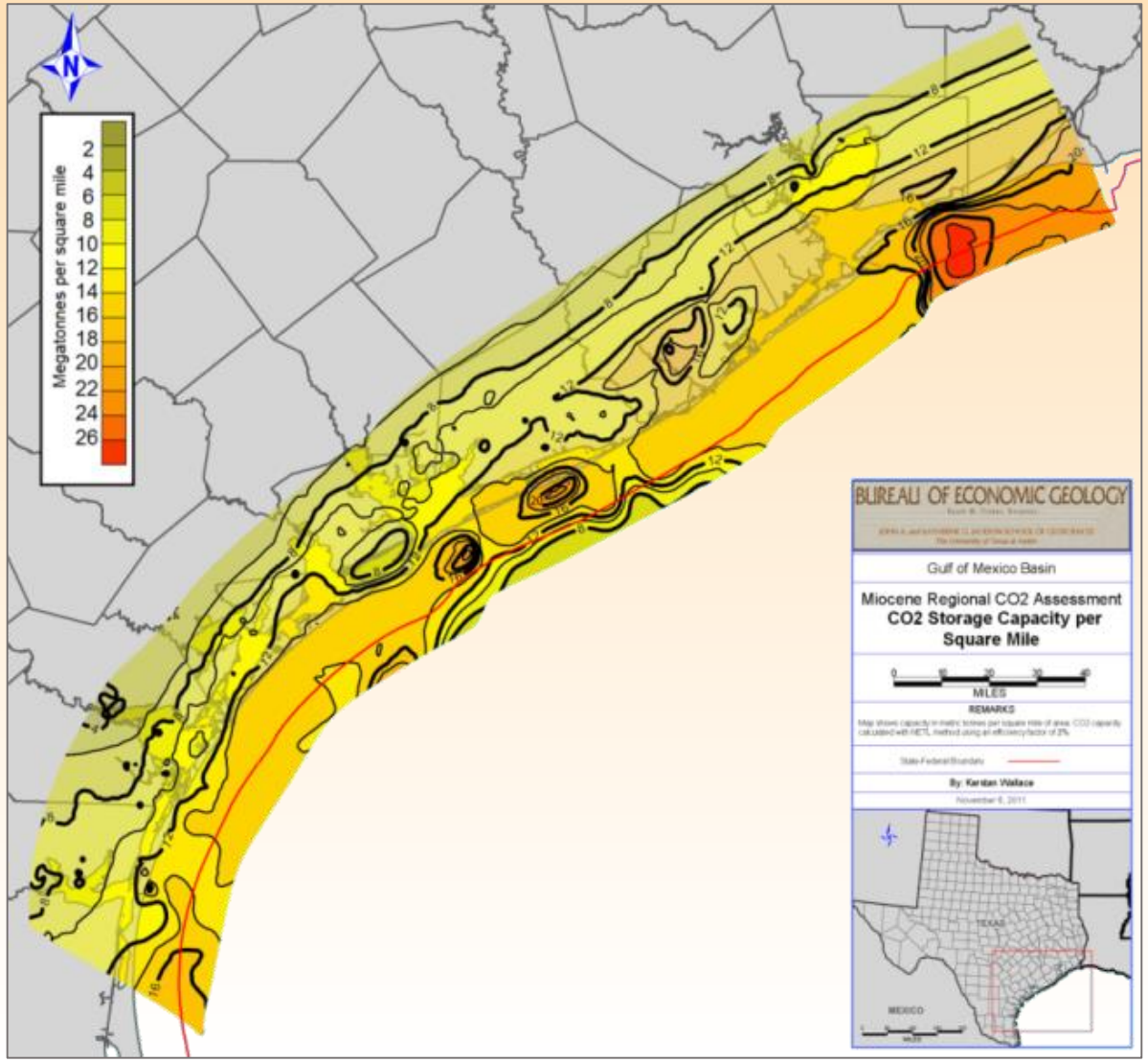
Red River merges with Mississippi River
Aggradational sands to **retrogradational** sands

Middle Miocene (~11-16MA)

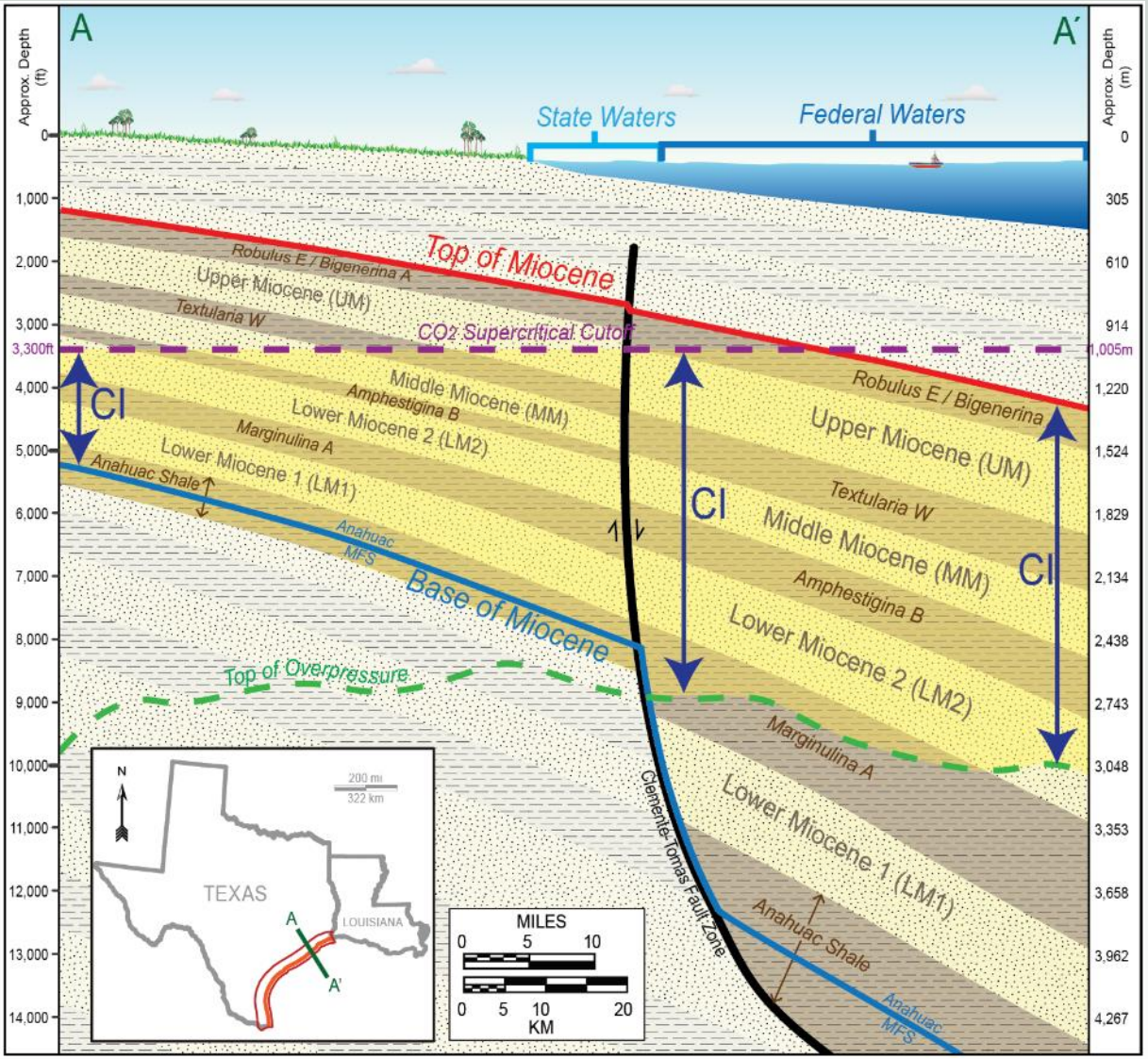
Static Regional Capacity
Texas Coast & Offshore

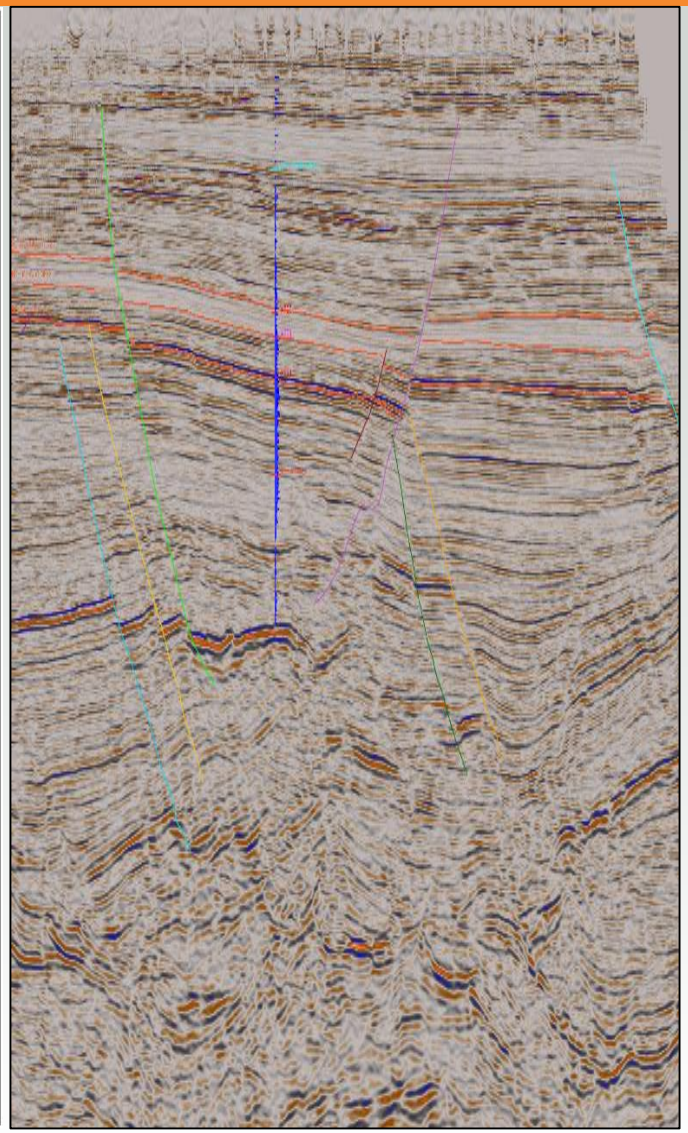
- NETL Methodology
- 40,000 sq. km.
- 3,300 logs
  - Tops, net sand, porosity
- 172 Gt CO2 storage total
  - TX State Waters

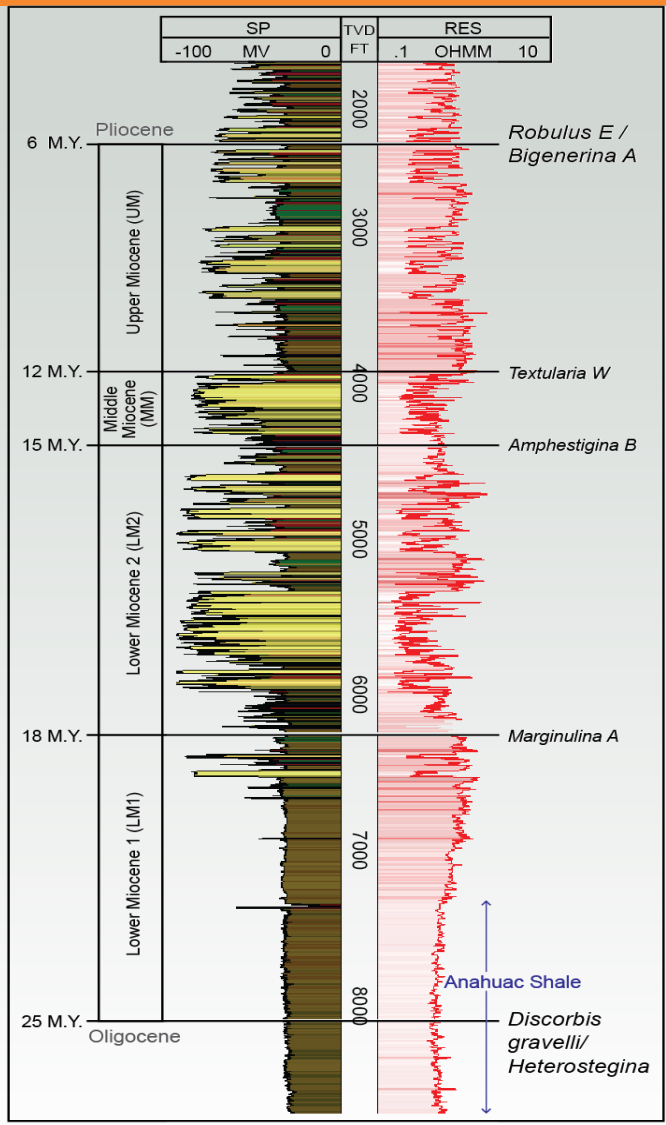




Wallace et al., 2013, *Regional CO_2 sequestration capacity assessment for the coastal and offshore Texas Miocene interval*, http://doi.org/10.1002/ghg.1380







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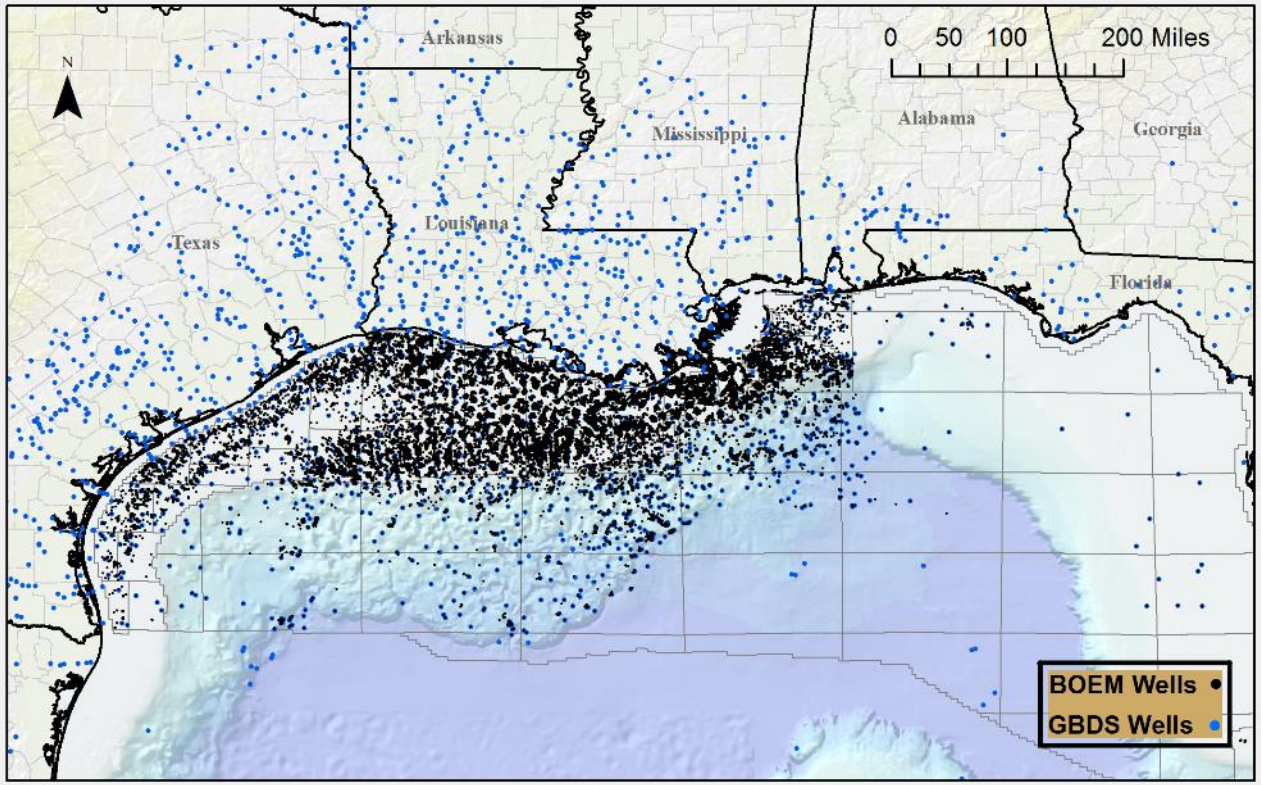
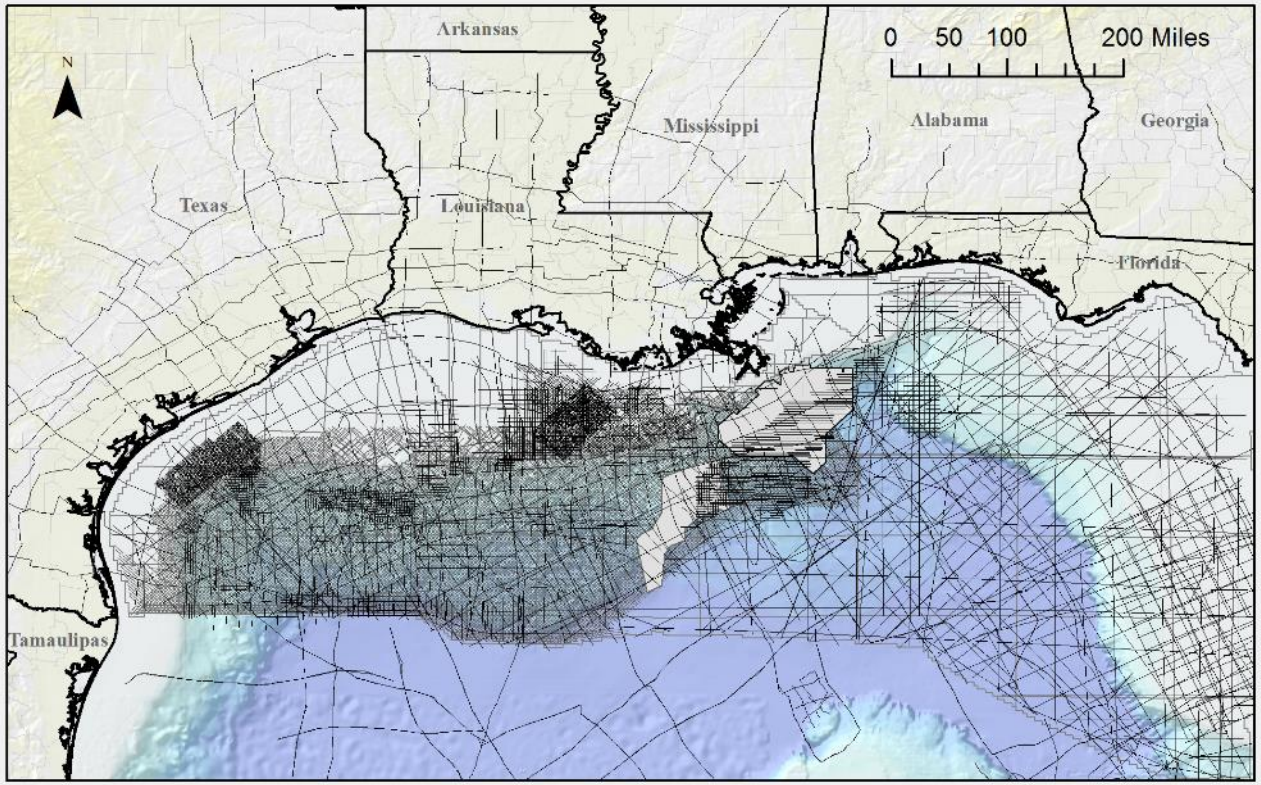
Leveraging UTIG GBDS Consortium





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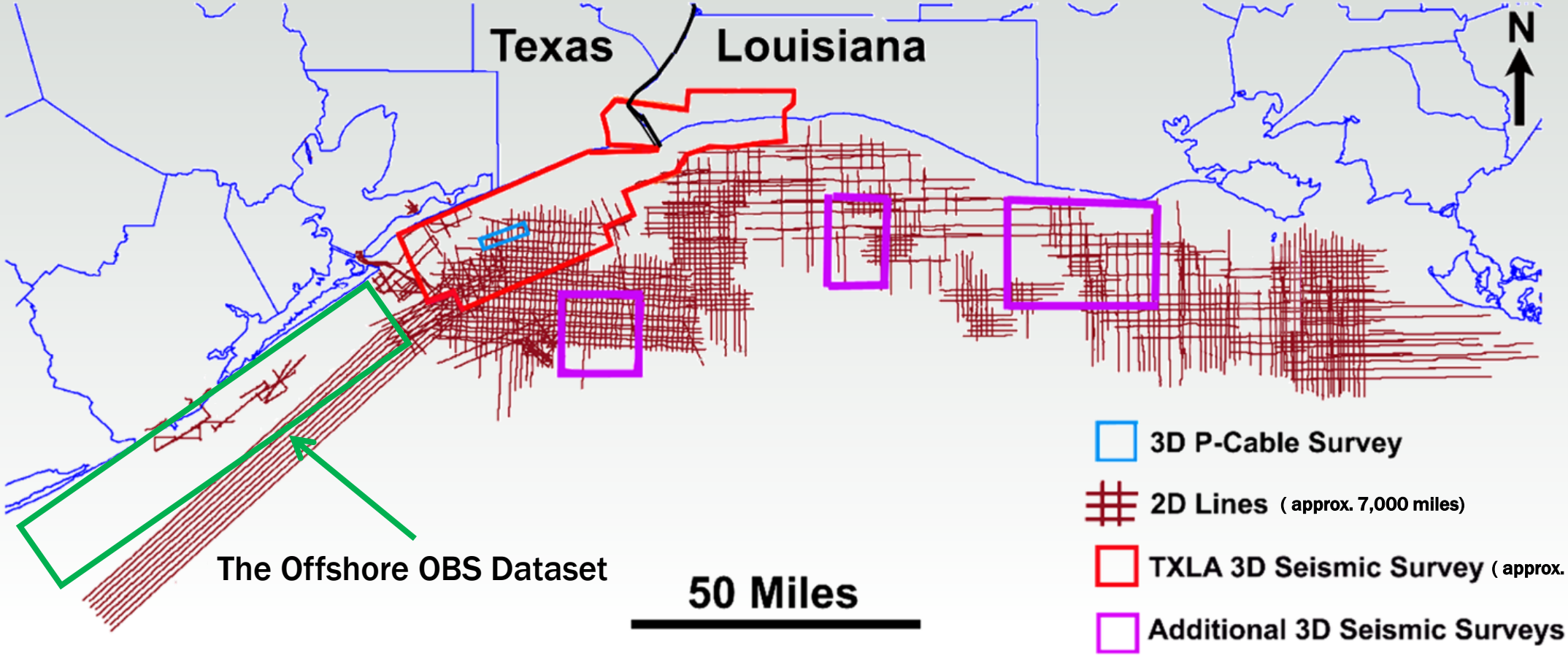
Inner-shelf data



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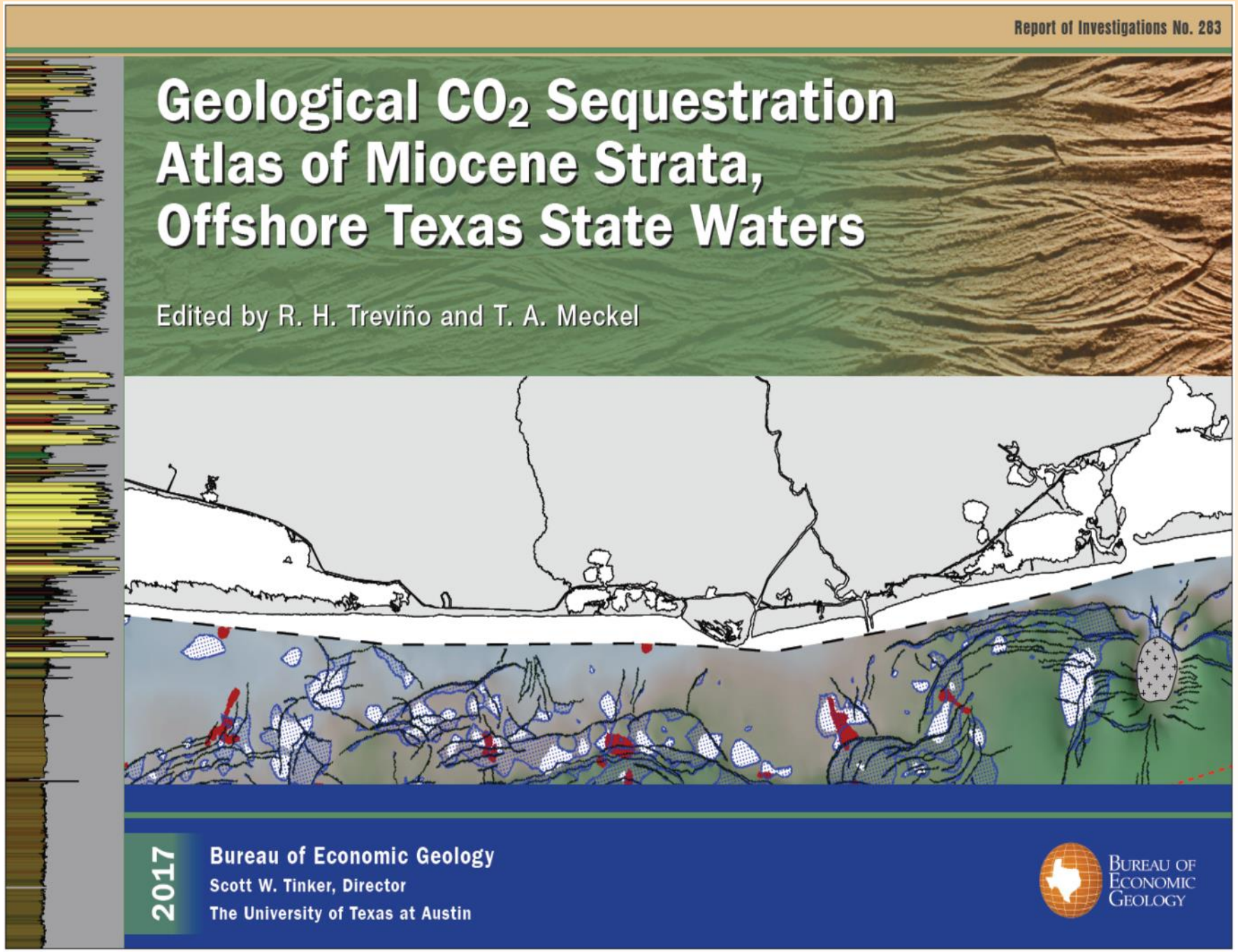
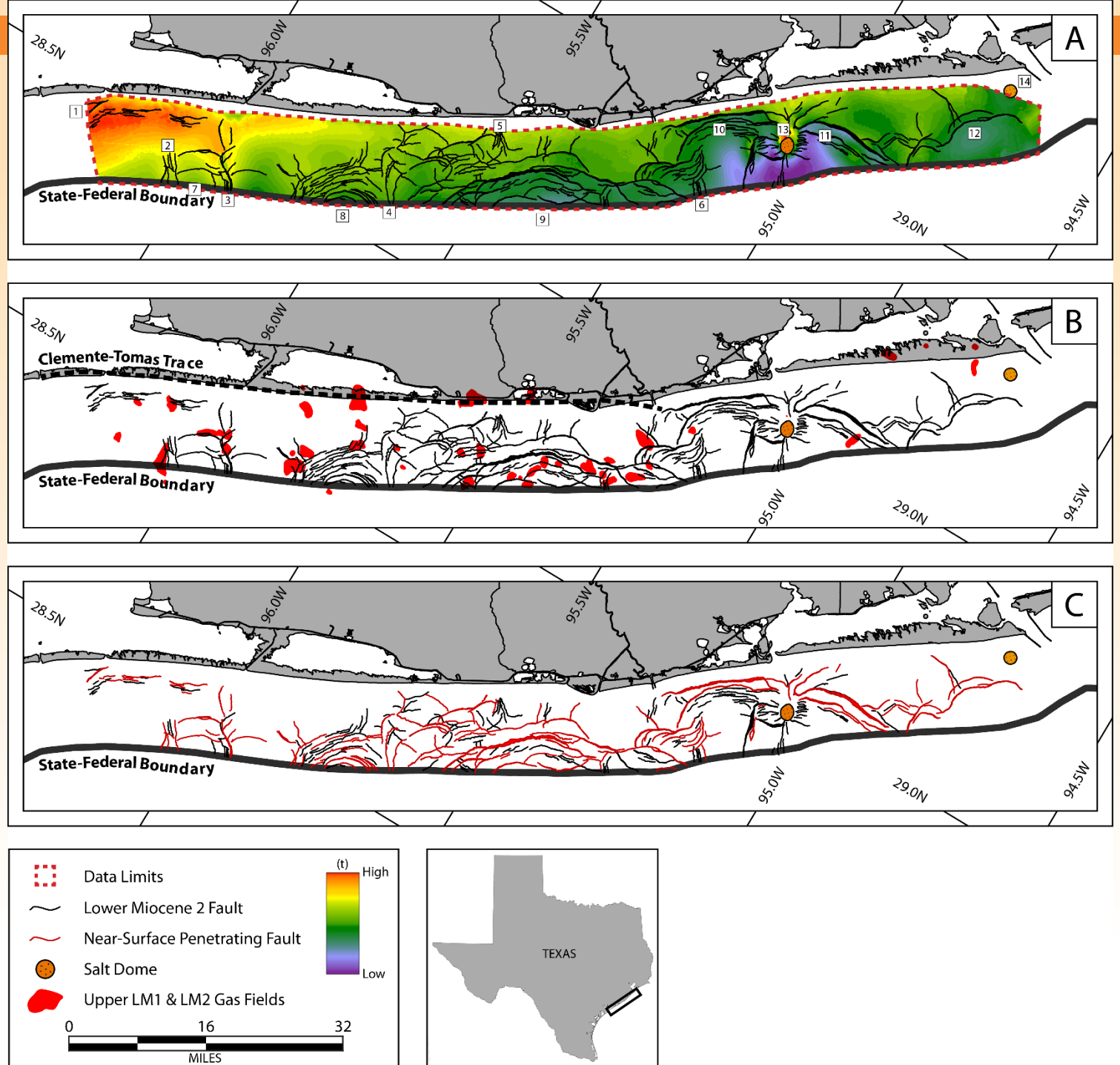
https://store.beg.utexas.edu/reports-of-investigations/3441-ri0283-atlas.html

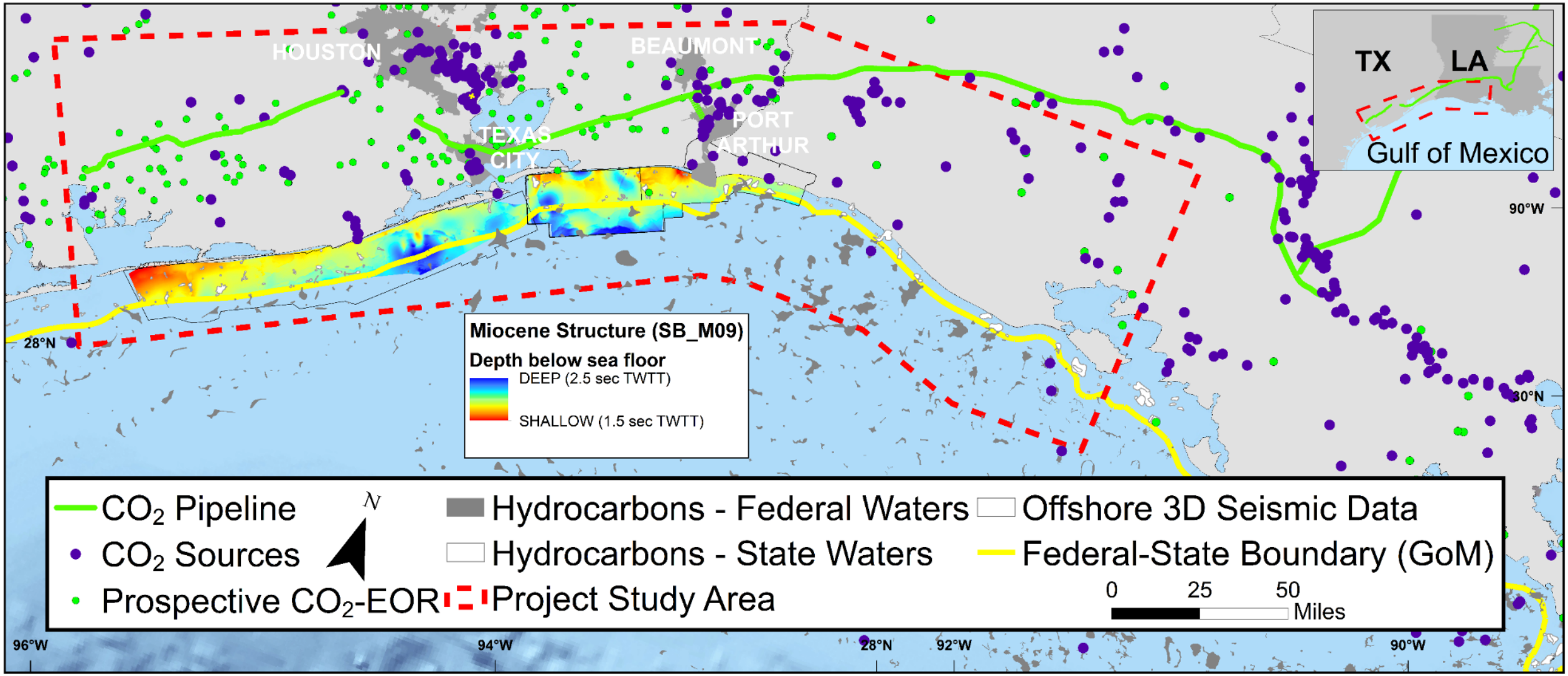


CHAPTERS

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



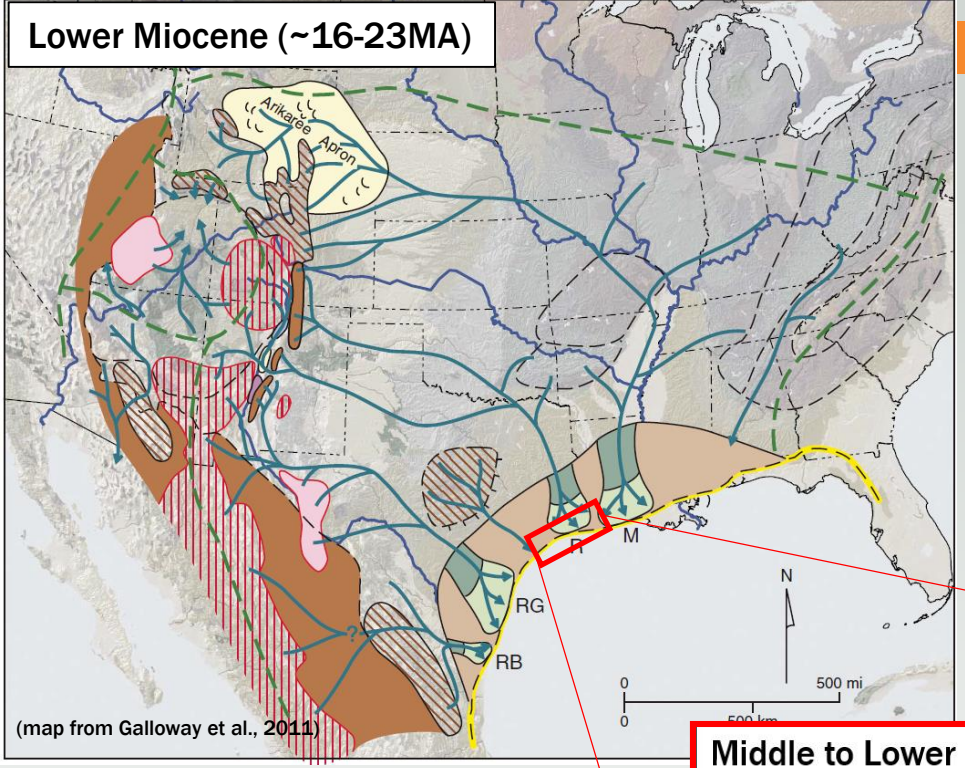
Bureau of Economic Geology



- Southeast Texas is a major industrial hub undergoing substantial expansion and billions in investment currently.
- The region is an evolving CO_2 hub, with existing infrastructure and EOR development.
- The coastal and near-offshore geology holds the majority of US CO_2 storage capacity and is a key market for CCS technology. Storage assessment studies are mature for the regions covered by integrated 3D seismic data.

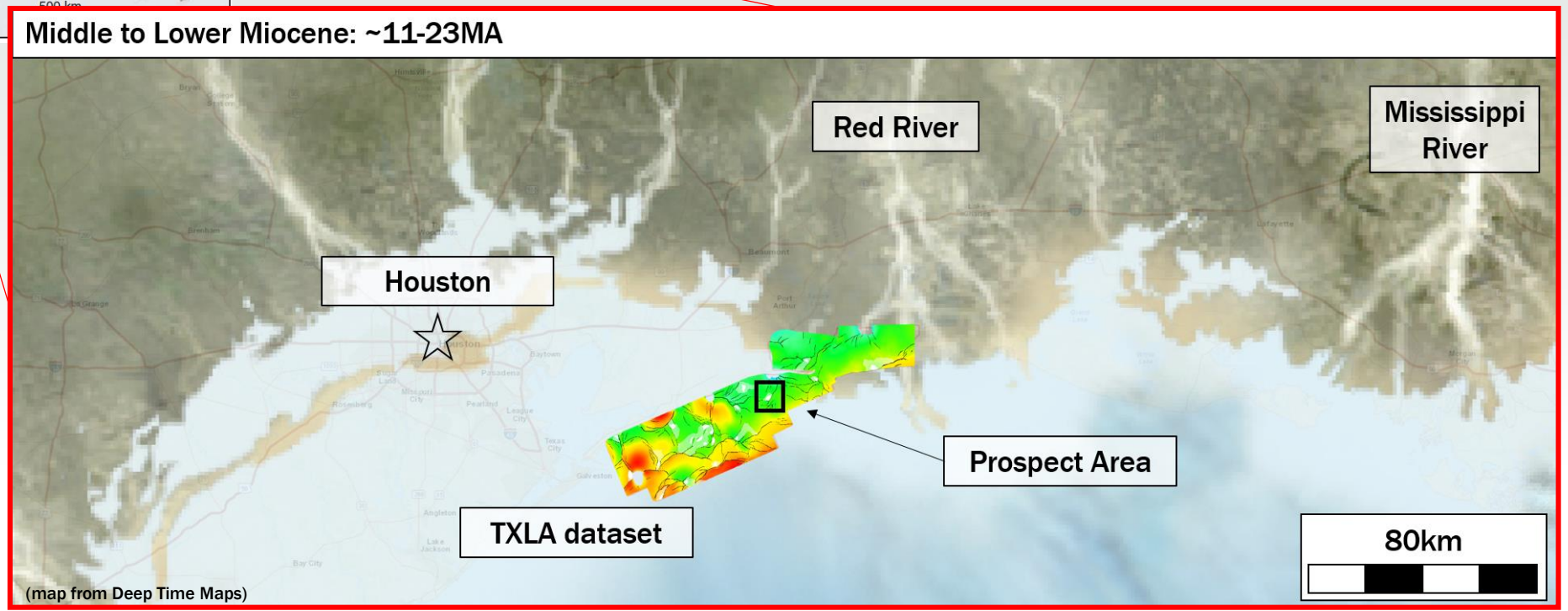
GOM Paleogeography

- Dominant environment: **Deltaic**
- Red River merging with Mississippi River



Receiving Basin Elements

- Depositional coastal plain
- Fluvial axes
- Deltaic depocenters
- Max. progradational shoreline



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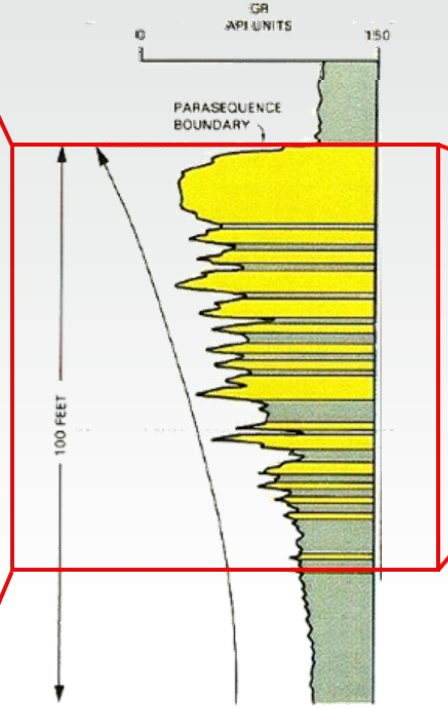
Deltaic Environments of Deposition

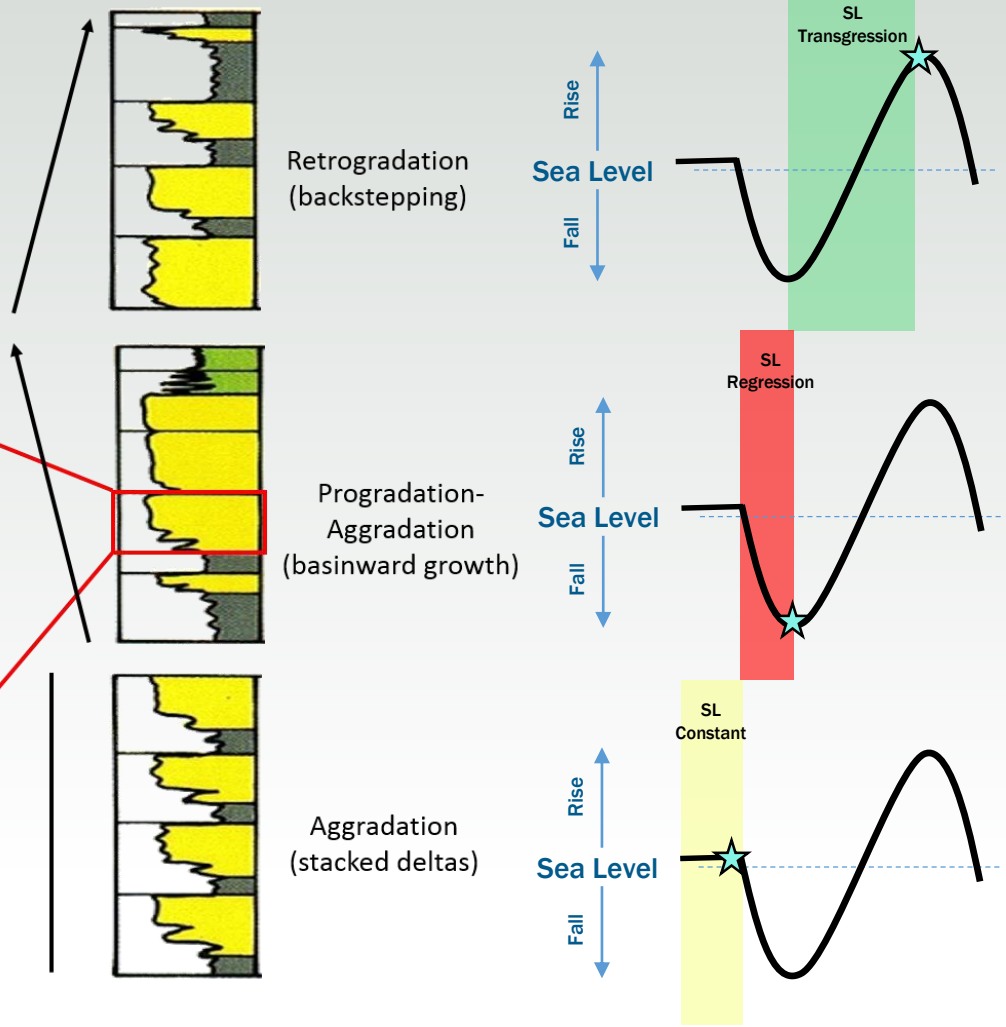
- Predictable and identifiable architecture

Panther Tongue Delta—thickens upwards

Internal Parasequence Geometries
(Van Wagoner et al., 1990)

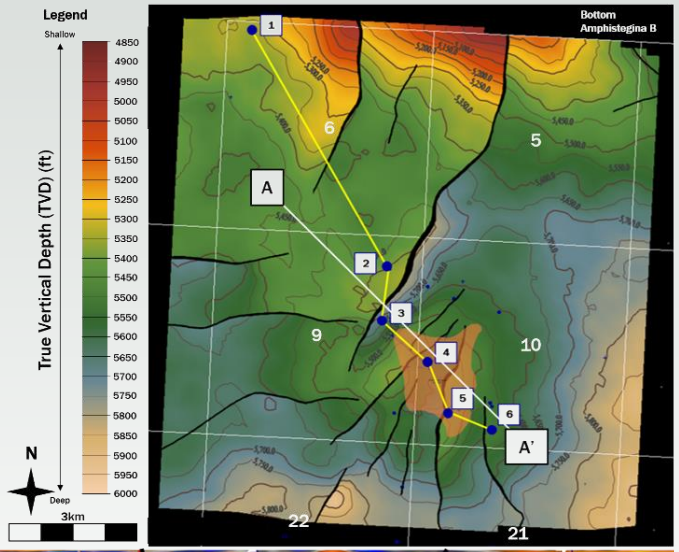


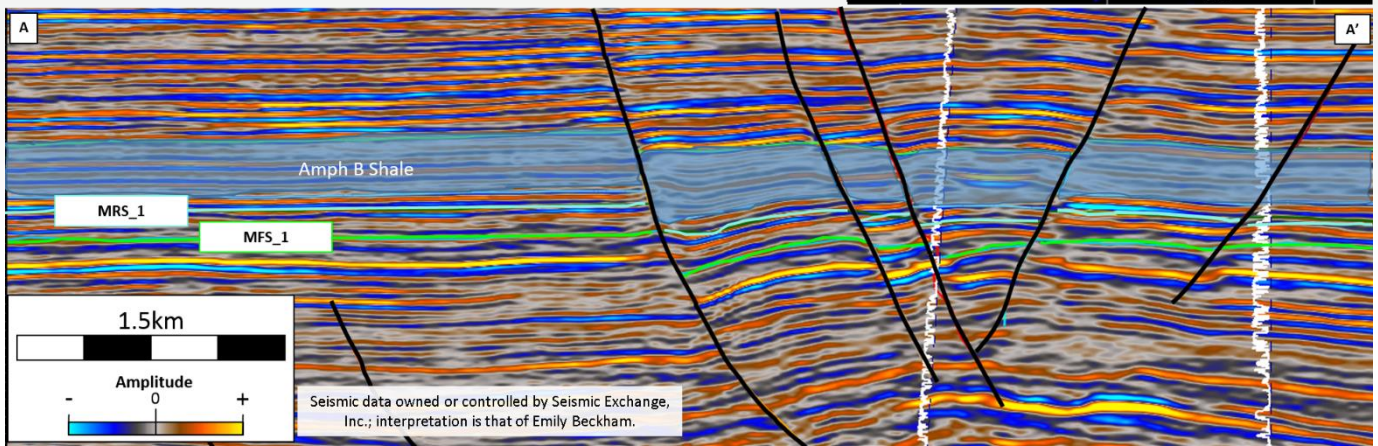
Parasequence Stacking Patterns
(Van Wagoner et al., 1990)

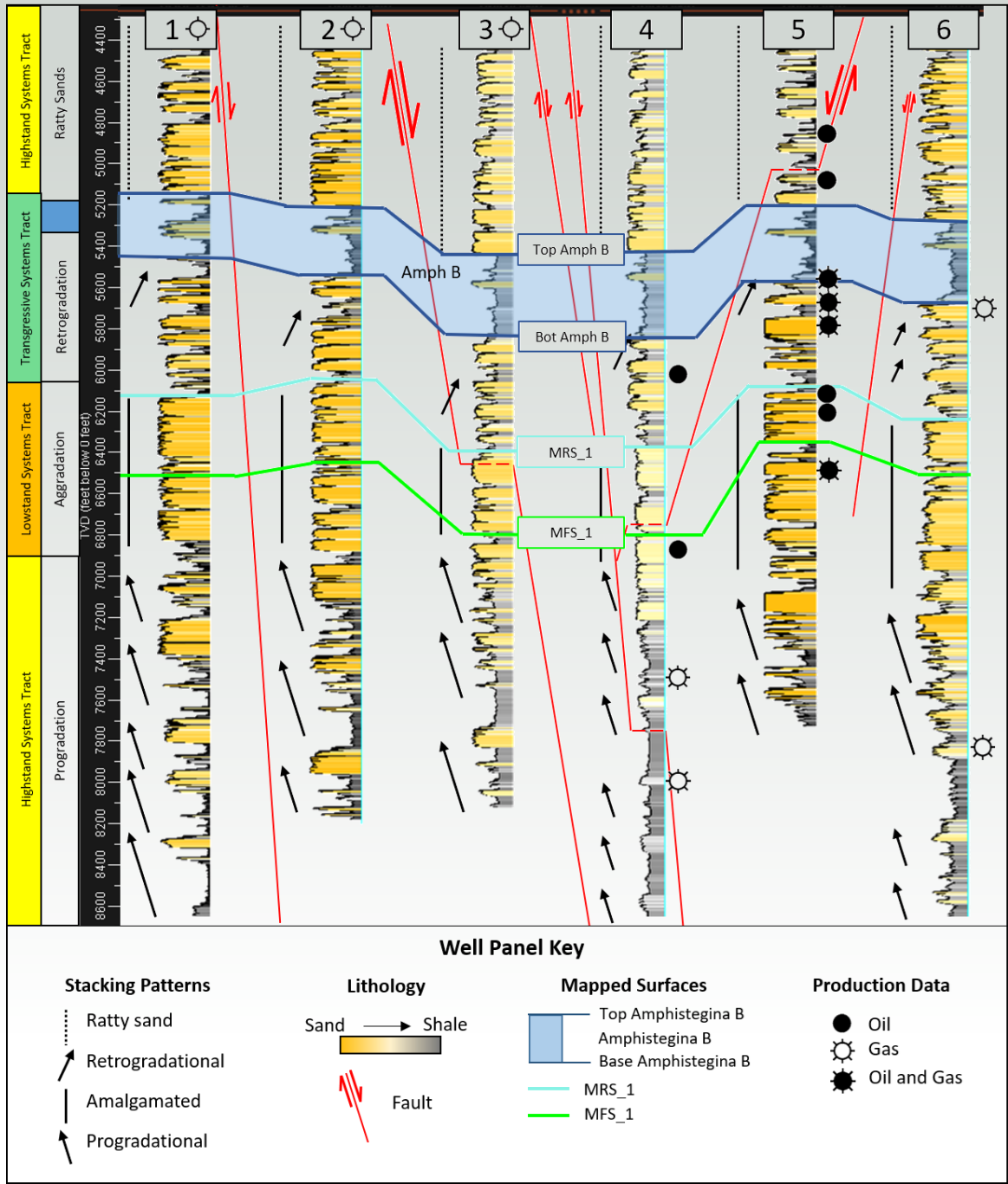


Subsurface Application

- GOM historical hydrocarbon reservoirs:
  - High Island Field 10L
- Establish sequence stratigraphic framework from stacking patterns
  - HST-LST-TST
- Seismic Mapping:
  - Regional seal
  - Maximum regressive surface
  - Lower flooding surface
- Map historical production
  - Accumulation under regressive surfaces
  - **Majority at transition of LST-TST**

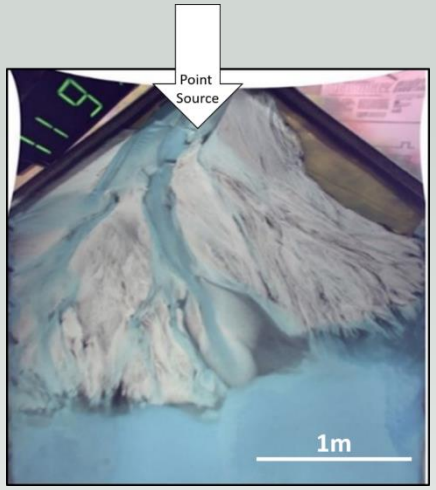


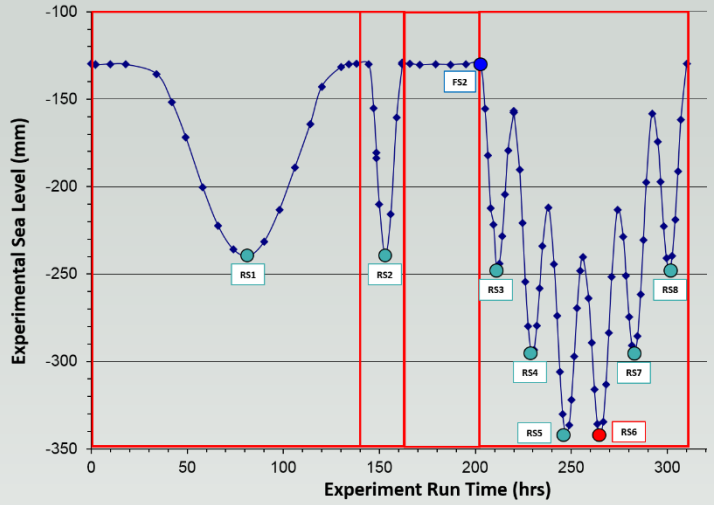


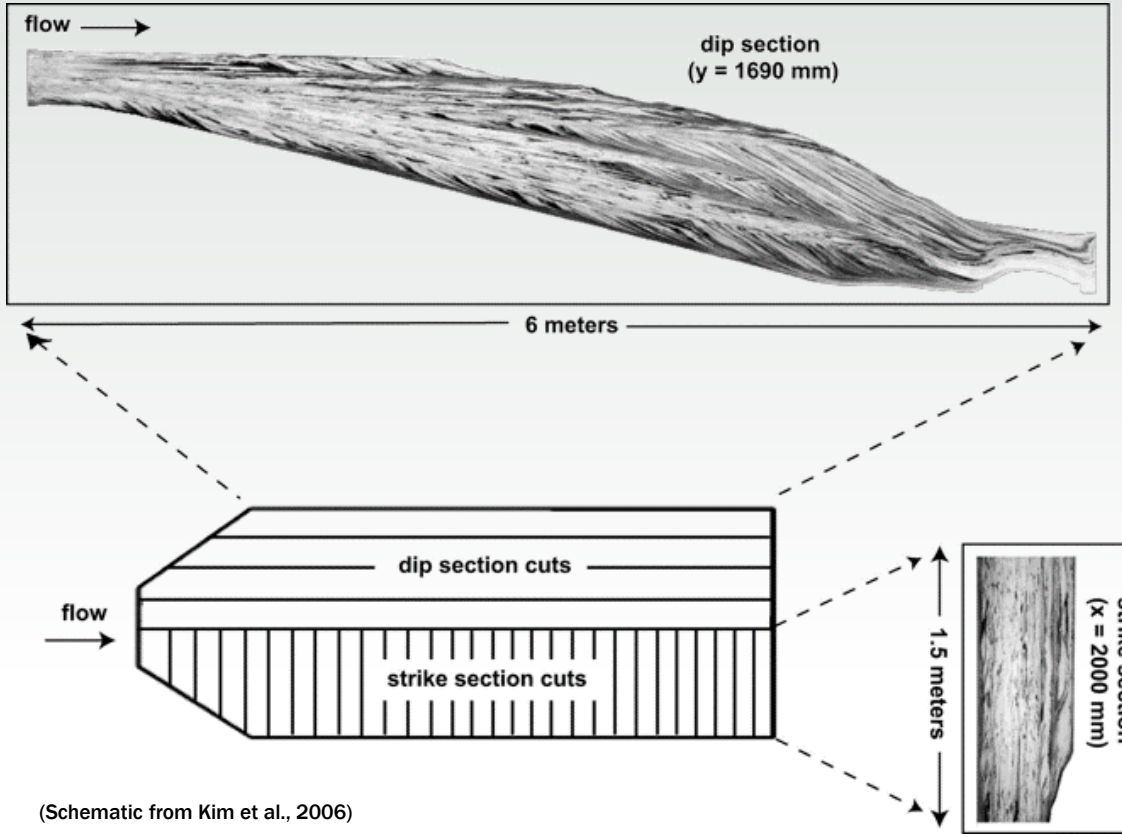


XES02 Data

- Sand tank data—XES02
  - St. Anthony Falls Laboratory
  - Variable 'sea level'
    - Slow cycle
    - Rapid cycle
    - Composite sequence
  - Realistic deltaic architecture
    - Black sediment→shale
    - White sediment→clean sand
- Significance of data
  - Computer generated models vs. natural systems
  - XES02 provides a realistic deltaic framework
- Goals:
  - Understand relationship between architectural surfaces and migration distance







(Schematic from Kim et al., 2006)

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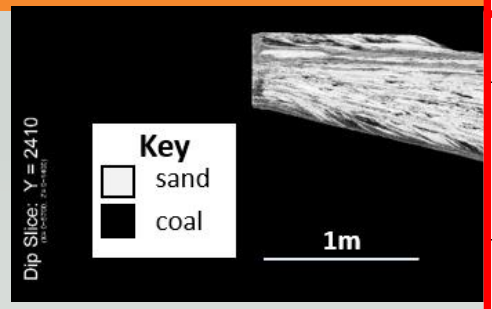
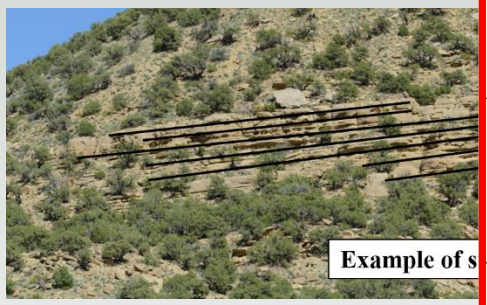
XES02 Geologic Model

1. Import model and scale
2. Populate the model according to greyscale
3. Drill wells and run buoyancy driven injection simulations

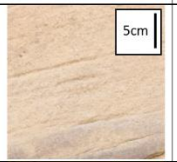
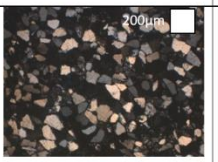
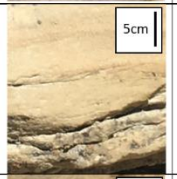
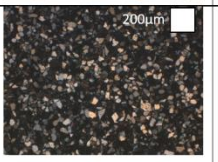
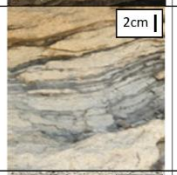
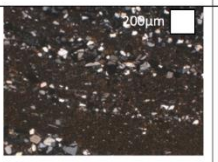


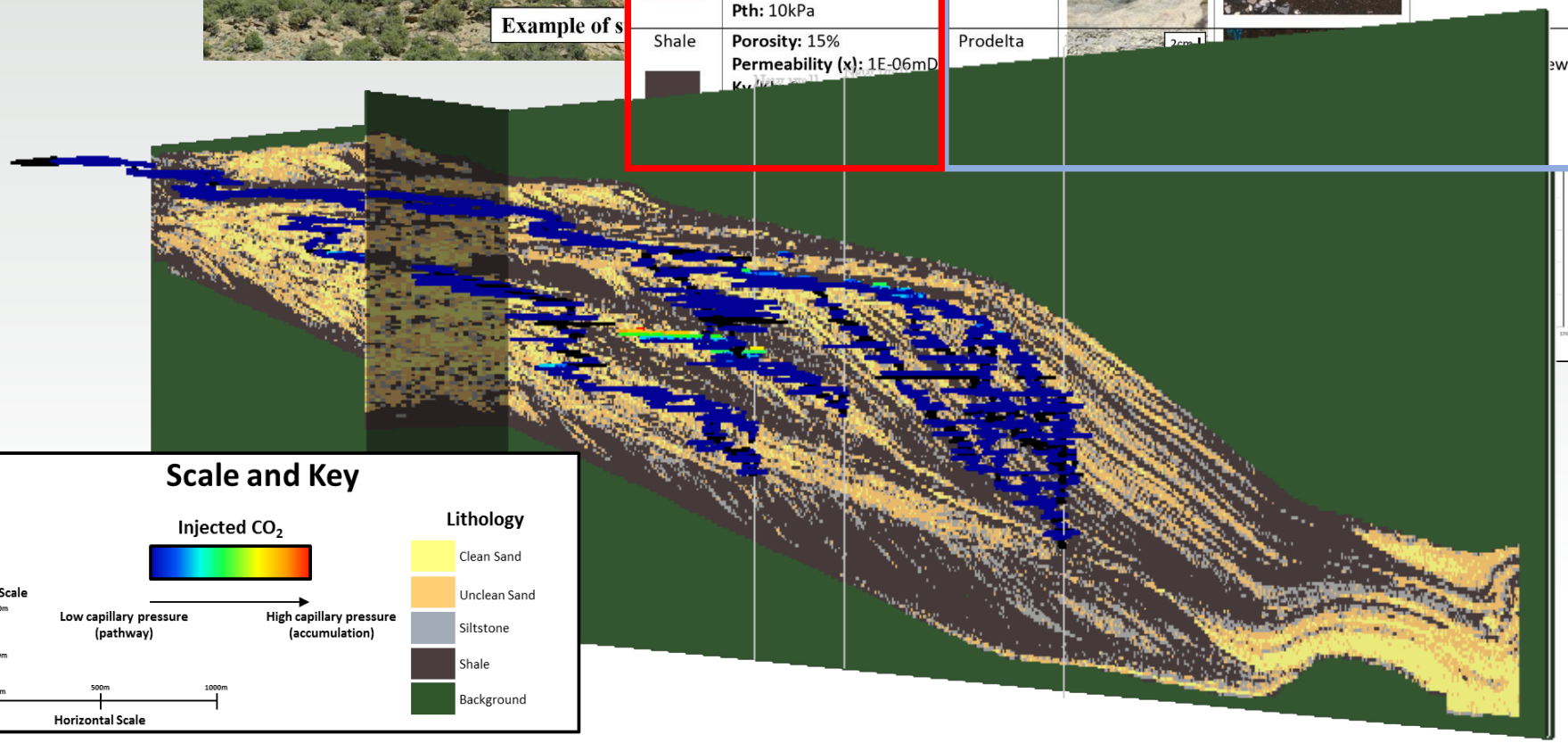


GOM Values

Model Facies	Description
Clean Sand	**Porosity:** 35% **Permeability (x):** 1000mD **Kv/Kh:** 0.1 **Sw:** 20% **Socr:** 3% **Pth:** 1.4kPa
Unclean Sand	**Porosity:** 25% **Permeability (x):** 100mD **Kv/Kh:** 0.1 **Sw:** 30% **Socr:** 3% **Pth:** 3.9kPa
Siltstone	**Porosity:** 15% **Permeability (x):** 10mD **Kv/Kh:** 0.1 **Sw:** 40% **Socr:** 3% **Pth:** 10kPa
Shale	**Porosity:** 15% **Permeability (x):** 1E-06mD

Loyd Outcrop Comparison

Outcrop Facies	Field Picture	Photomicrograph	Description
Proximal clinoform			Medium sand, planar lamination, well sorted
Medial clinoform			Upper fine to lower medium sand, trough cross stratification, planar lamination, moderate sorting
Distal clinoform			Very fine sand to silt, silt capped combined flow ripples
Prodelta			



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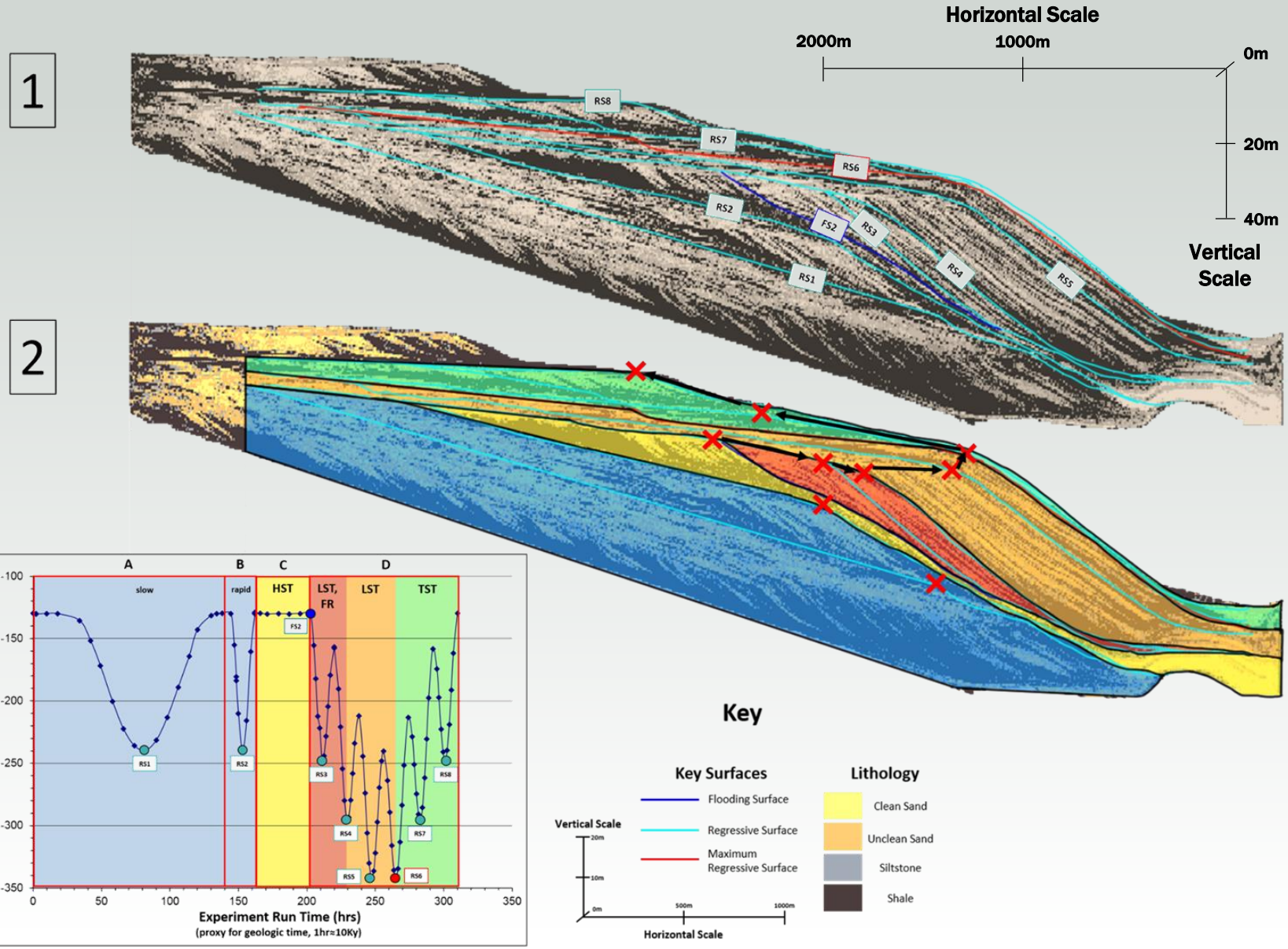
XES02 Mapping

1. Import/scale geomorphic scanned surfaces into the XES02 Geologic Model
2. Use slope break trajectory and sea level curve to place in sequence stratigraphic framework



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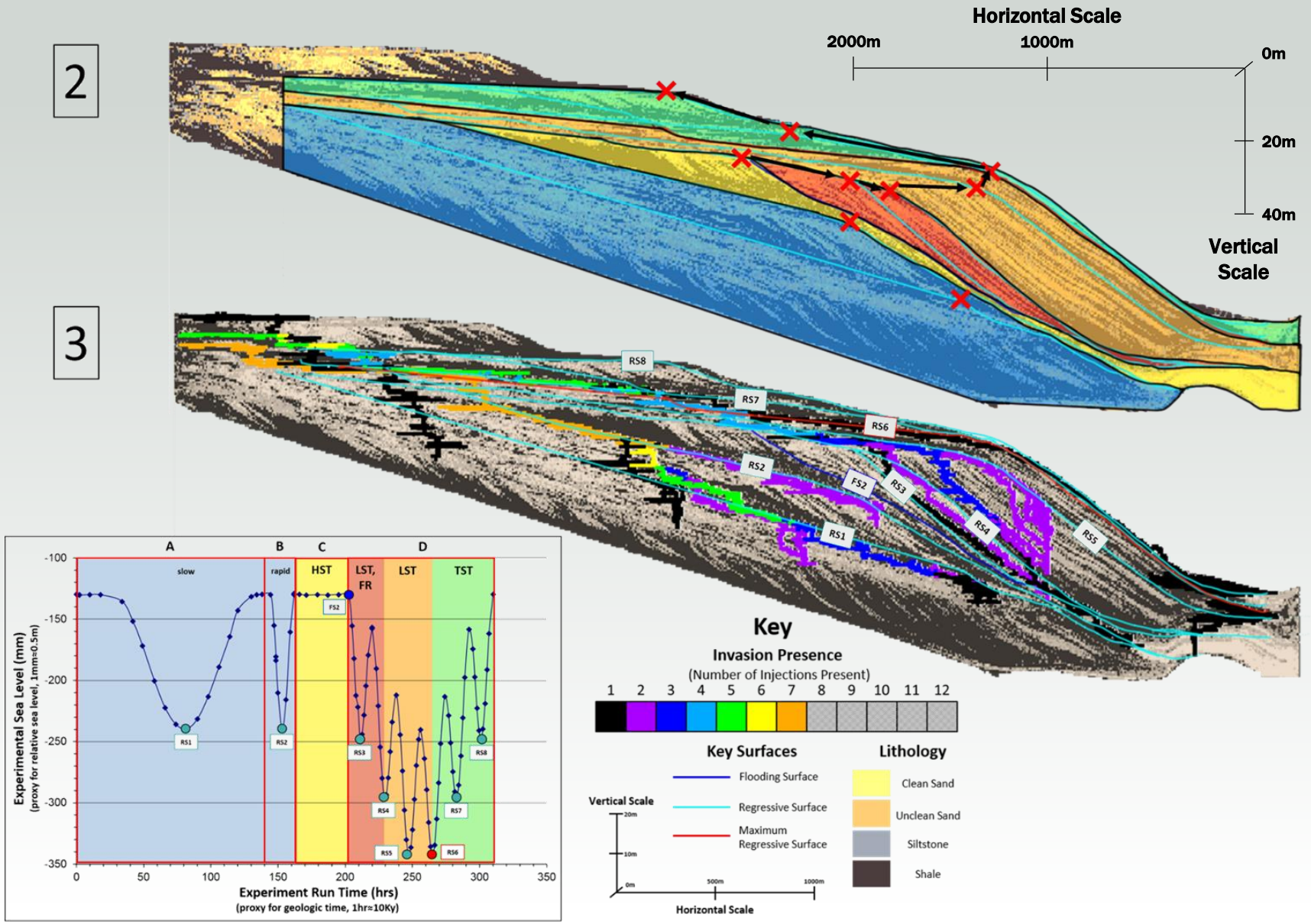
Injection Simulation Results

- CO_2 migrates below regressive surfaces
- Migration pathways converge in TST
- Local regressive surfaces=baffles
- Regional (maximum) regressive surface=barrier



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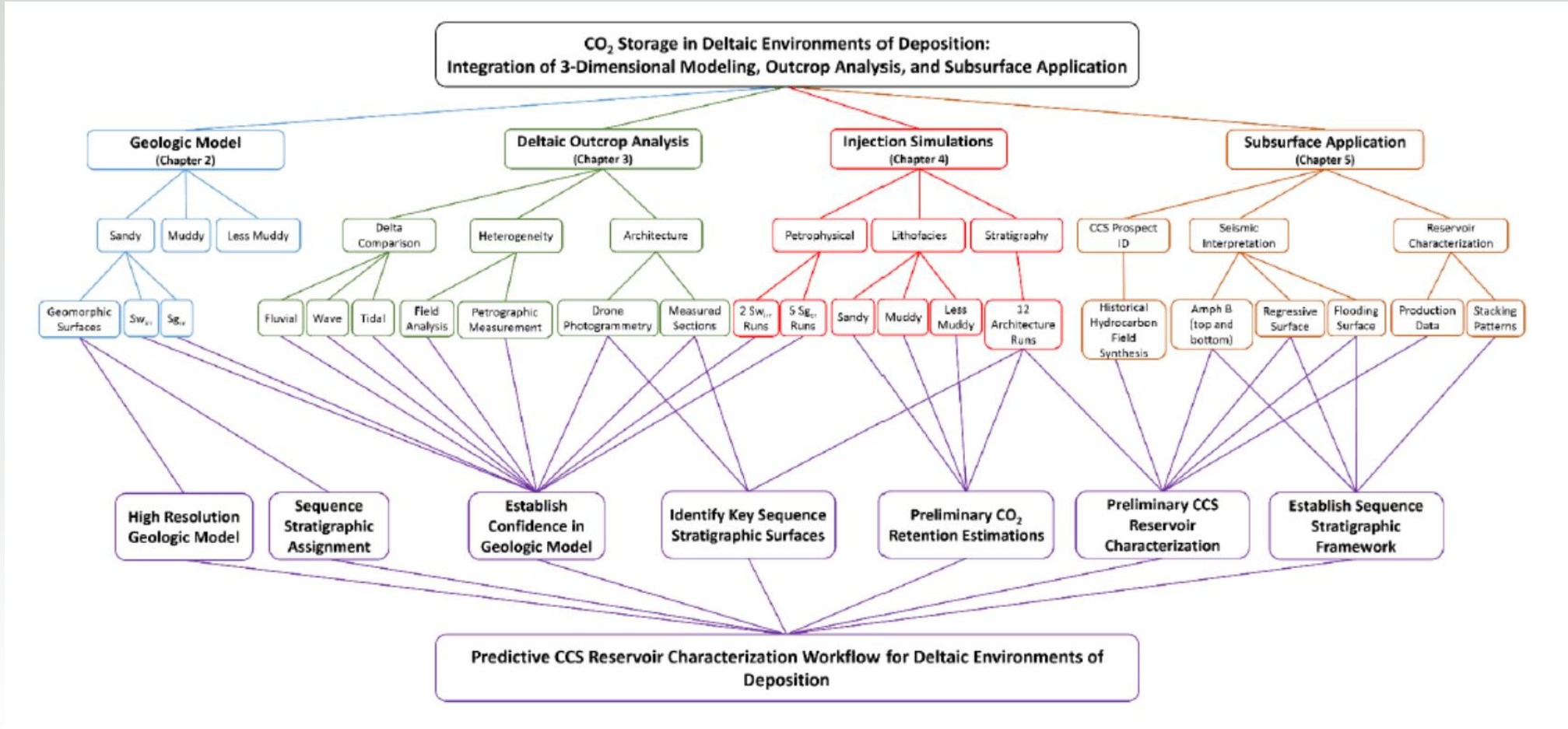
Relevant MS Theses (~900 pages)

1. Beckham, Emily, 2018, CO_2 storage in deltaic environments of deposition: Integration of 3D modeling, outcrop analysism and subsurface application, MS Thesis, The University of Texas at Austin, 220 p.
2. Maciel, R.S., 2017, Pre-injection reservoir characterization for CO2 storage in the inner continental shelf of the Texas Gulf of Mexico, MS Thesis, The University of Texas at Austin, 90 p.
3. Osmond, J.L., 2016, Fault seal and containment failure analysis of a Lower Miocene structure in the San Luis Pass area, offshore Galveston Island, Texas Inner Shelf, MS Thesis, The University of Texas at Austin, 220 p.
4. Mulcahy, F.J., 2015, Use of High Resolution 3D Seismic Data to Evaluate Quaternary Valley Evolution History during Transgression, Offshore San Luis Pass, Gulf of Mexico, MS Thesis, The University of Texas at Austin, 122 p.
5. Wallace, K.J., 2013, Use of 3-Dimensional Dynamic Modeling of CO2 Injection for Comparison to Regional Static Capacity Assessments of Miocene Sandstone Reservoirs in the Texas State Waters, Gulf of Mexico, MS Thesis, The University of Texas at Austin, 152 p.
6. Nicholson, A.J., 2012, Empirical Analysis of Fault Seal Capacity for CO_2 Sequestration, Lower Miocene, Texas Gulf Coast, MS Thesis, The University of Texas at Austin, 100 p.



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