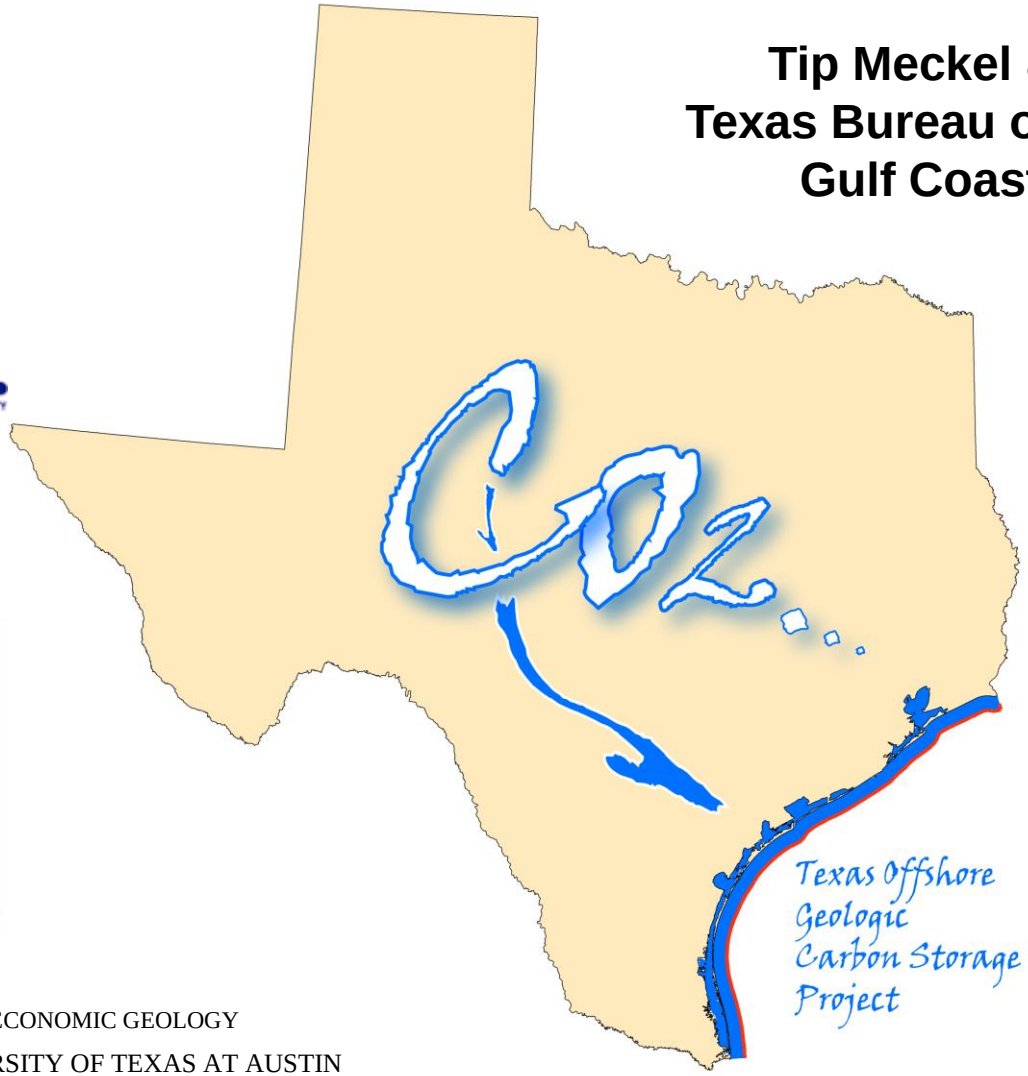
Texas Offshore Miocene Characterization Project

Tip Meckel & Ramon Trevino
Texas Bureau of Economic Geology
Gulf Coast Carbon Center

Review meeting
Pittsburgh, PA
October 6, 2010



BUREAU OF ECONOMIC GEOLOGY
THE UNIVERSITY OF TEXAS AT AUSTIN

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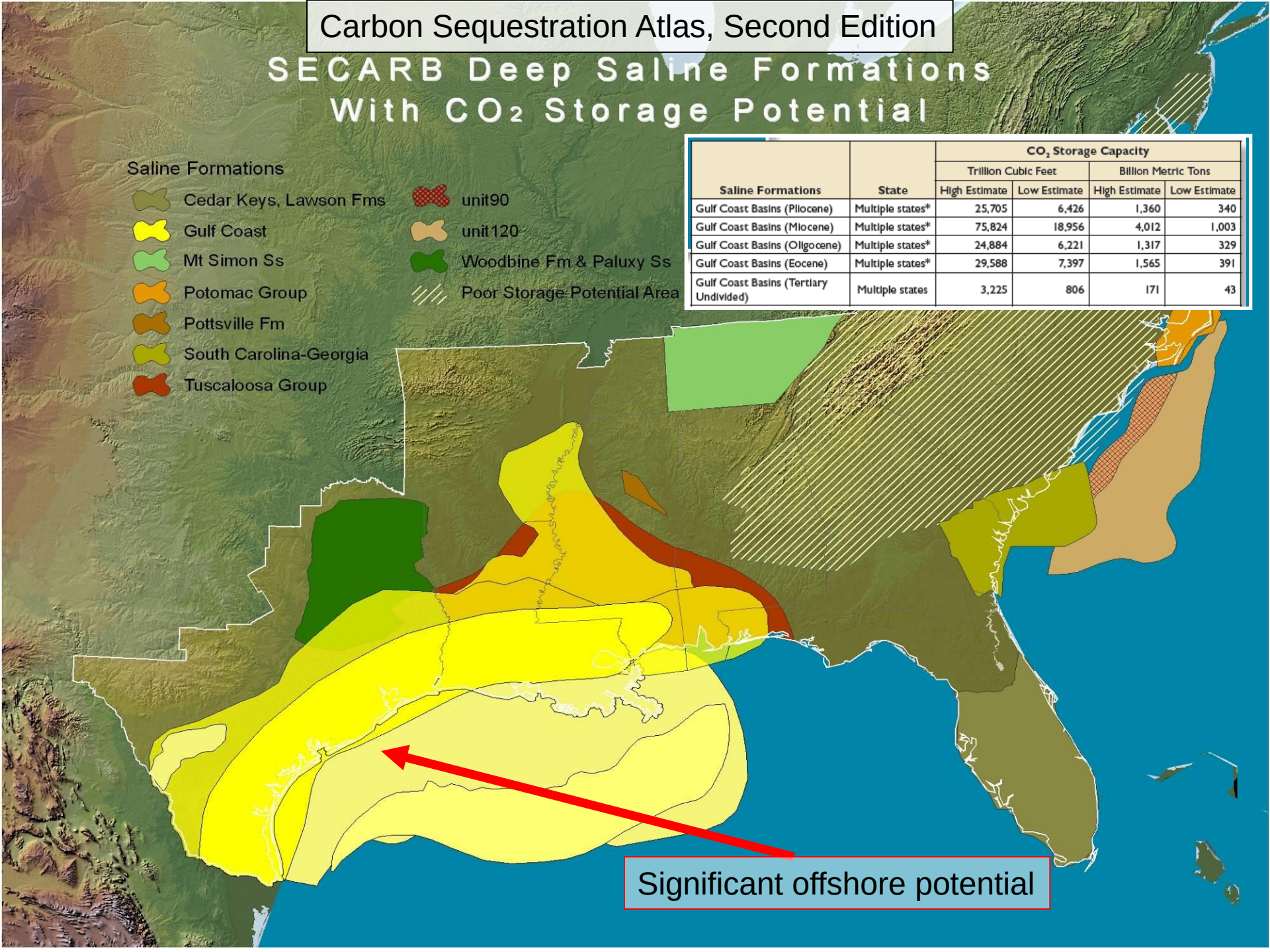
Participants

- NETL *Project Manager: Bruce Brown*
- The University of Texas at Austin
  - *Gulf Coast Carbon Center, Bureau of Economic Geology*
  - *Institute for Geophysics*
  - *Petroleum and Geosystems Engineering*
- Los Alamos National Laboratory
- Environmental Defense Fund
- Sandia Technologies

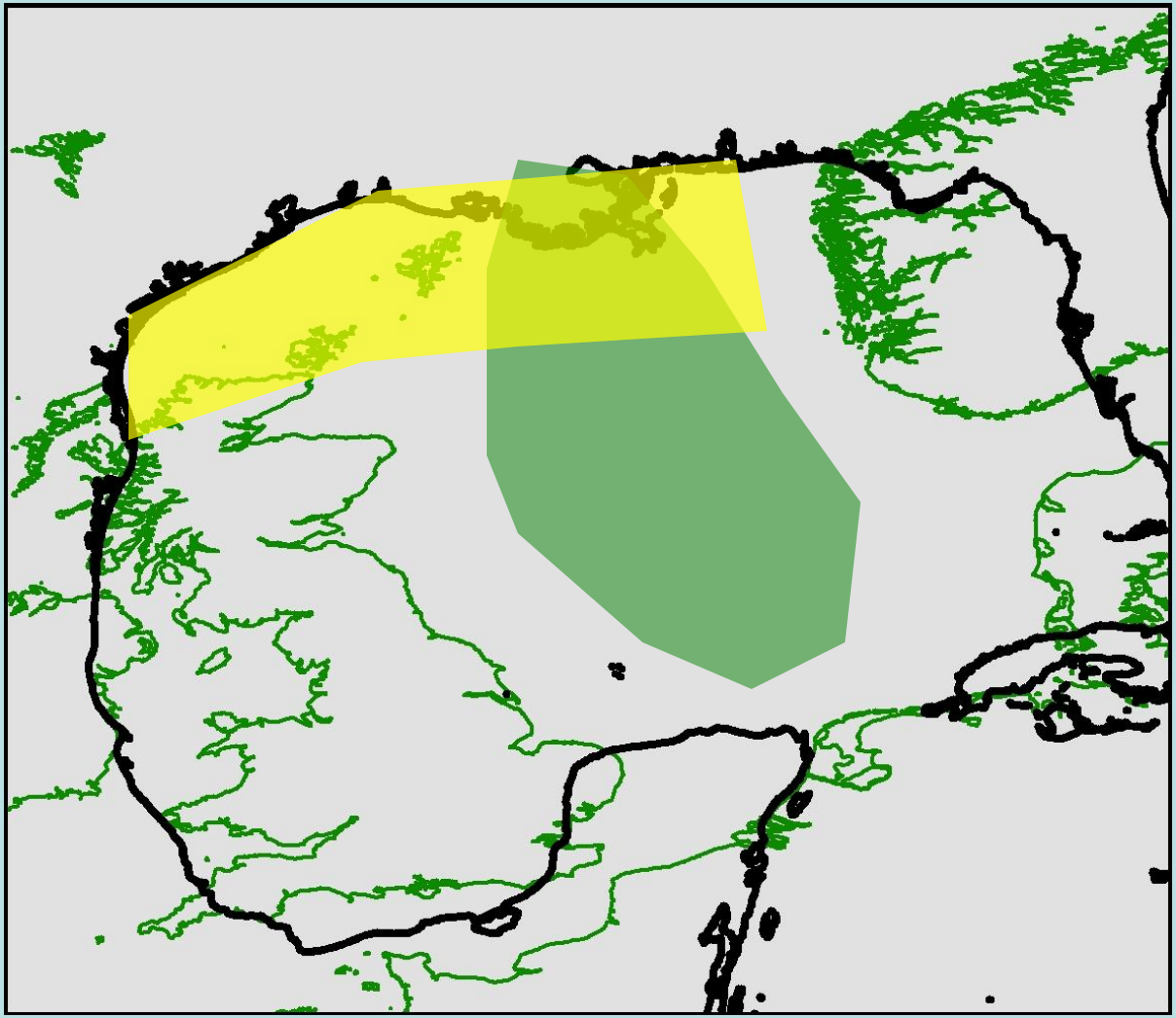
Carbon Sequestration Atlas, Second Edition

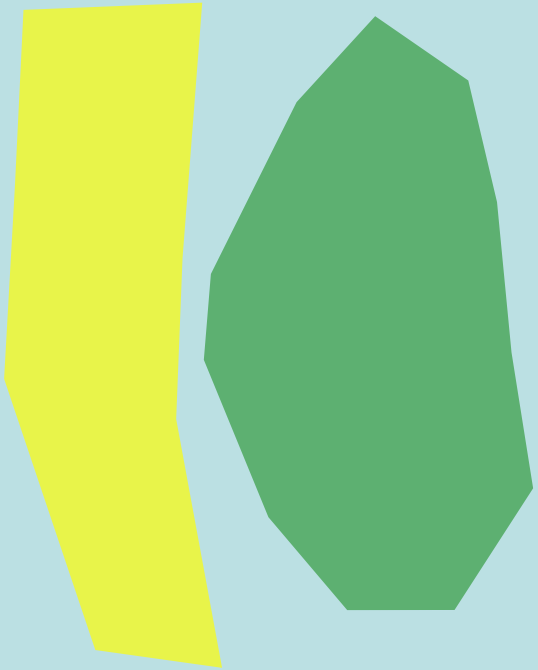
SECARB Deep Saline Formations With CO_2 Storage Potential



Saline Formations	State	CO_2 Storage Capacity			
		Trillion Cubic Feet		Billion Metric Tons	
		High Estimate	Low Estimate	High Estimate	Low Estimate
Gulf Coast Basins (Pliocene)	Multiple states*	25,705	6,426	1,360	340
Gulf Coast Basins (Miocene)	Multiple states*	75,824	18,956	4,012	1,003
Gulf Coast Basins (Oligocene)	Multiple states*	24,884	6,221	1,317	329
Gulf Coast Basins (Eocene)	Multiple states*	29,588	7,397	1,565	391
Gulf Coast Basins (Tertiary Undivided)	Multiple states	3,225	806	171	43

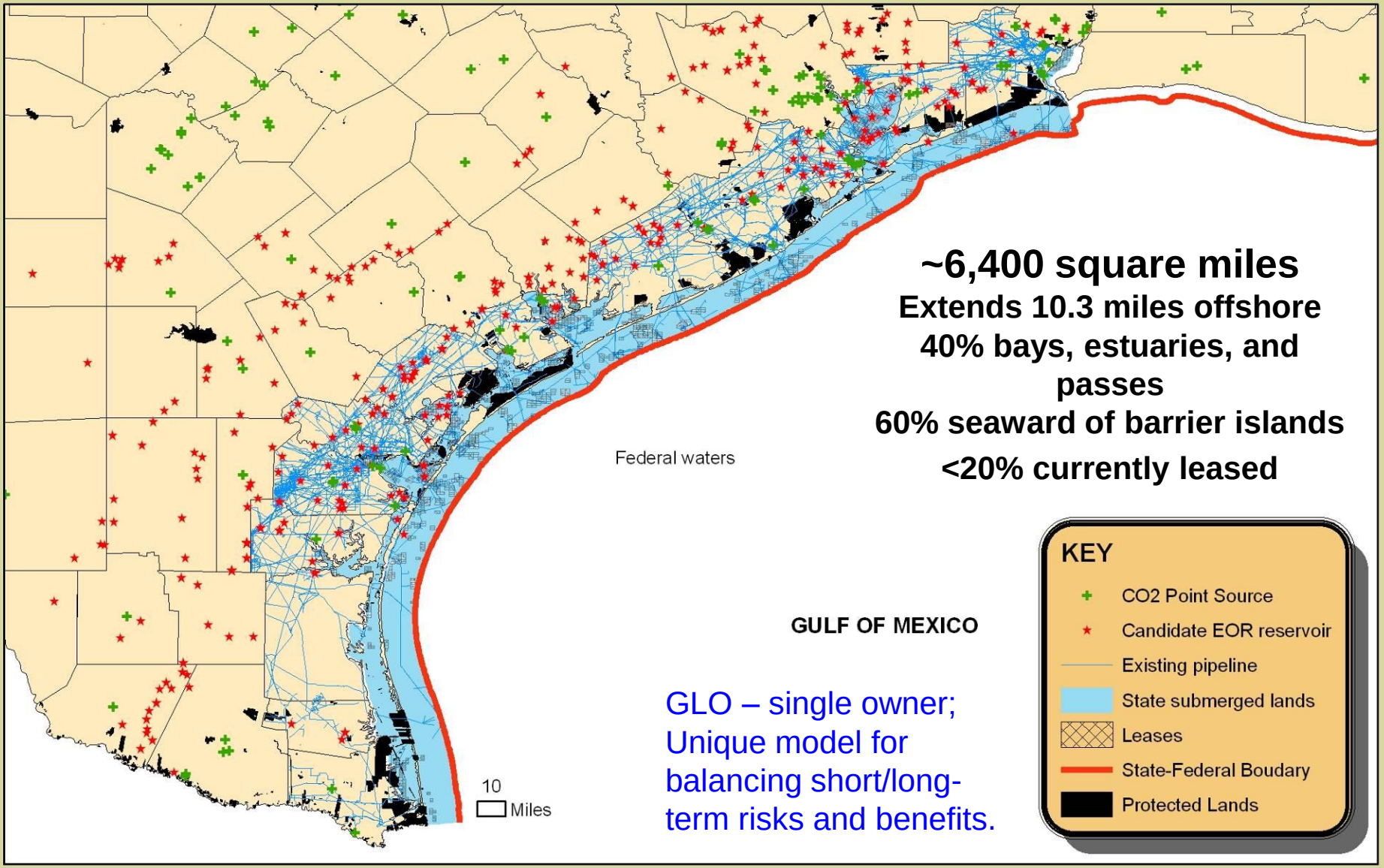
Comparing northern GOM with the North Sea





Offshore State-owned lands

Additional assurance is needed regarding capacity and containment



~6,400 square miles

Extends 10.3 miles offshore

40% bays, estuaries, and passes

60% seaward of barrier islands

<20% currently leased

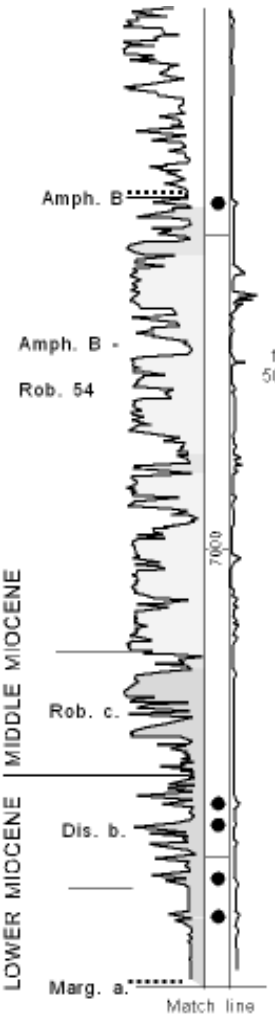
GLO – single owner; Unique model for balancing short/long-term risks and benefits.

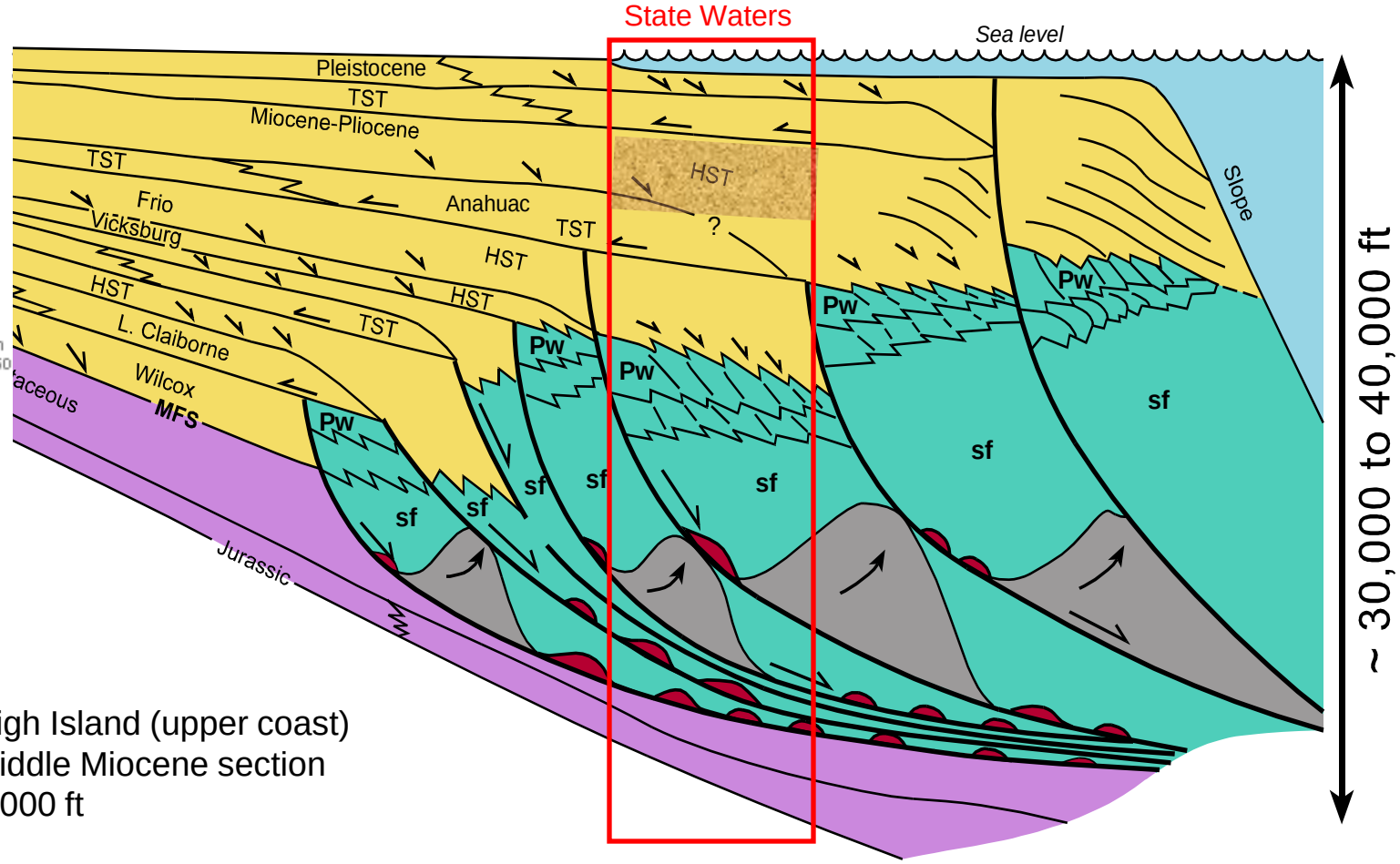
Tasks

- **Task 1: Project Management, Planning, and Reporting (Trevino, Meckel)**
- **Task 2: Regional Significance (Meckel, Carr, Hovorka)**
  - **Subtask 2.1: Atlas of prospective sequestration 'plays'**
  - **Subtask 2.2: Comprehensive data set of formation characteristics**
  - **Subtask 2.3: Best practices for site characterization**
- **Task 3: Site Capacity Estimates (Meckel, Hovorka, Nicot, Undergraduate research assistant)**
  - **Subtask 3.1: Coordination with NATCARB database**
- **Task 4: Site Injectivity (Trevino, Nicot, Zeng, Carr, Bryant, PhD student)**
  - **Subtask 4.1: Data collection / Analysis**
  - **Subtask 4.2: Simulation**
- **Task 5: Site Stratigraphic Containment (Meckel, Carr, Lu, PhD student, undergraduate research assistant)**
  - **Subtask 5.1 Modeling**
  - **Subtask 5.2: Caprock Seal Capacity**
- **Task 6: Brine Containment (Romanak, Zhang, Meckel, Nicot)**
  - **Laboratory hydrothermal simulations**
  - **Aqueous phase modeling**
- **Task 7: Mineralization Containment (Romanak, Zhang, Yang)**
- **Task 8: Leakage Pathways (Meckel, Lu, Hornback)**
- **Task 9: Site Selection (Trevino, Meckel)**
- **Task 10: Risk Assessment (Pawar-LANL; Anderson-EDF; Duncan-BEG)**
  - **Subtask 10.1: CO2-PENS analysis (Pawar)**
  - **Subtask 10.2: Identification of environmental risks specific to offshore settings (Anderson, Duncan)**
- **Task 11: Well Bore Management (Trevino, Collins)**
  - **Subtask 11.1: Wellbore Evaluation for Wells Within Study Area**
  - **Subtask 11.2: Draft Wellbore Management Plan**
- **Task 12.0: Produced Fluid Management**

Tremendous potential in offshore wedge

Prograding wedge of fluvio-deltaic sediments in Miocene stratigraphy





High Island (upper coast)
Middle Miocene section
7,000 ft

Modified from Bebout and Loucks (1981)

Cumulative Miocene
3.1 Tcf / 38 MMbbl

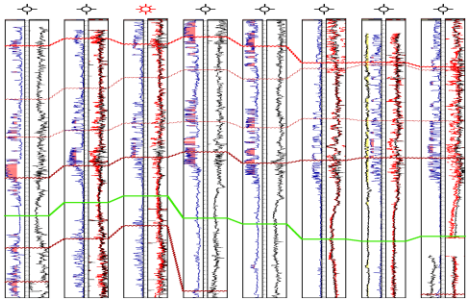
Transgressive
Aggradational
Progradational
Submarine fan

Task 2: Regional Significance

PROJECT STARR
State of Texas Advanced Oil and Gas Resource Recovery

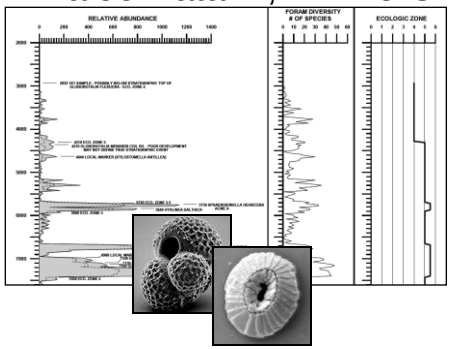
Database

- ~16,000 wells;
~4,700 logs identified

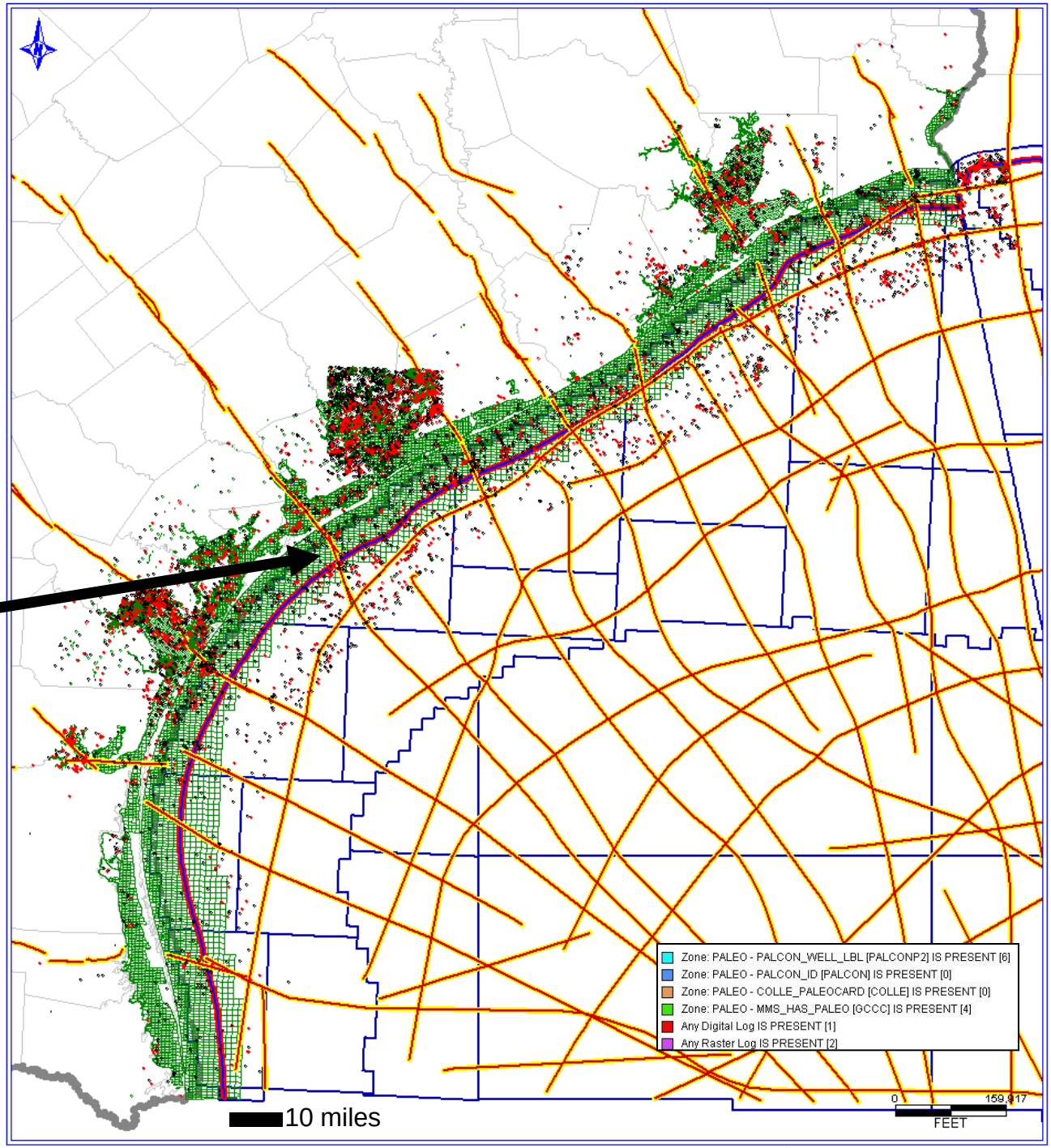


413 miles in State waters of GulfSpan 2D seismic lines (Ion Geophysical)

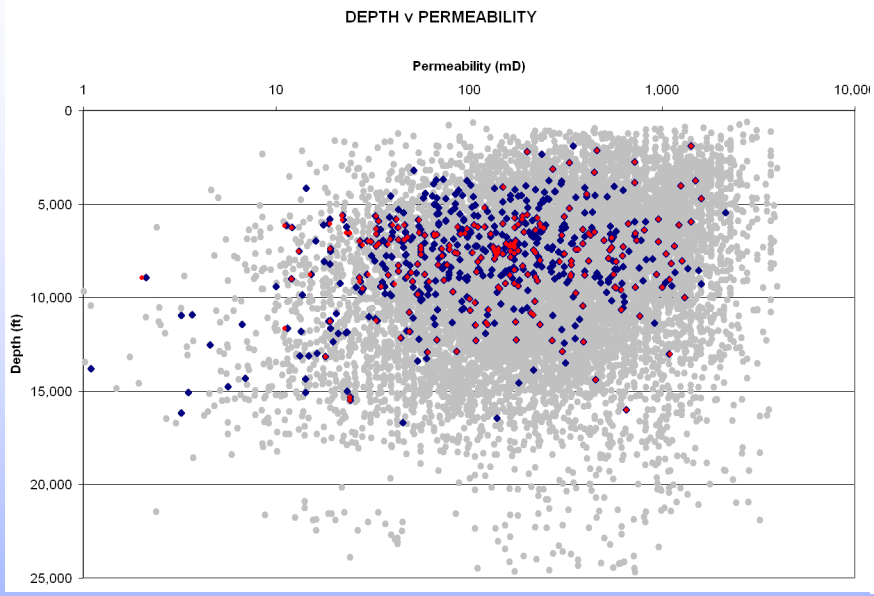
Paleo Data: 1,444 wells

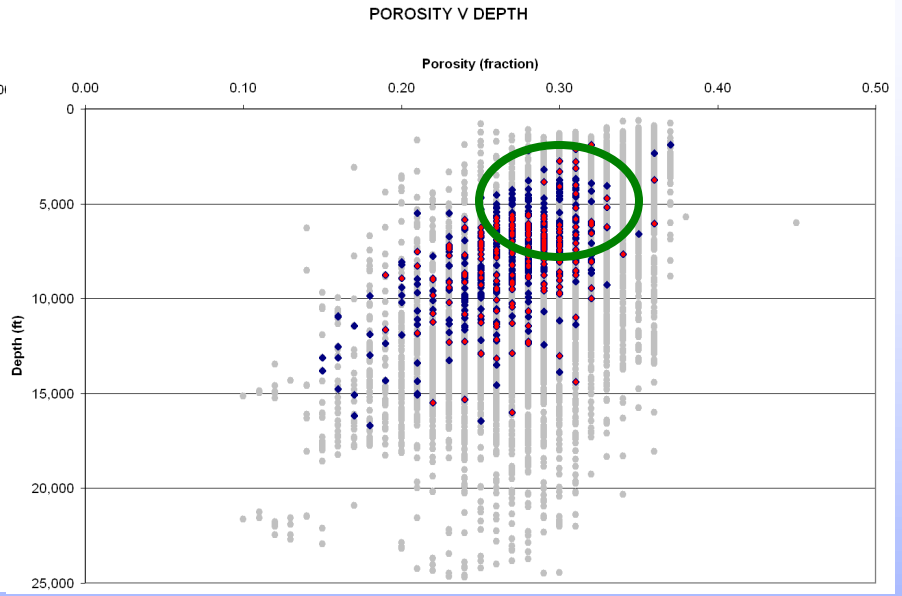


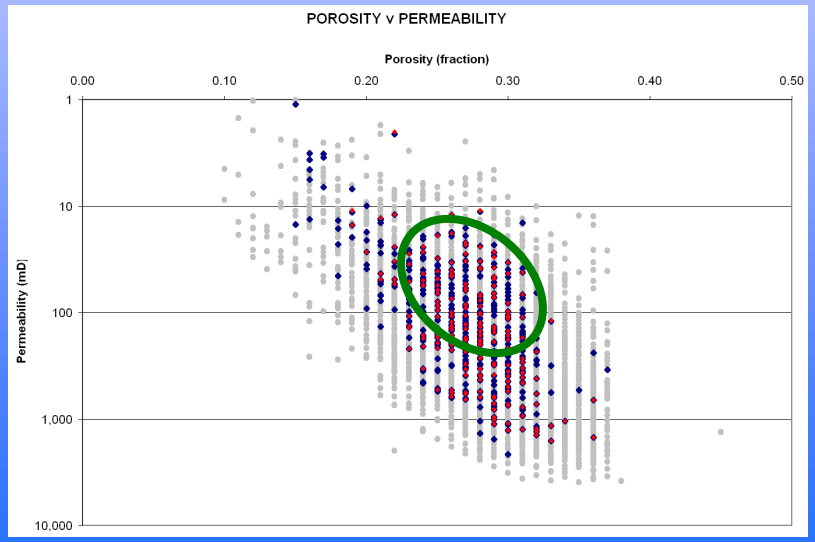
Task 2: Regional Significance
Task 3: Site Capacity Estimates



Characterization of Miocene sands



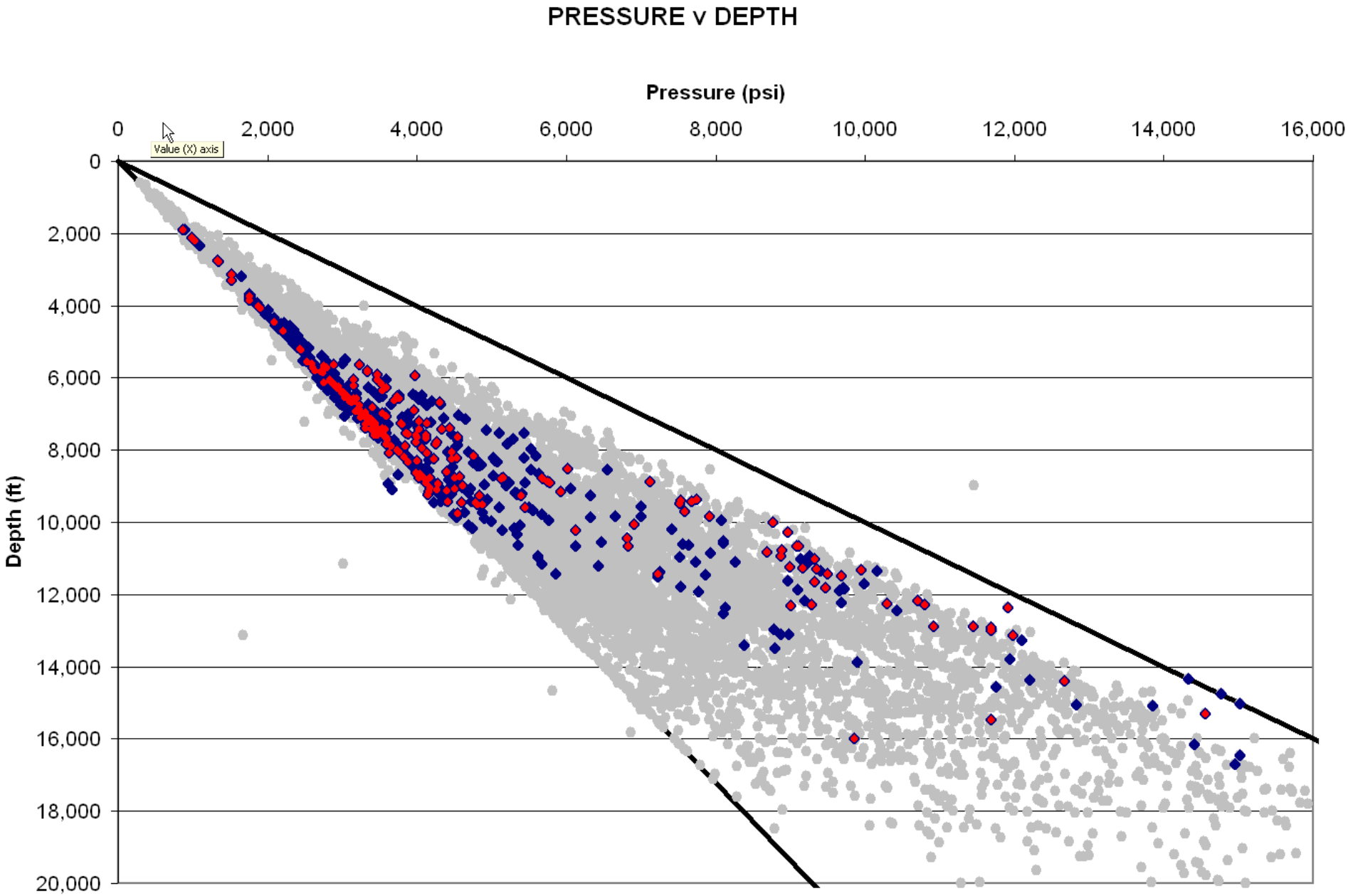




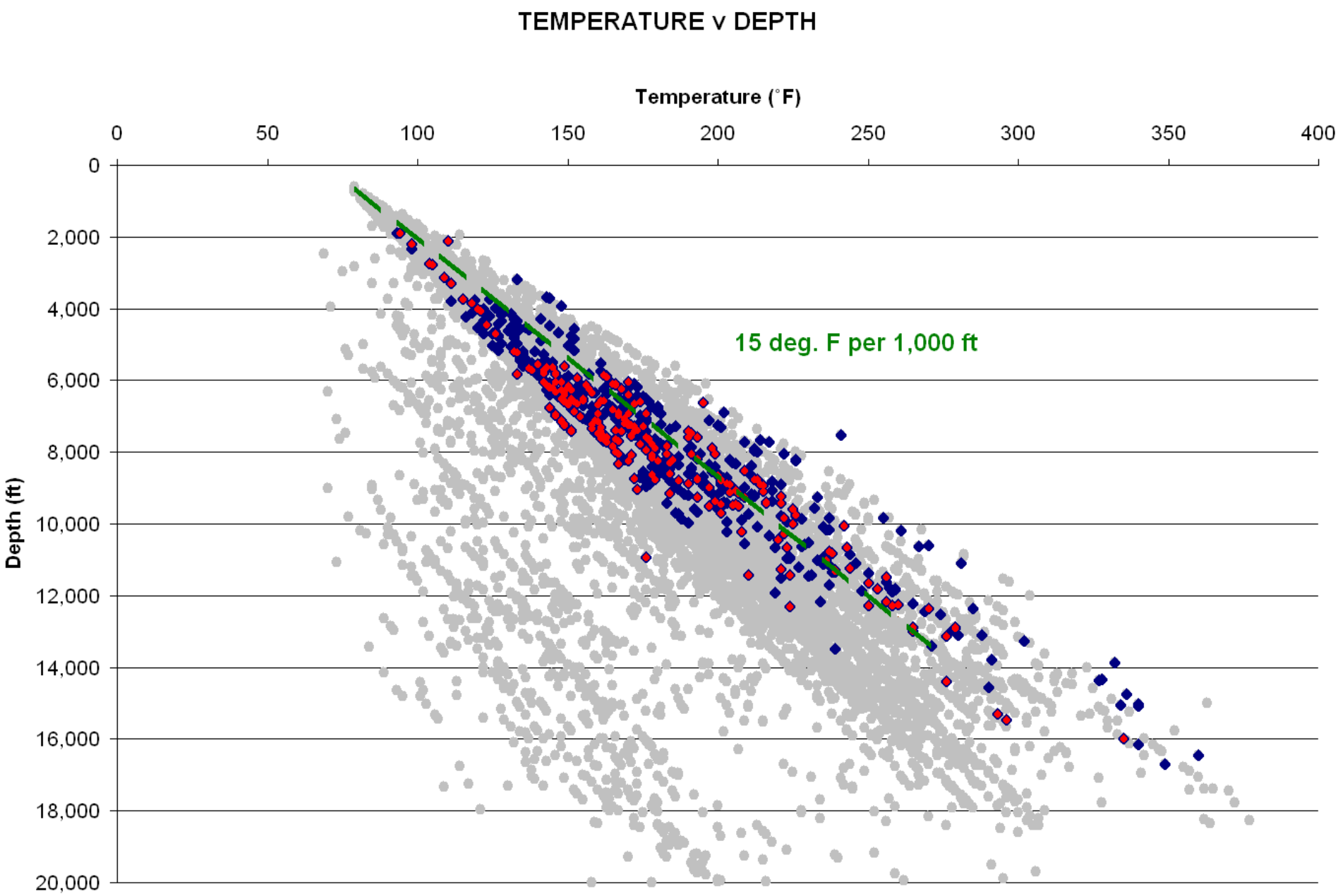
Reservoir presence/quality risks relatively low

- 13,000 offshore sands (OCS)
- 566 Miocene sands (OCS)
- 266 Miocene sands (inner shelf)

Task 2: Regional Significance
Task 3: Site Capacity Estimates



Task 2: Regional Significance
Task 3: Site Capacity Estimates

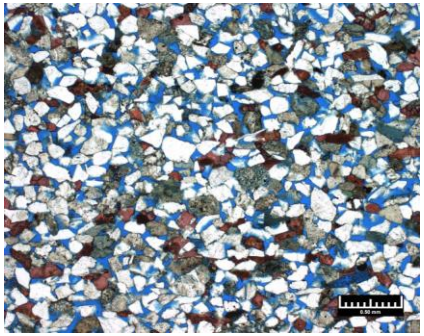


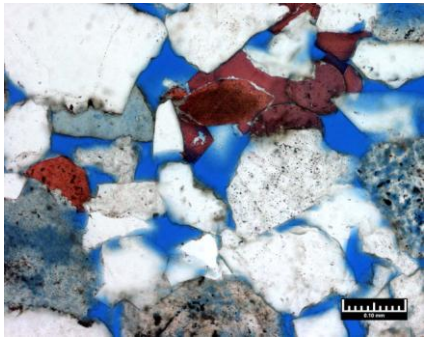
Task 2: Regional Significance
Task 3: Site Capacity Estimates

CORE DATA – Well State TR 487-L

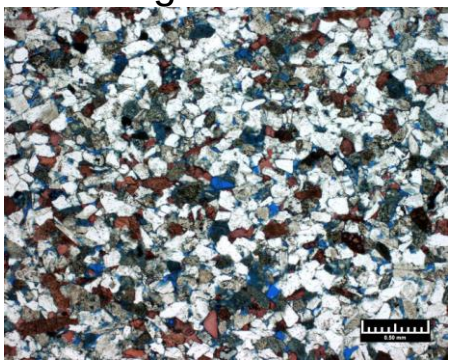
Worst-case example (DEEP)

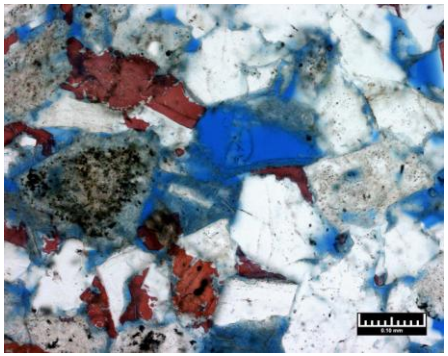
- 14912.0 ft
- 118 mD
- 19.5% porosity
- 2.64 gm/cc

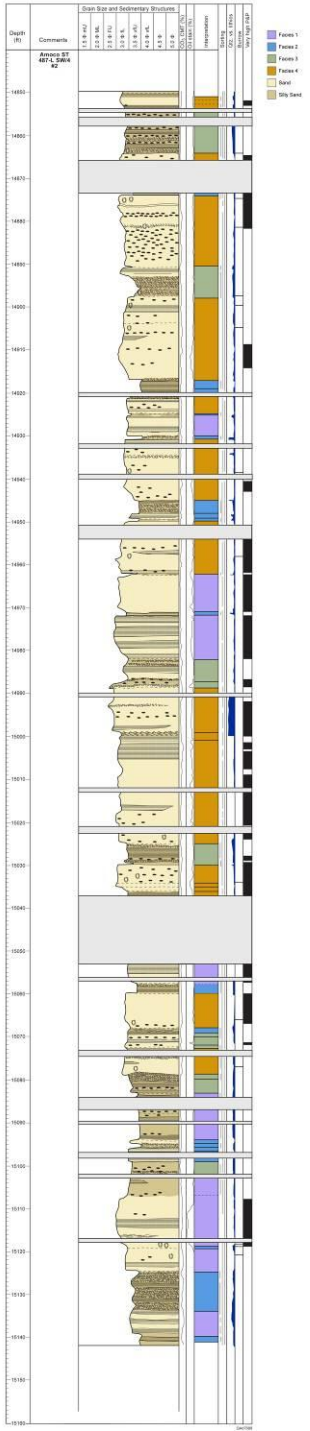




- 14927.0 ft
- 0.129 mD
- 10.9% porosity
- 2.63 gm/cc





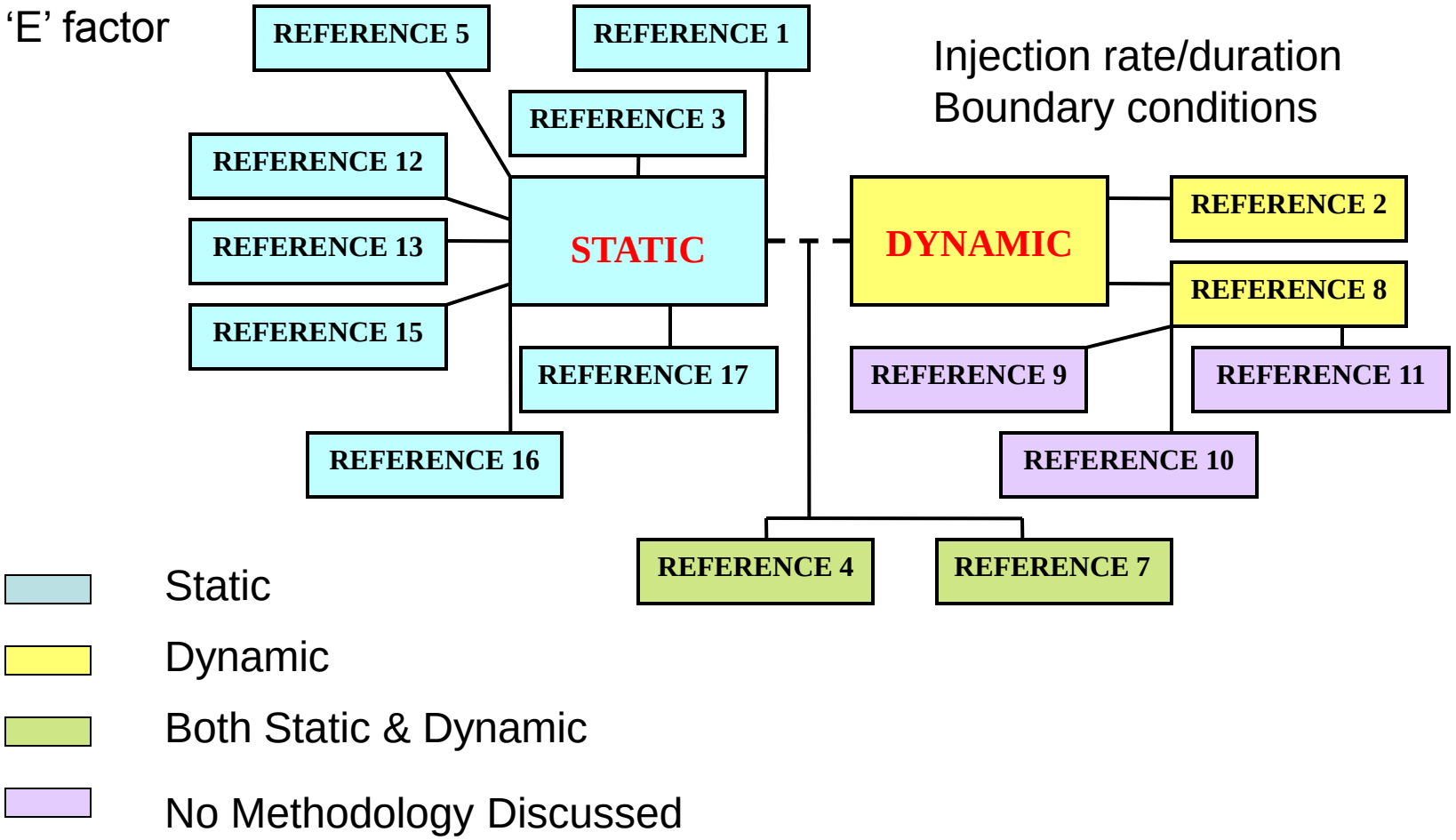


Task 2: Regional Significance
Task 3: Site Capacity Estimates

METHODOLOGY COMPARISON

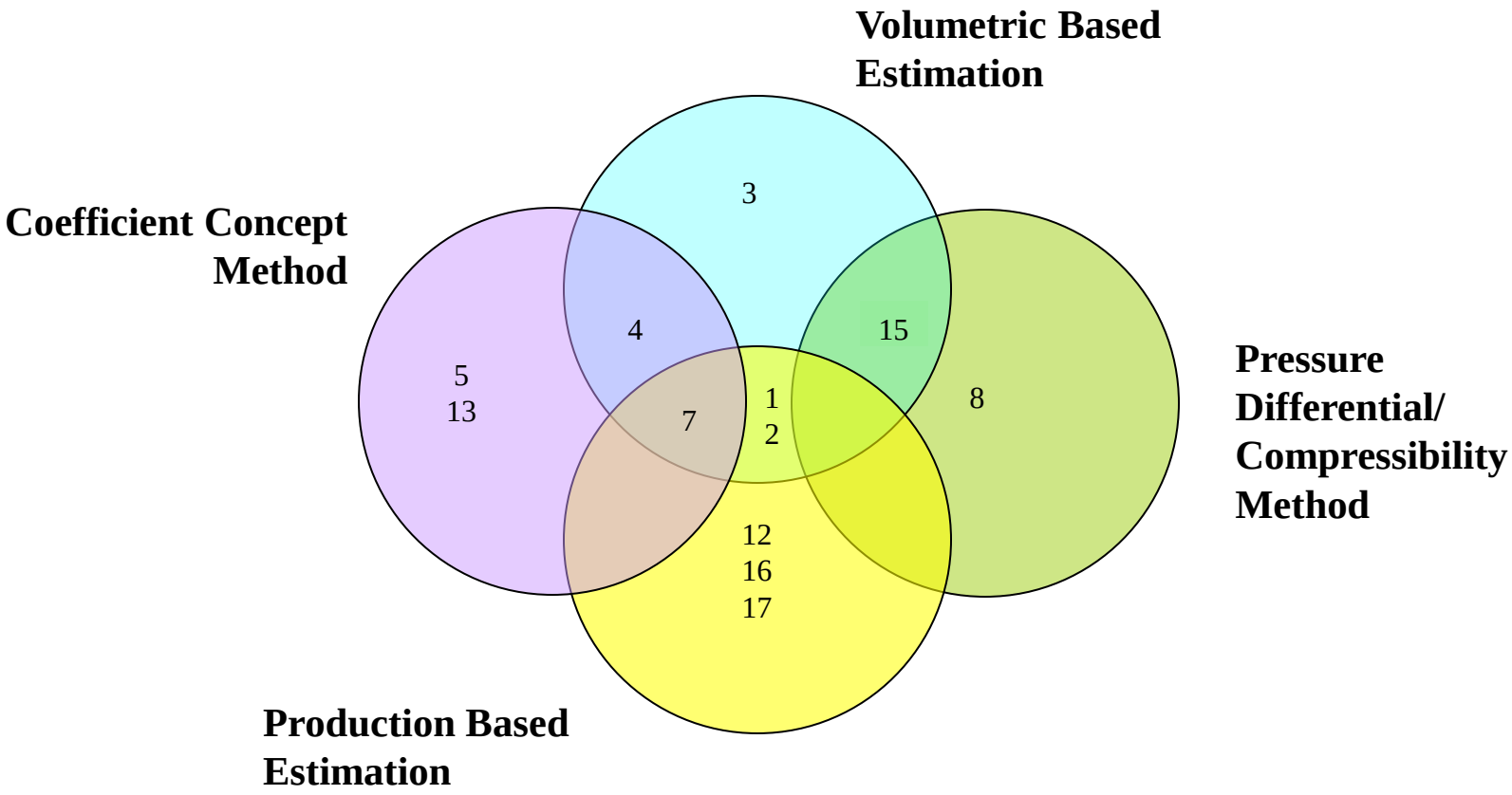
STATIC VS DYNAMIC

17 published methodologies evaluated

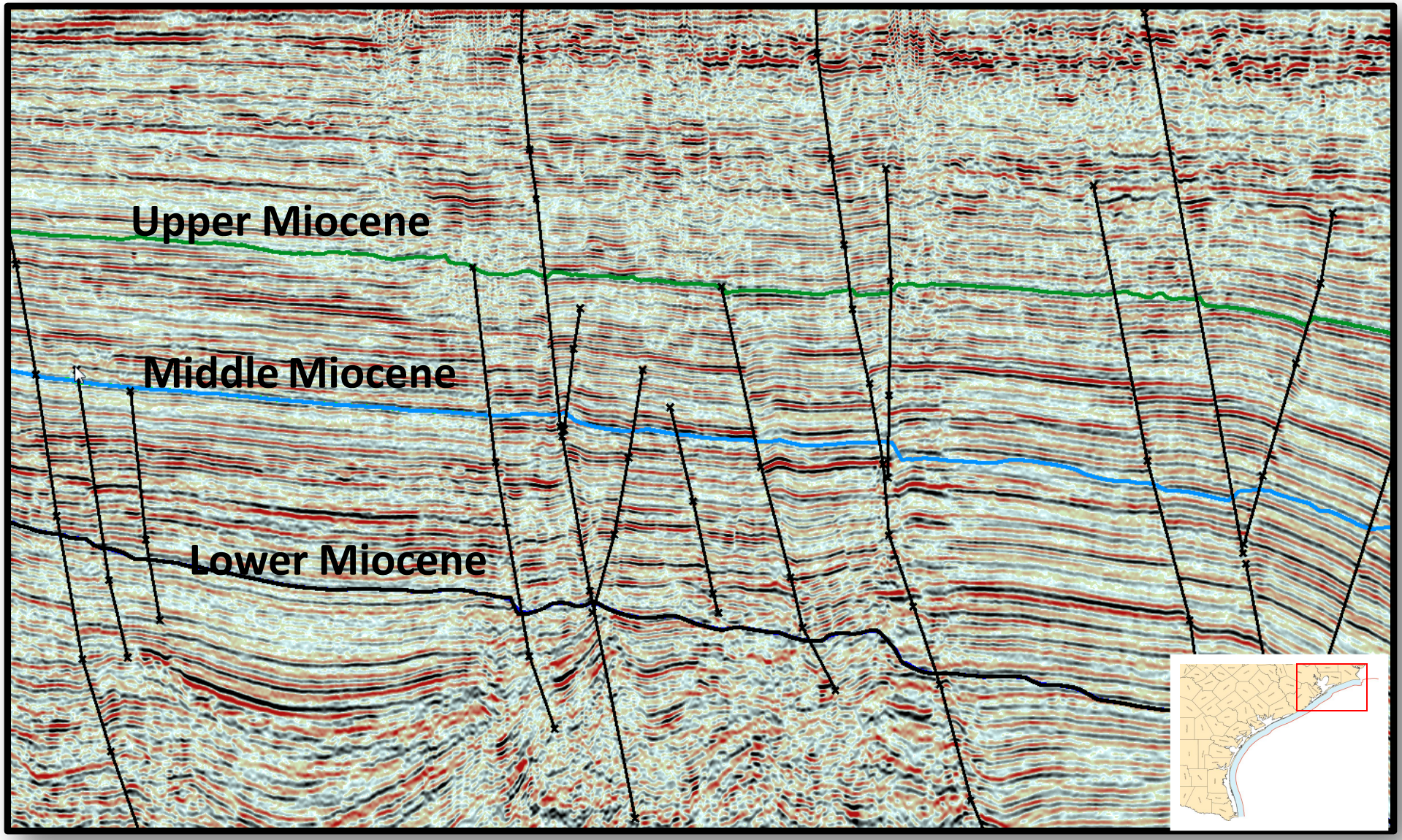


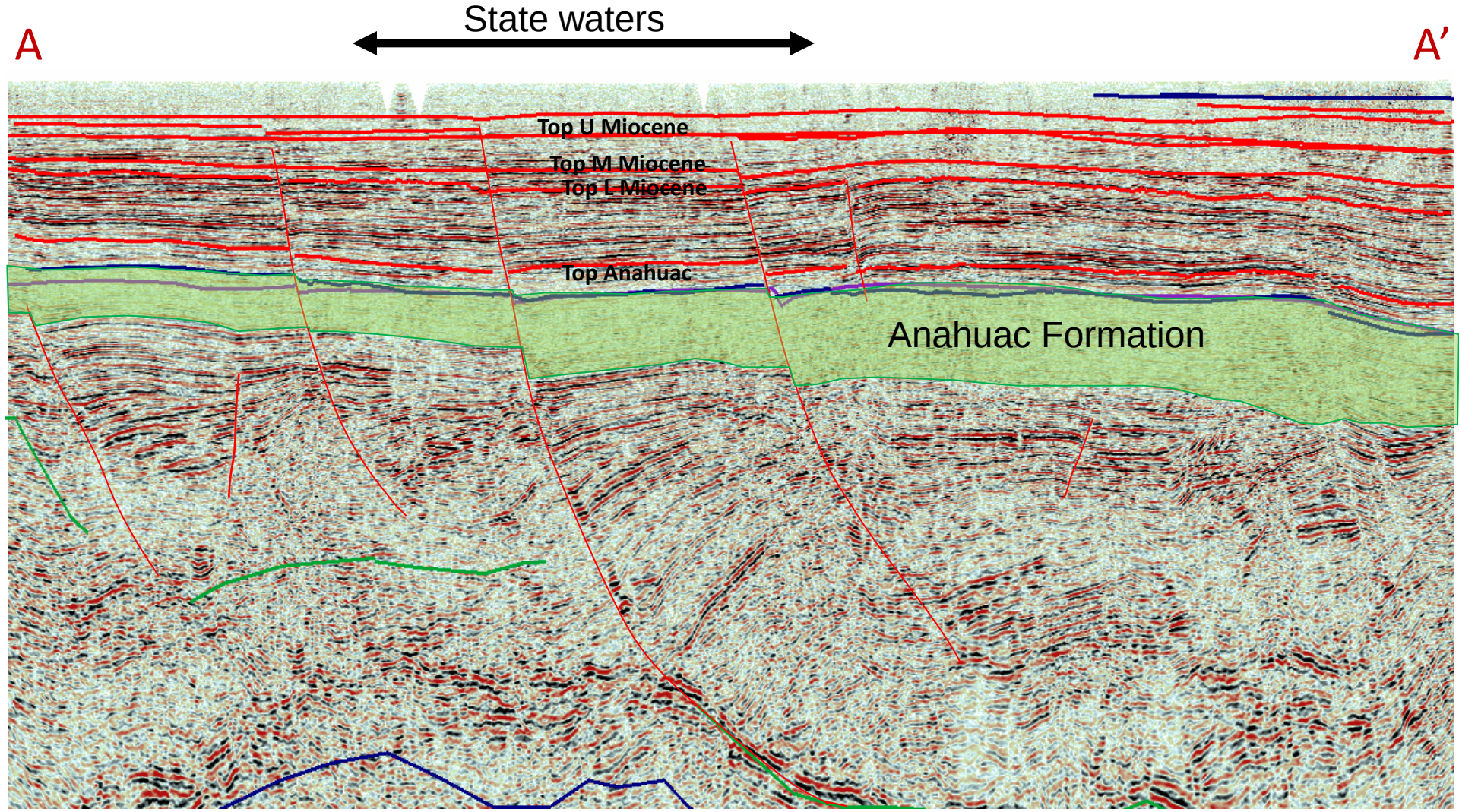
METHODOLOGY COMPARISON
VARYING APPROACHES

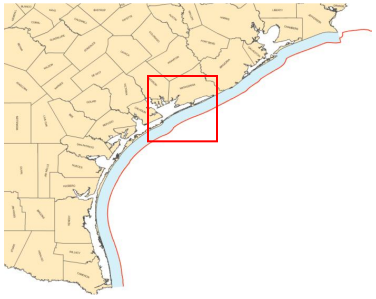
Methodology decision will be based on best overlap of available project data and varying approaches.



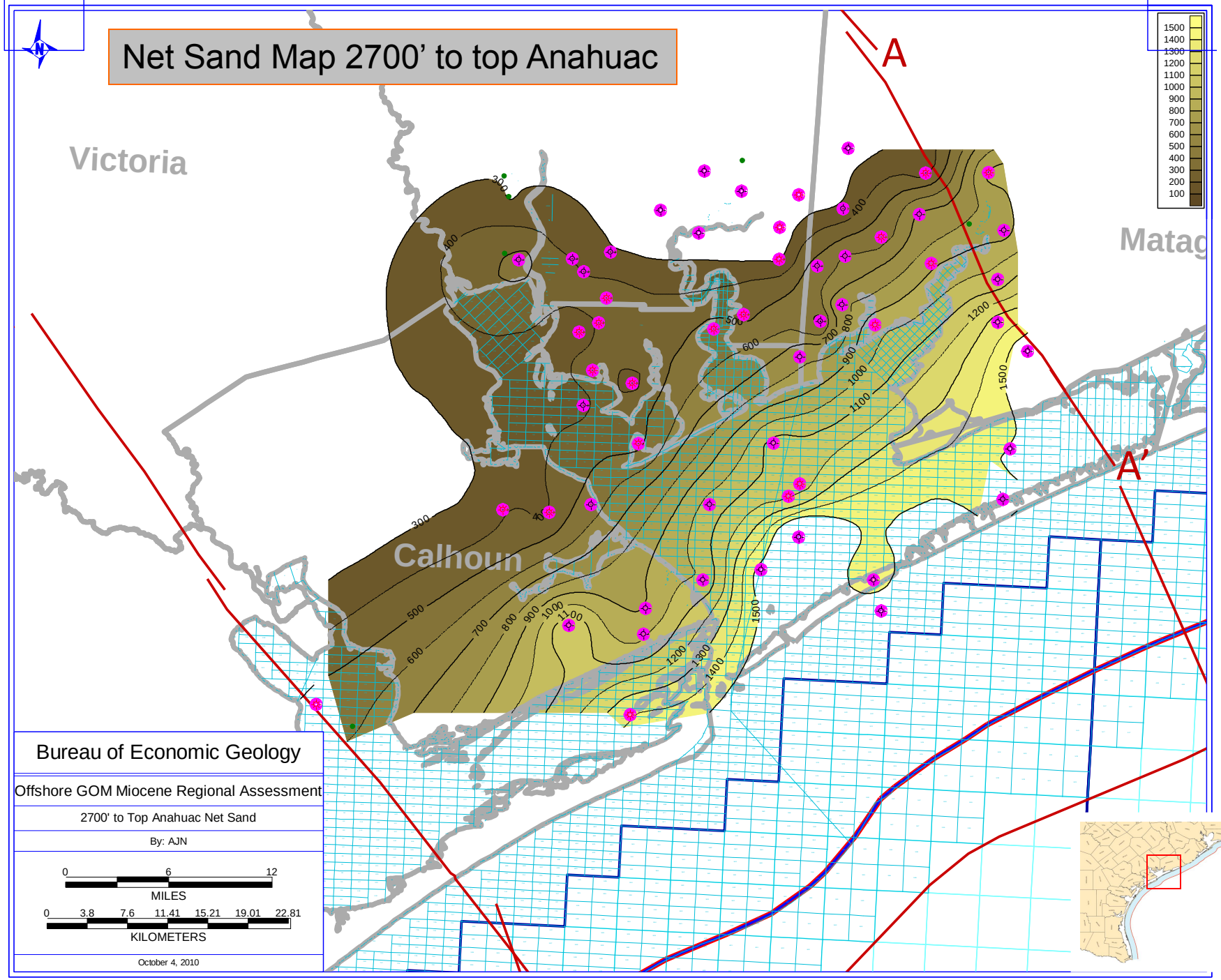
Horizon and Fault Interpretation of Regional 2D Lines




A
State waters
A'
Top U Miocene
Top M Miocene
Top L Miocene
Top Anahuac
Anahuac Formation



Net Sand Map 2700' to top Anahuac



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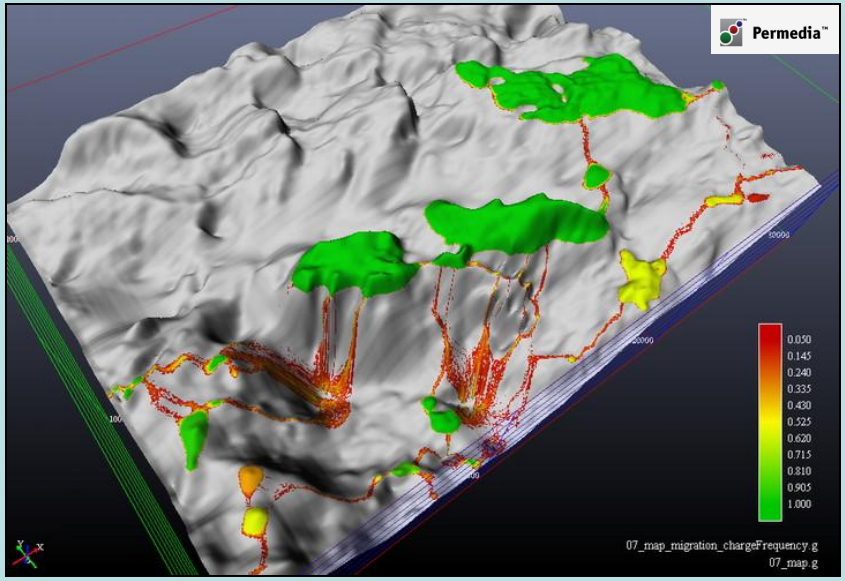
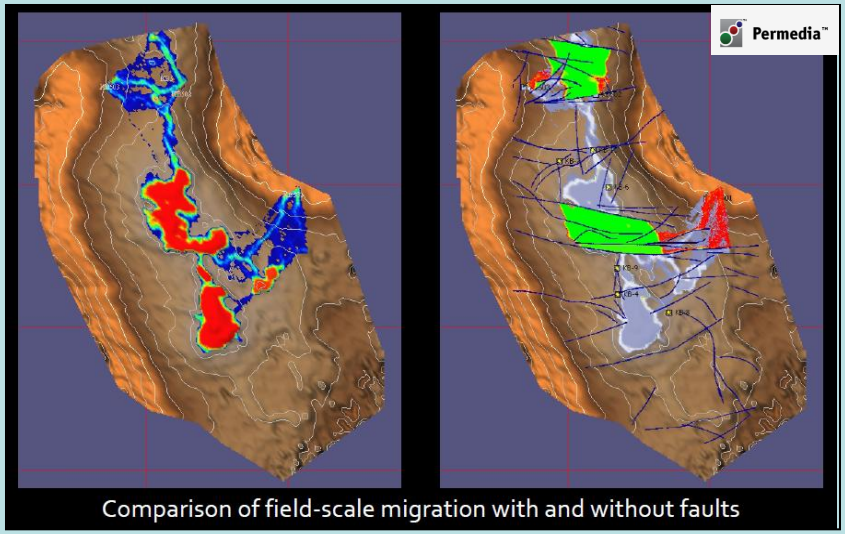
Modeling & Simulation

Focus on:

- Reservoir capacity (site)
- Potential long-term migration (invasion percolation – Permedia MPath licensed and running)
- Fetch areas & flow focusing; fill & spill sequence.
- influence of faults (compartmentalization)
- Pressure evolution





Comparison of field-scale migration with and without faults

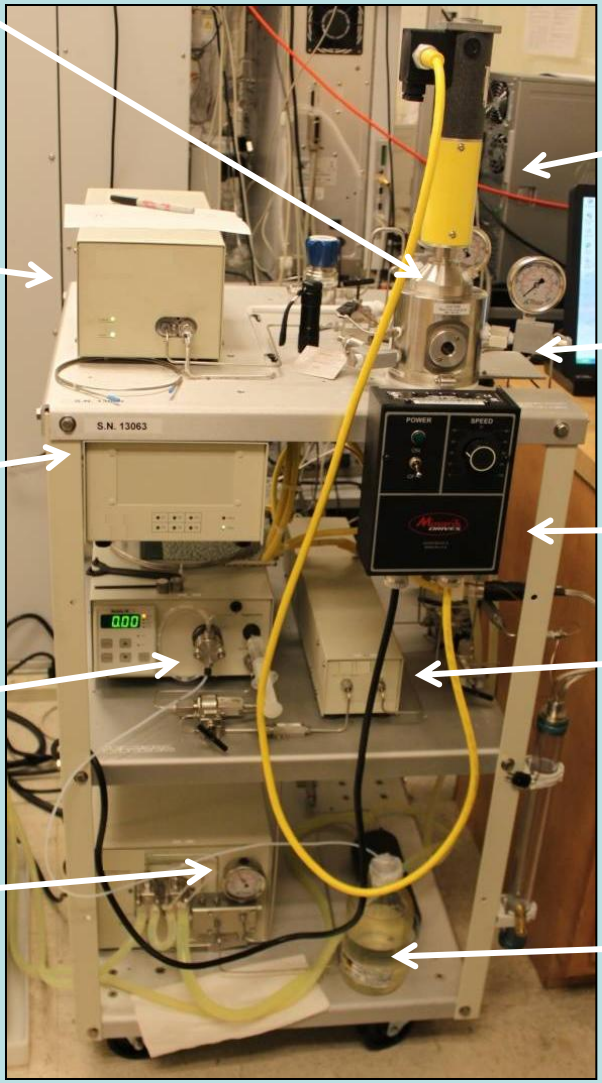
Innovative Apparatus for $SCCO_2$-Brine-Rock Experiments

New Hi P/T SuperCritical CO2 Geochemical Reactor System

Adapting technology and expertise used in supercritical fluid extraction industries for novel research approaches.

- Consulted experts in SC-CO_2.
- Integrated, automated, and tested system.
- No time-consuming build-up.
- $59,206 matching funds (JSG).
- Innovative sampling system overcoming struggles of current researchers.

Experimental System



Back Pressure Regulator

Multi-channel Temp Controller

"Co-solvent" pump (inc. impurities)

SC-CO_2 Pump

Stir Paddle Arm

250- ml Batch Reactor (Column Reactor not shown)

Stir Paddle Controller

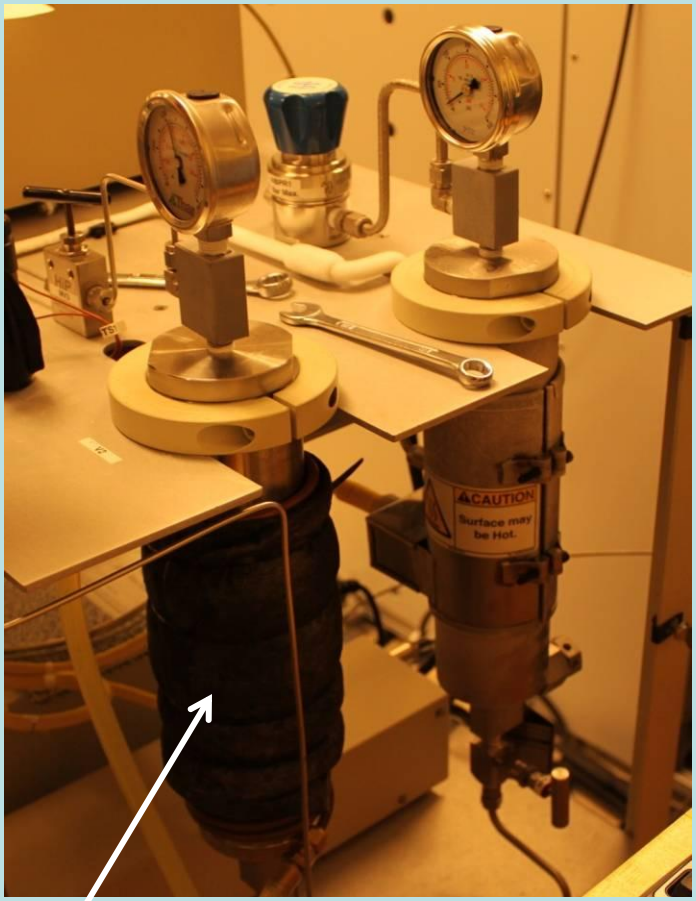
Heat Exchanger

"Co-solvent" Brine Reservoir

Goal: In-line, In-situ sampling at reservoir conditions.

Capabilities and features

- Batch and column experiments for brine/rock/$SCCO_2$ interactions.
- Equations of state for mixed systems of interest.
- Gas impurities studies.
- Tracer behavior.
- Seal rock intrusion experiments.
- Novel system for direct sampling of gas and fluid.



Rock Specimen

Environmental Risks:

- Guiding questions:
  - Should offshore be considered at all? (Pro/Con)
  - Where are most suitable areas?
  - What aspects of offshore CCS require unique requirements for site characterization and siting?
  - How are potential conflicts associated with competing interests to be addressed?
- Annotated bibliography of 67 articles related to various aspects of offshore sequestration & CO2 impacts.
- Monthly meetings
- IEA and IOGCC interactions

Augmentation

AIMS: Collect additional data for risk reduction (reservoir and seal) for candidate site to foster near-term utilization.

Task 8: Leakage pathways

- High-resolution 3D, SOA marine seismic acquisition system (**P-Cable**).
- Optimized for imaging overburden.
- Identify presence or lack of (shallow) faulting and any indication of fluid (methane) migration.
  - Geologic input & constraints for migration simulation & long-term containment.

- Reduce barriers to commercial development through characterization of potential drilling **geohazards**.

- **Baseline survey** for 4D monitoring of reservoir and overburden.

Task 9: Site Selection

- Conventional **seismic** dataset.
  - If necessary (Donation: match; P-Cable coverage).
  - Optimized for imaging reservoir interval.

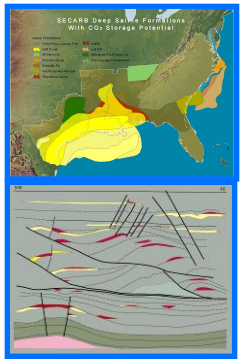
- **FIS**: Fluid inclusion stratigraphy
- **AMA**: Automated mineral analysis (QEMSCAN: XRD)
  - Site specific & Regional seal quality

Acknowledgements

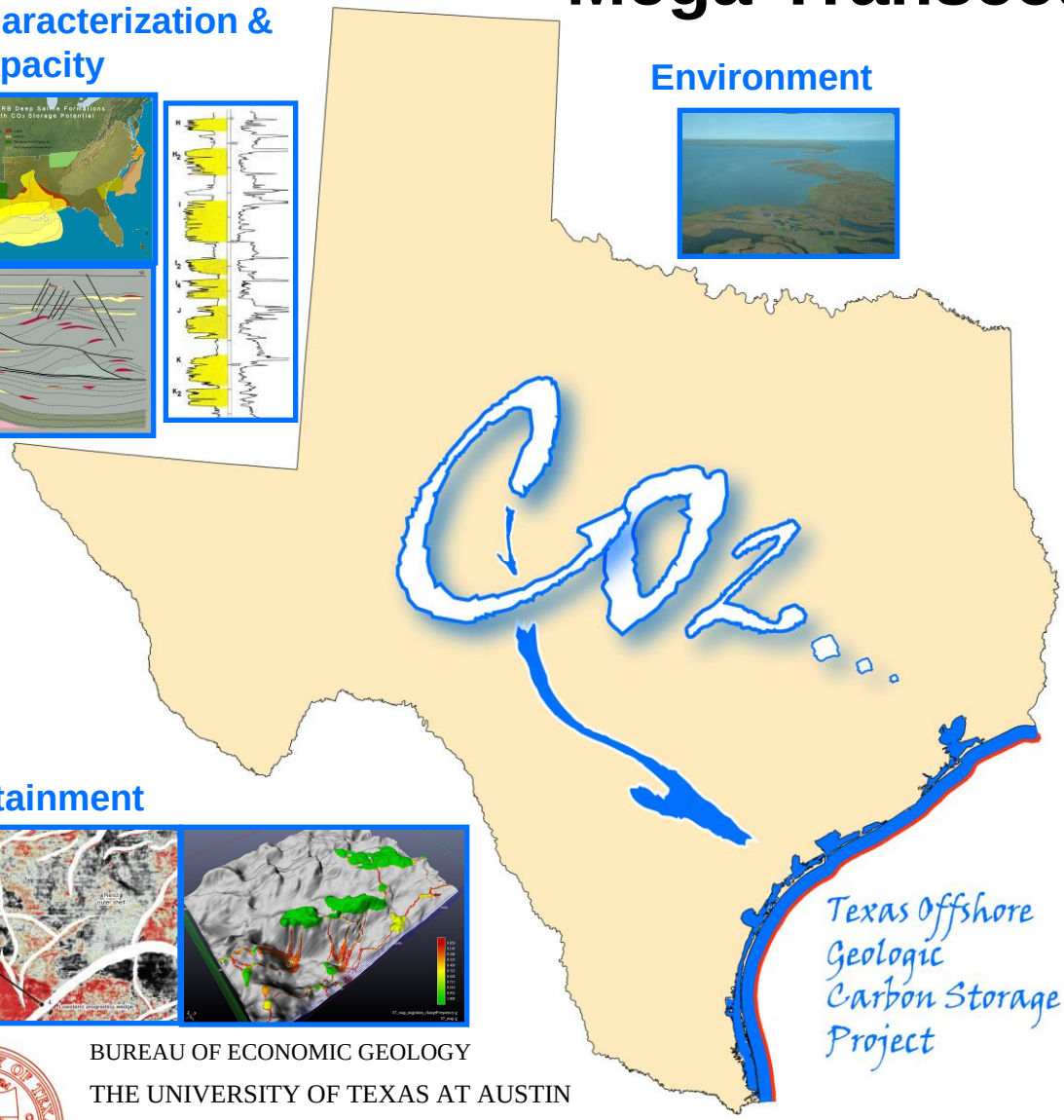
- U.S. Dept. of Energy (NETL)
- Texas General Land Office
- IHS
- DrillingInfo
- Gulf Basin Depositional Systems Consortium (UTIG)
- ION Geophysical
- Formosa Plastics / Neumin Production
- Victorian (AUS) Geological Carbon Storage Initiative

Gulf of Mexico Miocene CO_2 Site Characterization Mega-Transect

Characterization & Capacity



Environment



Containment

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THE UNIVERSITY OF TEXAS AT AUSTIN

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