

# Southeast Regional Carbon Sequestration Partnership

The logo for SECARB features the word "SECARB" in a bold, green, sans-serif font. A thick black curved line arches over the letters, starting above the 'S' and ending above the 'B'.

## **Presented to:**

Carbon Storage Program Infrastructure  
Annual Review Meeting  
November 15, 2011

## **Presented by:**

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Southern States Energy Board

# Acknowledgements

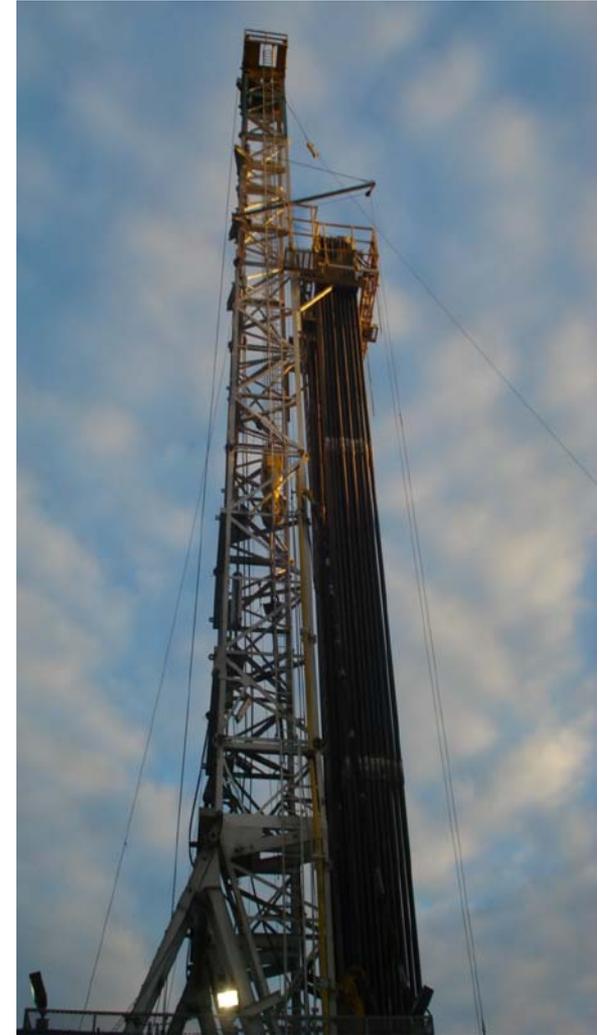
- This material is based upon work supported by the U.S. Department of Energy National Energy Technology Laboratory.
- Cost share and research support provided by SECARB/SSEB Carbon Management Partners.
- CO<sub>2</sub> Capture Unit funded separately by Southern Company and partners.



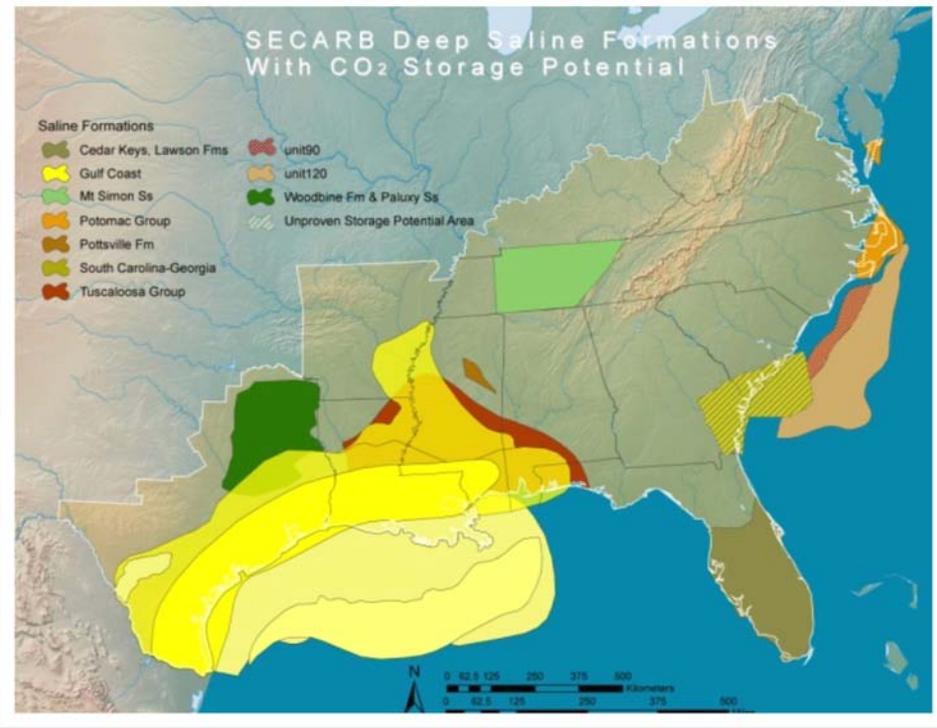
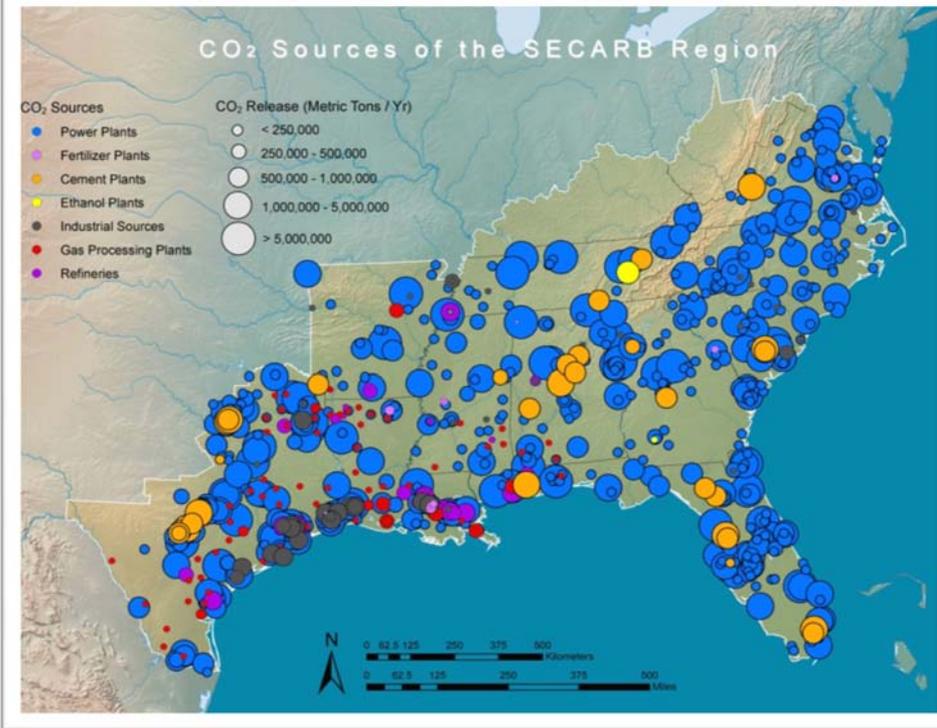
# Presentation Outline

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- Overview
- Characterization Studies
- Early Test – Cranfield, MS
- Anthropogenic Test – Citronelle, AL
  - Capture Unit Status
  - Pipeline Status
  - Injection Well Status



# SECARB Characterization: CO<sub>2</sub> Sources & Saline Reservoirs



# Continued Characterization (SECARB)

## Topical Reports Completed

- Capacity Report for Conasauga Shale (2010)
- CO<sub>2</sub> Capacity Assessment for Delineated Federal Waters (2010)
- CO<sub>2</sub> Capacity Assessment for Delineated State Waters (2010)
- Final Report on Lower & Upper Cretaceous Characterization (2011)
- Capacity Report on Mt. Simon (2011)
- Reconnaissance Assessment of the CO<sub>2</sub> Sequestration Potential in the Triassic Age Rift Basin Trend of South Carolina, Georgia, and Northern Florida (SRNL via FWP, 2011)



## Atlas IV

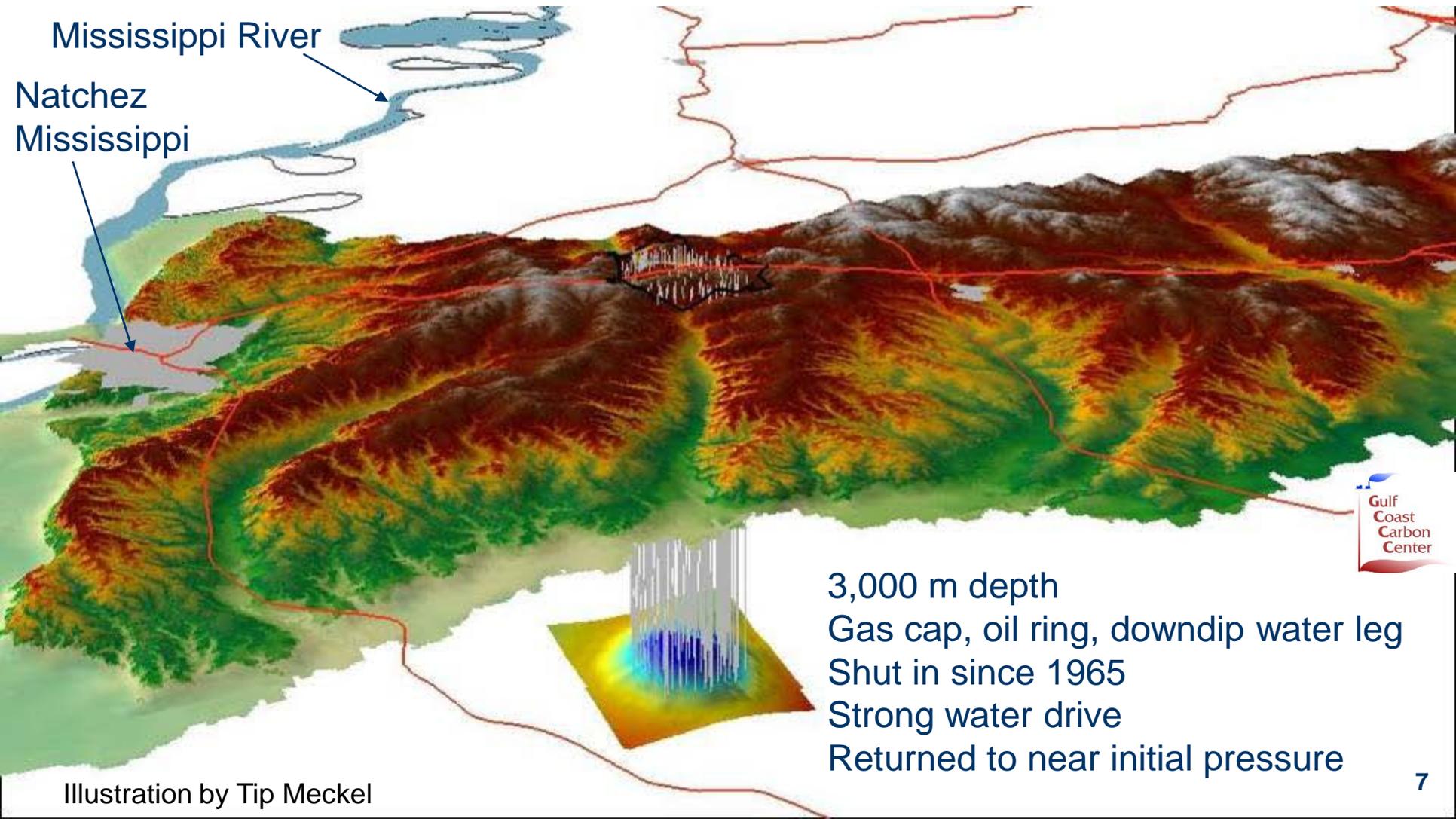
- Participating in GIS/NATCARB Working Group Conference Calls; Data Updates (Sources & Sinks)

# Continued Characterization (Industry Funded)

- Evaluation of Large-scale Geologic Carbon Sequestration Potential in the Virginia Piedmont and Coastal Plain
  - Status: Under review by funding partner
  - Virginia Center for Coal and Energy Research at Virginia Tech
  - Virginia Department of Mines, Minerals and Energy
- Continued Evaluation of Potential for Geologic Storage of CO<sub>2</sub> in the Southeastern United States
  - Status: Under final review by authors
  - Texas Bureau of Economic Geology
  - Southern States Energy Board



# SECARB Early Test Monitoring Large Volume Injection at Cranfield



# Early Test Monitoring at Cranfield: Detailed Area of Study



Injector

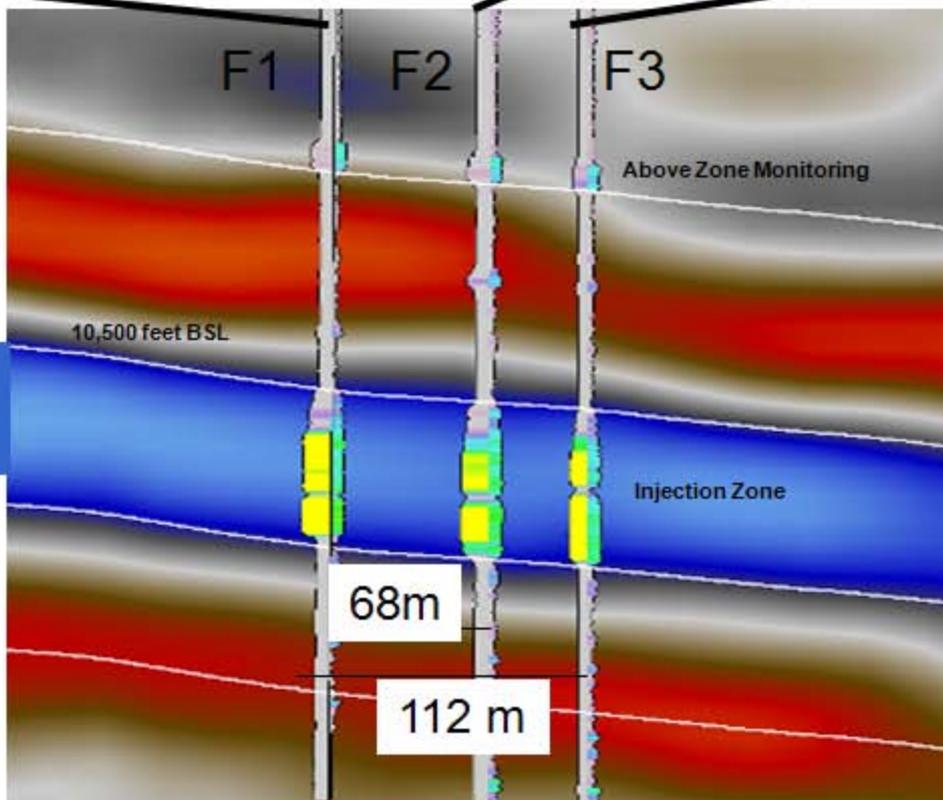
Obs

Obs

Closely spaced well array to examine flow in complex reservoir

Confining system

Lower Tuscaloosa injection zone



F1

F2

F3

Above Zone Monitoring

10,500 feet BSL

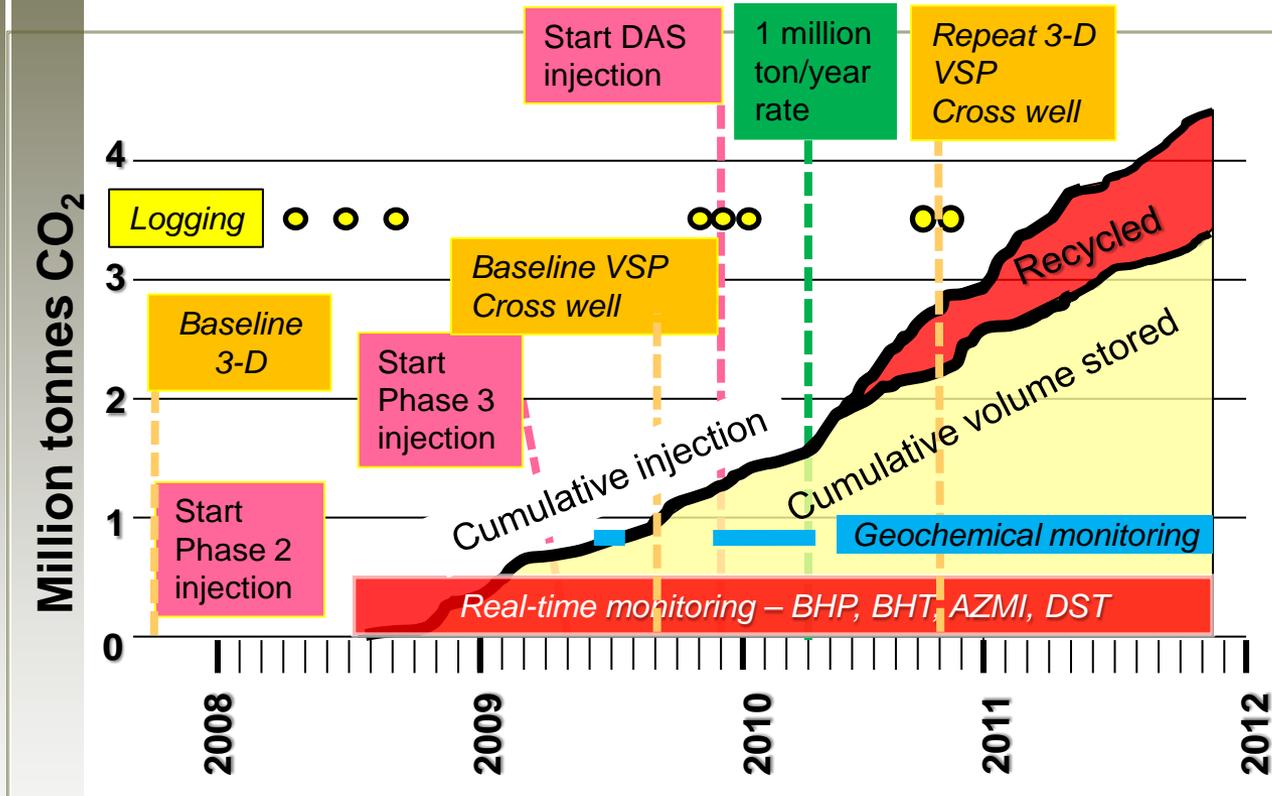
Injection Zone

68m

112 m

# Status: Monitoring 3 million tonnes of CO<sub>2</sub> injected at SECARB Cranfield Project

Michael H. Young, Sue D. Hovorka, Changbing Yang and SECARB Team  
Bureau of Economic Geology, UT-Austin



Take home messages:

- 3Mt of CO<sub>2</sub> stored at Cranfield to date
- Substantial progress on implementing new monitoring technologies
- Bright future for CO<sub>2</sub> storage and monitoring technologies/strategies that reduce risk
- Great collaborators show power of partnerships

2012: Fine-Tune MVA Approach & Mine Data Sets for CCUS Insight



# CARBON CAPTURE AND STORAGE (CCS)



MOBILE RIVER

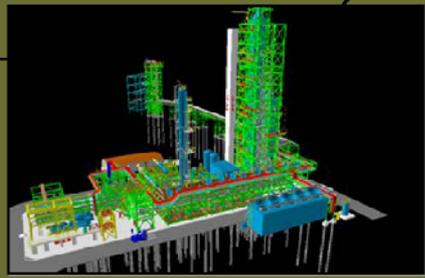
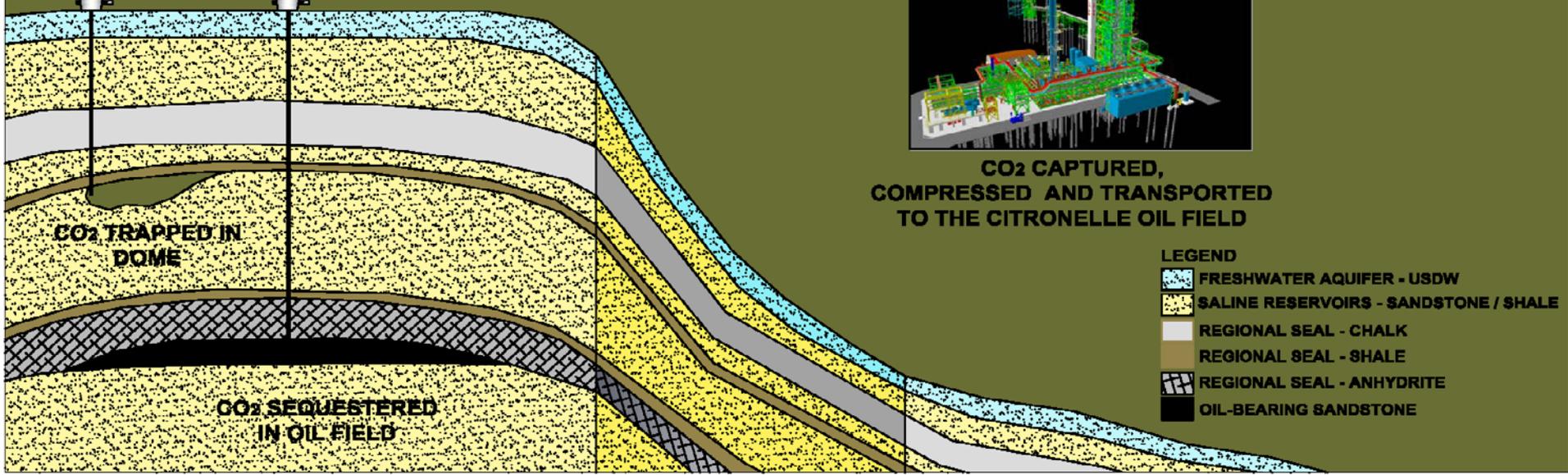


CO<sub>2</sub> INJECTED AND SEQUESTERED IN THE CITRONELLE DOME



SALINE STORAGE INJECTION WELL

ENHANCED OIL RECOVERY (EOR)



CO<sub>2</sub> CAPTURED, COMPRESSED AND TRANSPORTED TO THE CITRONELLE OIL FIELD

- LEGEND**
- FRESHWATER AQUIFER - USDW
  - SALINE RESERVOIRS - SANDSTONE / SHALE
  - REGIONAL SEAL - CHALK
  - REGIONAL SEAL - SHALE
  - REGIONAL SEAL - ANHYDRITE
  - OIL-BEARING SANDSTONE

# Anthropogenic Test: Plant Barry & Citronelle Field

## Characterization Well D9-8 #2 at Citronelle Field Drilled (Dec. 2010/Jan. 2011)



- Convert to Obs/Monitoring Well
- 11,800' Total Depth
- Whole core (98 feet in two intervals)
- 45 sidewall cores
- Full set of logs (Triple Combo, MRI, Mineralogy, Dipole Sonic, CBL, etc.)

System	Series	Stratigraphic Unit	Major Sub Units	Potential Reservoirs and Confining Zones	
Tertiary	Pliocene		Citronelle Formation	Freshwater Aquifer	
	Miocene	Undifferentiated		Freshwater Aquifer	
	Oligocene		Chicasawhay Fm. Bucatanna Clay	Base of USDW	
		Vicksburg Group		Local Confining Unit	
	Eocene	Jackson Group		Minor Saline Reservoir	
		Claiborne Group	Talahatta Fm.	Saline Reservoir	
Wilcox Group		Hatchetigbee Sand Bashi Marl Salt Mountain LS	Saline Reservoir		
Paleocene		Midway Group	Porters Creek Clay	Confining Unit	
		Selma Group		Confining Unit	
Cretaceous	Upper	Eutaw Formation		Minor Saline Reservoir	
				Minor Saline Reservoir	
		Tuscaloosa Group	Upper Tuba		Minor Saline Reservoir
			Mid. Tuba	Marine Shale	Confining Unit
Lower Tuba	Pilot Sand Massive sand	Saline Reservoir			
Cretaceous	Lower	Washita-Fredericksburg	Dantzer sand Basal Shale	Saline Reservoir Primary Confining Unit	
		Paluxy Formation	'Upper' 'Middle' 'Lower'	Proposed Injection Zone	
		Mooringsport Formation		Confining Unit	
		Ferry Lake Anhydrite		Confining Unit	
		Donovan Sand	Rodessa Fm. 'Upper' 'Middle' 'Lower'	Oil Reservoir Minor Saline Reservoir Oil Reservoir	

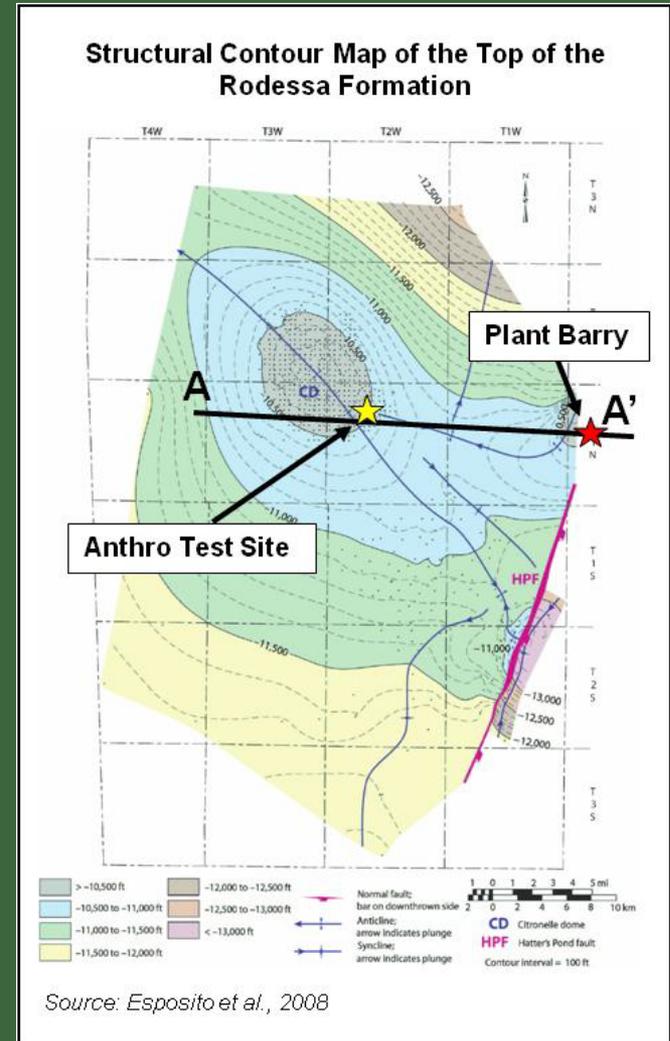
← Confining Zone  
→ Injection Zone

- Target: Lower Cretaceous Paluxy Fm (at 9,400').
- 1,100 foot interval of stacked sandstones and shales.
- Numerous reservoir seals and confining units.
- No evidence of faulting or fracturing, based on reinterpretation of existing 2D seismic lines.

## Citronelle Dome is:

- A subtle open fold
- Limbs dipping less than 1 degree
- Four-way structural closure

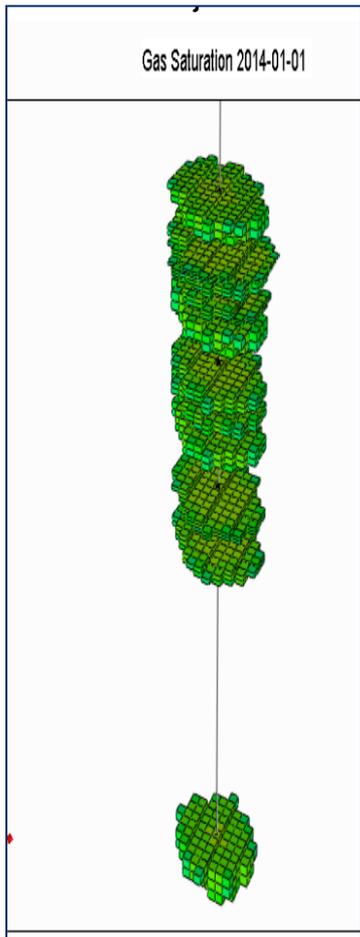
Sources: Pashin et al., 2008; Cottingham, 1988; Esposito and others, 2008



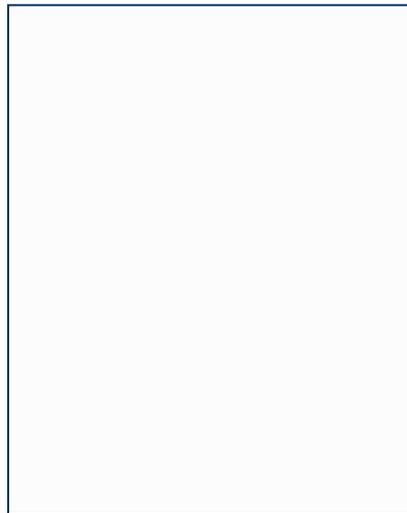
# Citronelle Field: Updating the Geocellular Model

## 3D View of CO<sub>2</sub> Plume End of Injection

Original Model



Updated Model



- Model plume extent was 1,000 ft radius in original model
- New model now shows plume extent nearly 1,700 ft
- Due to higher permeability in upper Paluxy sandstones
- Necessitates updated Area of Review
- MVA plan appears to be adequate
- Next step incorporate permeability variation within each sandstone – how does that affect the plume behavior?

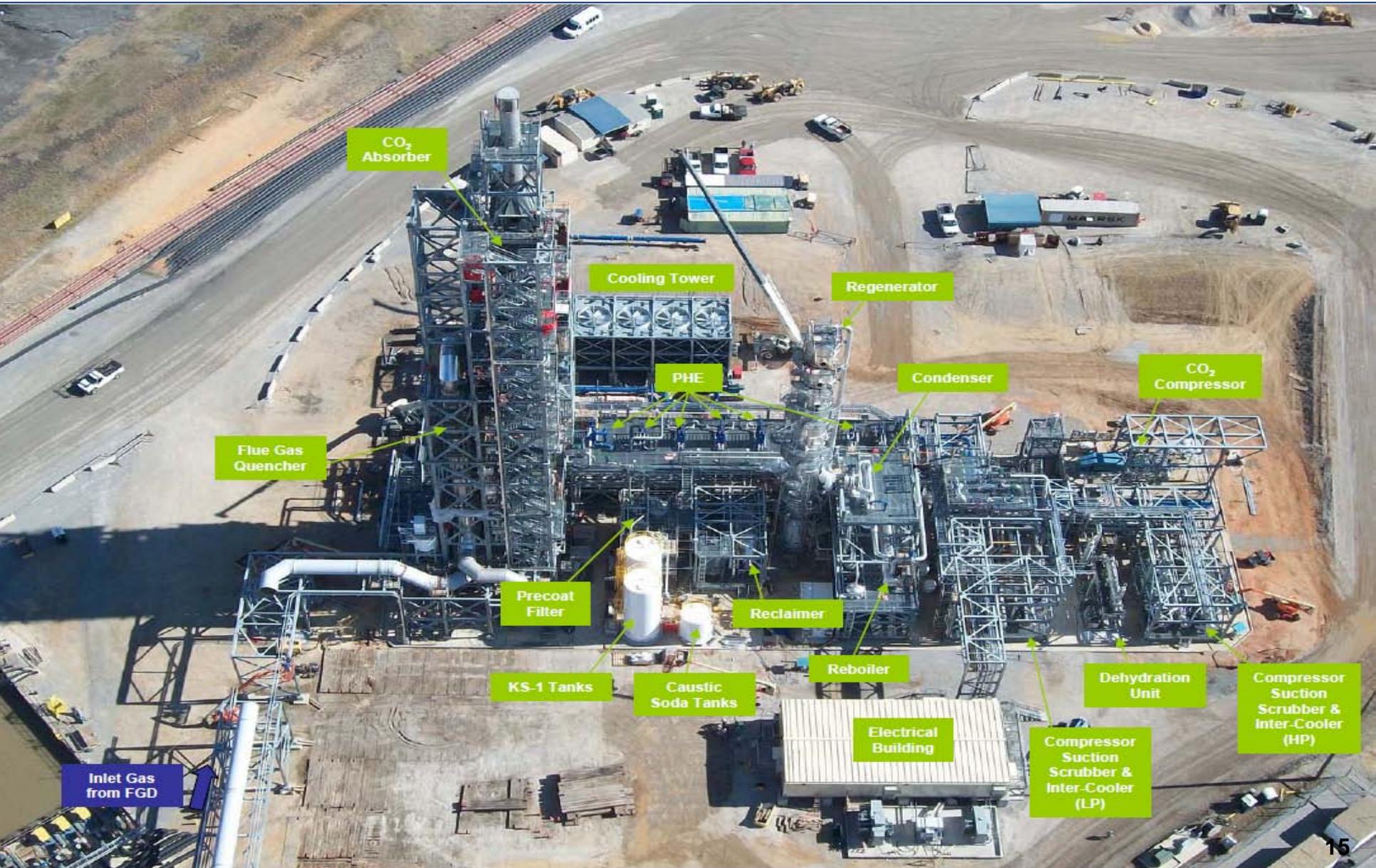
# Anthropogenic Test: Capture Unit Status

Groundbreaking: APRIL 2010

Initial testing: JUNE 2011



# Anthropogenic Test: Plant Barry CO<sub>2</sub> Capture Facility



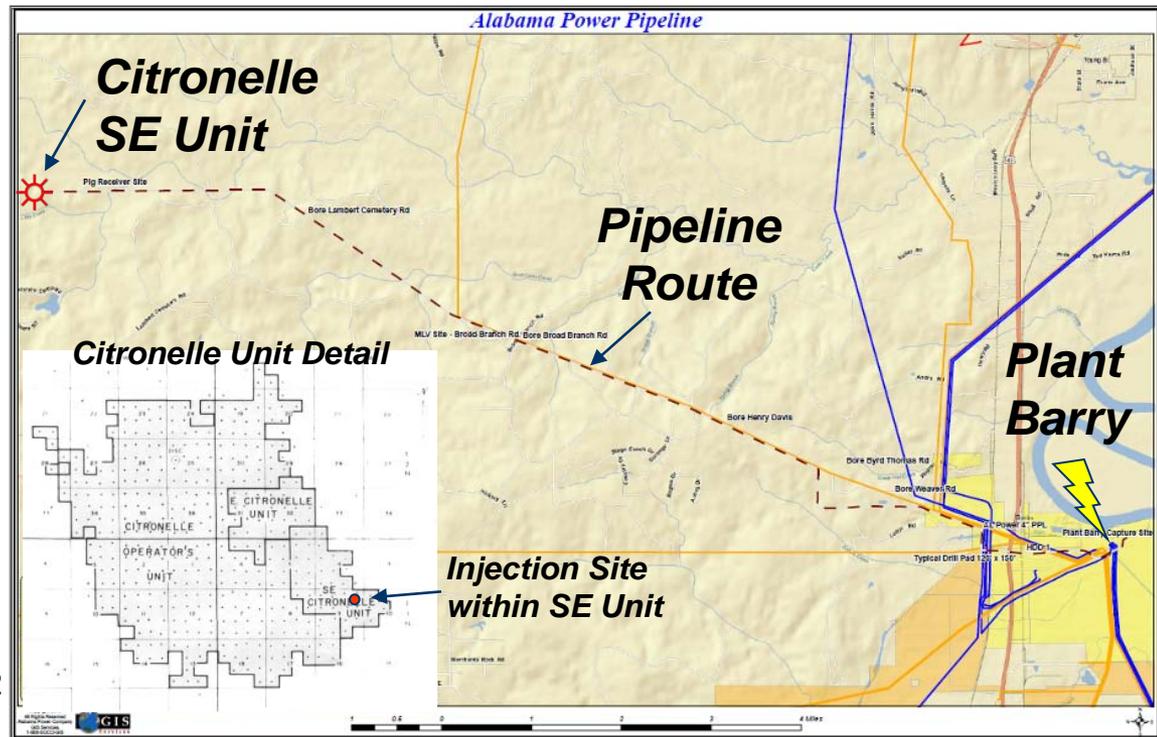
# Anthropogenic Test: Public Outreach

- Groundbreaking Event
- Briefing for Community Leaders
- Briefings at Power Plant
- Briefing for Governor and State Legislators
- Site Visit by State Regulators
- Hosted RECS 2011
- Upcoming Open House Hosted by Mayor of Citronelle at City Hall (Date TBD)



# CO<sub>2</sub> Pipeline Overview

- Approx. 12 mi to the SE operators unit in Citronelle Field
- Right-of-Way
  - Utility corridor for 80%; 9 land owners
- Pipe specifications
  - 4-in pipe dia.
  - X70 carbon steel
  - DOT 29 CFR 195 liquid pipeline; buried 3 feet with surface vegetation and maintenance
  - Purity is >97% dry CO<sub>2</sub> at 115°F, 1,500 psig (< 20 ppm H<sub>2</sub>S)
- Right-of-way habitat (pine forest in the Mobile River watershed; some wetlands)



# Pipeline Construction: Plant Barry to Citronelle Field



# Directional drilling required to avoid disturbing Gopher Tortoise habitat



Images Courtesy Southern Company

# Anthropogenic Test: Injection Well Status

