Sixth Annual Conference on Carbon Capture & Sequestration

CCS Models

SECARB'S MISSISSIPPI SALINE RESERVOIR FIELD TEST - - SITE SELECTION, TEST PLANNING AND RESERVOIR MODELING

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Mississippi Test Site: Three Primary Objectives

1. Identify and Develop a Safe and Secure CO2 Storage Site
2. Establish and Characterize a Regionally Extensive, High CO2 Storage Capacity Saline Formation
3. Build Acceptance and Confidence for Long-Term CO2 Storage

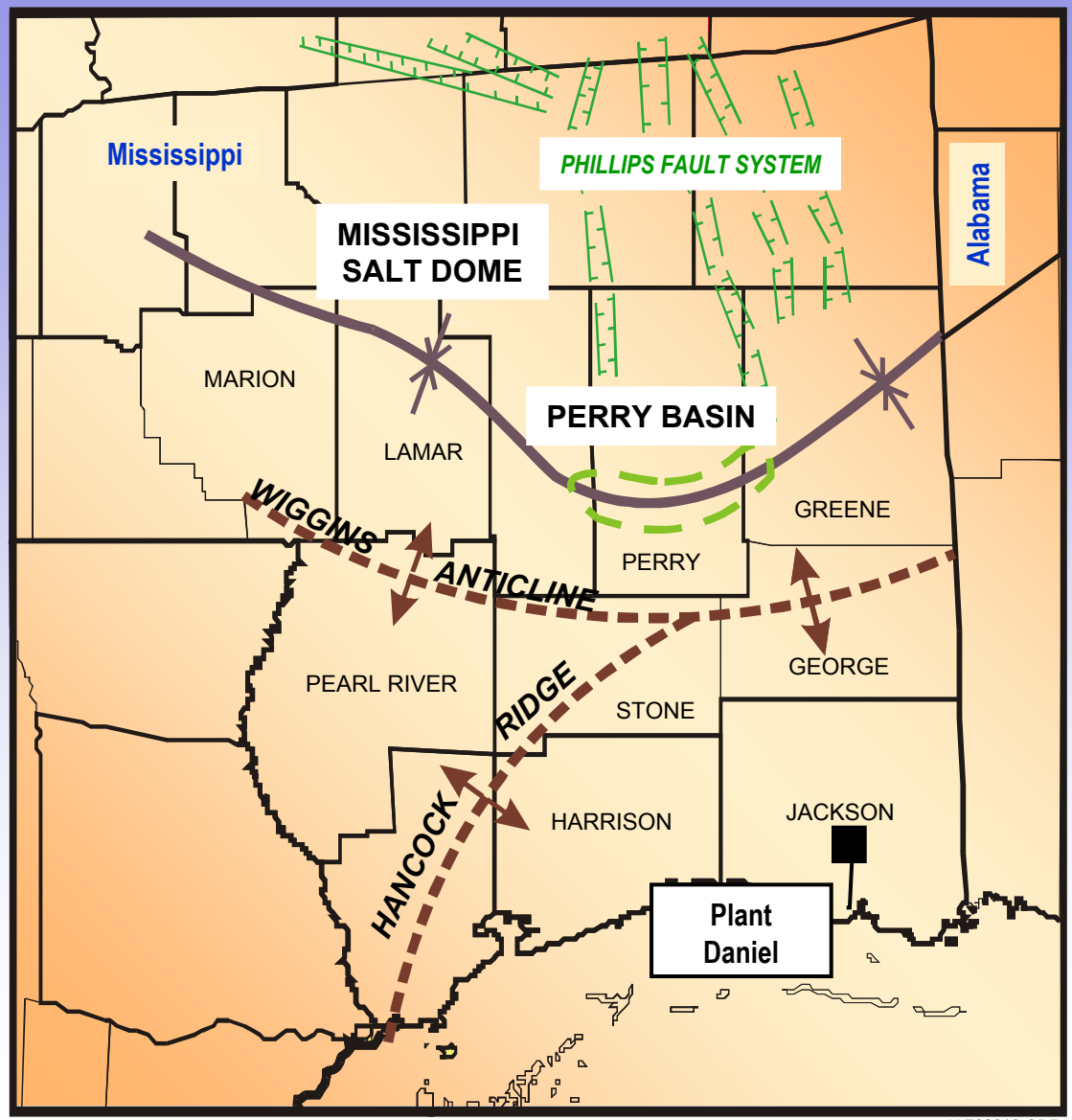
Key Test Site Issues

- How large and regionally continuous is the reservoir? Will it be able to store CO2 emissions from the power plant for the next 40 years?
- What is the injectivity of the formation? How many wells will need to be drilled and how should these be spaced?
- Do the reservoir seal and the shallower geologic strata provide a safe geologic setting plus secondary storage options?
- When and where will the CO2 plume become permanently trapped?
- What set of geologic data, reservoir assessments and monitoring systems will need to be established to meet regulatory requirements?
- What set of strategies and actions will help build local public awareness and acceptance for CO2 storage?

1. Mississippi Test Site Characterization

The site evaluation process is designed to assure selection of a safe, secure CO_2 storage site and formation:

- Competent, regionally extensive caprock and seal(s)
- Multiple shallower "safety zones"
- Updip structural confinement
- High CO_2 storage capacity with favorable reservoir properties
- Favorable hydrological system
- Protection of potable and low salinity water
- Mapping of older, abandoned wells



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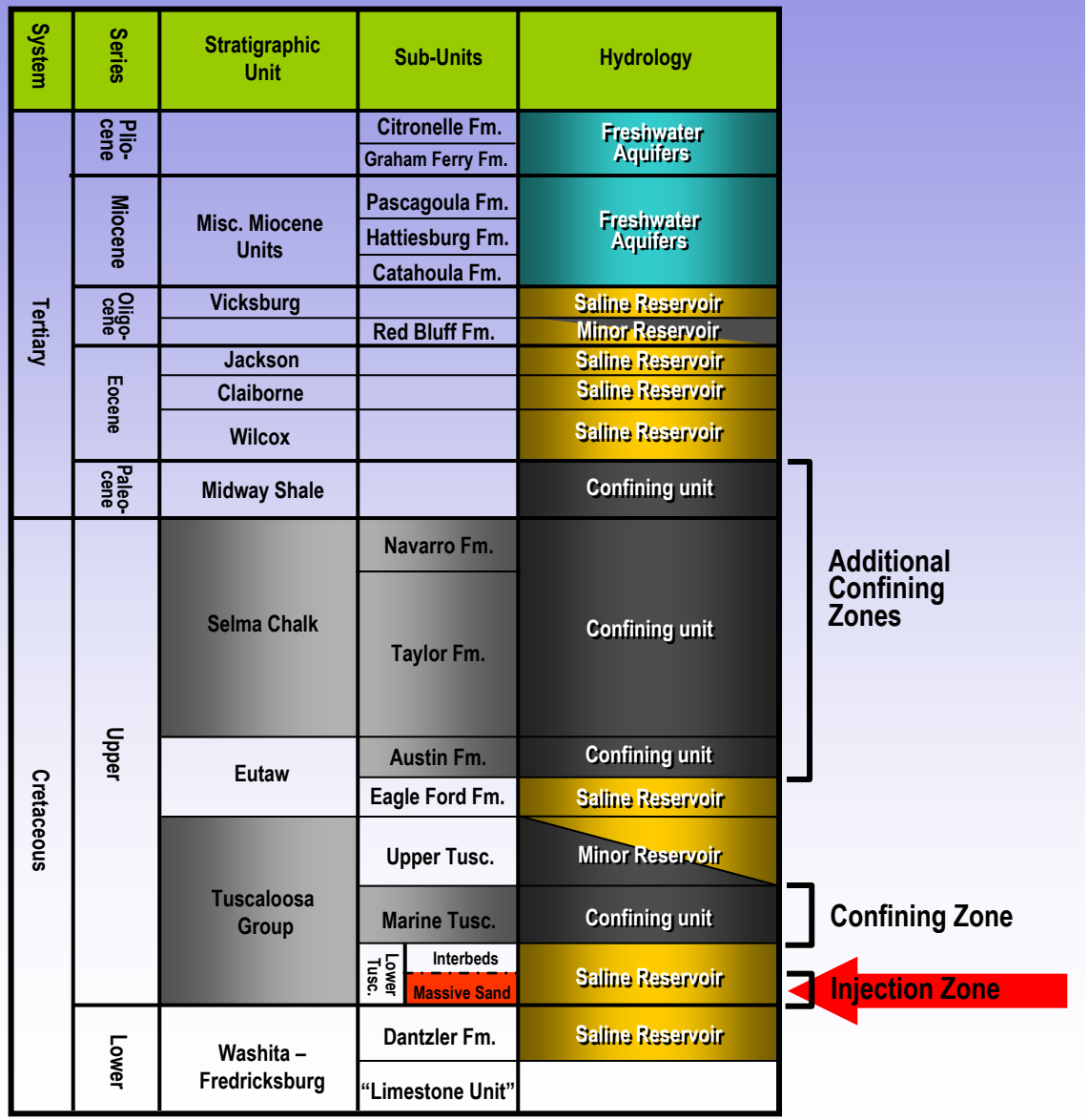
Saline Reservoir Units and Seals
(SE Mississippi)

Potential CO_2 Storage Units:

- Lower Tuscaloosa Massive Sand Unit (U. Cretaceous)
- Dantzler (Washita-Fredricksburg) Formation (L. Cretaceous)

Confining Units (Seals):

- Midway Shale
- Selma Chalk
- Austin Chalk
- Marine Tuscaloosa Shale

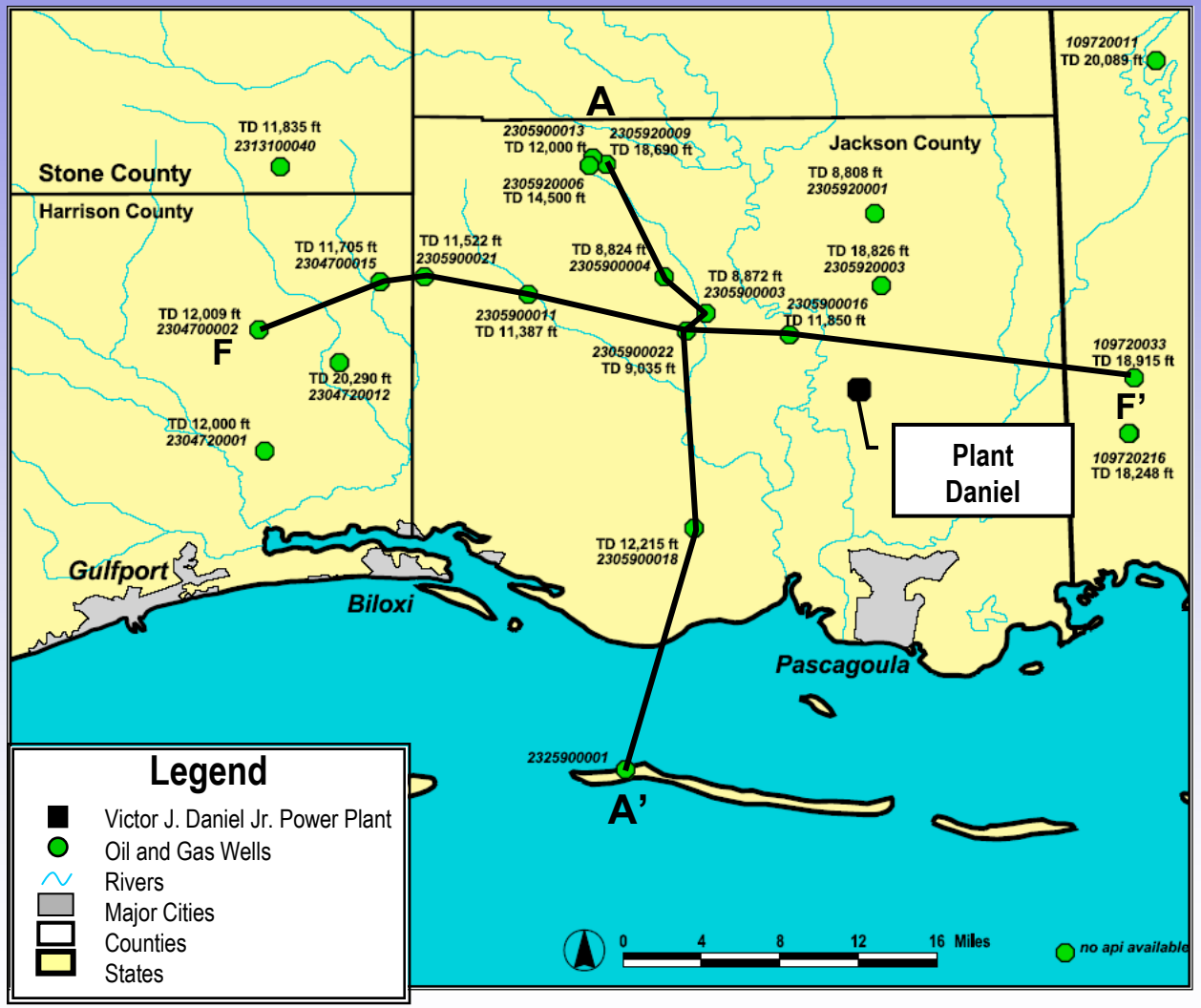


Cross Section A-A' Location

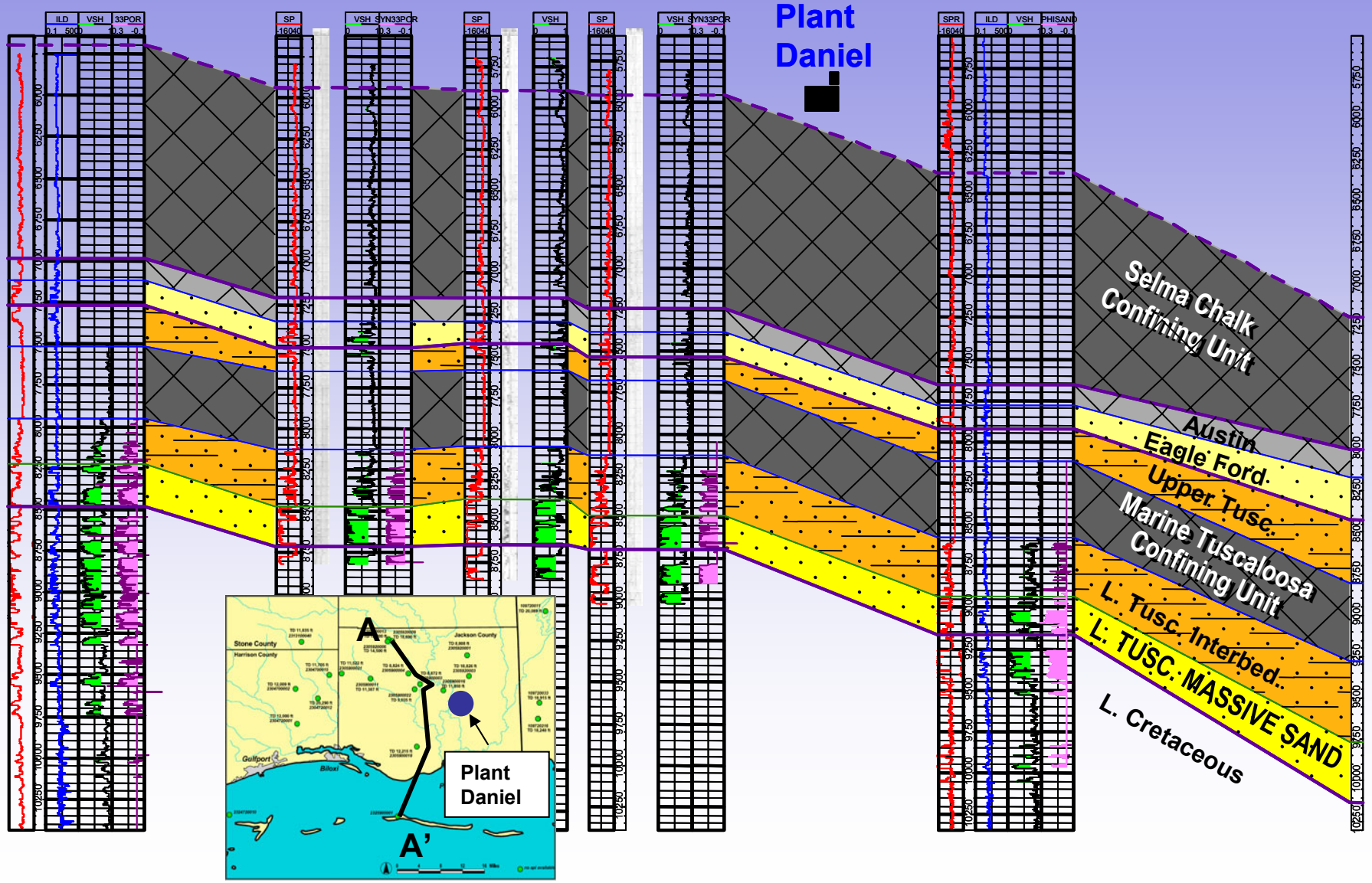
A total of 20 oil and gas wells provide the essential deep subsurface information for the Mississippi Gulf Coast area.

The A-A' North-South cross section contains 8 data wells.

Additional cross-sections providing detailed geologic characterization will be undertaken for the Gulf Coast region.



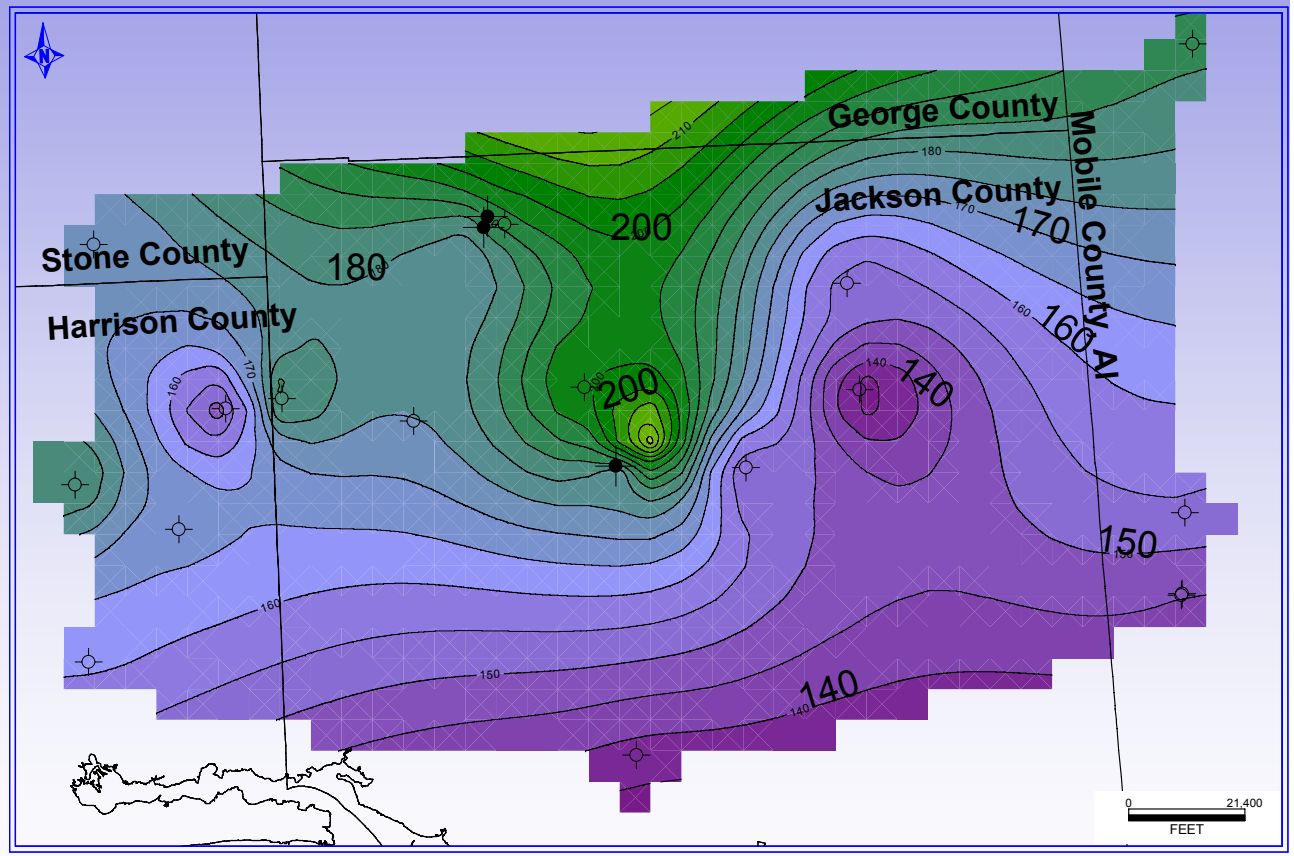
North-South Geologic Cross Section



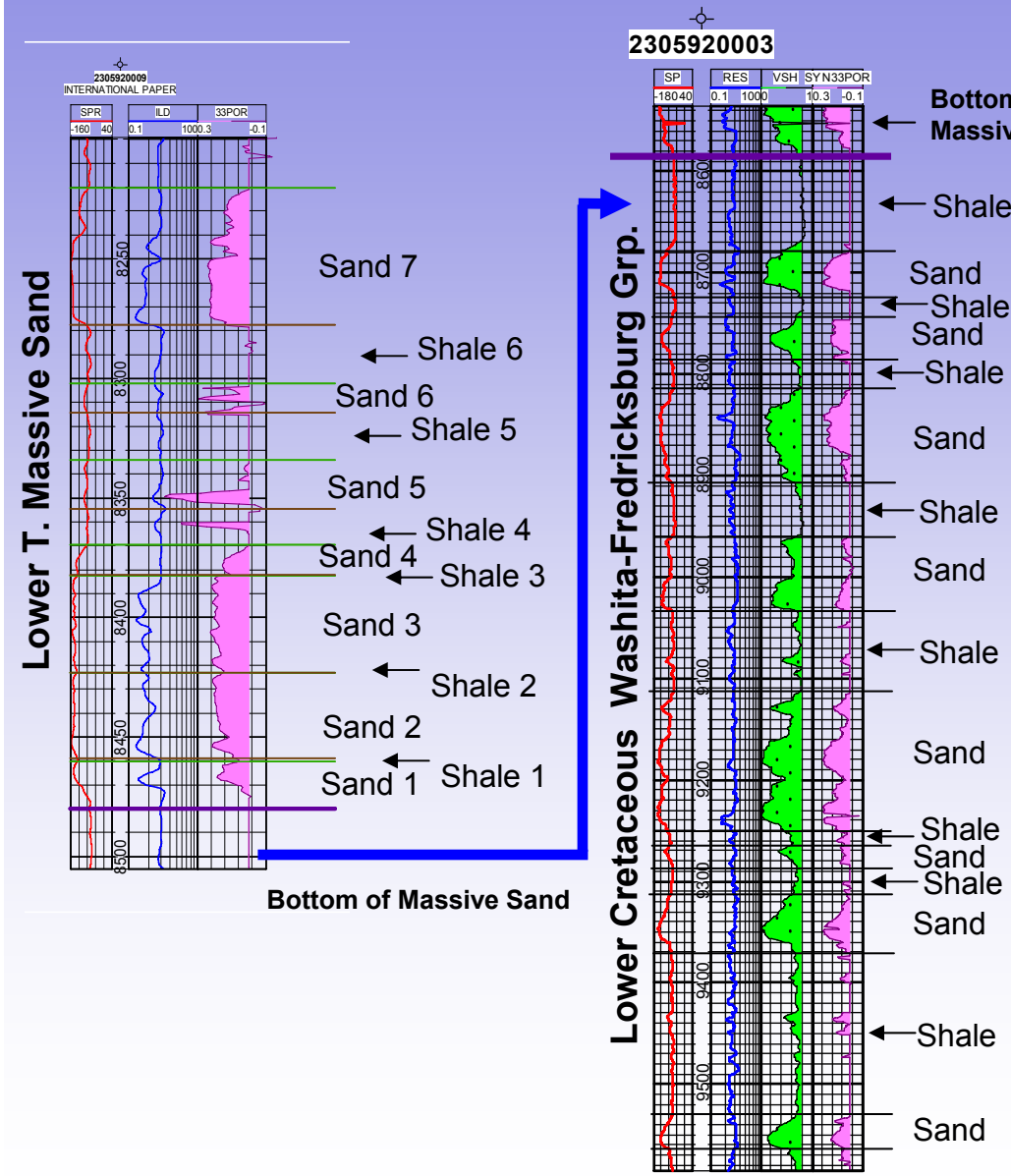
Net Sand Thickness
Lower Tuscaloosa Massive Sand Unit

Reservoir mapping confirms that the Massive Sand Unit of the Lower Tuscaloosa Fm. contains a thick section of net sand in southern Mississippi.

Even thicker units of deeper L. Cretaceous-age sediments underlie the Tuscaloosa Formation, but still require more detailed mapping.



Injection into Tuscaloosa Massive Sand Unit and Lower Cretaceous Sands (w/Baffles)



The figure to the left provides the type log for the Lower Tuscaloosa Massive Sand Unit and Lower Cretaceous Dantzler Fm. in Southern Mississippi.

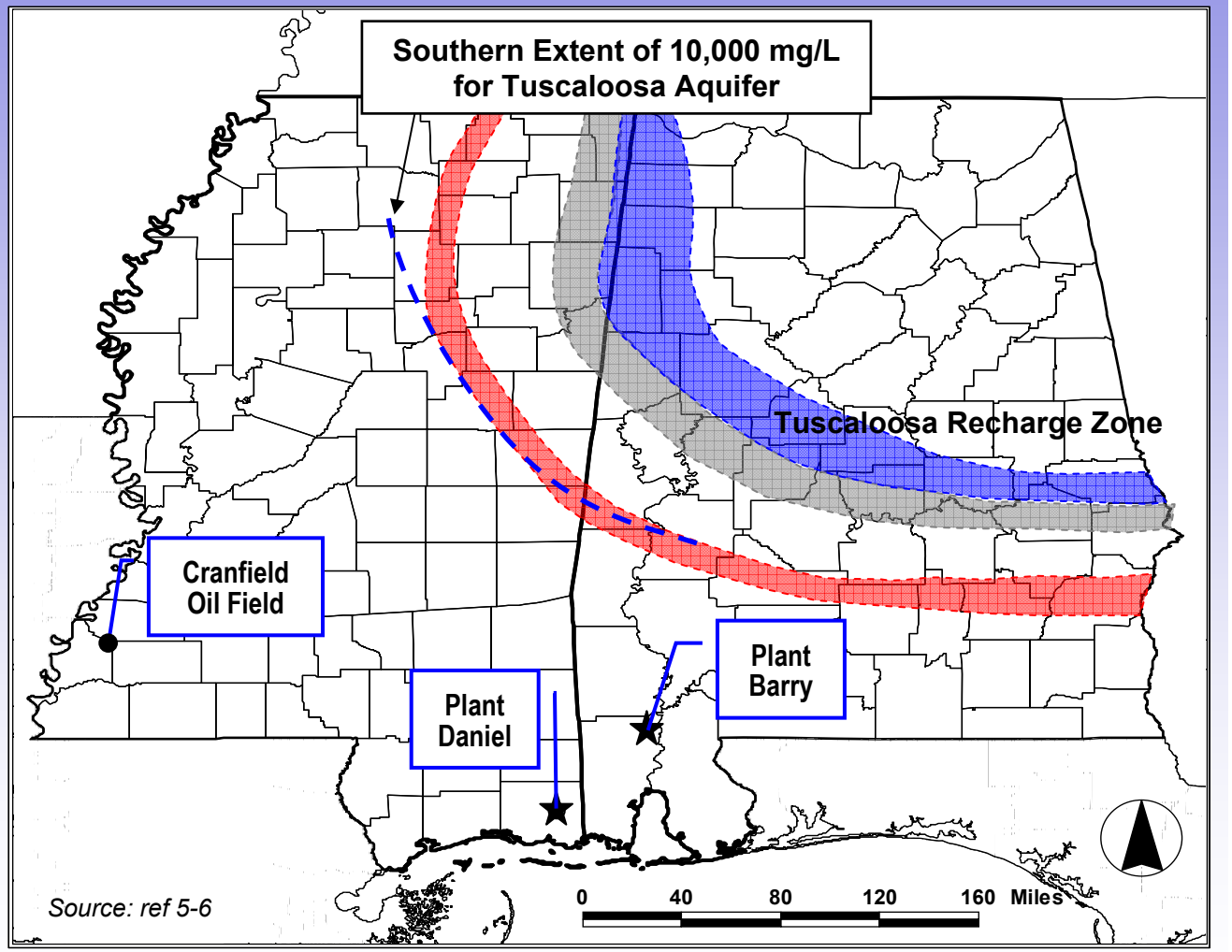
The Massive Sand Unit and Washita-Fredricksburg formations together hold over 600 ft of net sand. These two formations contain multiple flow units and shale breaks over a 1,300 ft interval.

Regional Hydrogeology and Potable Water Sources

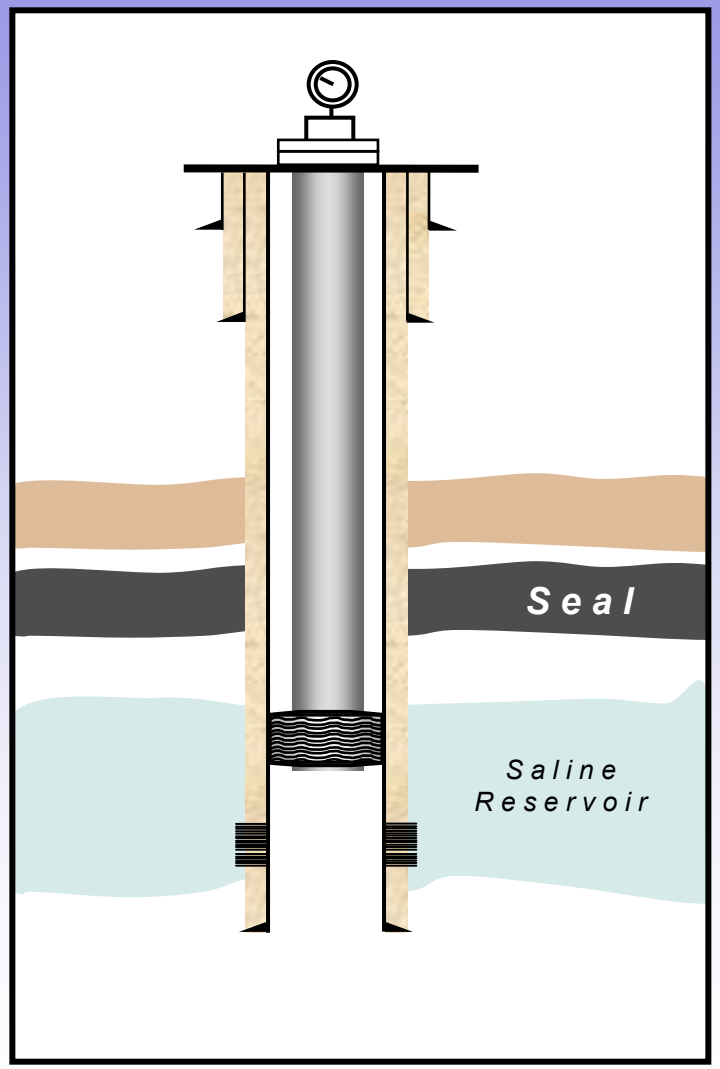
The hydrogeology map for Mississippi and Alabama shows:

- The EPA defined Underground Sources of Drinking Water (TDS <10,000 mg/L) portion of the Tuscaloosa aquifer
- The aquifer recharge zones at formation outcrops

The Tuscaloosa injection interval is well below the EPA protected water limits.



Further Reservoir Characterization



The drilling of observation and injection wells will allow for additional data collection that will be used for geologic characterization and subsequent reservoir modeling.

- Core from the caprock (seal) and proposed storage formation
  - Permeability , porosity and lithology
- Wireline geophysical logging
  - Depth, thickness and porosity
- Pressure transient testing
  - Permeability and completion efficiency
- Stress testing
  - Fracture gradient and injectivity
- CO2 plume tracking/robust MMV
  - Calibration with reservoir simulation

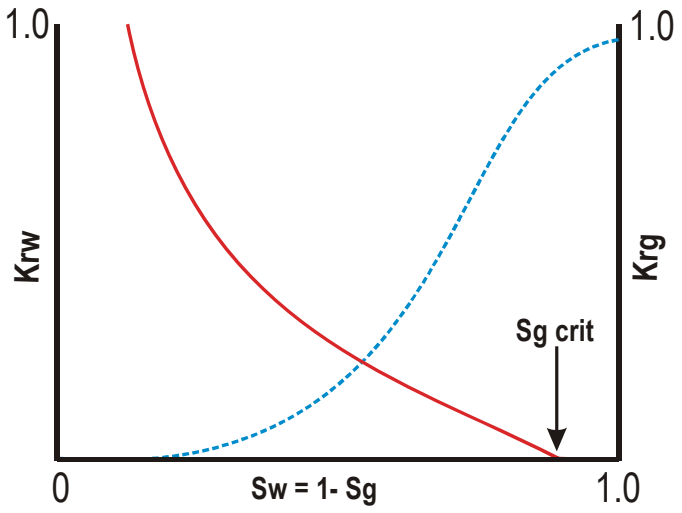
2. Integration of Geologic Characterization and Reservoir Modeling

As part of its Phase II Regional Characterization, the SECARB Team will:

1. Further characterize the massive wedge of Cretaceous-age sediments deposited along the Gulf Coast
2. Identify the high quality, secure CO2 storage options within this massive wedge, areally and vertically
3. Examine the role of alternative CO2 trapping and storage mechanisms on local and regional estimates of CO2 storage capacity:
   - Pore space trapping
   - Internal reservoir architecture
   - Regional dip and aquifer flow

Defining Pore Space Trapping of CO2

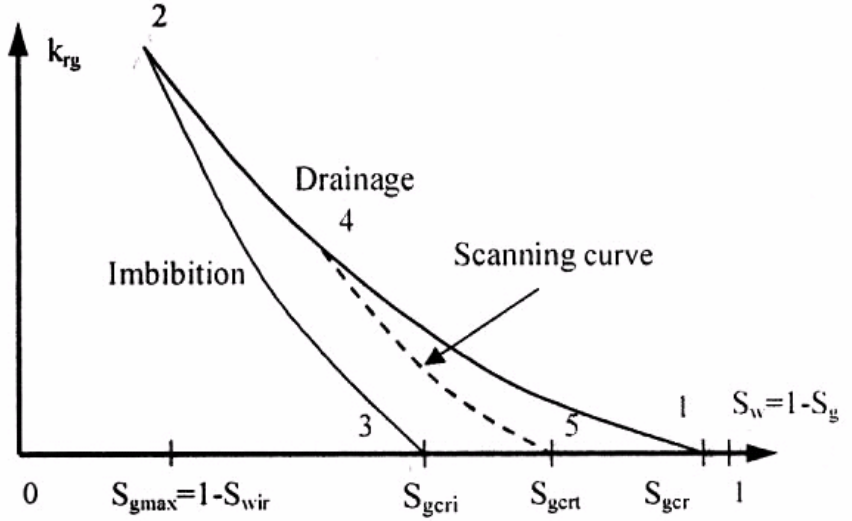
CO2 and Water Relative Permeability Curves



Defining Effects of Critical Gas Saturation

CO2 Relative Permeability Hysteresis

(Mo and Akervoll, 2005)



Defining Effects of Hysteresis

First Order Assessment of CO2 Storage Capacity/Plume Extent

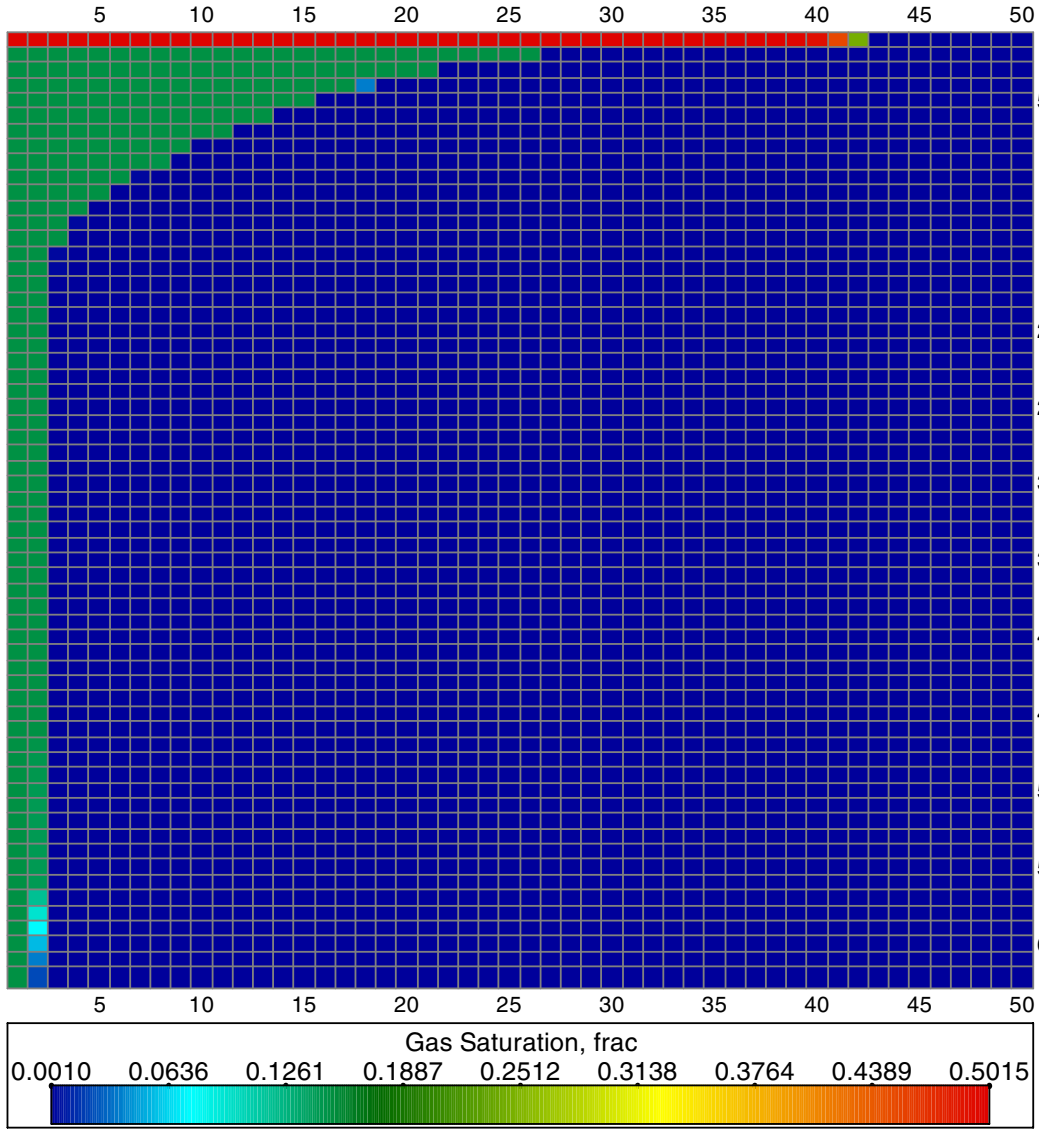
The example involves:

- Injecting 100,000 metric tons/year of CO2 into the Lower Tuscaloosa Massive Sand Unit (for four years).

The modeling shows:

- Outer extent of the CO2 plume at the end of ten years is 4,300ft.
- Most of the injected CO2 rises to the top of the formation, due to buoyancy.

CO2 Injection into Lower Tuscaloosa Massive Sand (No Shale Baffles)



Note: One grid block = 100 ft horizontally

Second Order Assessment of Storage Capacity/ Plume Tracking

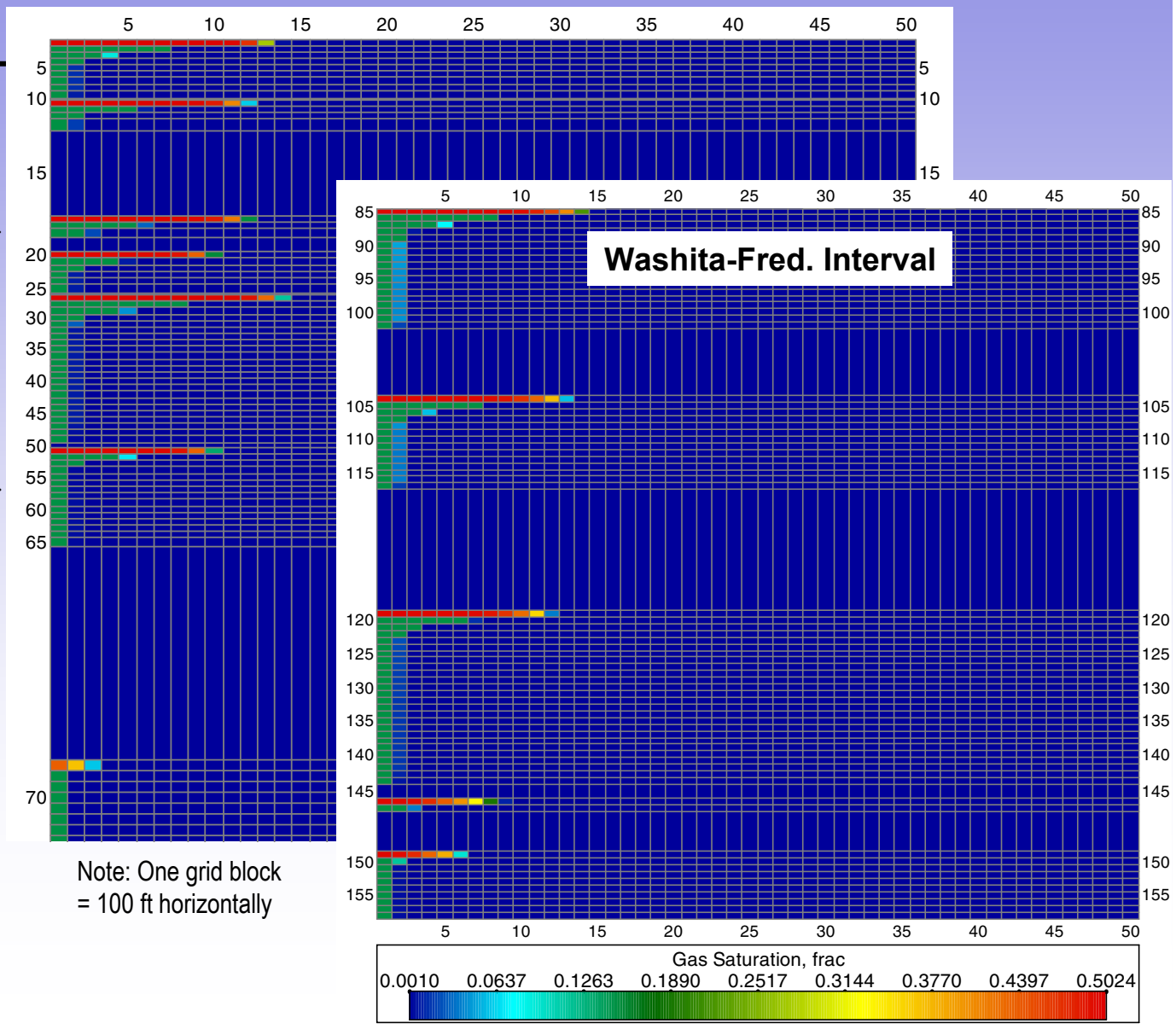
The example involves:

- Injecting 100,000 metric tons/year of CO2 into the L. Tuscaloosa Massive Sand and L. Cretaceous sands

The modeling shows:

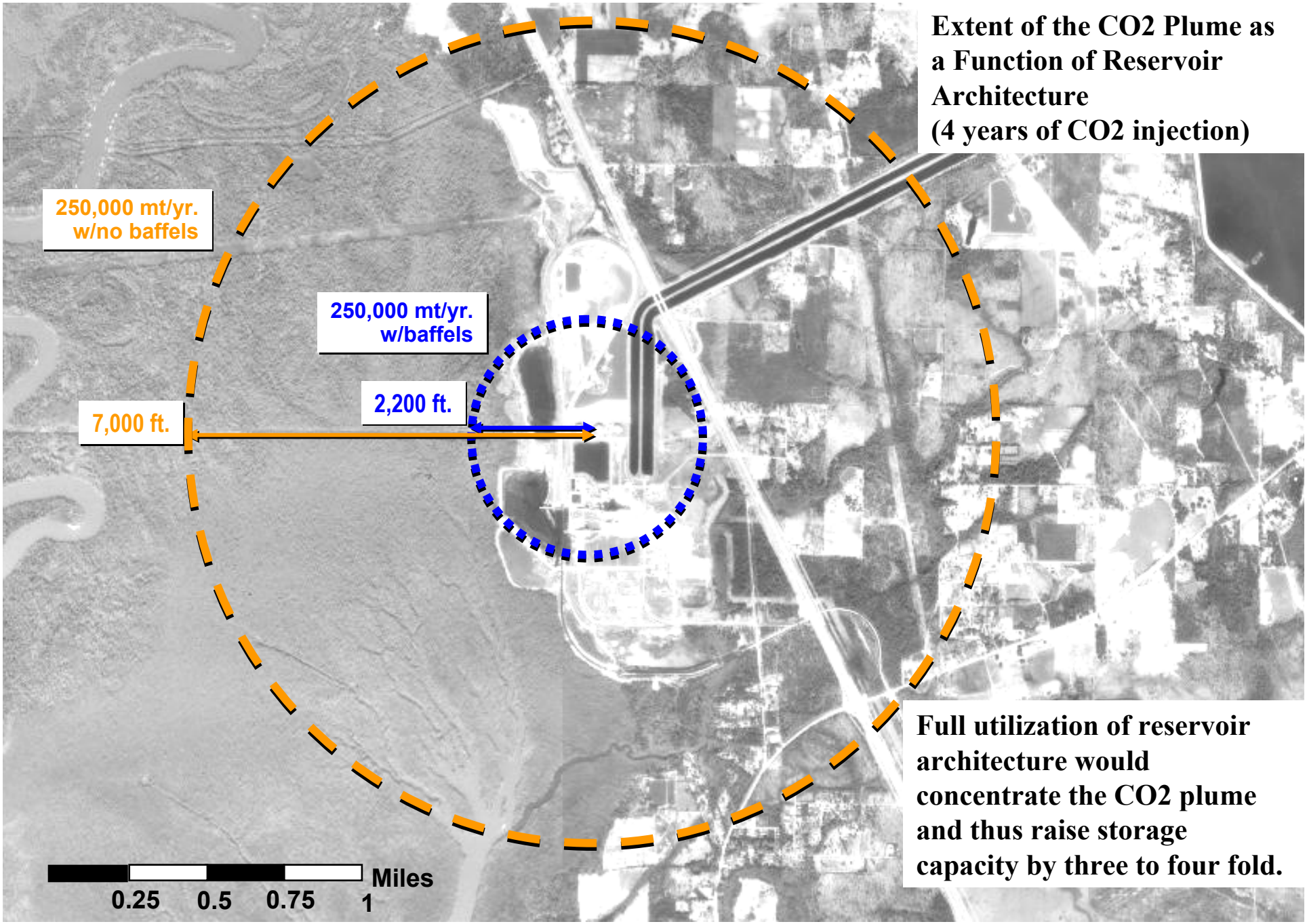
- Maximum plume extent at the end ten years is 1,400 ft.
- Internal reservoir architecture (baffels) creates multiple CO2 intervals that restrict the vertical migration of the CO2 plume

CO2 Injection into Massive Sand Unit and Lower Cretaceous Sands (w/Baffles)



Note: One grid block = 100 ft horizontally

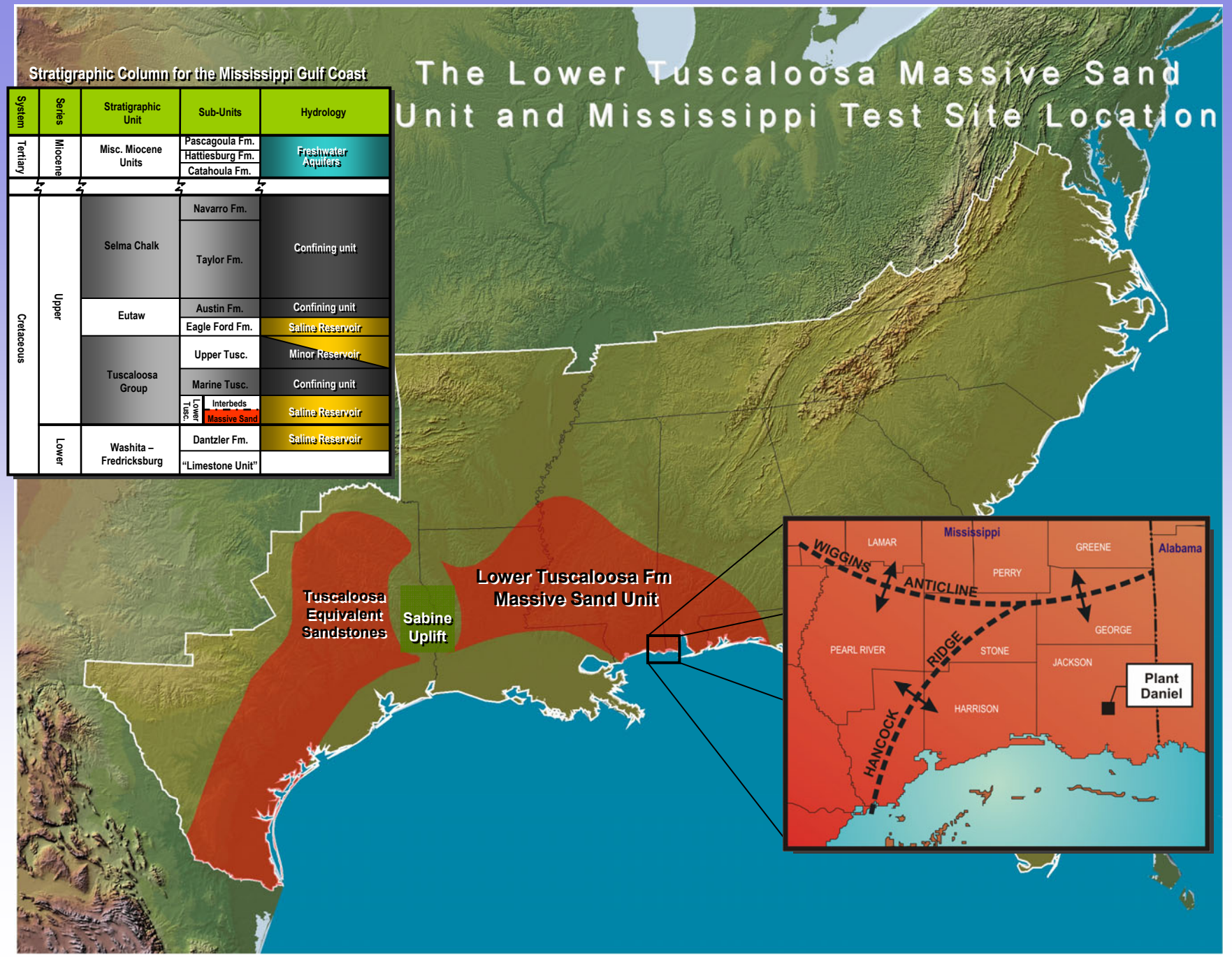
CO2 Concentration Assuming Larger (250,000 mt/yr) of Injection



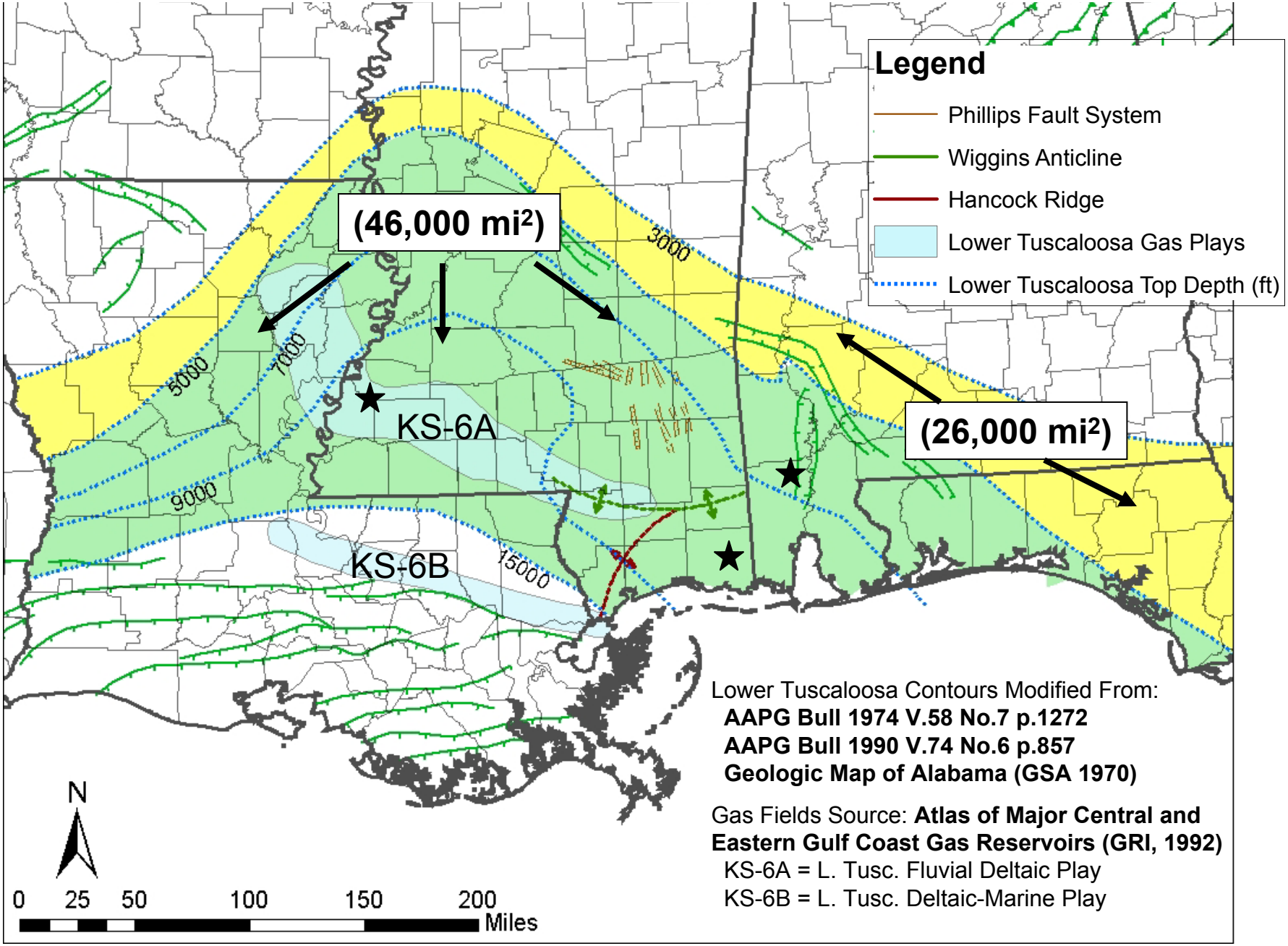
3. Large Favorable Regional CO2 Storage Capacity

The Cretaceous- and Tertiary-age sediments along the Gulf Coast provide one of the nation's most significant options for geologically storing CO2.

- These formations extend from southeast Texas, through Louisiana, Mississippi, Florida and Georgia and into the offshore of the Carolinas.
- These formations appear to have major, regionally extensive reservoir seals (confining units).
- The formations are deep, with generally good porosity and thickness, providing significant CO2 storage capacity and storage concentration.


The Lower Tuscaloosa Massive Sand Unit and Mississippi Test Site Location
Stratigraphic Column for the Mississippi Gulf Coast
System
Series
Stratigraphic Unit
Sub-Units
Hydrology
Tertiary
Miocene
Misc. Miocene Units
Pascagoula Fm.
Hattiesburg Fm.
Catahoula Fm.
Freshwater Aquifers
Cretaceous
Upper
Selma Chalk
Navarro Fm.
Taylor Fm.
Confining unit
Eutaw
Austin Fm.
Confining unit
Eagle Ford Fm.
Saline Reservoir
Tuscaloosa Group
Upper Tusc.
Minor Reservoir
Marine Tusc.
Confining unit
Lower Tusc.
Interbeds
Massive Sand
Saline Reservoir
Lower
Washita – Fredricksburg
Dantzler Fm.
Saline Reservoir
"Limestone Unit"
Tuscaloosa Equivalent Sandstones
Sabine Uplift
Lower Tuscaloosa Fm Massive Sand Unit
Mississippi
Alabama
LAMAR
GREENE
PERRY
WIGGINS
ANTICLINE
GEORGE
PEARL RIVER
RIDGE
STONE
JACKSON
Plant Daniel
HARRISON
HANCOCK

A Variety of Reservoir Settings Exist for the Lower Tuscaloosa Formation



Next Steps

Because of its pervasive presence and favorable characteristics, particular emphasis will be given to the CO2 storage capacity of the Lower Tuscaloosa Fm and its equivalent sandstones.

- Build on the detailed geological work underway in Southern Mississippi, at Plant Daniel and other field tests in the SECARB region.
- Capitalize on the potential for further detailed data and geological characterization in Alabama, Georgia, and other states.
- Developed improved confidence in the CO2 storage capacity of this saline formation (currently estimated at about 100 billion metric tons) and establish more detailed characterization of this formation in the SECARB area.