Southeast Offshore Storage Resource Assessment (SOSRA)
Project Number: DE-FE0026086

Jack Pashin, Camelia Knapp, James Knapp | Oklahoma State University
Nino Ripepi| Virginia Tech
Patricia Berry | Southern States Energy Board

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Presentation Outline

- Goals and Objectives
- Project Team
- Technical Status
- Accomplishments to Date
- Synergy Opportunities
- Summary

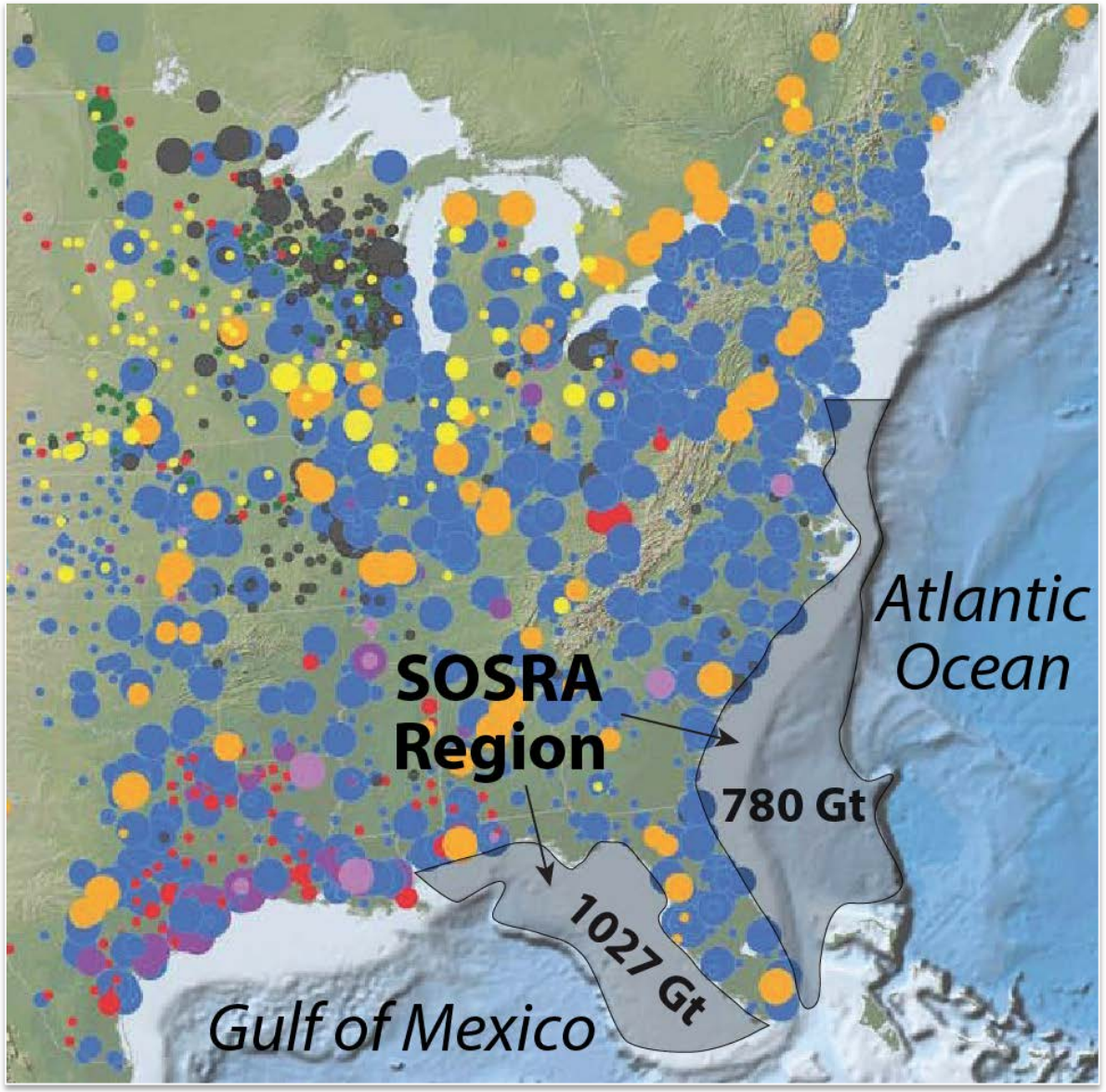
Project Overview: Goals and Objectives

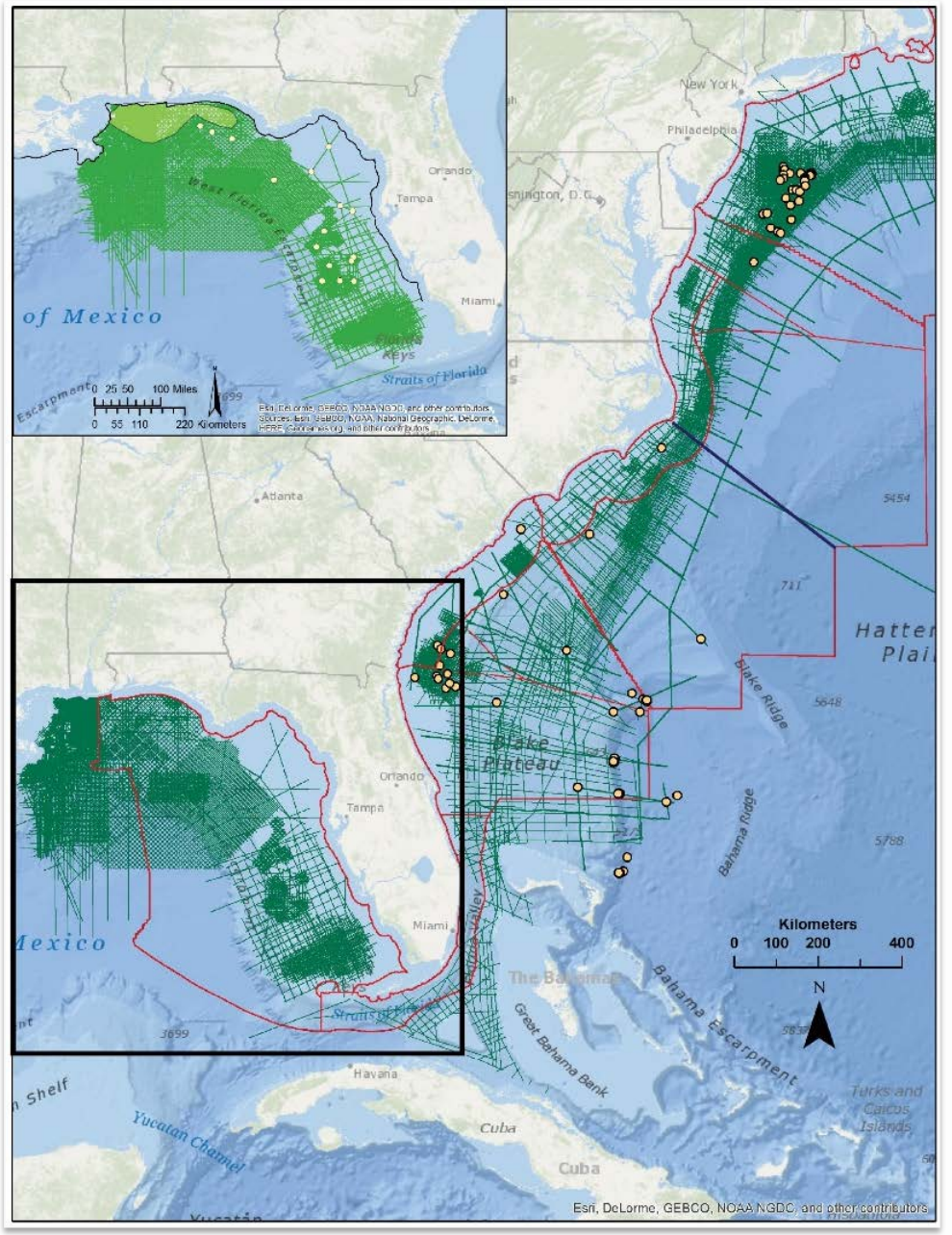
- Assess storage capacity of offshore saline formations in the eastern Gulf of Mexico (DeSoto Canyon Salt Basin and West Florida Shelf) and the Atlantic shelf (Mid-Atlantic and South Atlantic (Florida to Virginia).
- Assess technical risks associated with geologic storage and the implementation of storage technology.
- Develop geologic and reservoir models.
- Develop MVA Inventory and Characterization, Outreach and Risk Inventory.

Technical Status

- Geological characterization and assessment complete.
- MVA Inventory and Characterization, Outreach and Risk Inventory under development.
- Reservoirs models developed.
- Technology Transfer continuing.
- Data being uploaded to EDX.
- Project nearing completion.

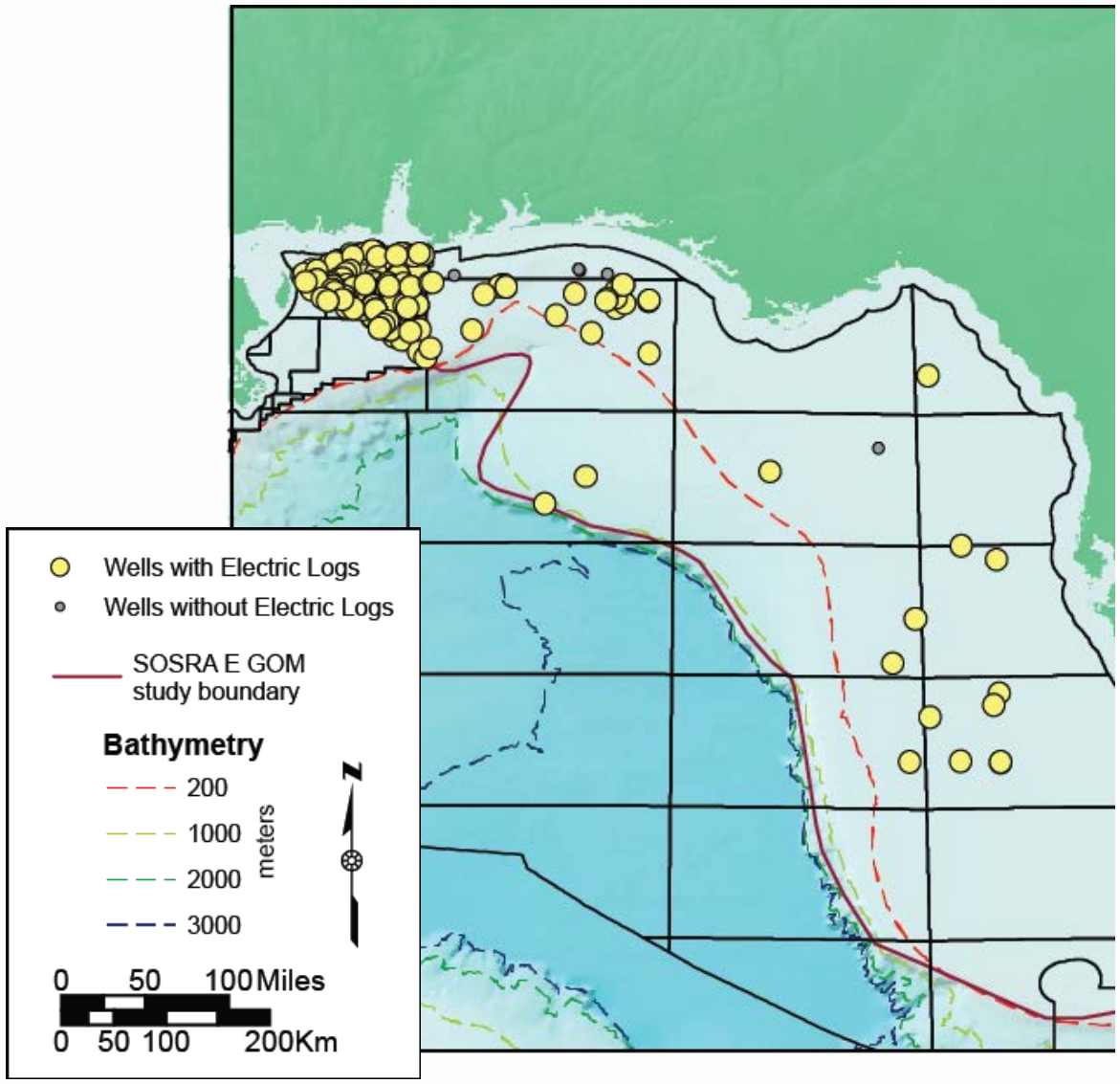
SOSRA Project Area



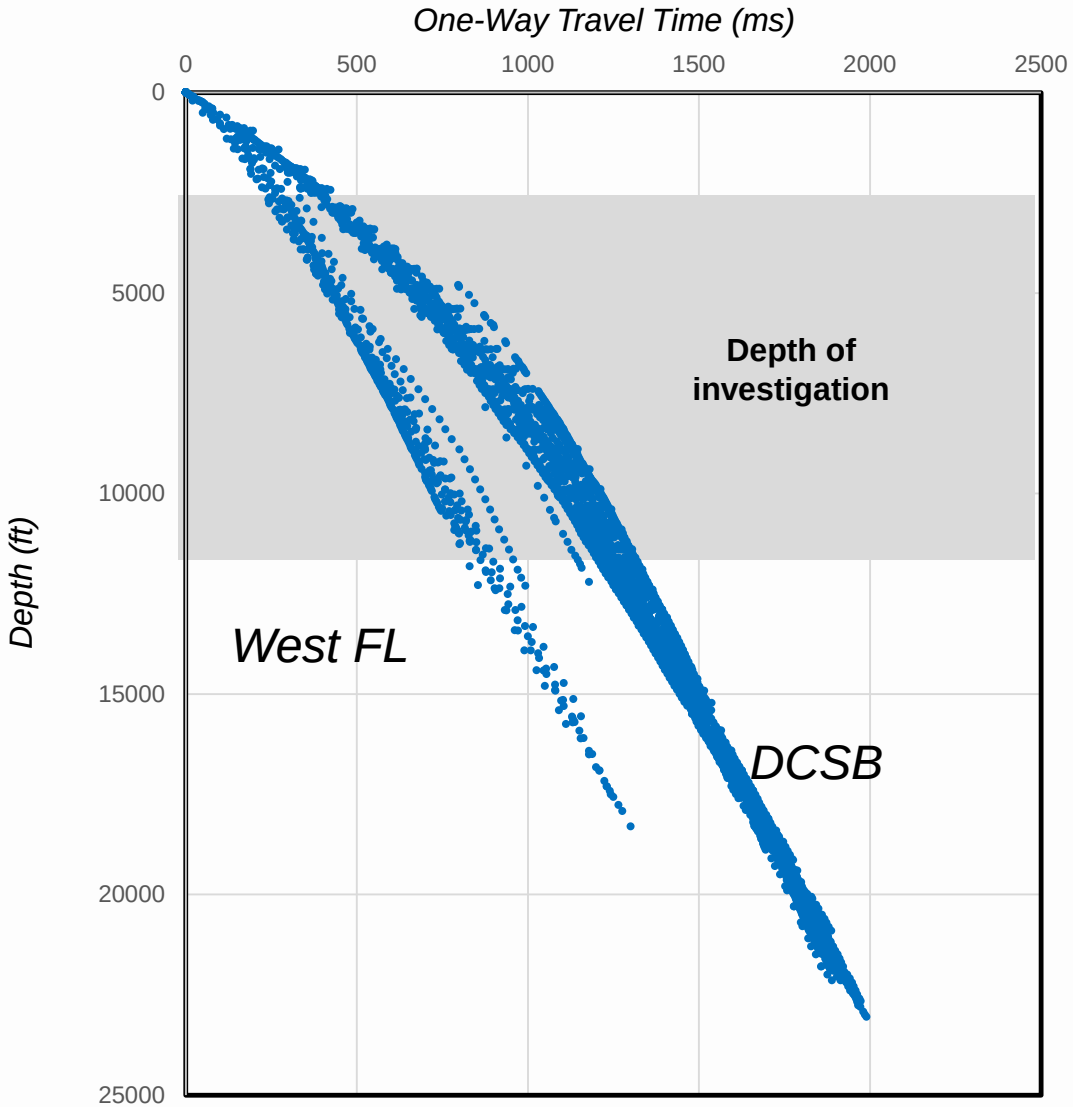


Well data, Velocity Surveys

Well and log identification, EGOM



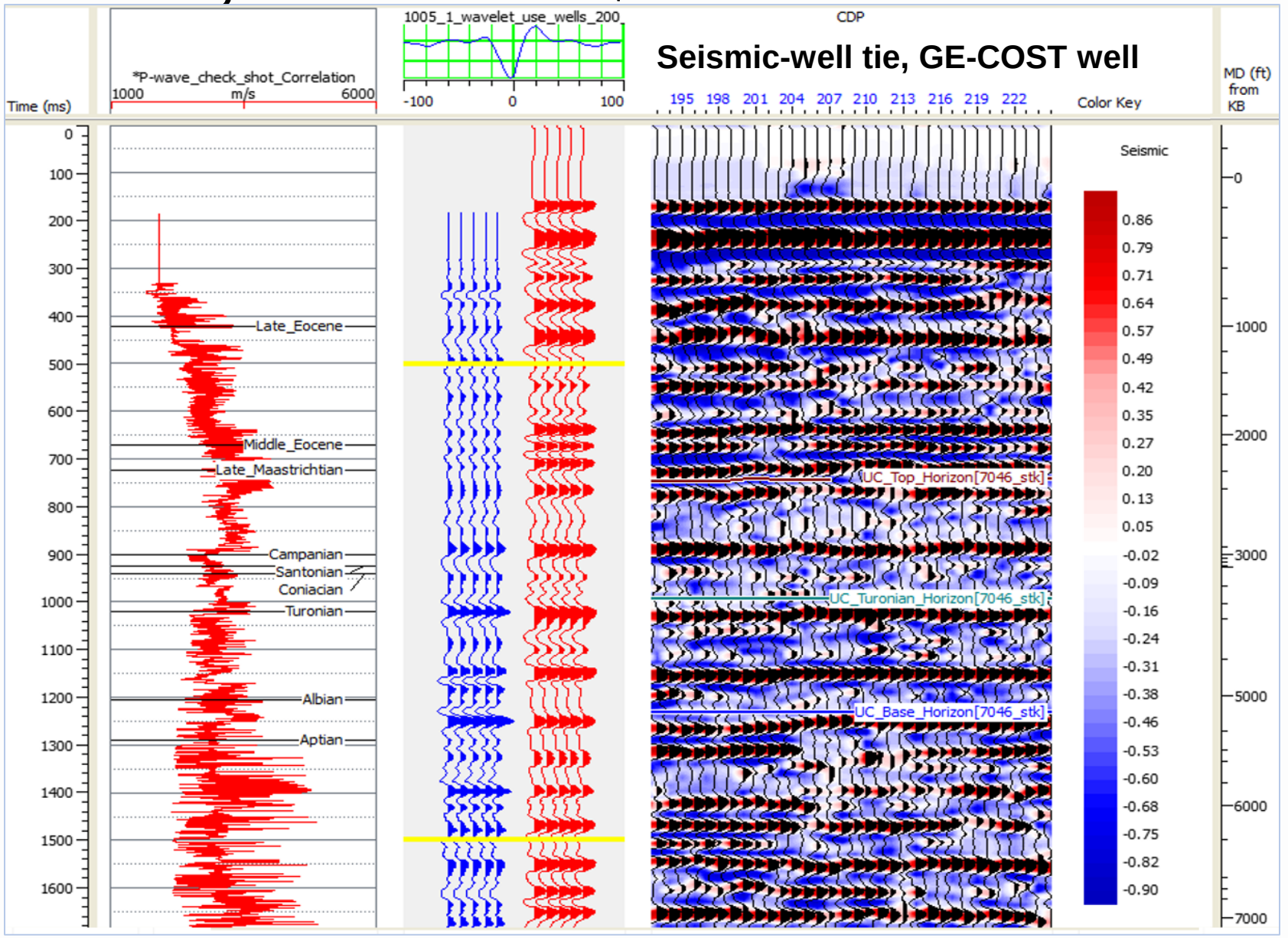
Velocity Surveys, EGOM



Synthetic Seismogram, South Atlantic

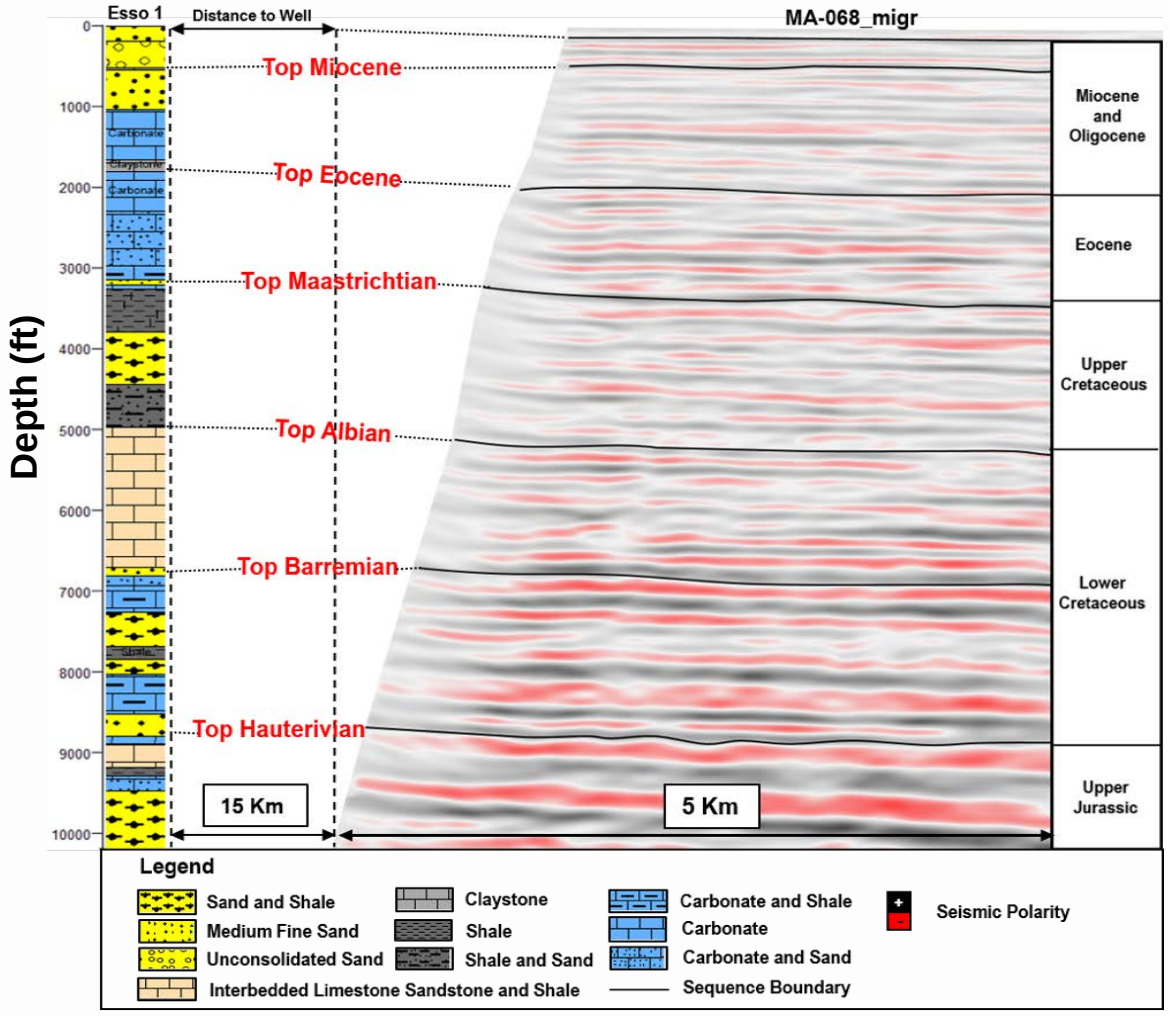
Upper Cretaceous section

MD (ft)	Lithology description	Thickness (ft)	Prospective reservoir/seal
-3500	Shale, micrite /limestone, mica, chert, quartz sand	120	Potential Seal
-3600	Argillaceous limestone, soft and calcarenite	60	Potential Reservoir
-3700	Shale, biomicrite, limestone	90	
-3800	Very fine calcareous siltstone with fairly porosity, some quartz sand	260	Potential Seal
-4050	Micrite (limestone), shale, chert	120	Potential Reservoir
-4150	Micrite/ LS, biomicrite, quartz sand, loose	50	
-4200	Biomicrite, soft, clay, shale At 4360ft, porosity 23.2% permeability 0.1 mD	215	Potential Seal Potential Reservoir
-4400	Micrite, biomicrite, shale (soft), quartz sand, more shale with depth Low-moderate porosity	185	
-4600	Shale, fine bedding Low-moderate porosity	360	Potential Seal A
-4950	More biomicrite and shale, calcite fragments, soft quartz sand Poor-fair porosity	390	
-5300	Shale, soft, siderite, some pyrite, quartz, limestone Low-moderate porosity High porosity between 5500 and 5576 ft then low porosity until 5765 ft	280	Potential Reservoir A
-5600	Shale with low porosity , fine-med silt, and biomicrite	120	Potential Seal B
-5750	Biomicrite, calcite, shale, Q. sand and SS with low porosity	45	
-5800	Sandstone, quartzose silt, loose sand Moderate-high porosity	105	Potential Reservoir B
-5900	Shale, fine grain, calcite low porosity	30	
-5950	Shale, fine grain, calcite, sandstone, coal, siltsone	60	
-6000	Shale, fine grain, sandstone Low Porosity	90	

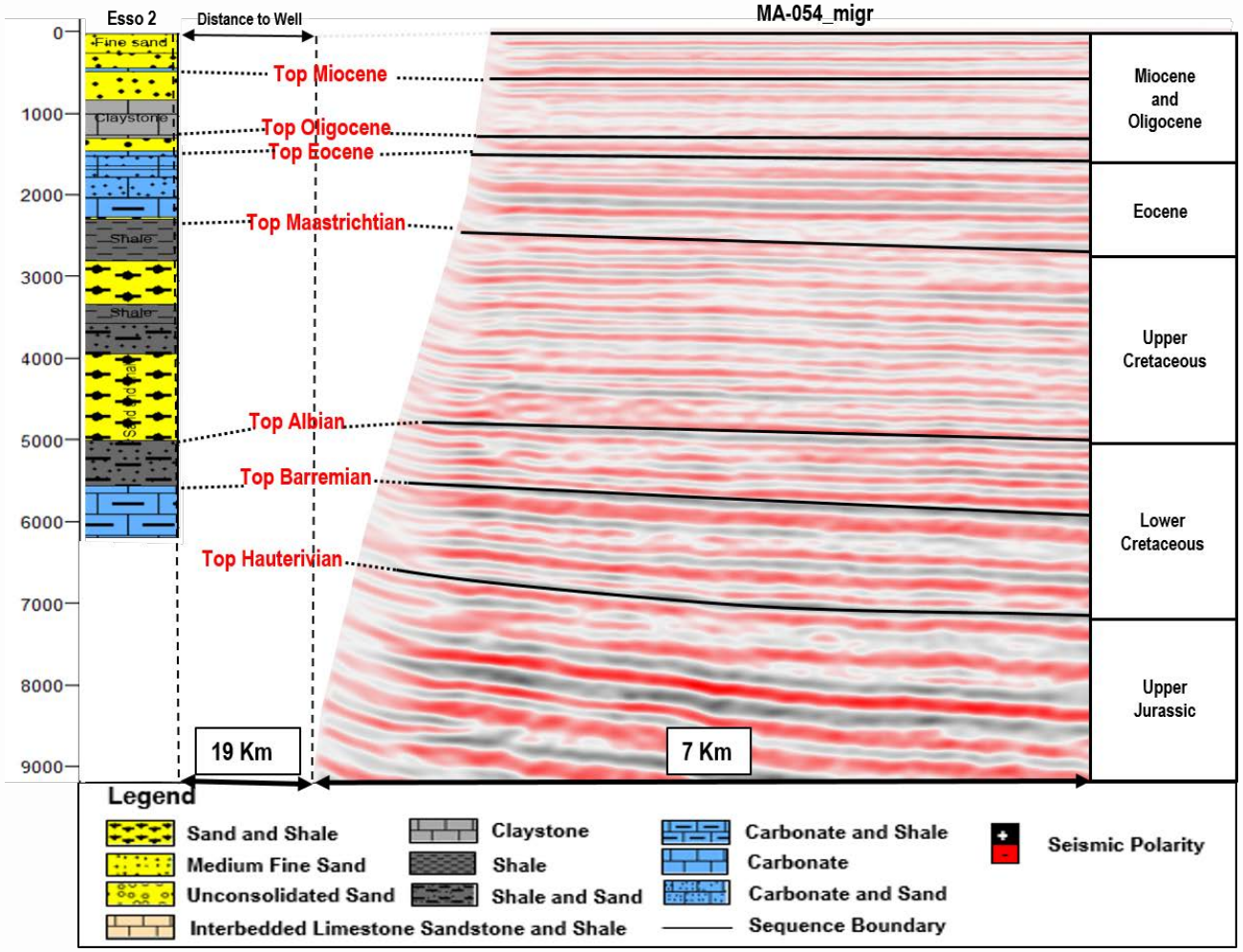


Seismic-Well Ties, Mid Atlantic

Ties Between Esso 1 and Closest 2D Profile

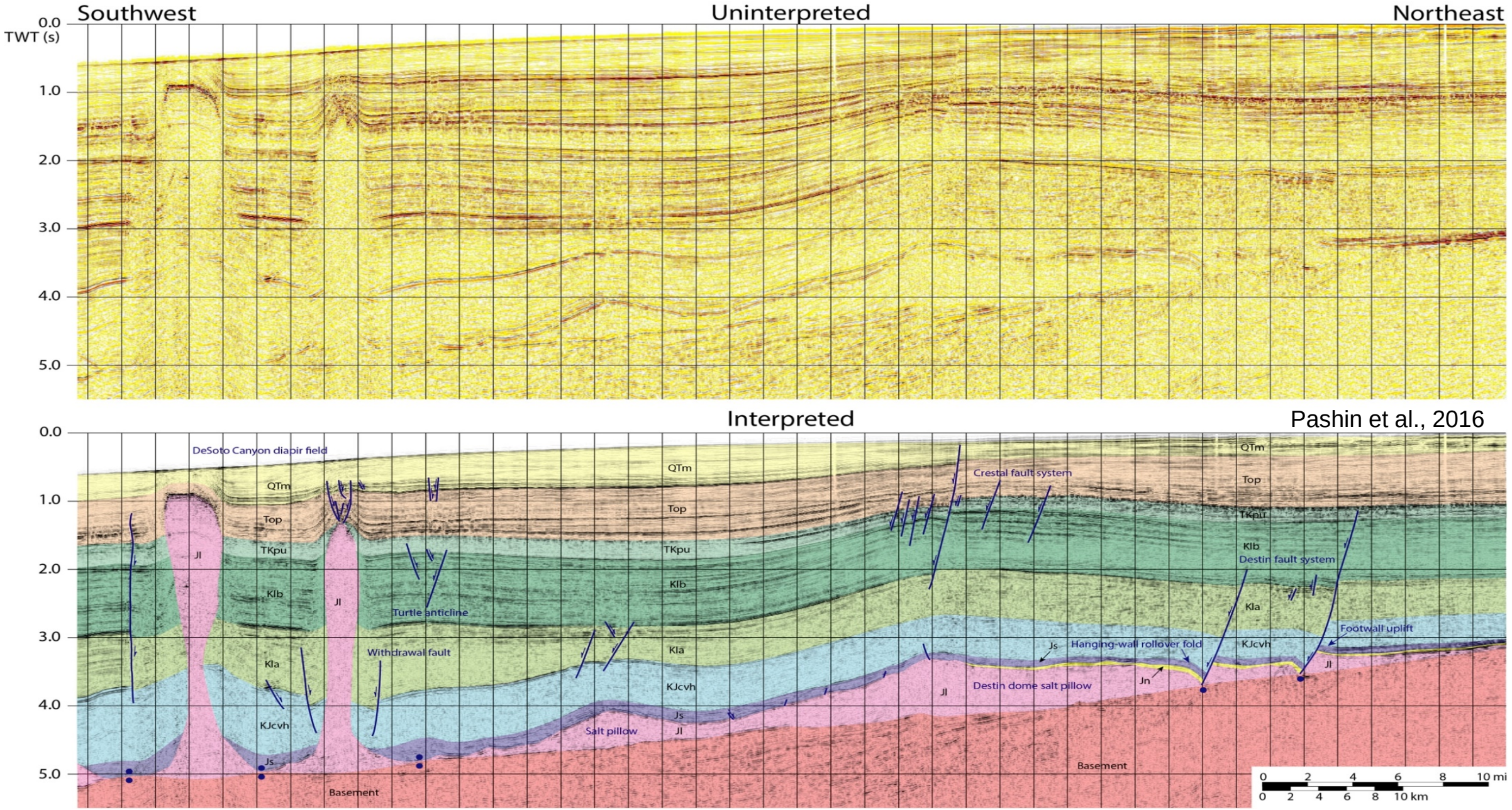


Ties Between Esso 2 and Closest 2D Profile

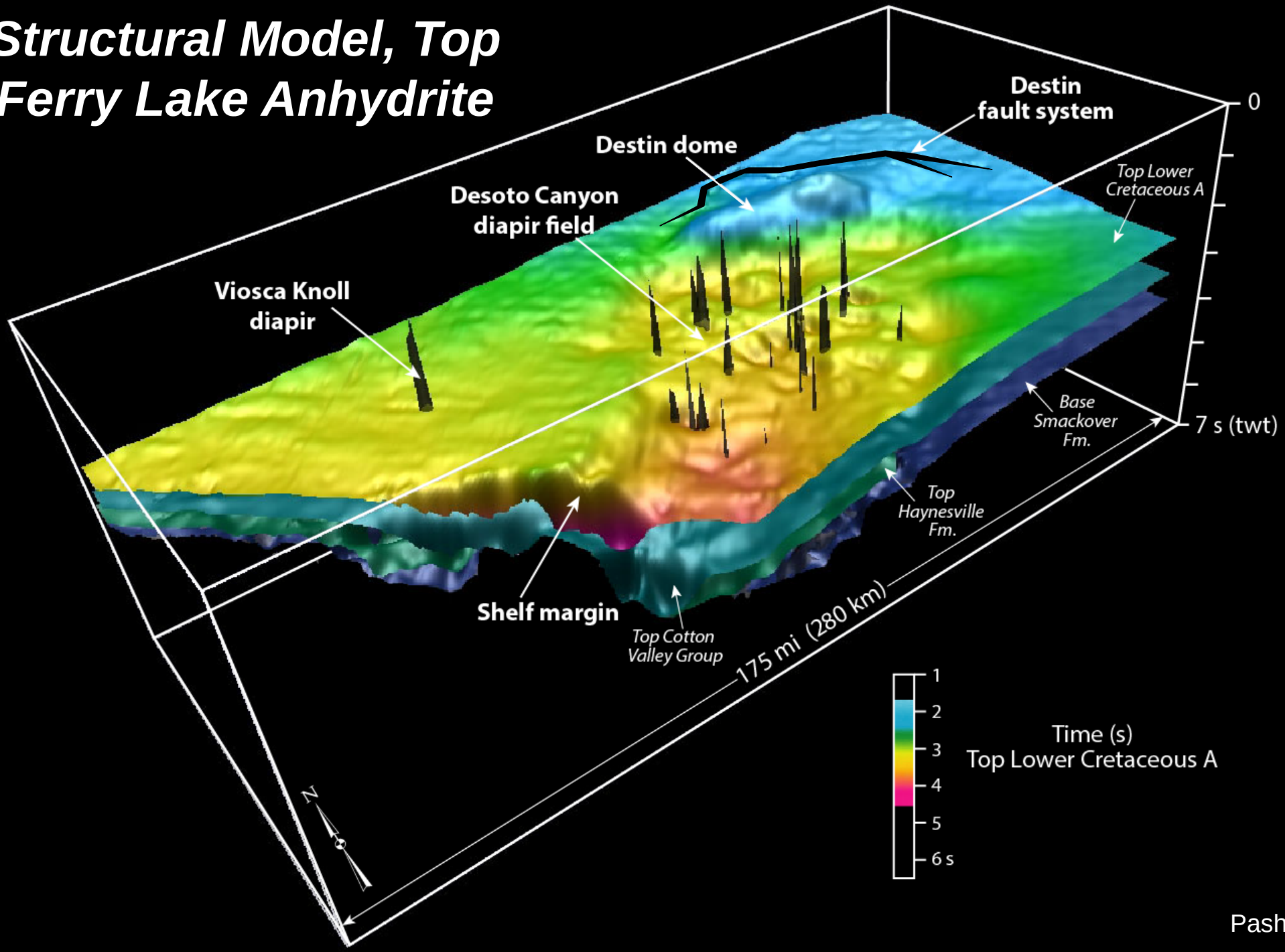


Mullendore et al, 2019

Seismic Interpretation, DCSB Destin Dome

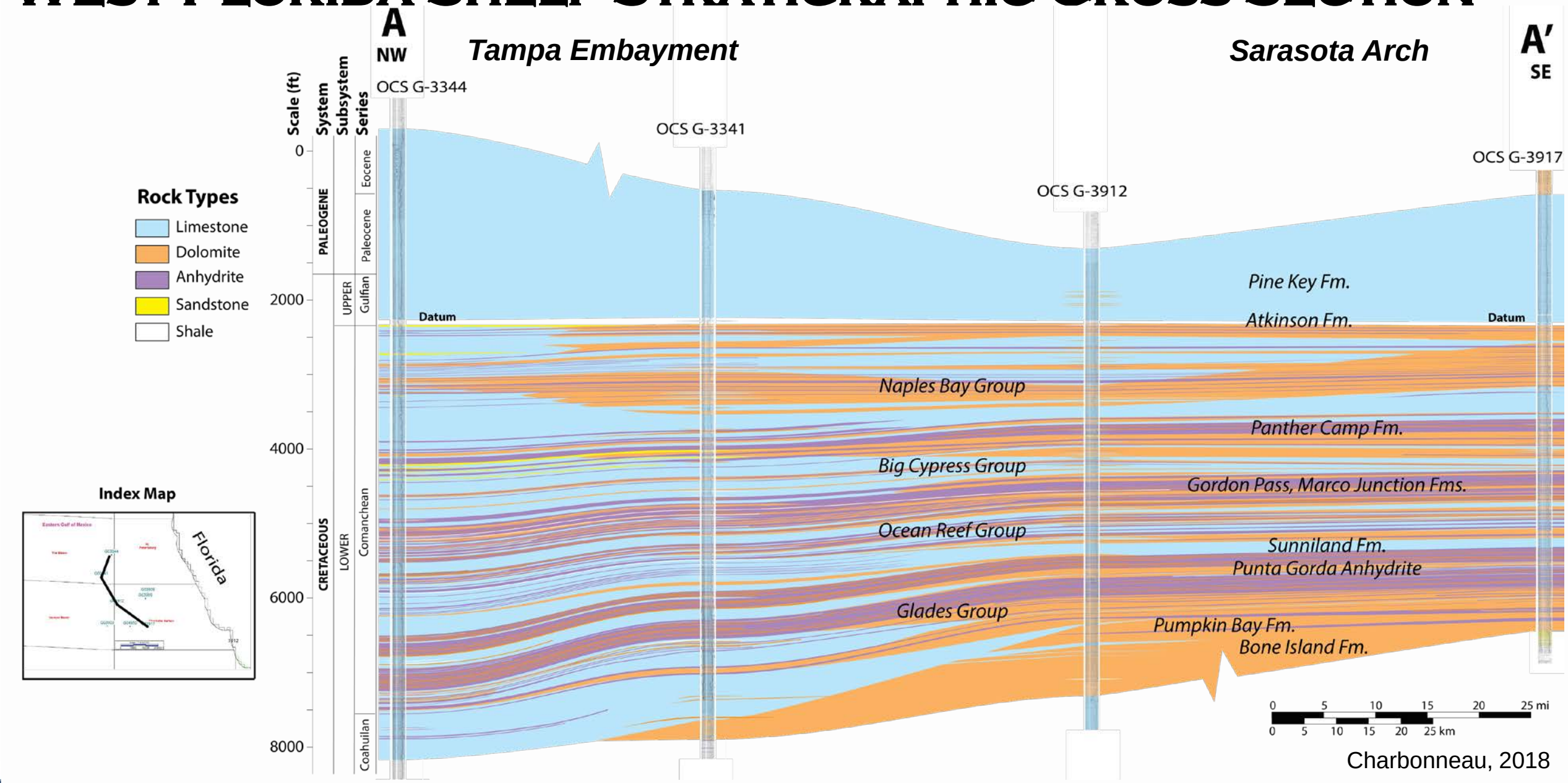


Structural Model, Top Ferry Lake Anhydrite



Pashin et al., 2016

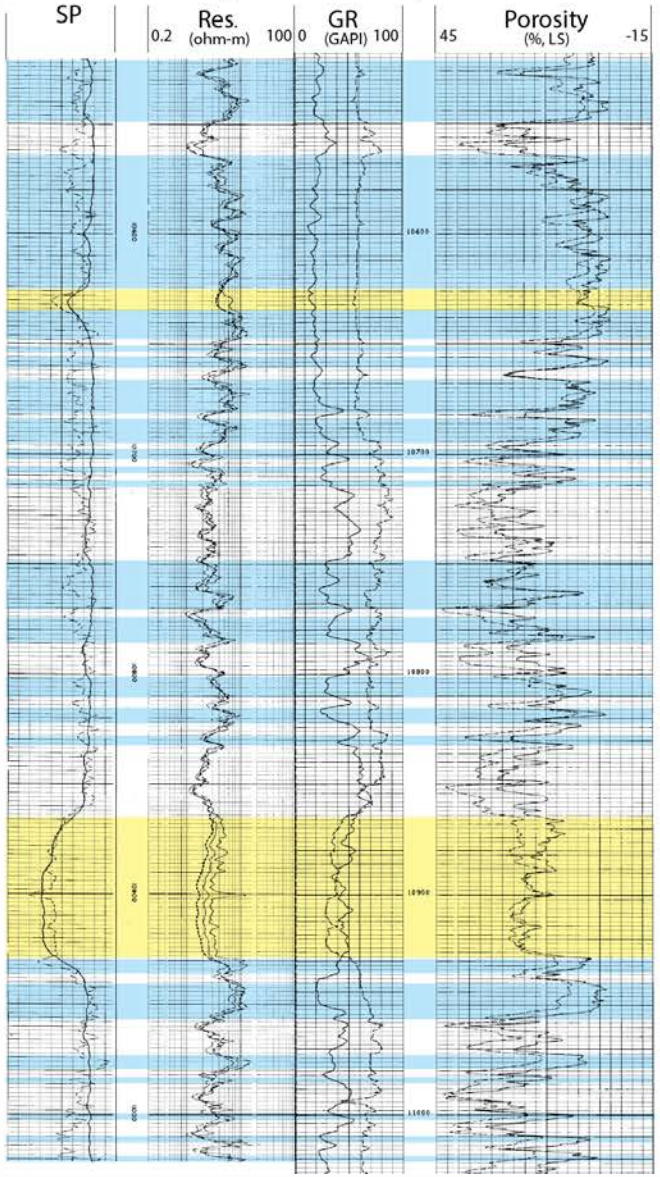
West Florida Shelf Stratigraphic Cross-Section



Charbonneau, 2018

Geophysical Well logs, EGOM

Well G02468, Desoto Canyon Salt Basin



Paluxy Formation

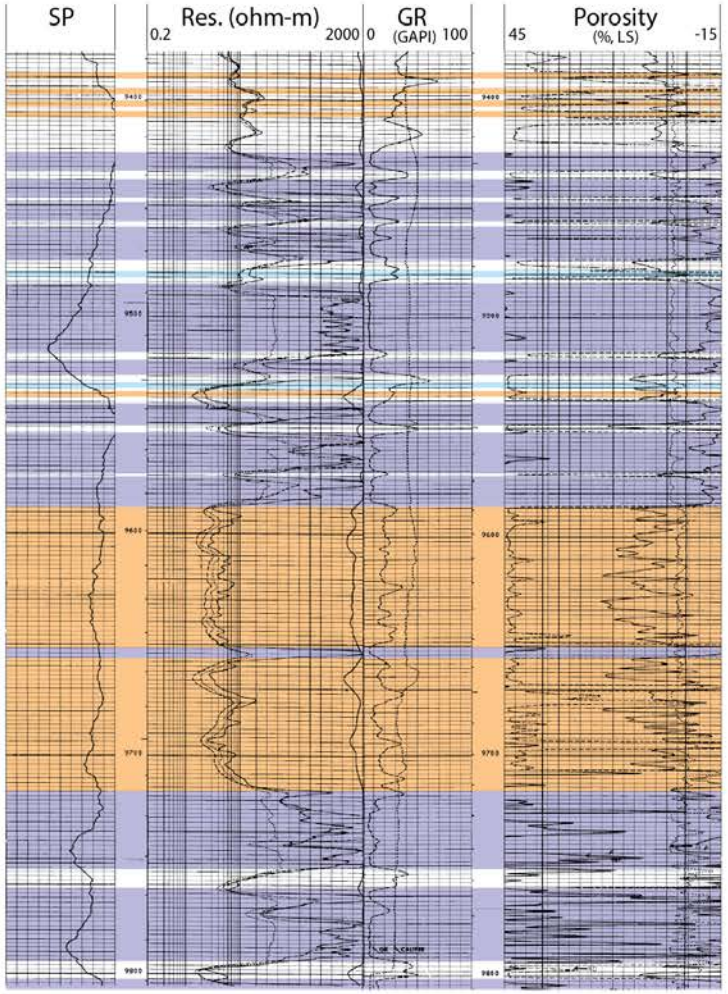
Major prospects in sandstone of Tuscaloosa Group and Paluxy Fm.

Topseal

Reservoir

Porosity locally >20%

Well G3912, West Florida Shelf



Punta Gorda Anhydrite

Topseal

Reservoir

Porosity locally >15%

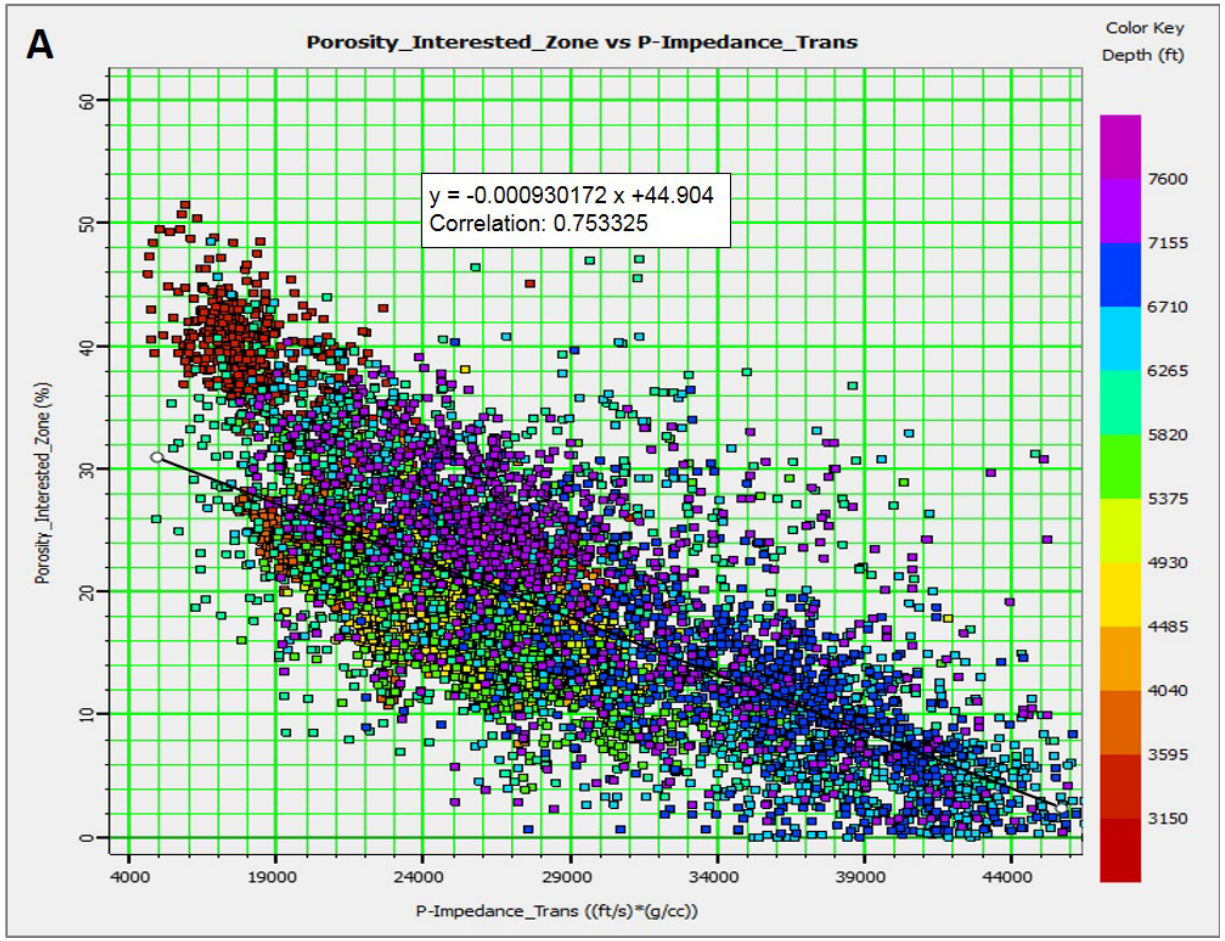
Reservoir

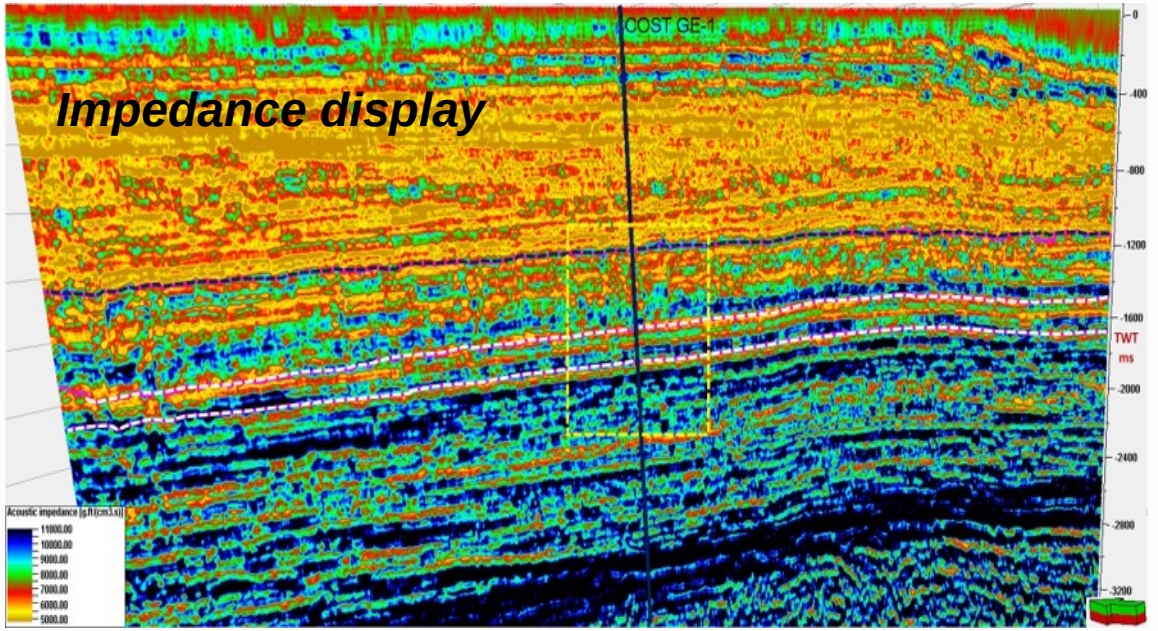
Major prospects in porous dolomite associated with anhydrite intervals

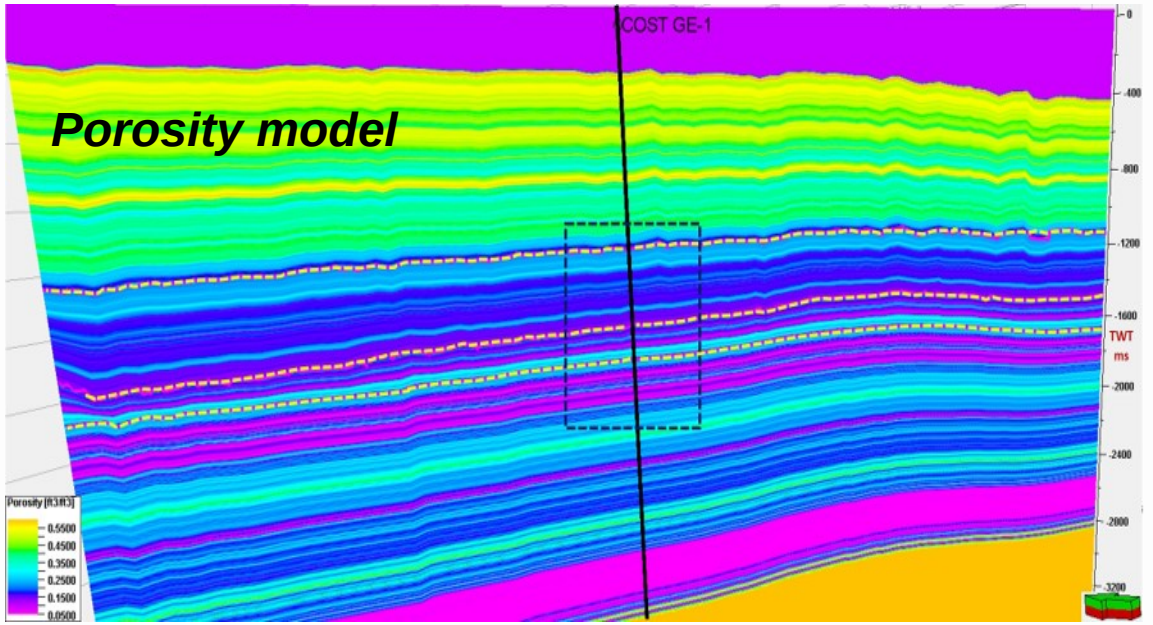
Shale | Sandstone | Limestone | Dolomite | Anhydrite

Seismic Inversion

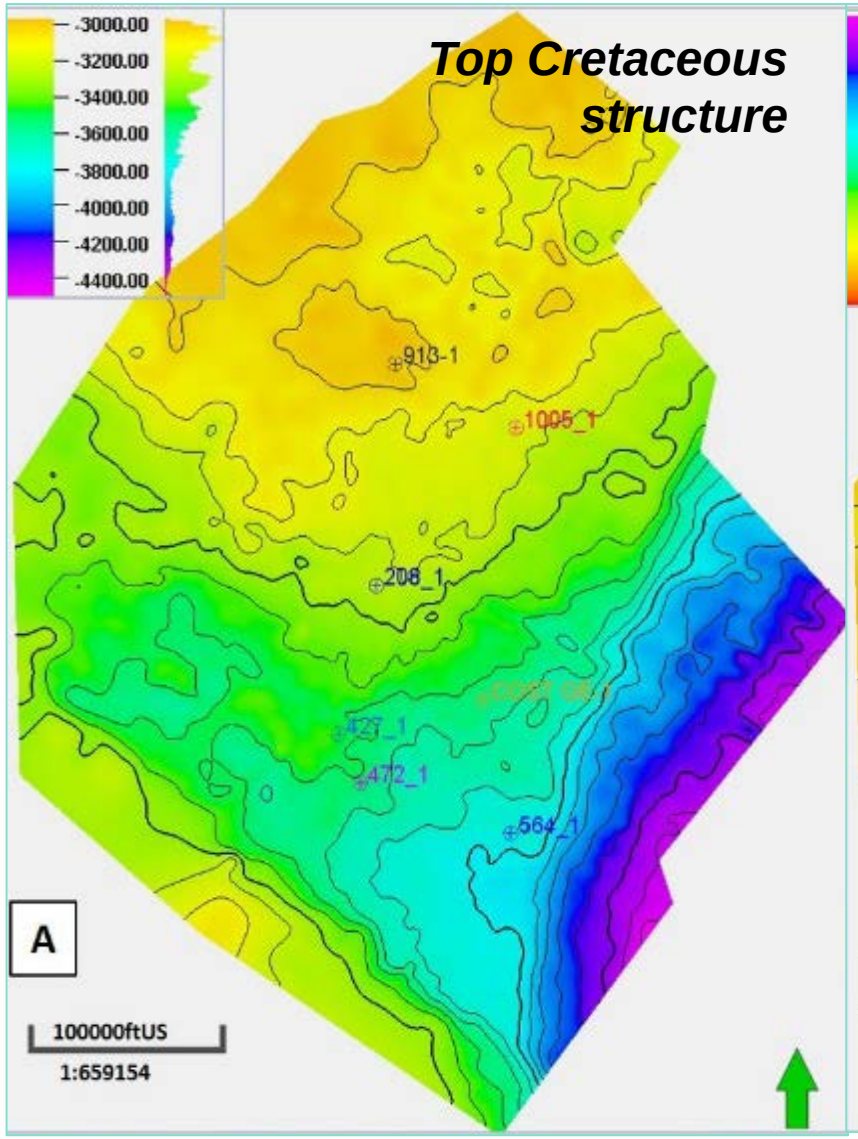
Acoustic impedance vs. porosity,
Upper Cretaceous, South Atlantic



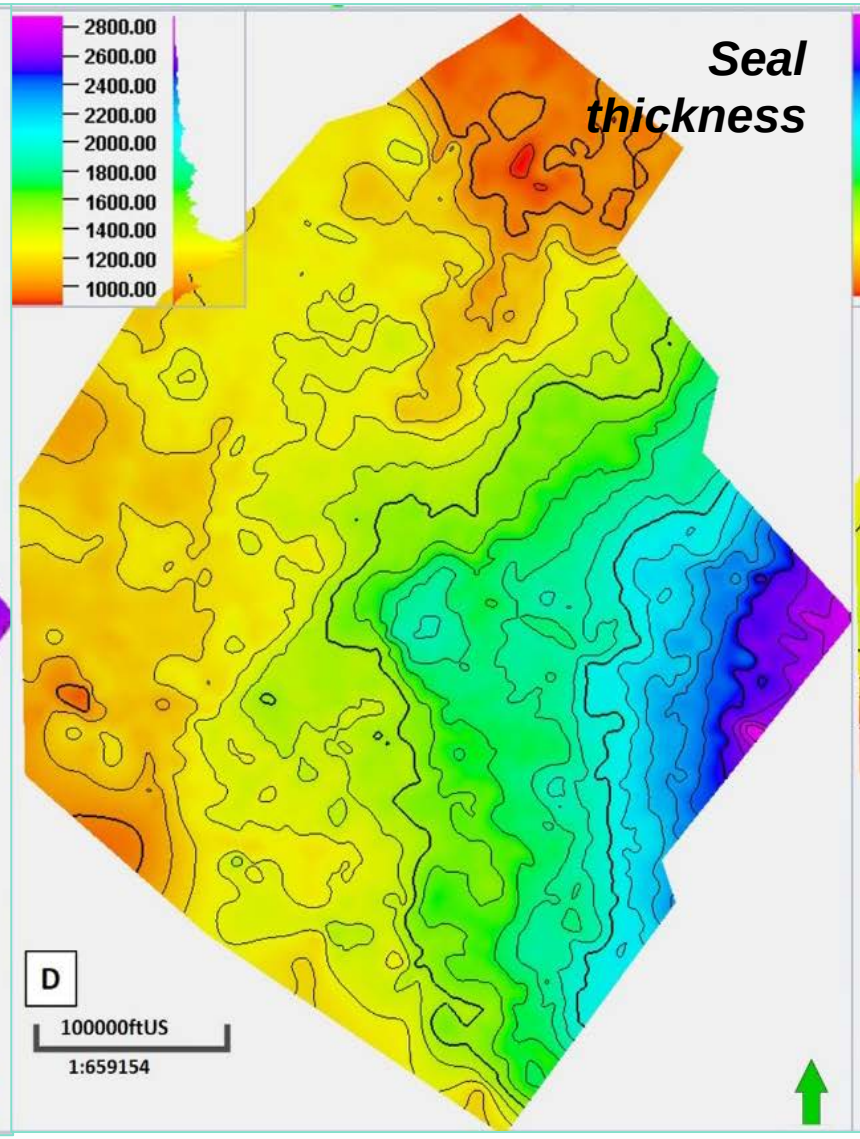




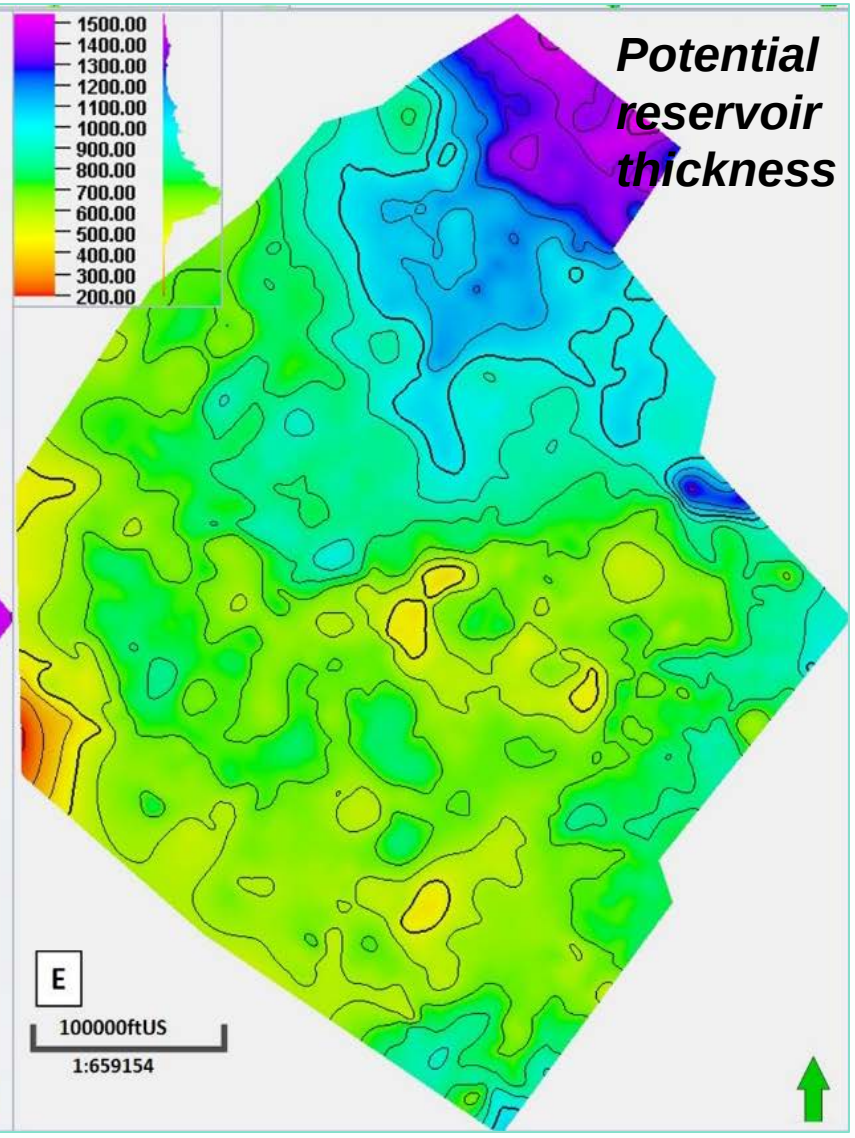
Mapping, South Atlantic



Top Cretaceous structure



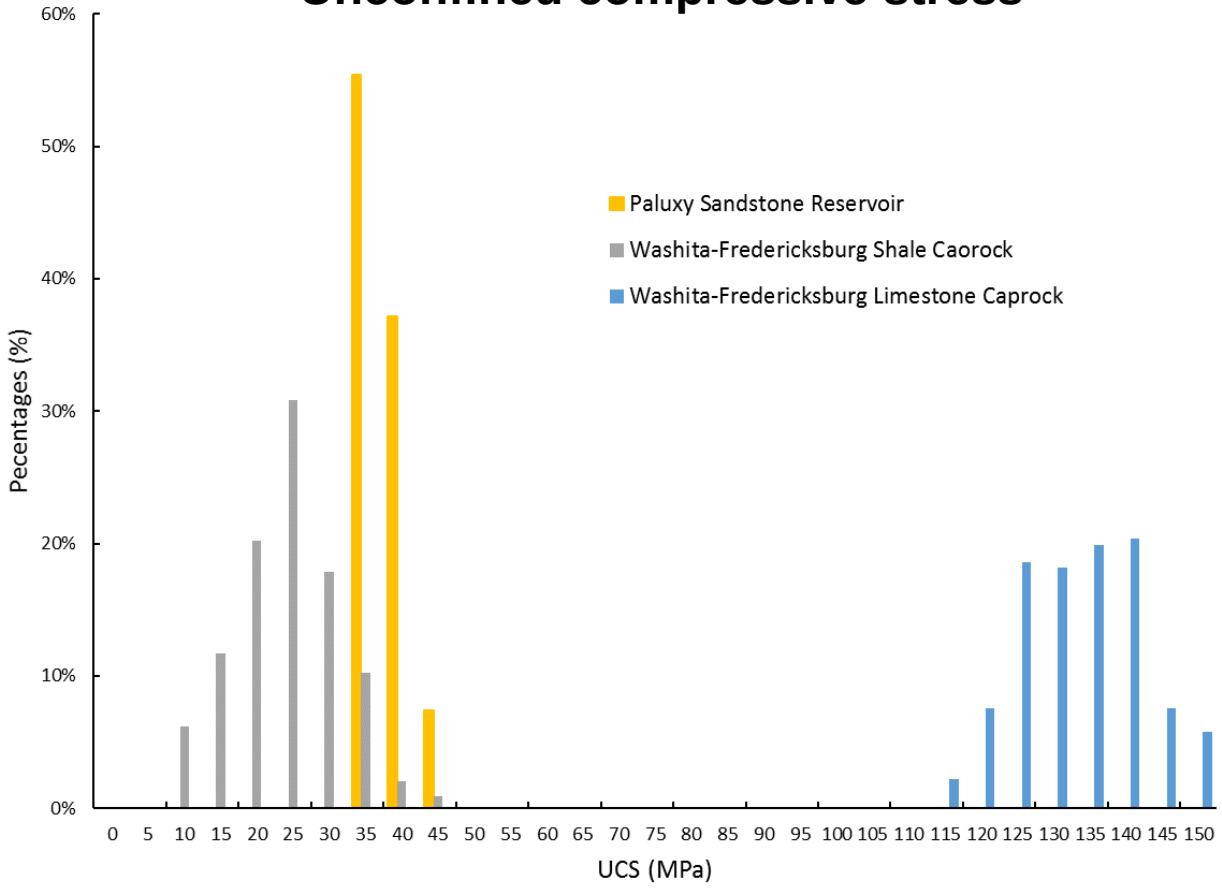
Seal thickness



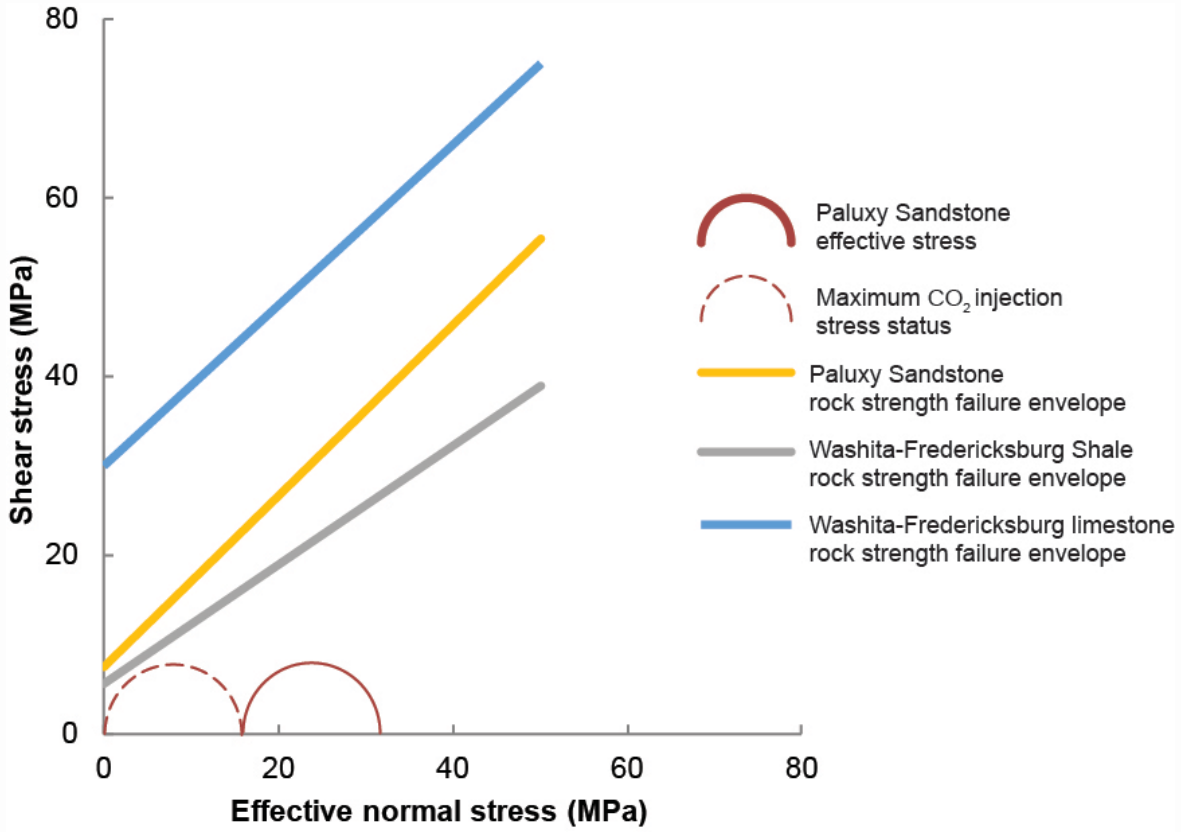
Potential reservoir thickness

Rock Strength (Paluxy Formation, EGOM)

Unconfined compressive stress

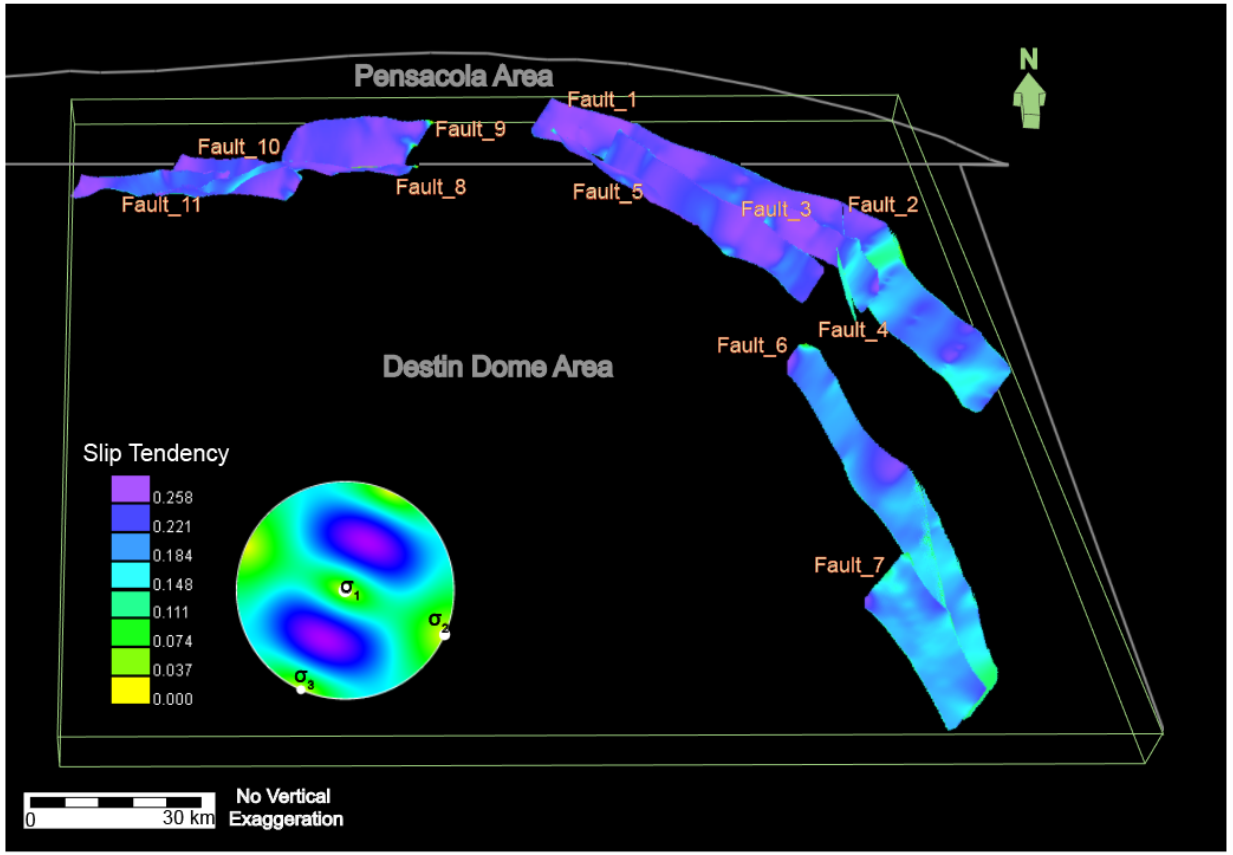


Mohr failure analysis



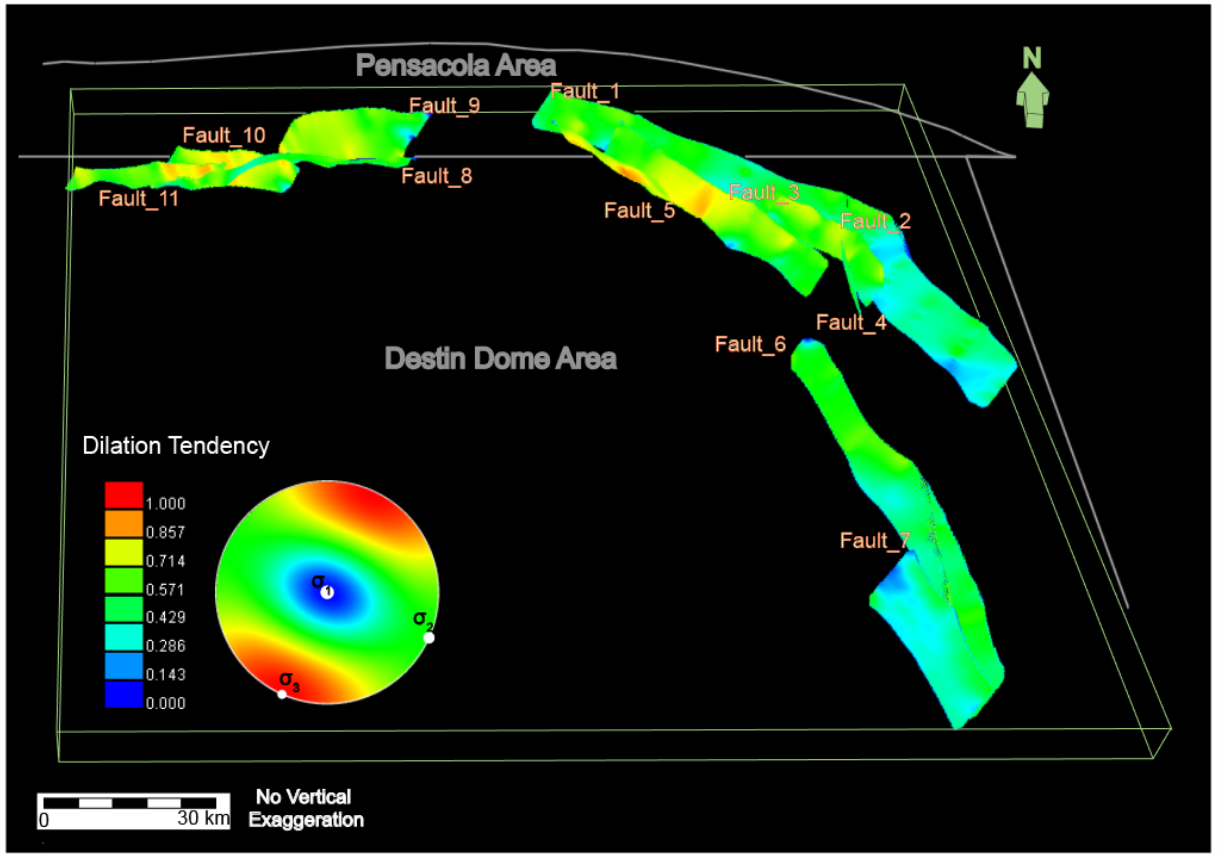
Meng, 2019

Fault Slip and Dilation Tendency, EGOM



Slip tendency

$T_s = \tau / \sigma_n$

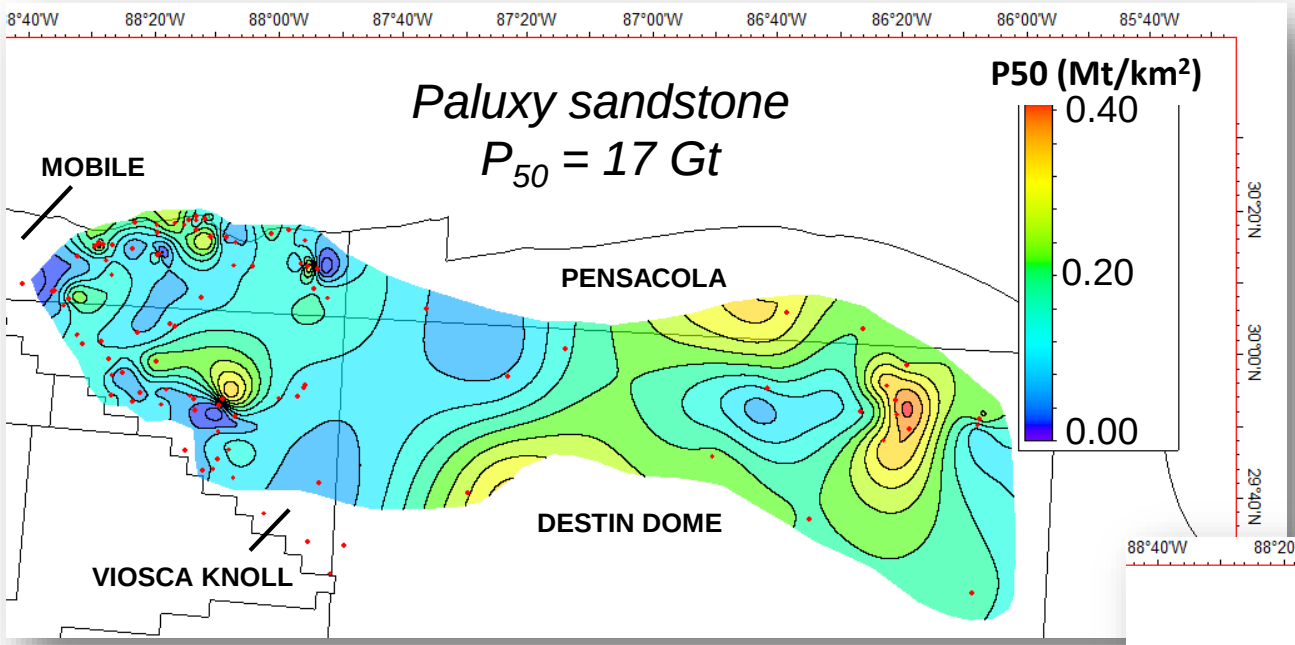


Dilation tendency

$T_d = (\sigma_1 - \sigma_n) / (\sigma_1 - \sigma_3)$

Meng, 2019

Static Volumetric Assessment, DeSoto Canyon Interest Area



$$G_{CO_2} = A_t h_n \phi_{tot} \rho E_{saline}$$

Where,

A_t is the reservoir area

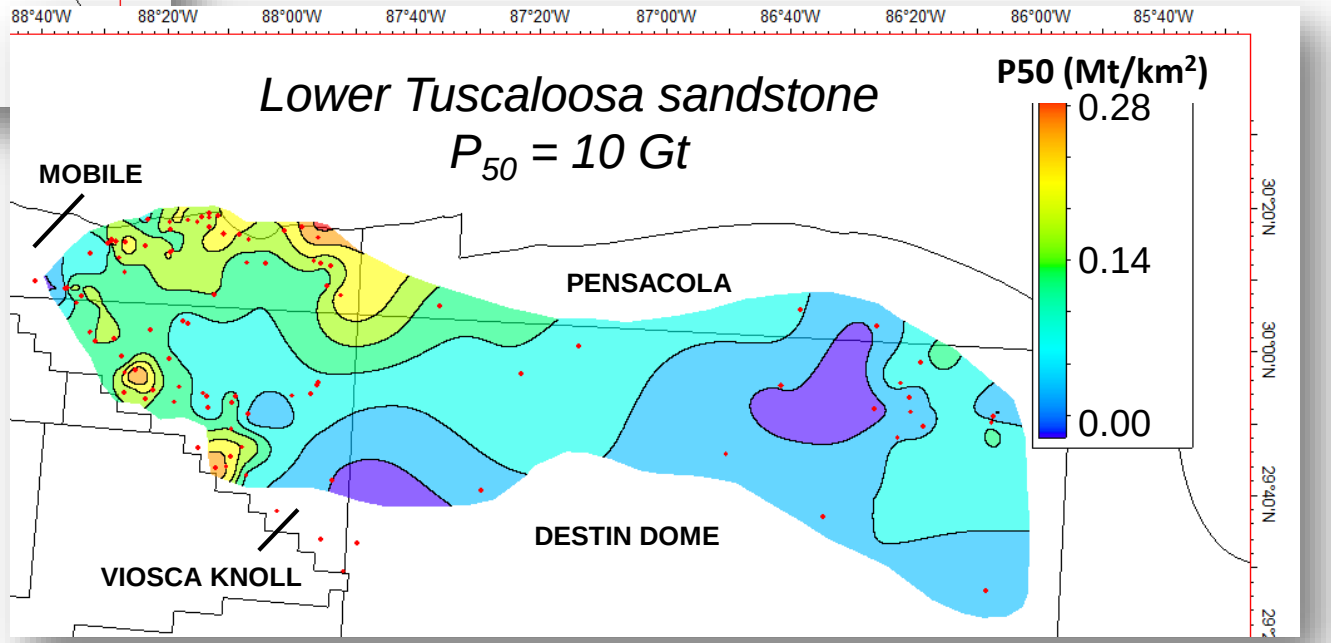
h_n is net sandstone thickness

ϕ_{tot} is the total porosity

ρ is the CO_2 density

E_{saline} is the CO_2 storage efficiency factor

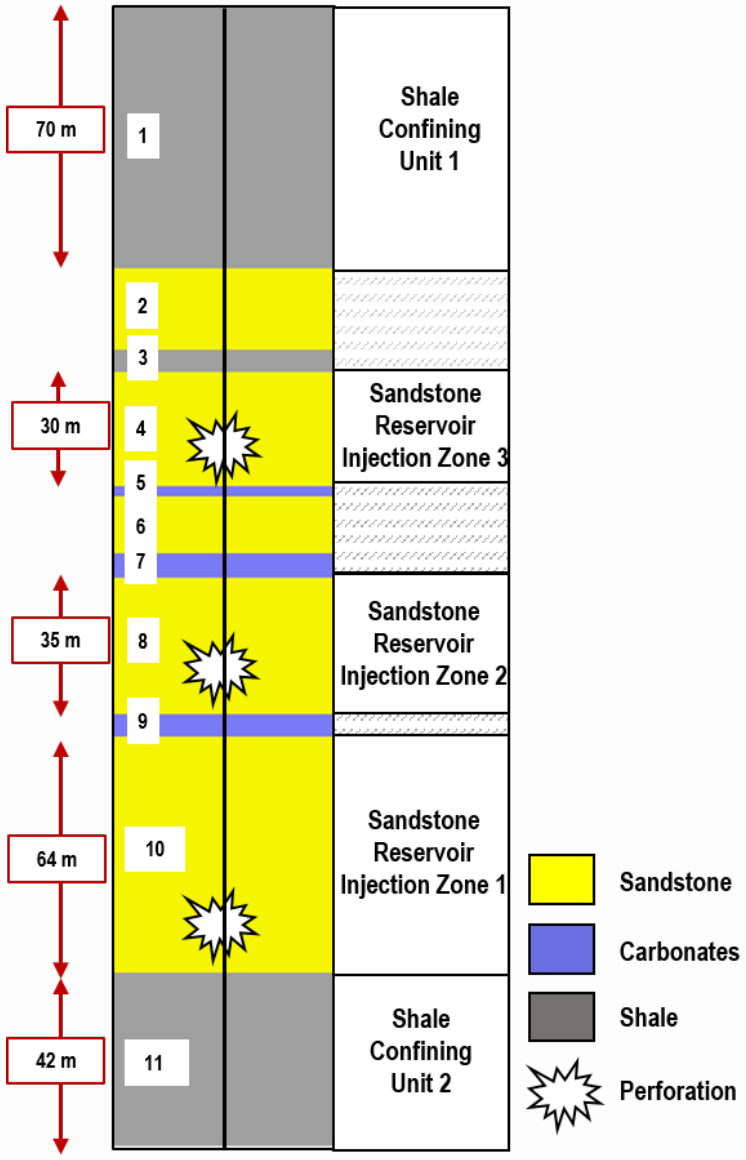
Paluxy + Lower Tuscaloosa
P50 = 3.6 Gt



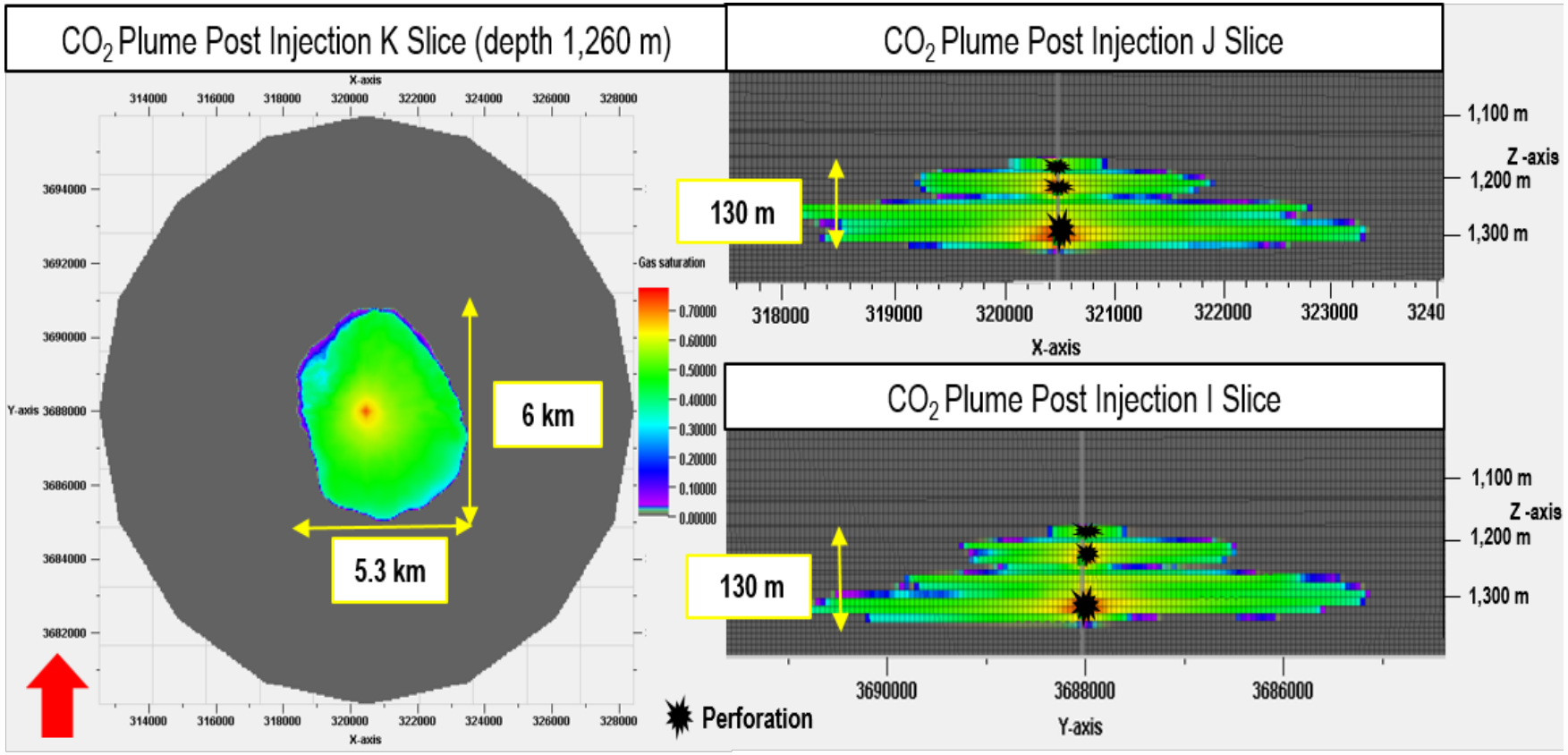
E_{P10} = 7.4%
E_{P50} = 14.0%
E_{P90} = 24.0%

Porosity cutoff = 15%

Dynamic Volumetric Calculations, Mid Atlantic

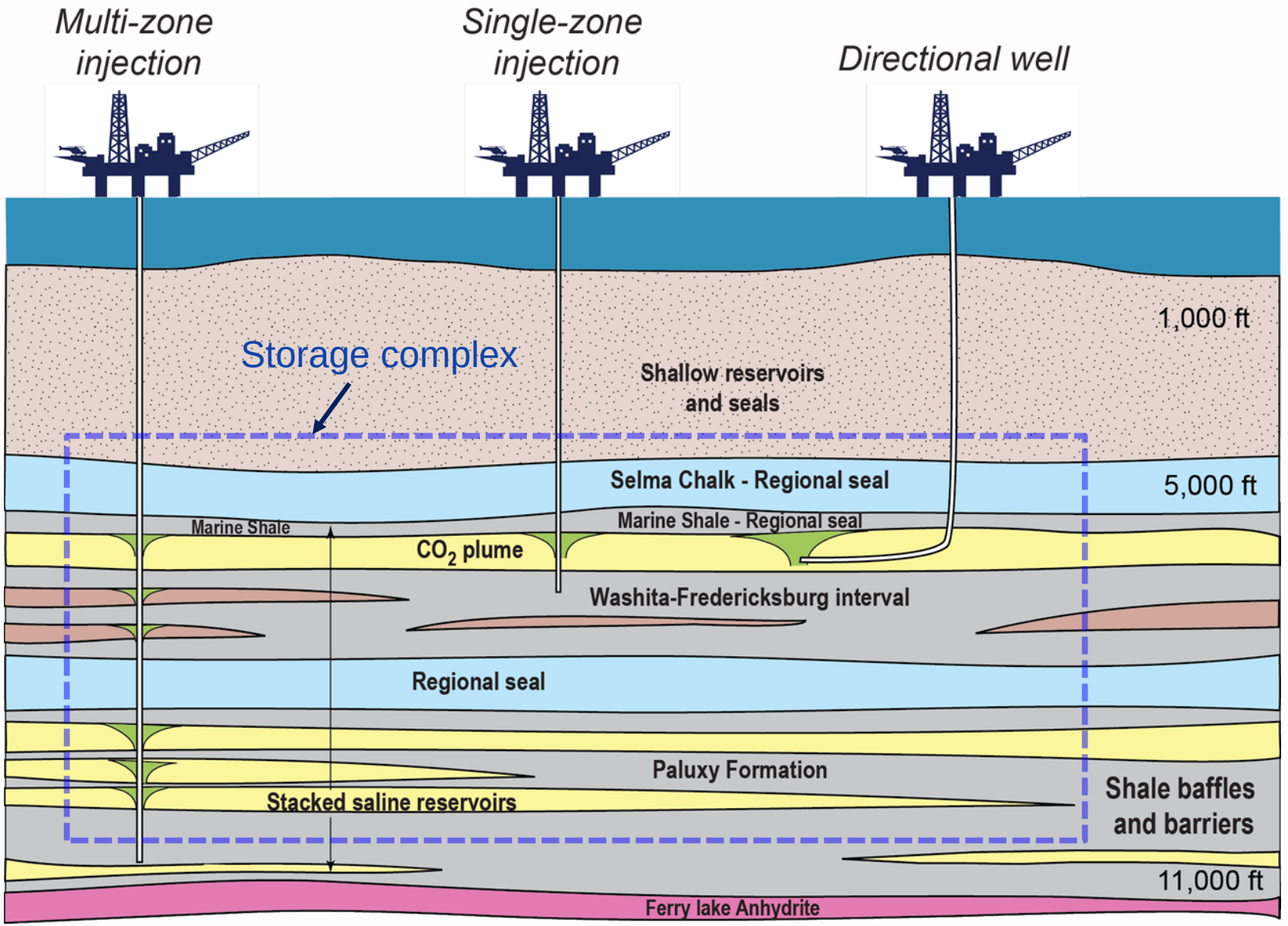


Facies	Porosity	Permeability IJ (mD)	Permeability K (mD)	Net-to-Gross
Sand	0.1-0.4	1-500	0.1-50	0.6-0.9
Shale	0.2-0.3	0.01-0.1	0.001-0.01	0.1-0.3
Carbonate	0.1-0.2	0.01-0.1	0.001-0.01	0.1-0.3



Mullendore et al, 2019

Development Strategies



Accomplishments to Date

- Storage resource assessed at >1,800 Gt at P_{50}.
- Geologic characterization of reservoirs indicates abundant porosity (>20% in sandstone); net reservoir thickness >> 150 m.
- Seals thick (~100-400 m) and numerous; they have high geomechanical integrity, particularly in carbonates.
- Low slip and dilation tendency along faults.
- Nominal geologic risk; identified risks are manageable.
- MVA inventory being developed to identify applicable technologies.

Lessons Learned

- Large ranges of storage resource potential when comparing $_{P10, 50, 90}$ values.
- Well control of reservoir properties is source of uncertainty outside areas of major oil and gas exploration; seismic inversion helps reduce uncertainty.
- Reservoir heterogeneity and other factors affecting development strategies not readily apparent without significant well control.
- Seismic data provide great control of interval thickness but do not record facies changes within most intervals.
- Recommendations for development limited by lack of offshore experience in storage and CO_2-enhanced recovery.

Synergy Opportunities

- Limitless opportunities for collaboration with complementary research groups.
- Continued assessment and modeling efforts can employ multidisciplinary teams, leading to development of heuristic decision systems.
- Work with governmental and corporate stakeholders to identify regulatory pathways and best technical approaches to demonstration and deployment.
- Field deployment of technology helps define applicability, limitations, and best practices.

Summary

- Large portfolio of potential sinks and seals in eastern SOSRA region.
- Main storage prospects in Cretaceous-Miocene section.
- Multiple sandstone formations prospective; abundant mudrock and carbonate seals, including chalk.
- Porosity of sandstone commonly > 20%.
- Widespread anhydrite seals; porous dolomite abundant on Sarasota Arch.
- Porosity of dolomite in places > 15%.
- P_{50} storage resource assessed at > 1,800 Gt.

Appendix

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

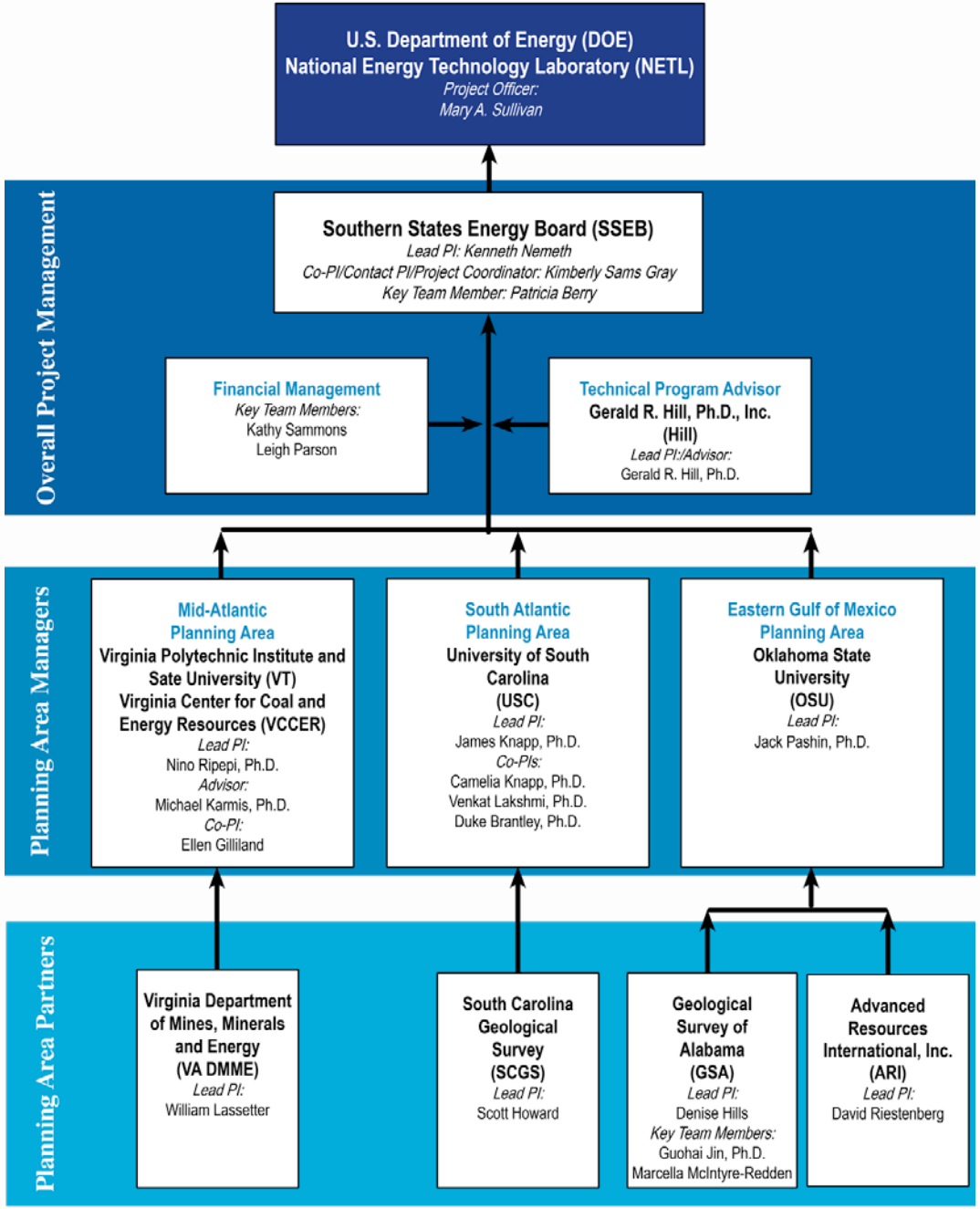
Benefit to the Program

- Support industry's ability to predict offshore CO_2 storage capacity in geologic formations of the eastern Gulf of Mexico and Atlantic continental shelves to within ±30 percent .
- Develop Best Practice Manuals related to carbon storage in offshore reservoirs.
- This project is assessing the geologic CO_2 storage resource of offshore formations in the southeastern United States. Risks are being assessed in the study region, preliminary reservoir models are being developed, and best practice manuals are being prepared.

Project Overview: Goals and Objectives

- Assess storage capacity of offshore saline formations in the eastern Gulf of Mexico (DeSoto Canyon Salt Basin and West Florida Shelf) and the Atlantic shelf (Mid-Atlantic and South Atlantic (Florida to Virginia).
- Assess technical risks associated with geologic storage and the implementation of storage technology.
- Develop preliminary reservoir models.
- Develop Best Practices Manuals.

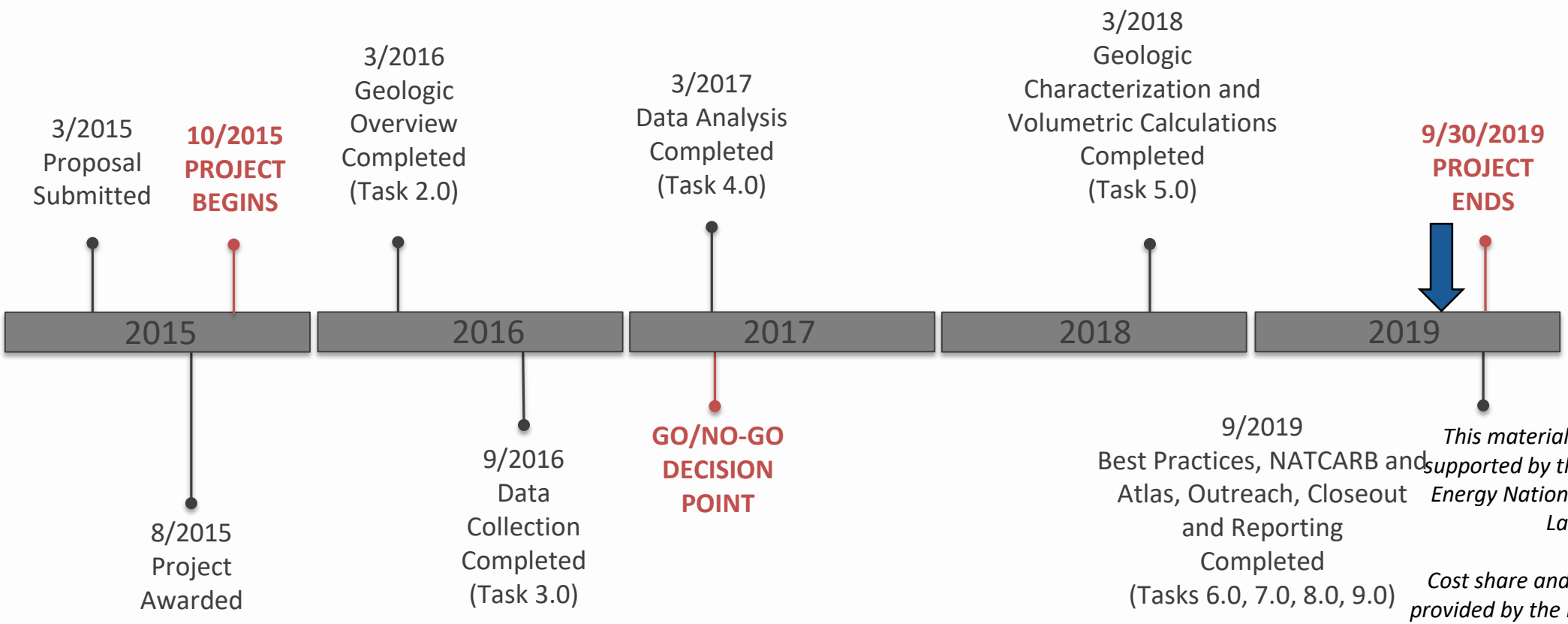
Organizational Chart



Decision Making & Communications

Advisory Committee:
state geological surveys, universities, state oil and gas boards, oil and gas companies, and utilities
(no contract, no decision making authority)

SOSRA Project Timeline



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GO/NO-GO DECISION POINT: *The data collected and analyzed in Phase I is sufficient to perform a quality prospective storage resource assessment and the project should proceed to Phase II.*

Note: Task 1.0, Project Management and Planning, extends throughout the entire program period.

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