Southeast Regional Carbon Sequestration Partnership (SECARB)

Large Scale CO_2 Storage in the Lower Tuscaloosa Massive Sand Formation

NETL RCSP Annual Project Review Meeting

Pittsburgh, Pennsylvania

December 12, 2007

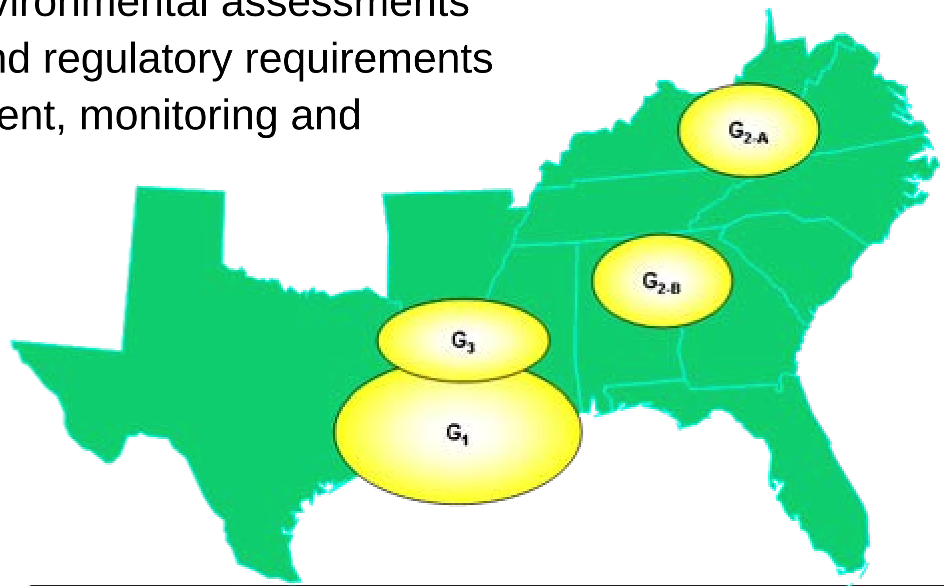
Presented by:

Gerald R. Hill, Ph.D.

SECARB Technical Coordinator

SECARB Partnership Objectives

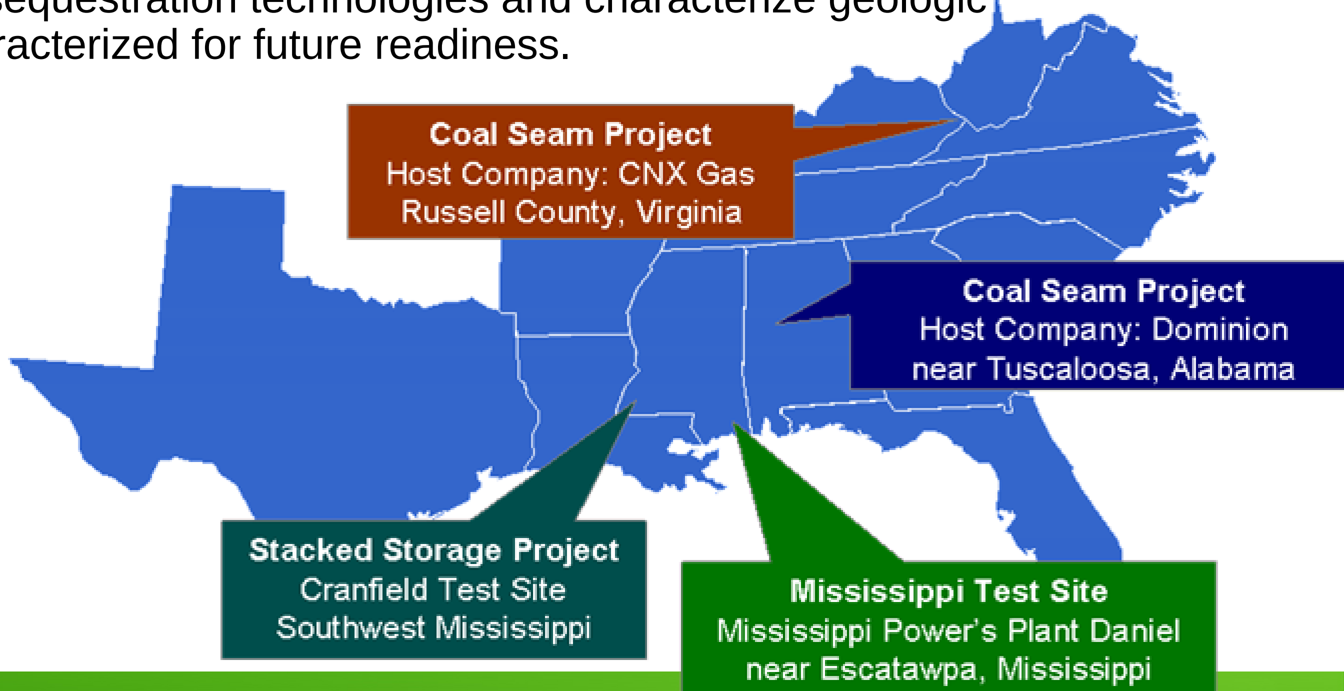
- **Phase I: Characterization**
  - Describe CO_2 sources, sinks and transport requirements
  - Develop outreach plan
  - Conduct risk and environmental assessments
  - Review permitting and regulatory requirements
  - Establish measurement, monitoring and verification protocols
  - Establish accounting frameworks (including Section 1605(b) of EPAct)
  - Identify most promising capture and sequestration opportunities
  - Develop Phase II field validation test plans



G_1	Gulf Coast Stacked Storage Sequestration Project
G_{2-A} and G_{2-B}	Coal Seam Sequestration Project
G_3	Saline Reservoir Test Center Sequestration Project

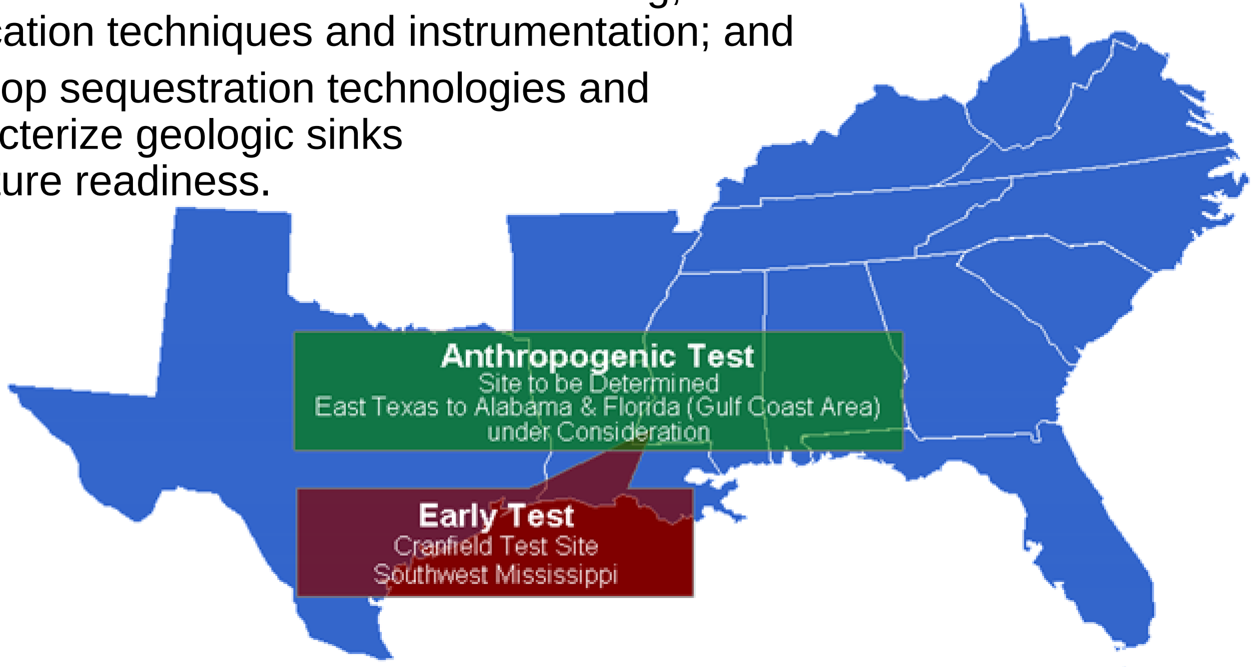
SECARB Partnership Objectives

- **Phase II: Implementation**
  - Further characterize the potential carbon sequestration sinks in the Southeast;
  - Conduct three field verification studies in some of the most promising geologic formations in the region;
  - Advance the state of the art in monitoring, measurement and verification techniques and instrumentation; and
  - Develop sequestration technologies and characterize geologic sinks characterized for future readiness.



SECARB Partnership Objectives

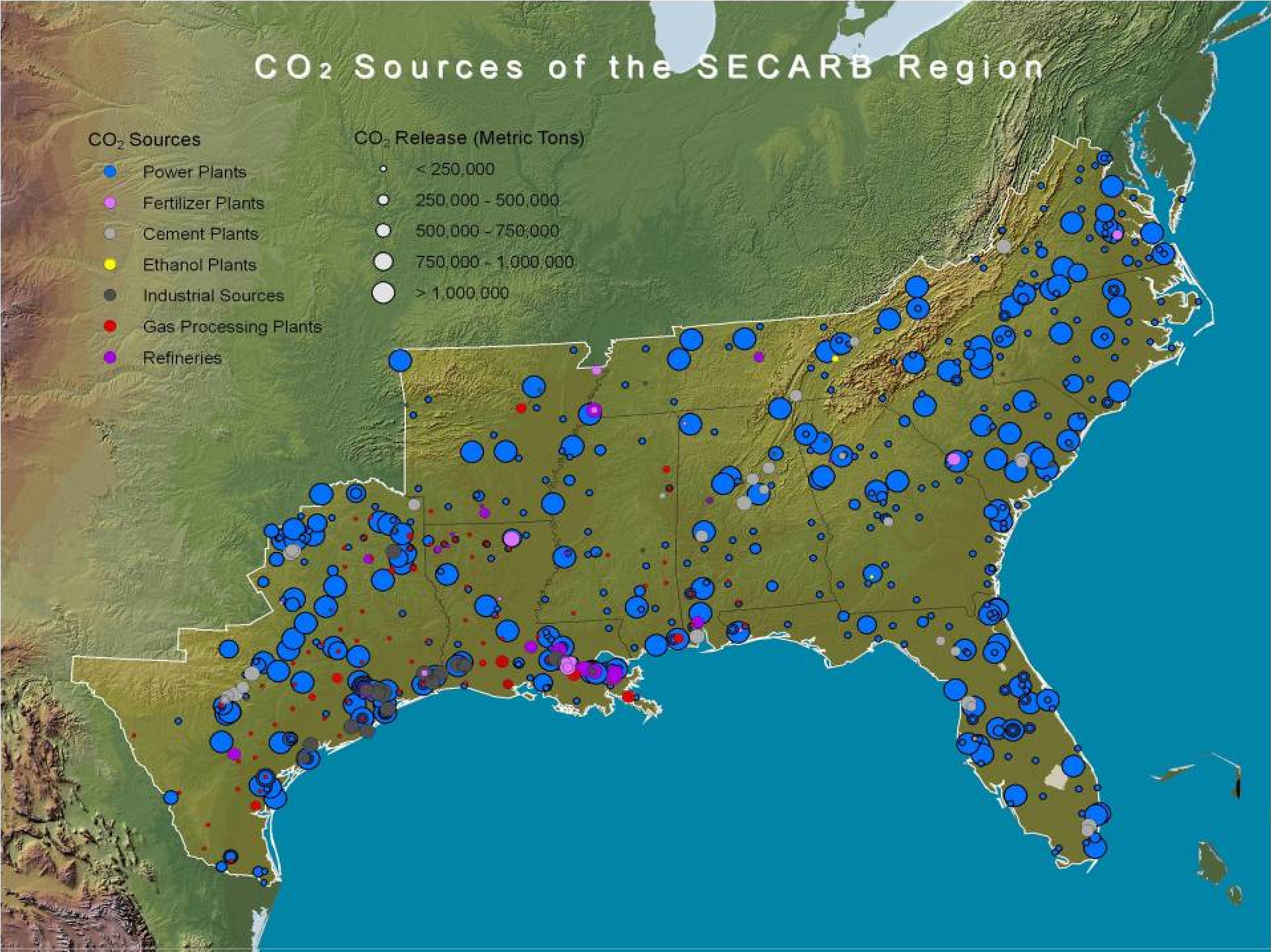
- **Phase III: Demonstration**
  - Characterize the potential carbon sequestration sinks in the Southeast;
  - Conduct field verification studies in the most promising geologic formations in the region;
  - Advance the state of the art in monitoring, measurement and verification techniques and instrumentation; and
  - Develop sequestration technologies and characterize geologic sinks for future readiness.



SECARB

NETL

SSEB


CO2 Sources of the SECARB Region
CO2 Sources
Power Plants
Fertilizer Plants
Cement Plants
Ethanol Plants
Industrial Sources
Gas Processing Plants
Refineries
CO2 Release (Metric Tons)
< 250,000
250,000 - 500,000
500,000 - 750,000
750,000 - 1,000,000
> 1,000,000

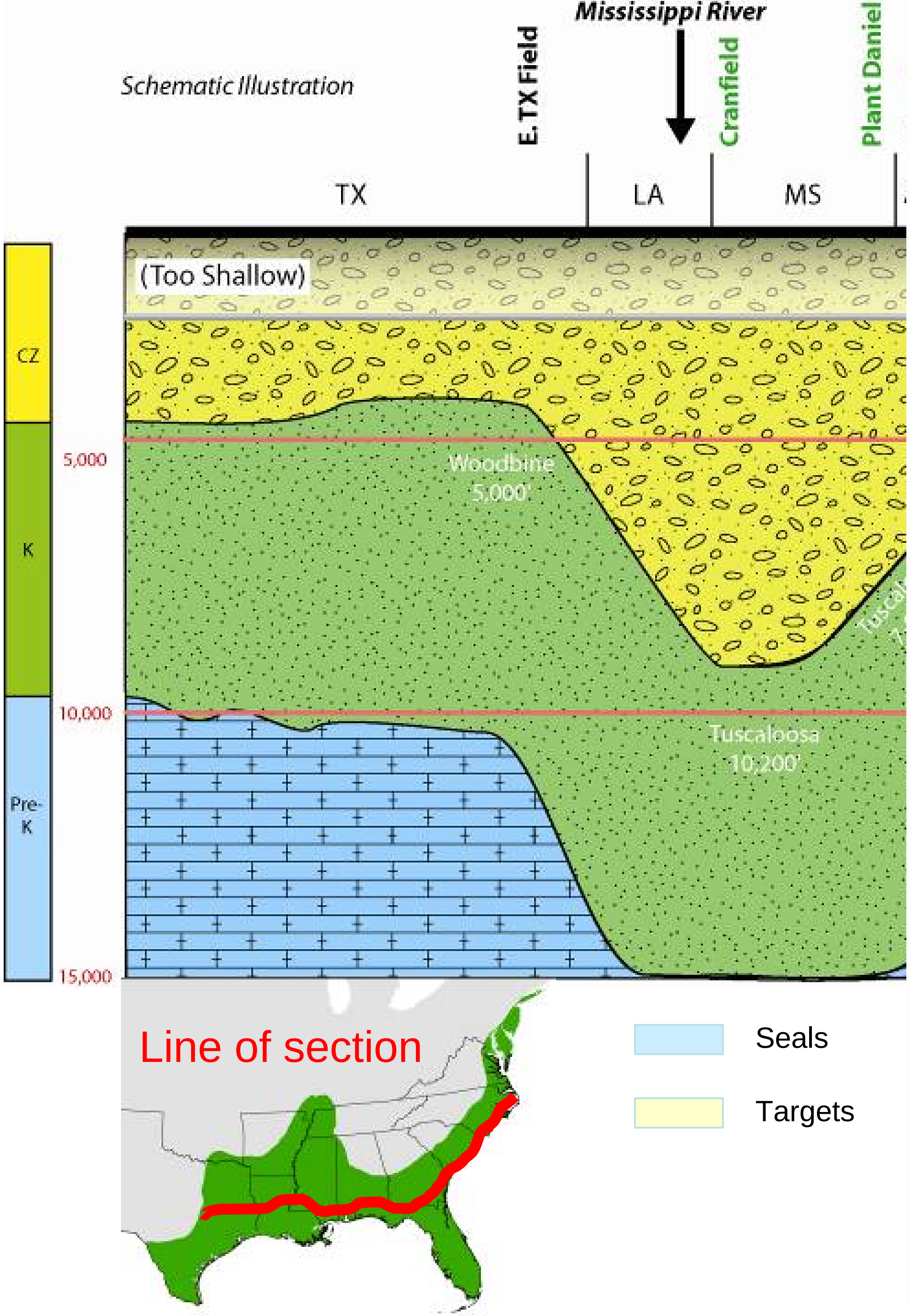
SECARB Regional and National Involvement

Regional Involvement: 100+ Participants

- Member States (Executive, Legislative and Regulatory)
- Industry and Electric Utilities
- Universities and National Laboratories
- NGOs and Trade Associations

National Involvement in RCSP Working Groups

- Storage
- MMV
- Outreach and Education
- Regulatory
- Modeling



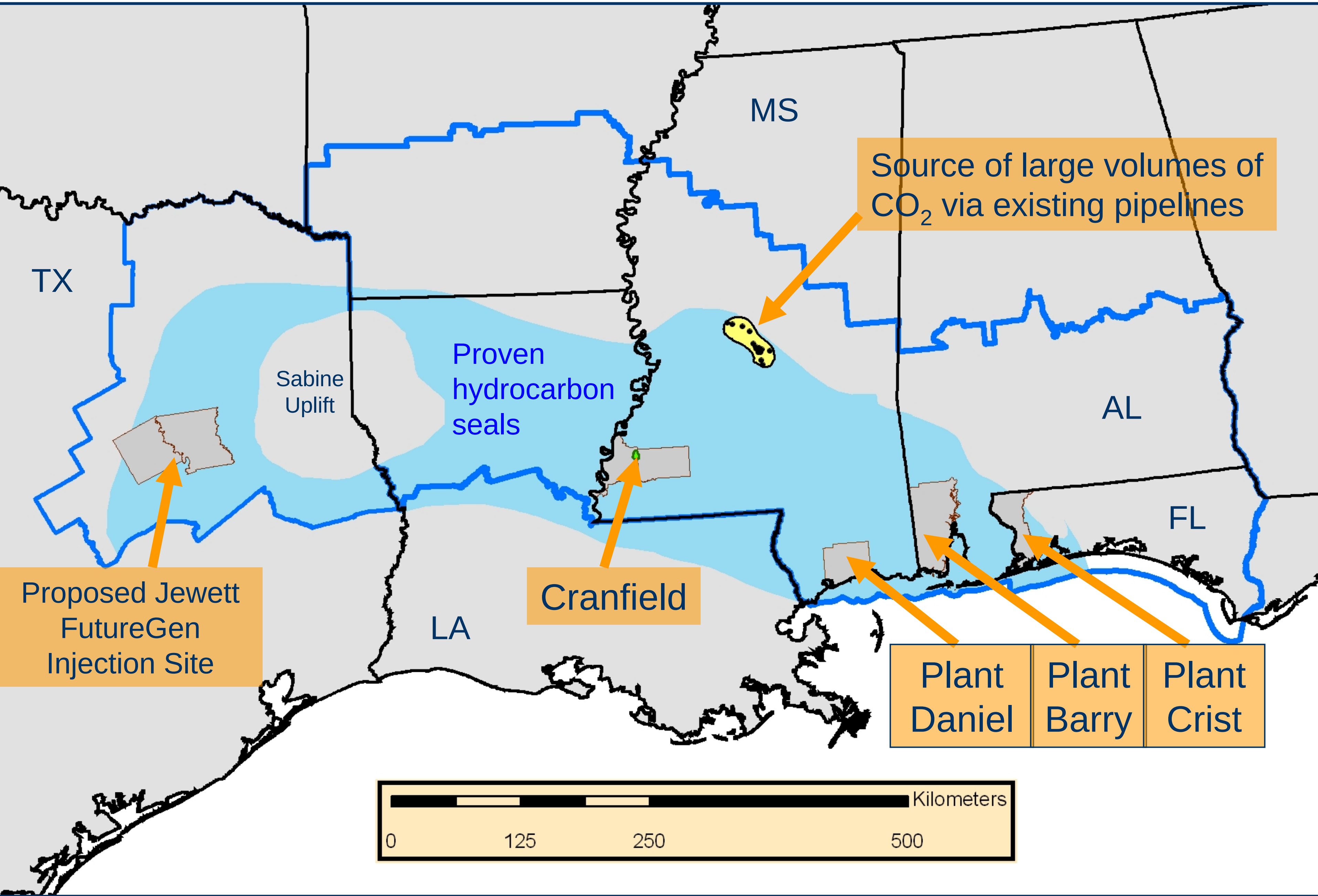
SYSTEM	SERIES	EAST TEXAS	S. ARKANSAS, N. LOUISIANA	S. MISSISSIPPI	SW ALABAMA, FLORIDA
		STRATIGRAPHIC UNIT			
TERTIARY	Miocene				
	Oligo.	Frio	Frio	Frio	Tampa
			Vicksburg	Vicksburg	
	Eocene		Jackson	Jackson	Jackson
		Yegua	Claiborne Group	Claiborne Group	Claiborne Group
		Cook Mountain			
		Sparta			
		Queen City			
		Reklaw			
		Carrizo			
	Paleo-cene	Wilcox Group	Wilcox Group	Wilcox Group	Wilcox Group
		Midway	Midway / Monroe Gas Rock	Midway / Selma Gas Rock	Midway
CRETACEOUS	Upper	Navarro	Nacatoch / Gas Rock	Selma	Selma
		Taylor	Ozan/Annona		
		Austin	Austin/Tokio	Eutaw	Eutaw
		Eagleford	Eagleford	Eagleford	Tuscaloosa Group
		Woodbine Group	Tuscaloosa Group	Tuscaloosa Group	
	Lower	Buda Limestone	Washita / Fredericksburg	Washita / Fredericksburg	
		Georgetown			
		Fredericksburg			
		Paluxy	Paluxy	Paluxy	Paluxy
		Glen Rose subgroup	Glen Rose subgroup	Glen Rose subgroup	Glen Rose subgroup
		James Limestone	James Limestone	James Ls.	
		Pettet	Sligo	Sligo	Sligo
		Travis Peak	Hosston	Hosston	Hosston
JURASSIC	Upper	Cotton Valley Gp.	Cotton Valley Gp.	Cotton Valley Gp.	Cotton Valley Gp.
		Gilmer Ls.	Gilmer Ls.		
		Haynesville	Haynesville	Haynesville	Haynesville
		Buckner	Buckner	Buckner	Buckner
		Smackover	Smackover	Smackover	Smackover
		Norphlet	Norphlet	Norphlet	Norphlet
	Middle	Louann Salt	Louann Salt	Louann Salt	Louann Salt
		Werner	Werner	Werner	Werner
TRIASSIC		Eagle Mills	Eagle Mills	Eagle Mills	Eagle Mills

Power Generation Capacity and CO_2 Emissions by Fuel and State (2004)

State	Gas			Oil			Coal		
	Number	Capacity (MW)	CO_2 Emissions (Mt)	Number	Capacity (MW)	CO_2 Emissions (Mt)	Number	Capacity (MW)	CO_2 Emissions (Mt)
AL	23	8,976	5.6	2	28	0.0	12	11,690	65.5
AR	15	6,132	4.1	3	202	0.0	4	4,115	28.8
FL	57	22332	32.9	26	17,827	32.8	16	13,893	71.3
GA	23	13,010	3.5	16	1,172	0.1	20	16,318	84.4
LA	47	19,377	21.4	1	8	0.0	6	5,386	31.2
MS	23	7,629	3.3	5	2,510	2.8	6	4,211	22.2
NC	6	4,960	1.3	17	2,040	0.1	29	14,806	75.3
SC	12	5,872	2.1	12	495	0.0	17	7081	34.0
TN	5	1,122	0.1	2	1,041	0.1	14	12,873	61.6
TX*	125	62,938	91.0	3	355	0.0	16	19,452	146.6
VA	14	7,849	3.9	18	1,458	0.2	23	7780	40.5
Total	**350**	**160,197**	**169**	**105**	**27,135**	**36**	**163**	**117,604**	**661**

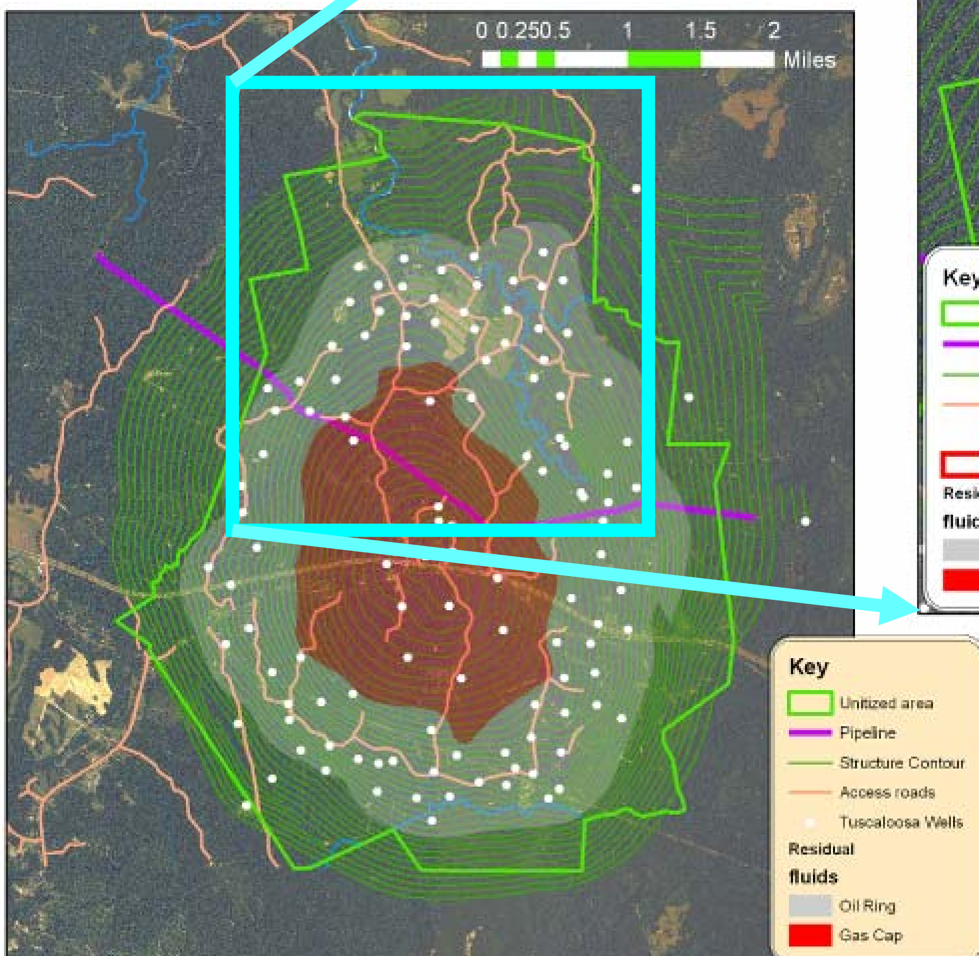
* eastern Texas

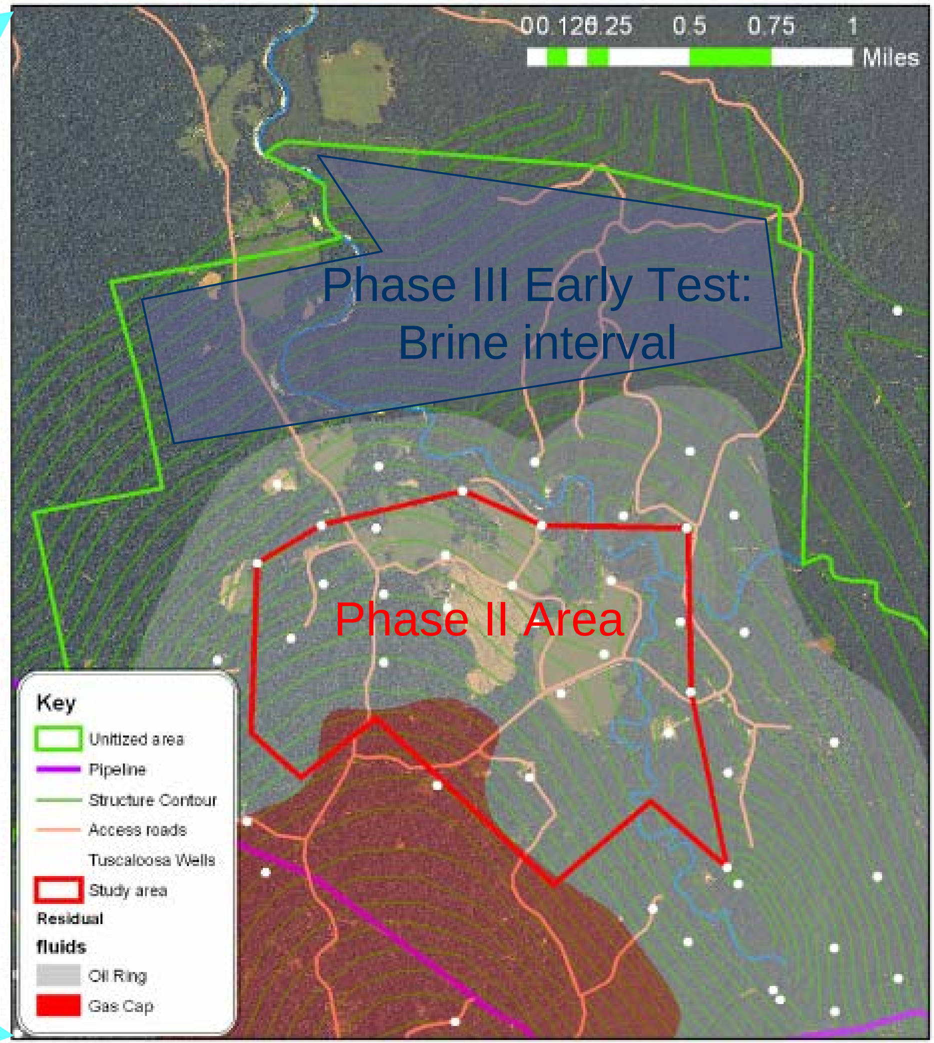
Geographic Focus of SECARB Phase III Program



Site Selection for SECARB Phase III Early Test

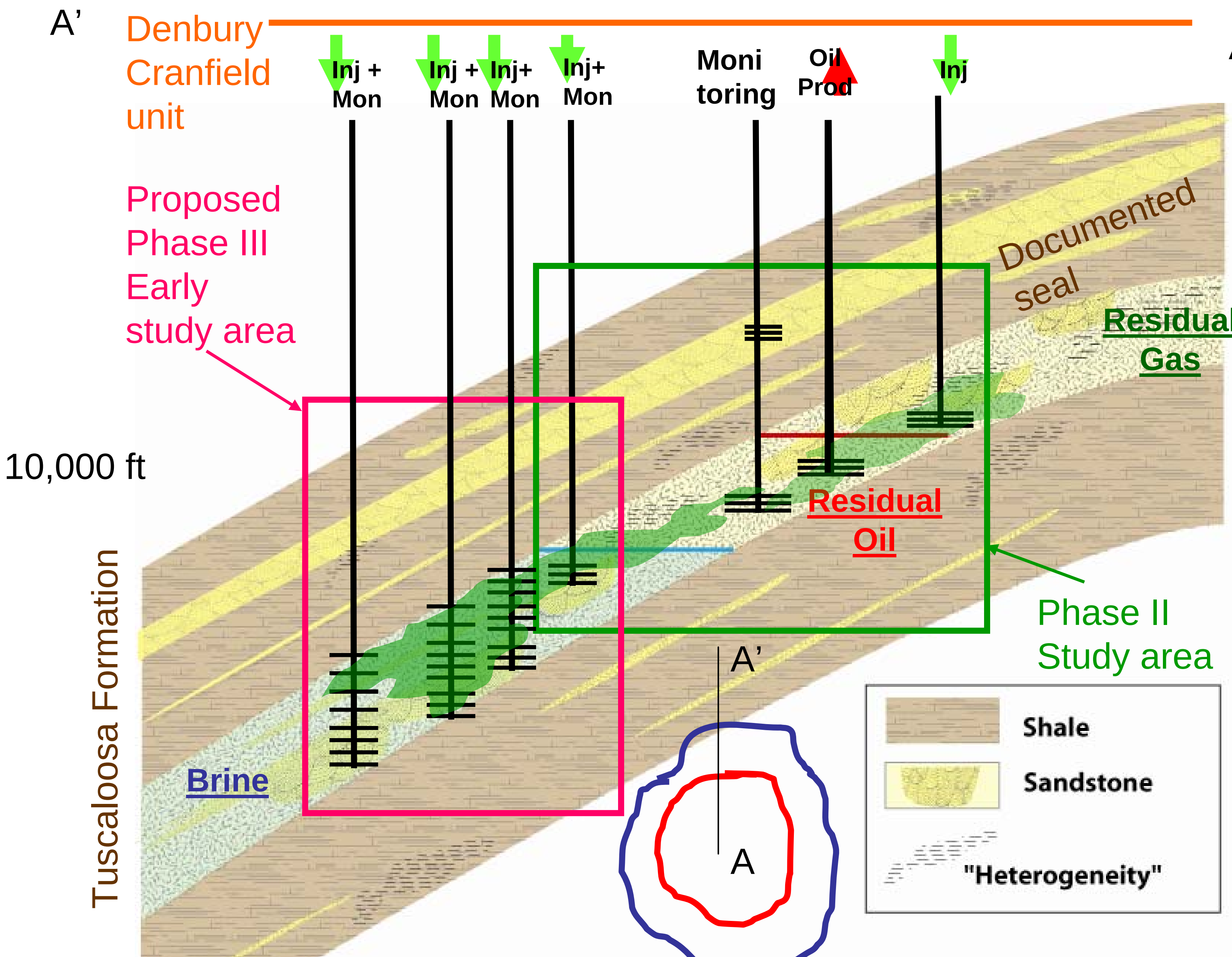
- Large volumes of low-cost CO_2 available 2008
  - Denbury Sonat pipeline
- Well-known geologic environment in saline aquifer
  - injectivity and seal are demonstrated
  - 3-D seismic available
- Mineral and surface rights available in short time
  - Minerals rights owned by Denbury
  - Surface ownership well known and owners likely to welcome monitoring for standard use fee
- Permitting streamlined
  - EQ similar to Phase II EQ





The area selected for the Phase III Early Test is immediately north of the SECARB Phase II "Stacked Storage" study underway, within unitized field.

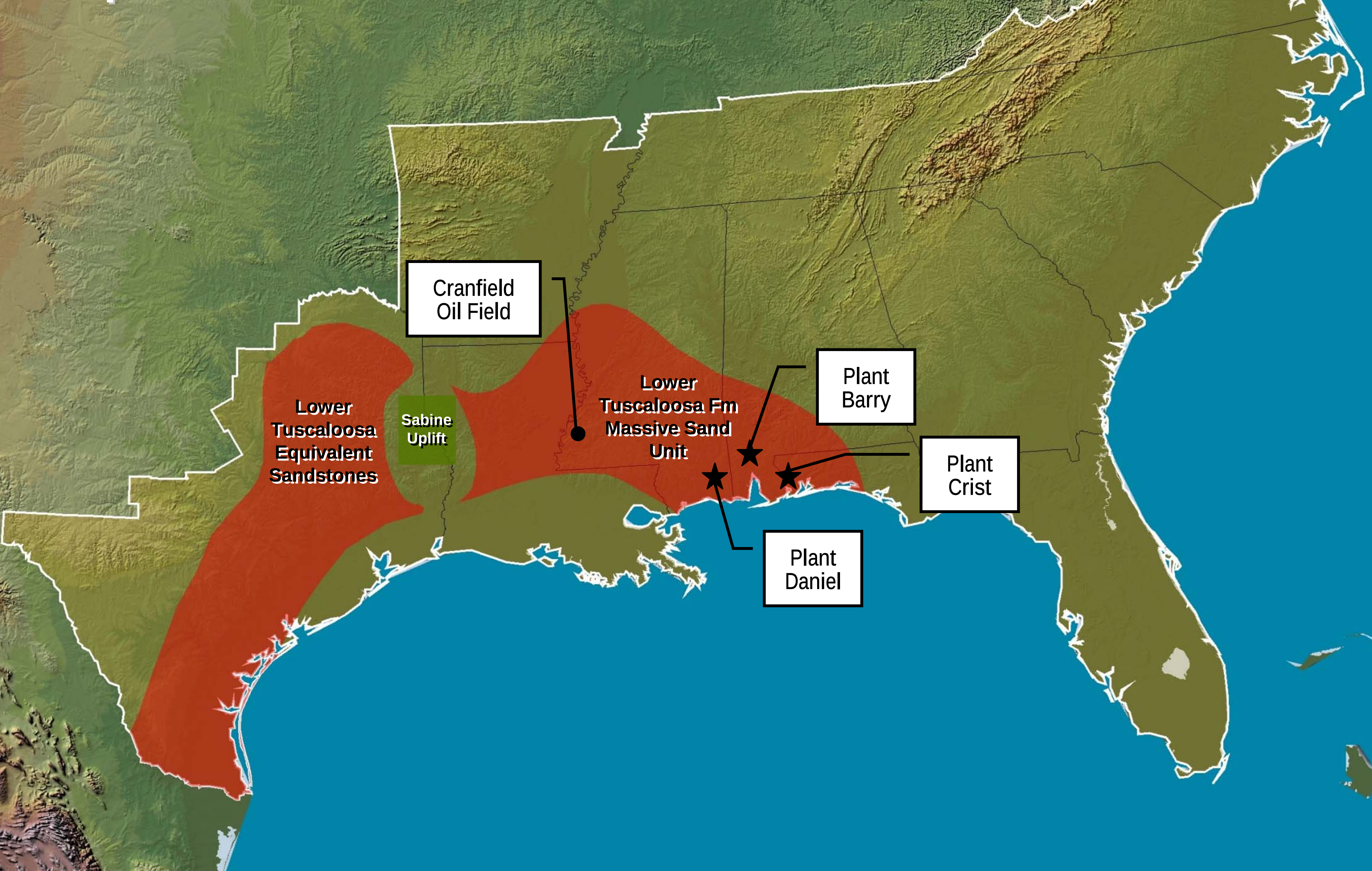
Cranfield Program Overview



SECARB Phase III Anthropogenic Test

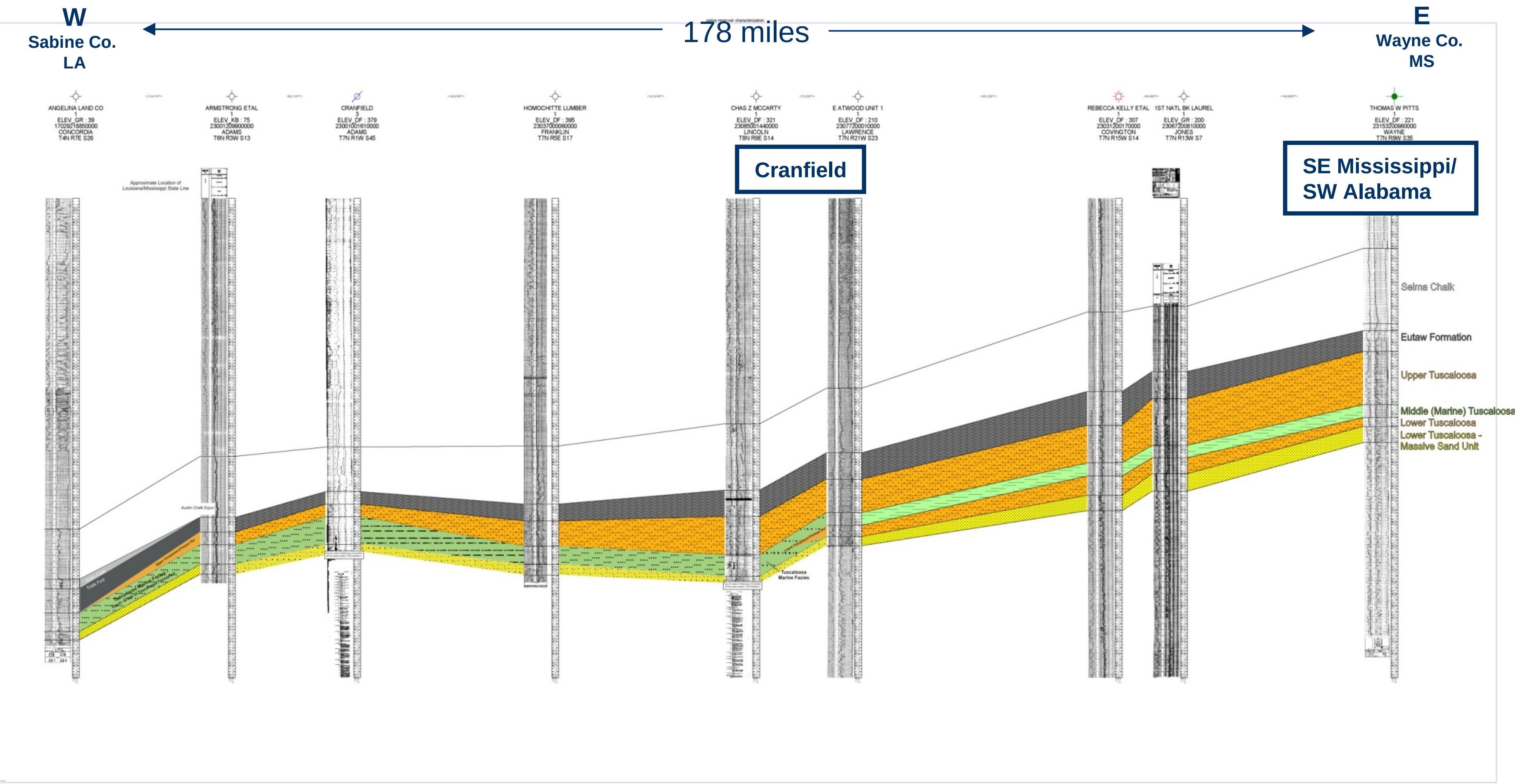
- **Unique opportunity to demonstrate storage and MMV at a coal coal-fired power plant**
  - Seek to transfer lessons learned from Cranfield test and apply lessons learned at a power plant site
  - Will help determine appropriate MMV techniques and protocols as they apply to a power plant site (what works/what doesn't)
  - Defines business and legal issues that make a power plant site unique, i.e., demonstration in light of electrical reliability and cost of commercialization
- **Appropriately planned and implemented MMV is the pathway to public acceptance. This is a high priority for SECARB at a coal-fired power plant as it will:**
  - Assure operator & public safety (often the same)
  - Support regulatory and institutional framework and public outreach
  - Support long-term management, liability, and compliance considerations
  - Help address siting criteria for future CCS coal-fired power plants
  - Support utility owner's engineer understanding

The Lower Tuscaloosa Massive Sand Unit and Equivalent Sandstones



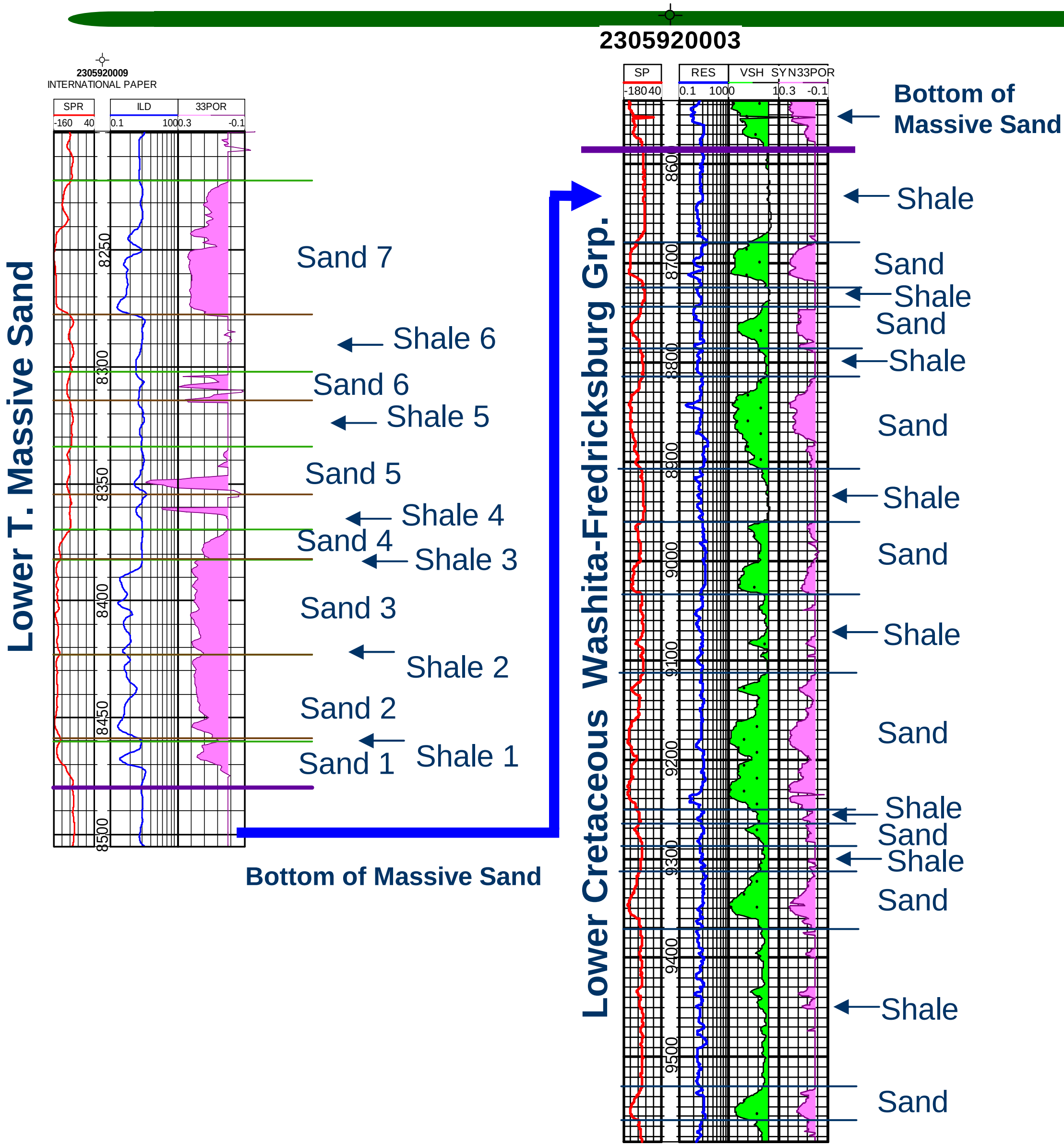
Regional Cross Section D-D'

W-E Structural Cross-Section from Sabine Co., LA, to Wayne Col, MS



Identifying Flow Units and Shale Baffles

Tuscaloosa (Massive Sand Unit) and Lower Cretaceous Sands



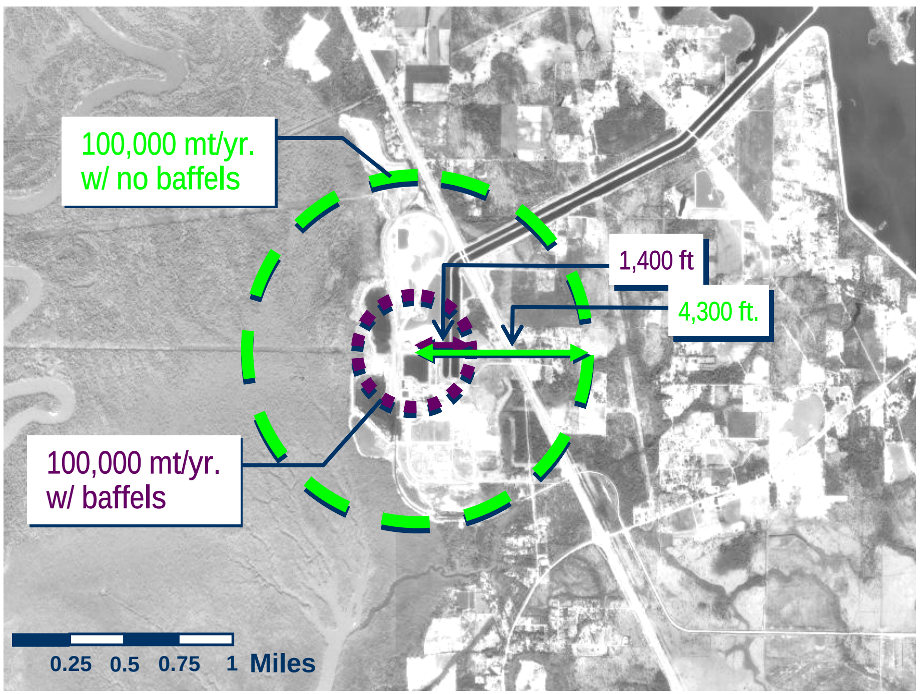
We plan on using logs and core to define the internal architecture of the CO_2 storage formations at the field test sites:

- Type log for the Lower Tuscaloosa Massive Sand Unit and Lower Cretaceous Dantzler Fm. in S. Mississippi.
- Characterization of the type log shows multiple flow units and shale breaks over a 1,300 ft interval.

Optimizing and Concentrating CO_2 Storage

Extent of the CO_2 Plume

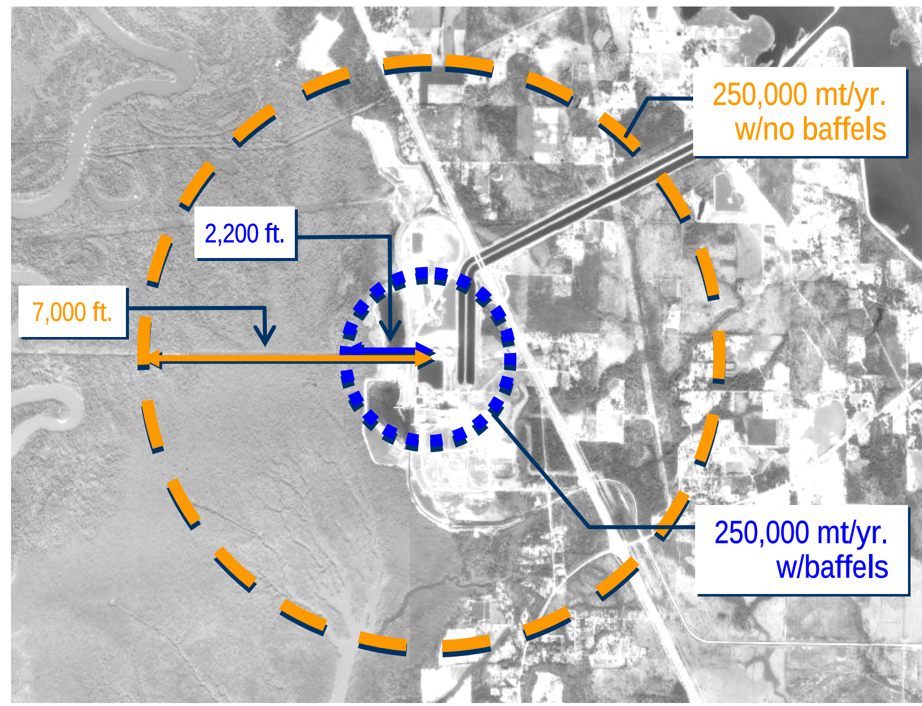
(4 years of CO_2 injection @ 100,000 mt/yr; 10 years of time)



Extensive use of reservoir architecture increases CO_2 storage by nearly 10 fold.

Extent of the CO_2 Plume

(4 years of CO_2 injection @ 250,000 mt/yr; 10 years of time)



Extensive use of reservoir architecture reduces the areal extent of the CO_2 plume by 90%.

SECARB Phase III MMV Goals


Brian Strazisar – NETL (Isotopes)

- Demonstrate that geologic storage of CO_2 is environmentally safe with public acceptance of science-based monitoring protocols
- Demonstrate protocols capable of surveying large areas and identifying seepage over project life cycle
- Understand the relationship between site characterization, storage mechanisms, and leakage
- Validate and calibrate model predictions and monitoring tools for fate and transport
- Transfer knowledge and technologies:
  - lessons learned from Phase II to Phase III
  - unique opportunity to deploy MMV at a coal-fired power plant


Glen Thompson – Praxair Tracer Research Division (PFTs)


Adam Dayan – University of Alabama (Soil Flux)