Southeast Regional Carbon Sequestration Partnership Phase III Update

Regional Carbon Sequestration Partnerships
Annual Review Meeting

Pittsburgh, Pennsylvania
November 18, 2009

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SSEB Technical Coordinator

Acknowledgements

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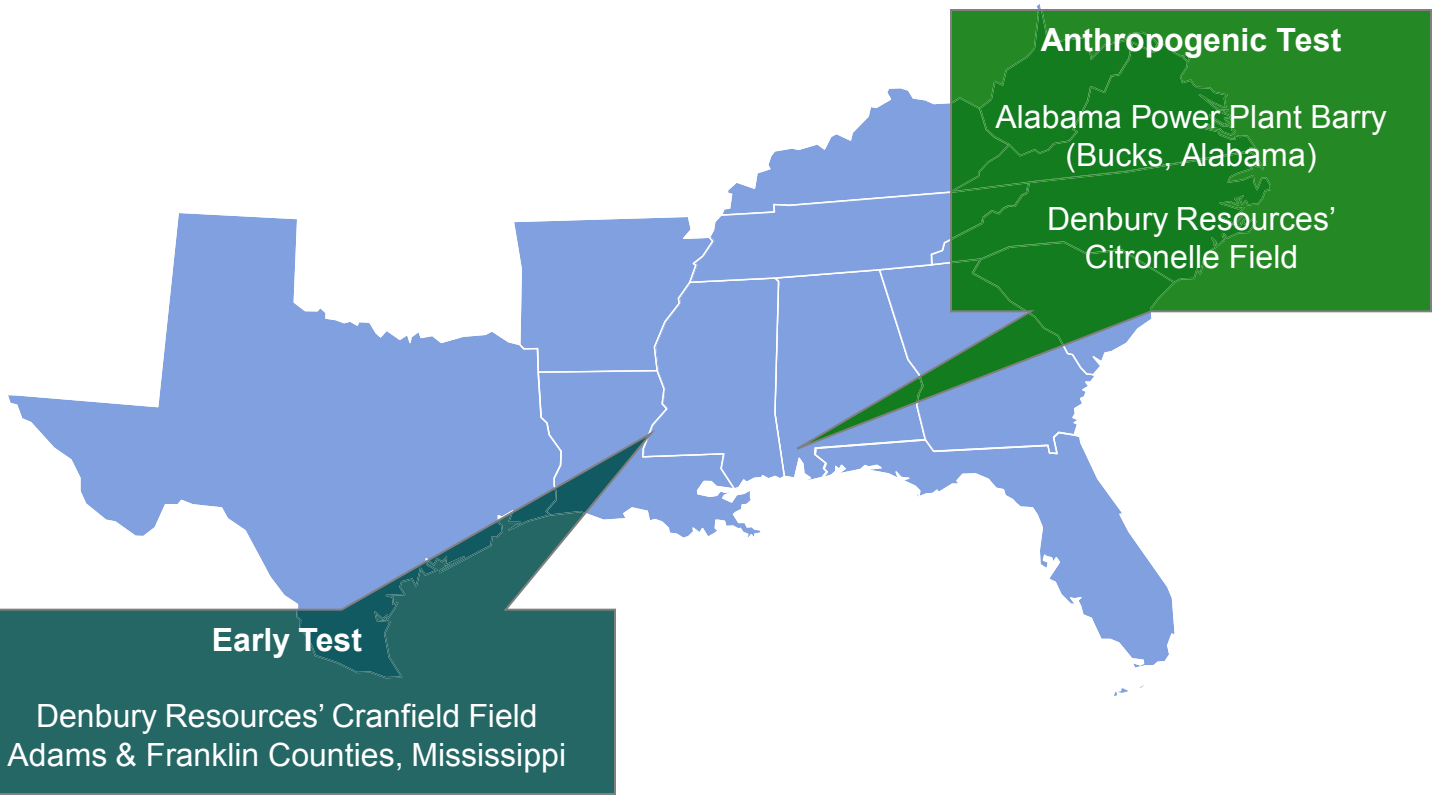
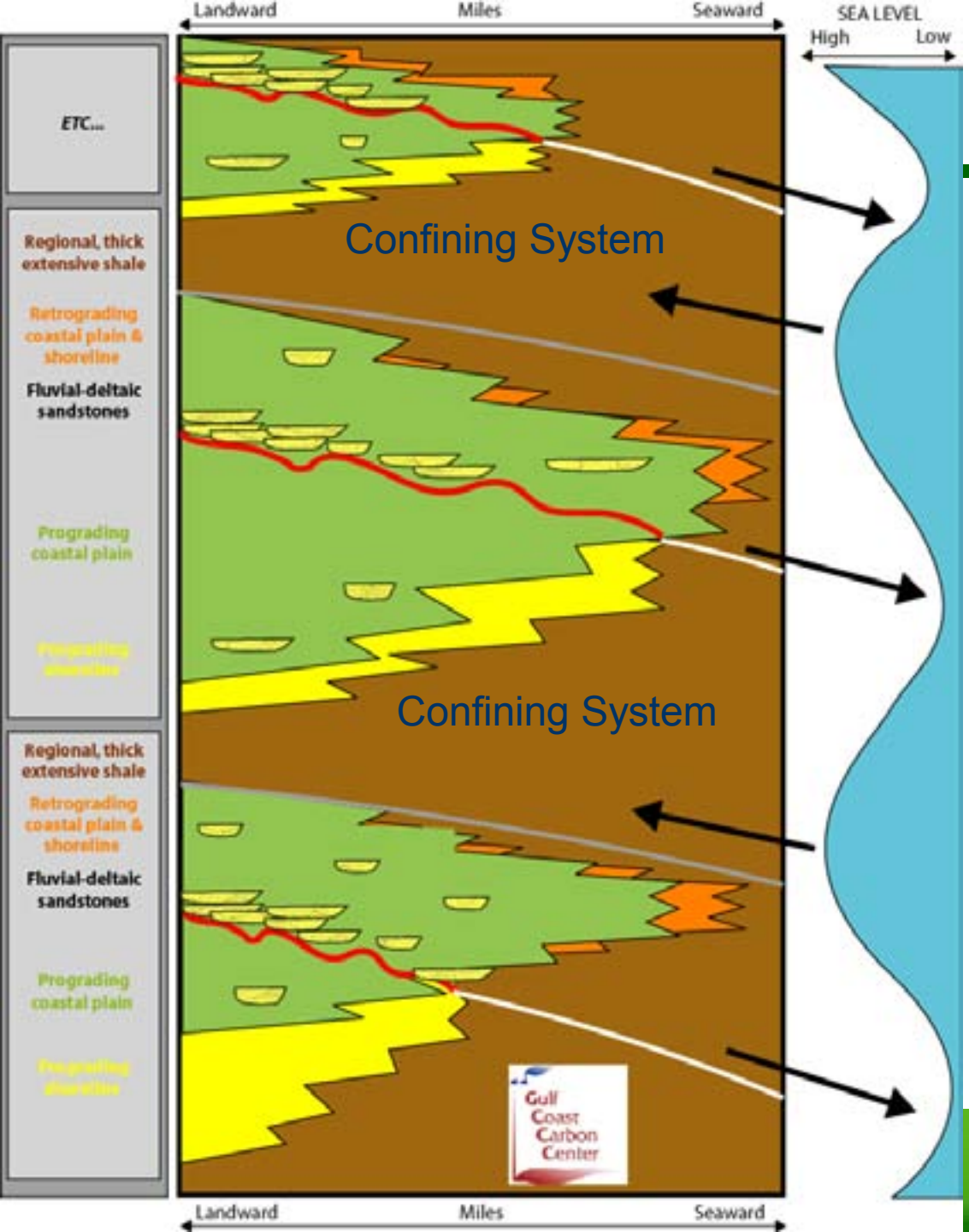
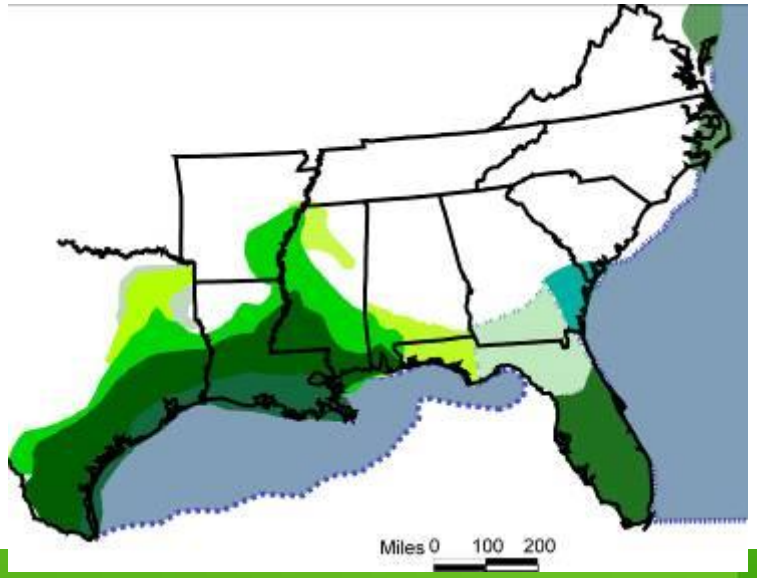
Phase III Geographic Region & Field Test Site Locations





Continued Characterization During 2009 and 2010

Assessments will be conducted in the Gulf of Mexico, South Georgia Basin and along the Carolina coast.



SECARB Phase III Projects - Overview

- **Phase III Early Test:** Large volume saline injection "down-dip" of EOR activity at Cranfield Unit – 1.5 million tonne injection started in April 2009

- **Phase III Anthropogenic Test:** Large volume saline injection with power plant capture & separation source – 125,000 metric tons per year for 4 years – with injection starting FY2011

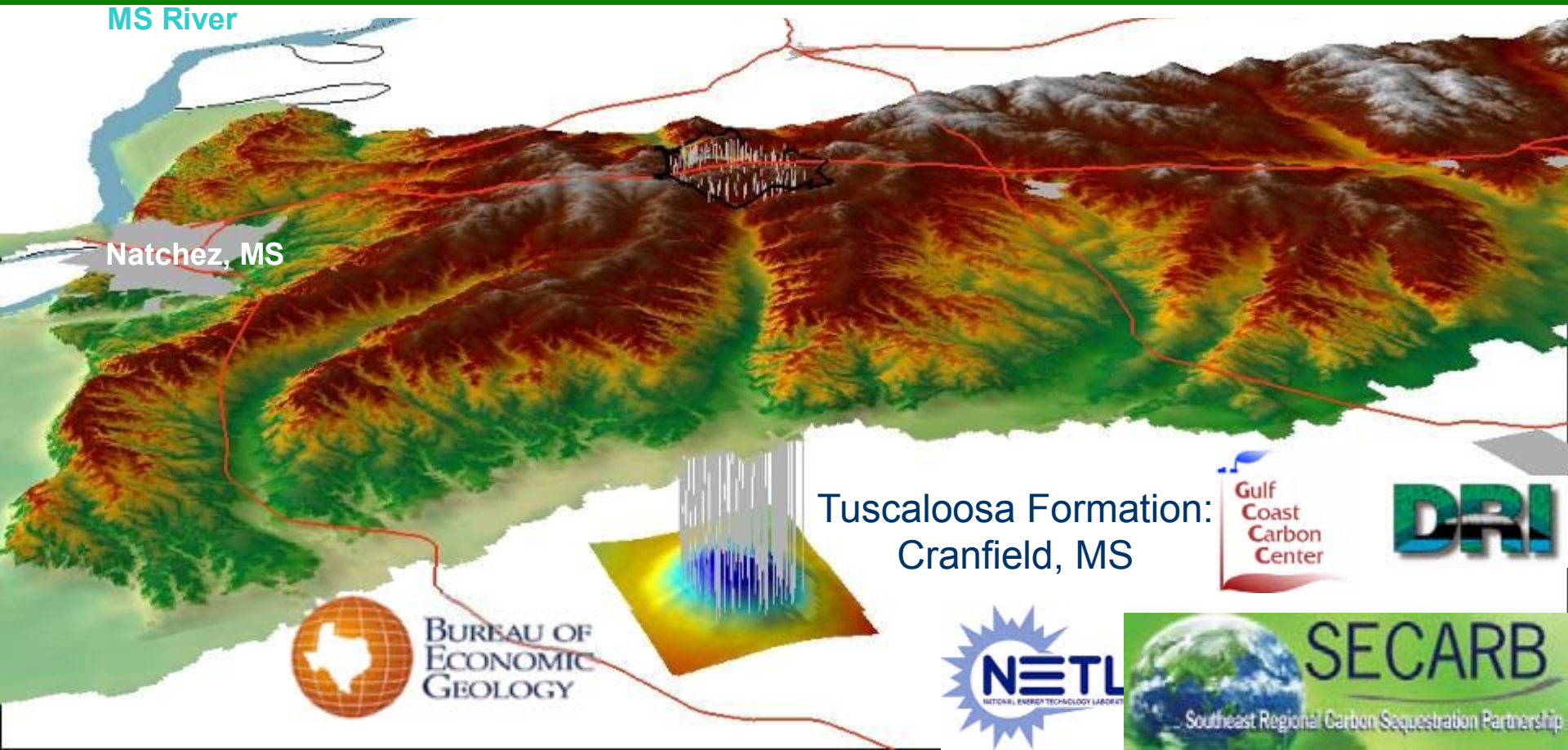
SECARB Early Large Volume Injection Tests

Cranfield Unit operated by Denbury Resources Inc

Depth >10,300 ft

Injection Zone – lower Tuscaloosa Formation

Injection rate>1 Million Tones per year



Management of SECARB

Project Management
Gerald Hill
Bruce Lani/Bruce Brown

Cranfield Research Team

University of Texas at Austin

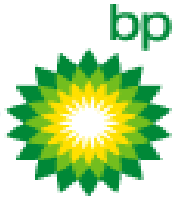
Denbury Resources Inc

Sandia Technologies LLC

LBNL LLBL USGS ORNL
QEA
U Mississippi
Miss State

Schlumberger Carbon Services

Gulf Coast Carbon Center



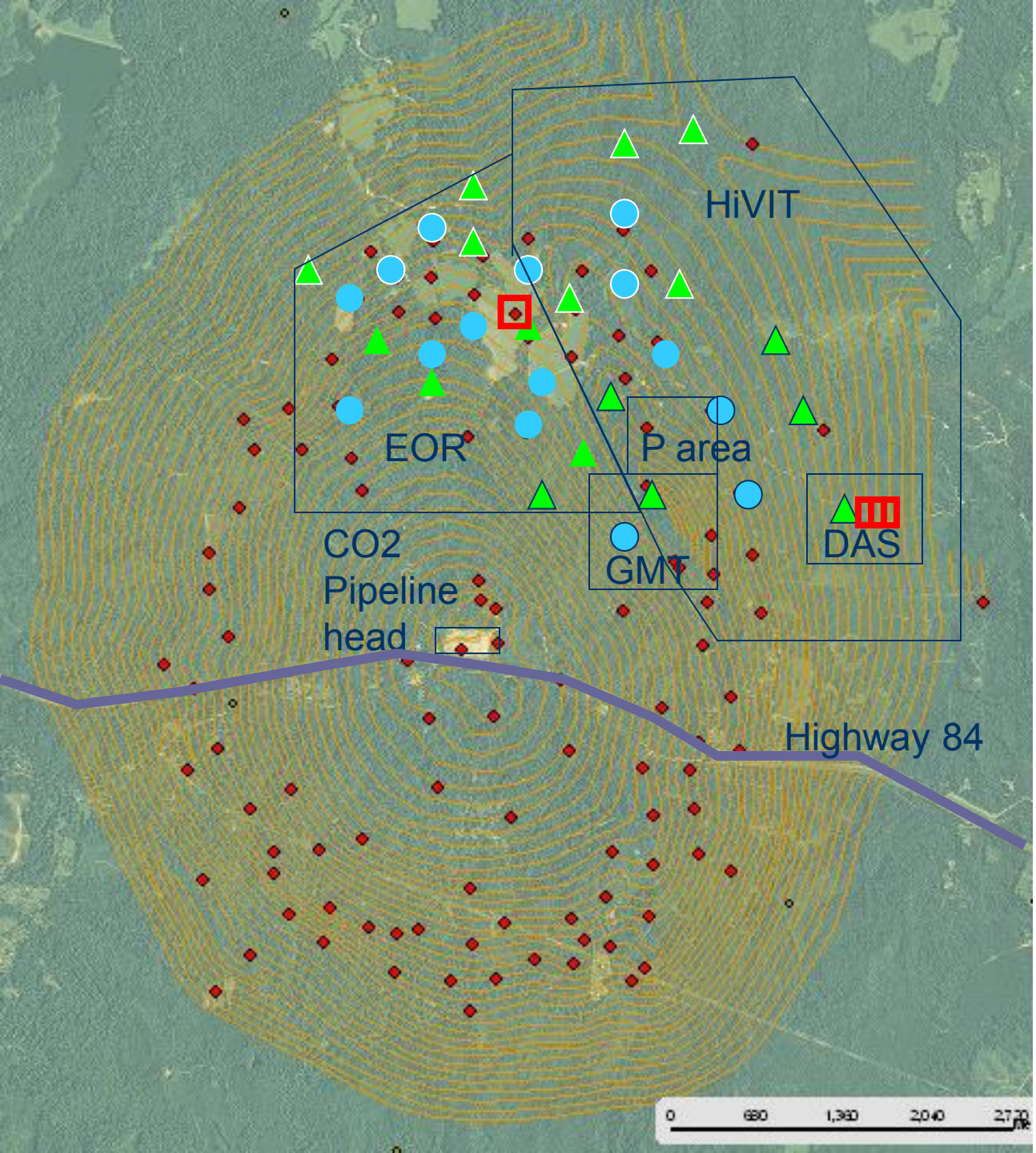
Other SECARB tests

SECARB coal seam tests
Geological Survey of Alabama
Virginia Tech

SECARB Power Plant tests
EPRI
Southern Co
ARI

Scientific and Technical Objectives & Benefits

Objective	Anticipated Benefit
DAS Detailed Area of Study Sweep efficiency brine system	Well-quantified measure of how CO_2 occupies pore volumes
HiVIT High Volume injection Test - Account for volume input	Add rigor to measurement for storage prediction
GMT GeoMechanical Test Measure microseismicity	Assess energy input and pressure increase
P-Area Pits- pad plants Effectiveness of surface monitoring - deep water table	Reliable leakage detection in deep water table/ complex site
EOR- Pressure based in-zone & above monitoring methods for area with many well penetrations	Technique development for EOR permanence



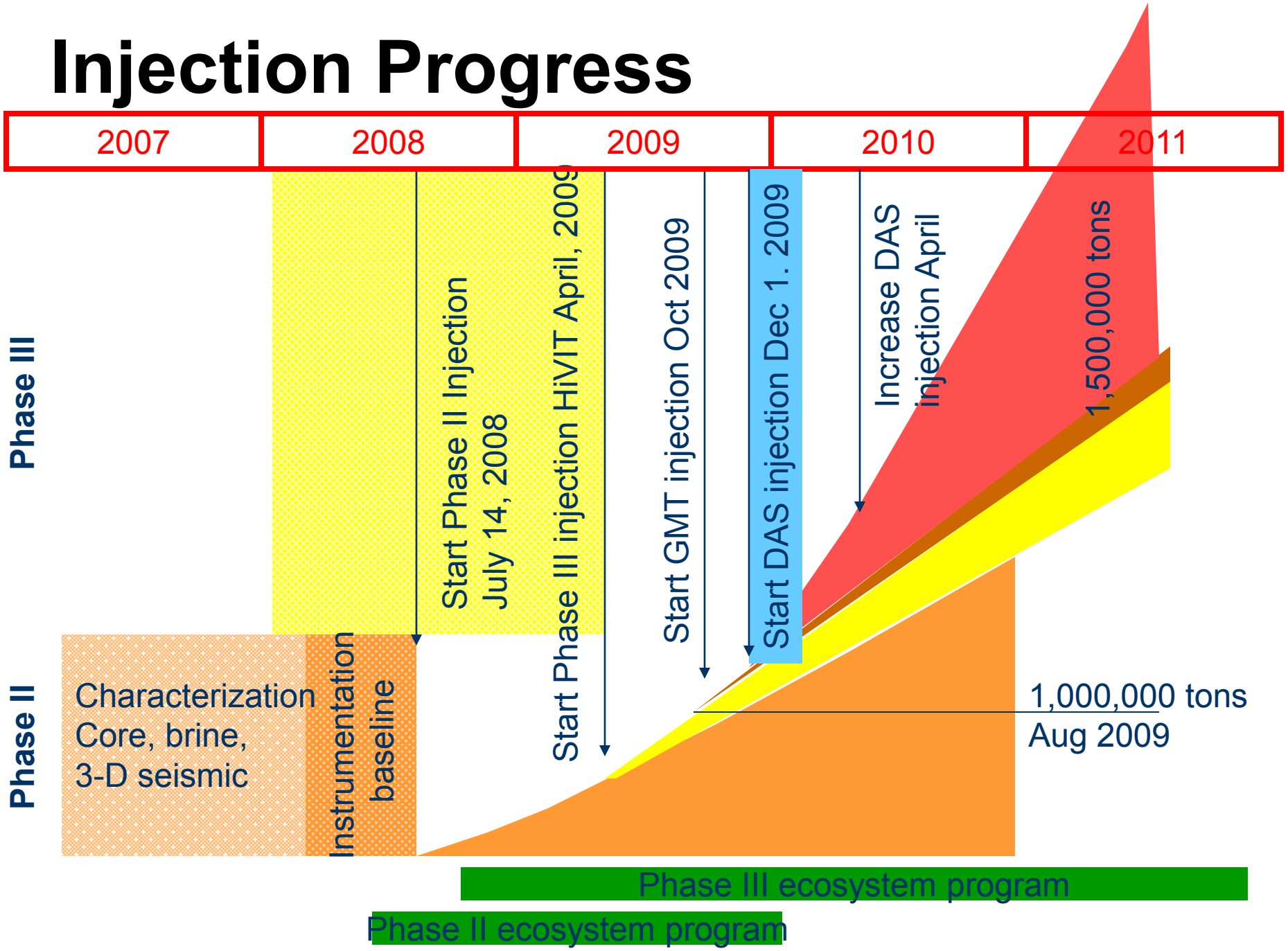
Injector

Monitoring Point (producer)

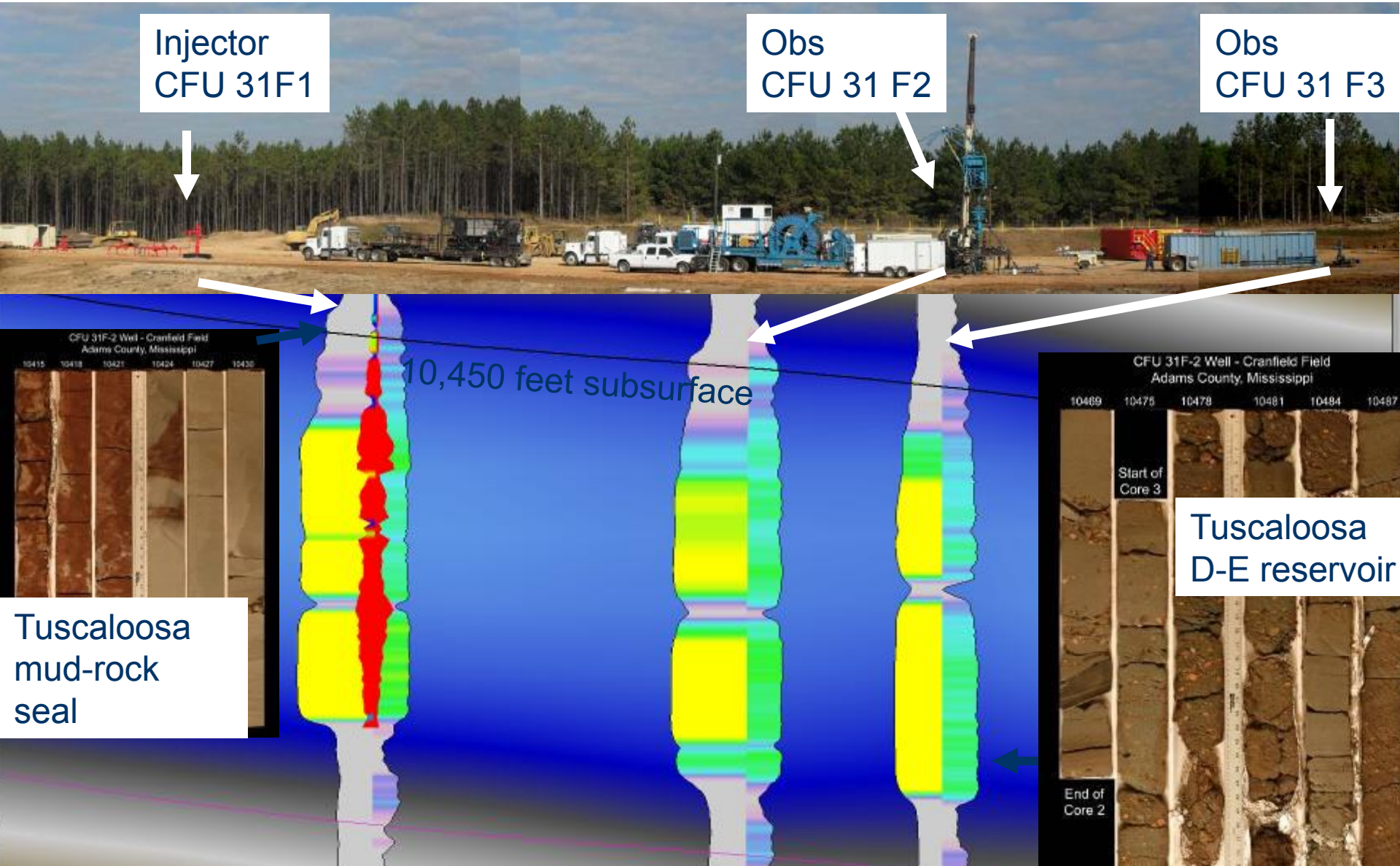
Observation Well

DAS	Detailed Area of Study
HiVIT	High Volume Injection Test
GMT	GeoMechanical Test
P-Area	Pits, Pad, Plants
EOR	Enhanced Oil Recovery

Injection Progress

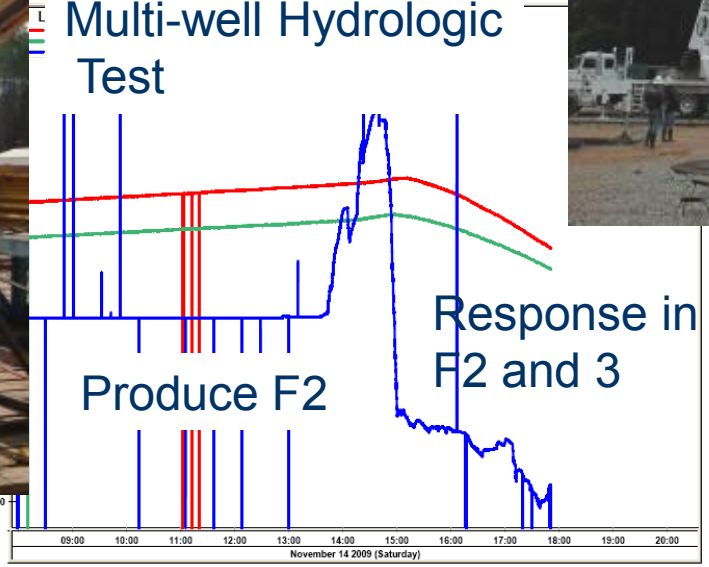


DAS: Detailed Area of Study



DAS: Detailed Area of Study

Installation of
Instrument string
In CFU31-F3



GMT: GeoMechanical Test

One injector
One observation well (future producer)
Pinnacle Tech. Clamped in- receiver string
Real-time uplink
Injection Oct – Dec 2009

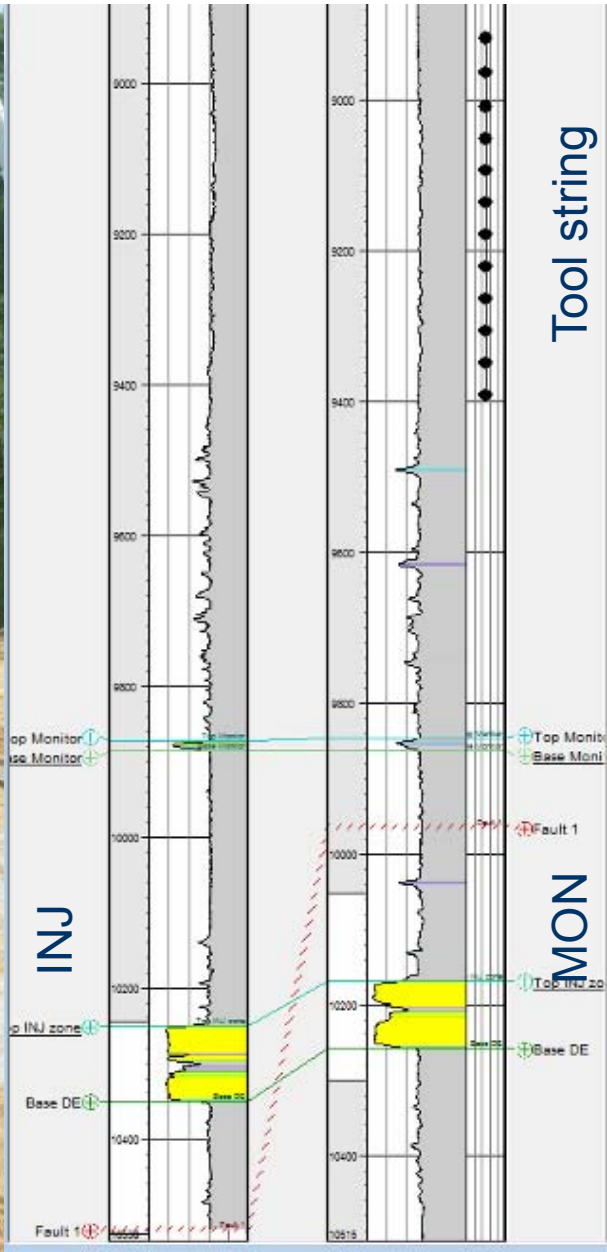
Wellhead assembly

Satellite uplink

Recording Electronics

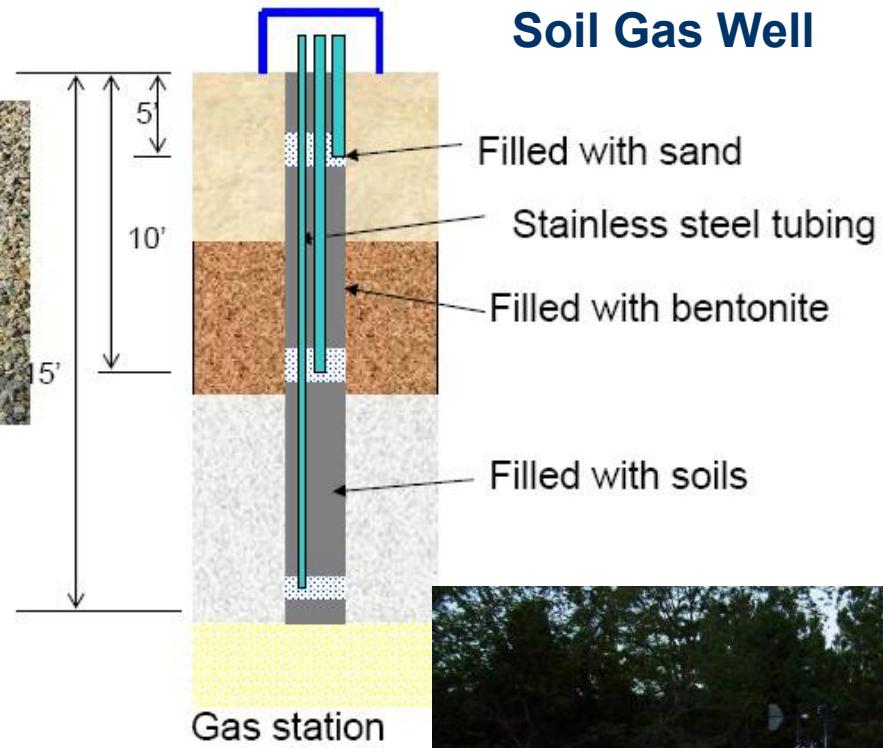
Diesel electricity generator

Fuel tank

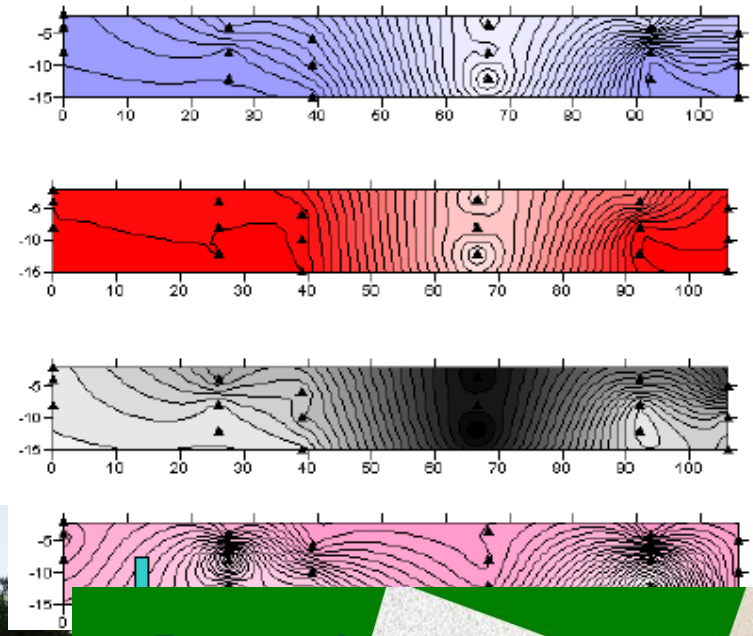


“P” Area: Plants, Pad, Pit

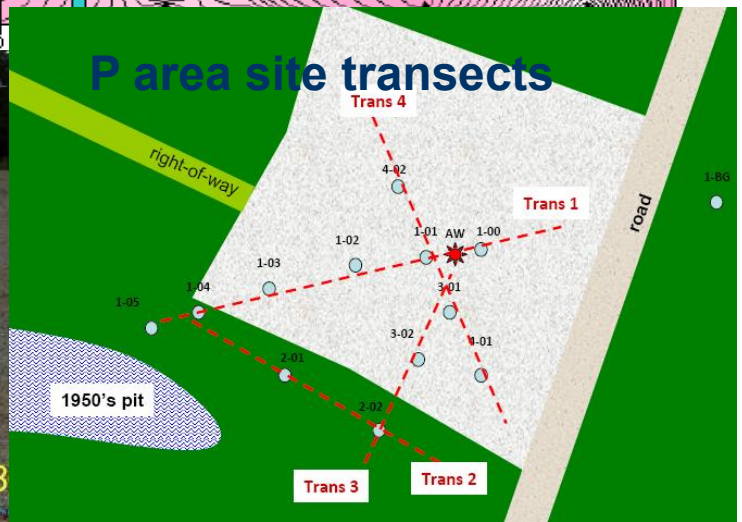
Soil Gas Well



Baseline soil gas after rain

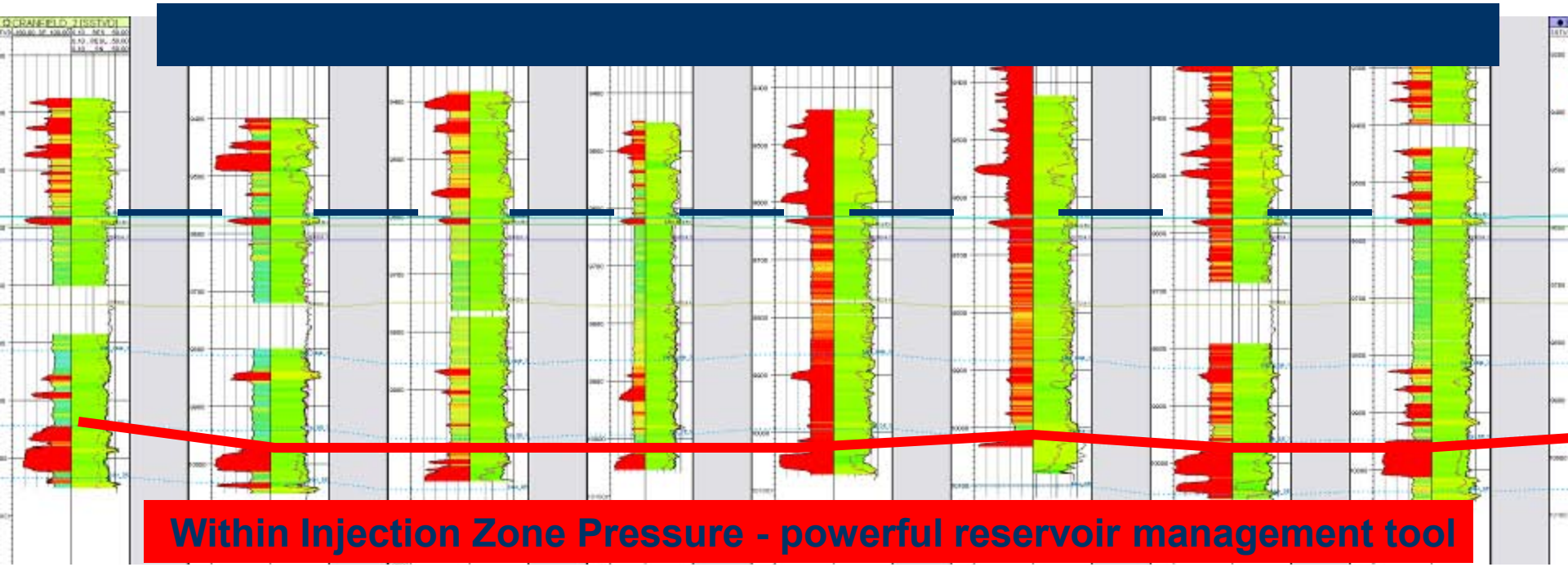


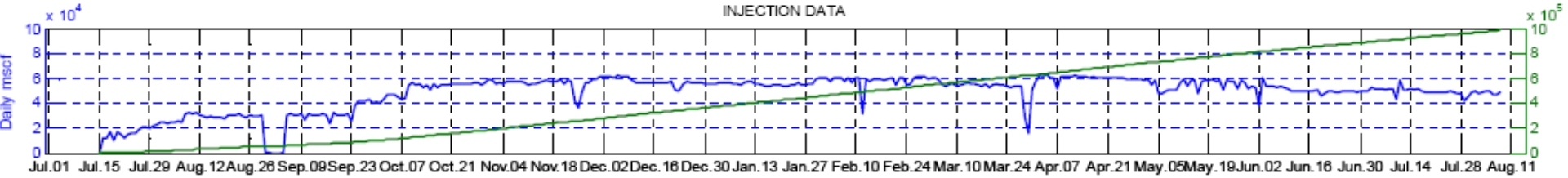
P area site transects

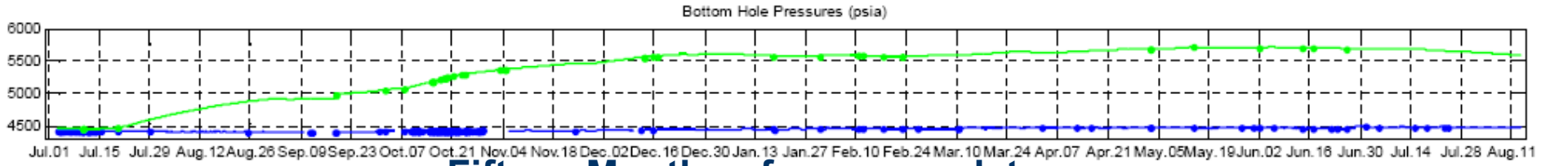


Weather station to assess natural variability

Pressure Monitoring EOR







Fifteen Months of pressure data

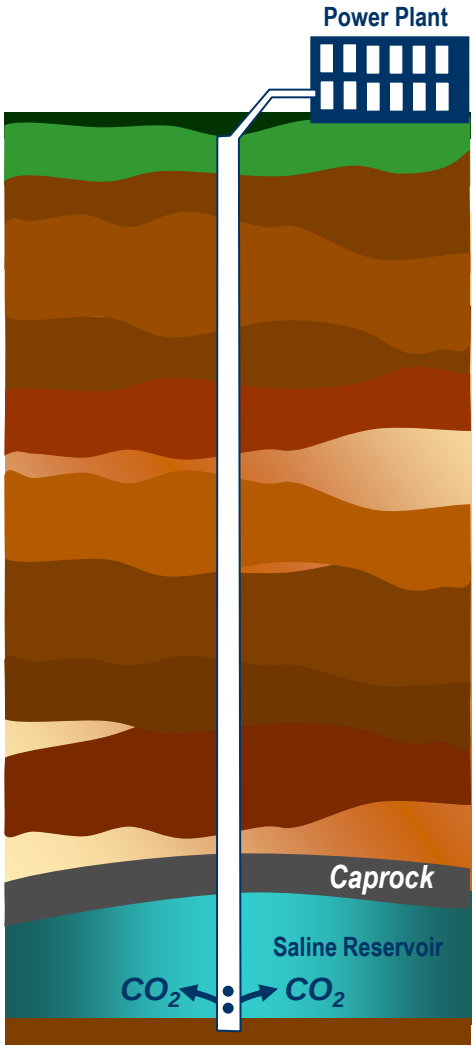
FY2009 Activities: Phase III Anthropogenic Test

- Capture technology announced in May 2009
- Site hosts announced in May 2009
  - Plant Barry: CO_2 Source
  - Denbury Resources: CO_2 injection at Citronelle Field
- CX received in August 2009 for site characterization at Citronelle Field
- UIC permit application preparation underway
- Detailed geologic assessment underway
- Reservoir simulations began/ongoing
- Data collection for EIVs underway
- Regular coordination/planning meetings with ADEM
- Regular Anthropogenic Test team meetings and conference calls

Anthropogenic Test

- **Purpose:** Locate suitable geological sequestration sites in proximity to the 25 MW MHI post-combustion CO_2 capture pilot at Plant Barry and inject CO_2
  - One of the first integrated capture, transport and storage demonstration projects on an existing coal-fired power plant in the U.S.

- **Sequestration Target:** Lower Cretaceous Gulf Coast saline reservoirs with high CO_2 storage capacity and injectivity



Anthropogenic Test

- **Sequestration Objectives:**
  - Build geological and reservoir maps for test site
  - Conduct reservoir simulations to estimate injectivity, storage capacity, and long-term fate of injected CO_2
  - Address state/local regulatory and permitting issues
  - Foster public education and outreach
  - Inject 125,000 metric tons of CO_2 per year for four years
  - Conduct longer-term monitoring for 3-4 years post-injection

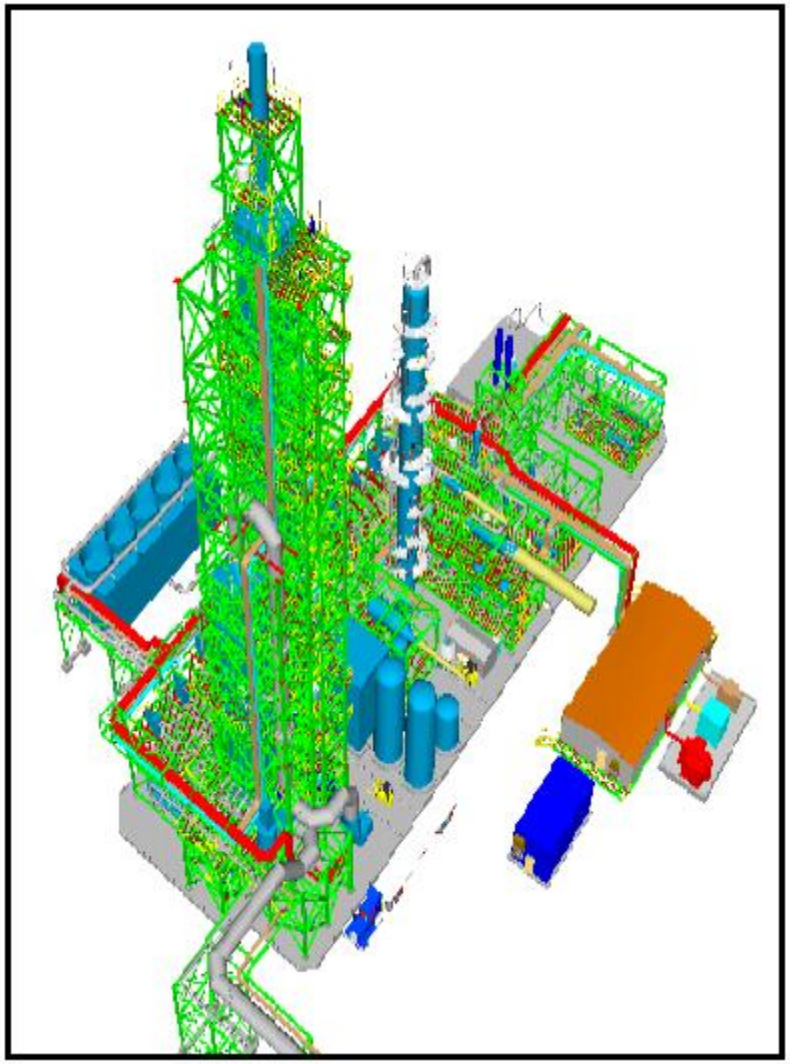
Anthropogenic CCS Team:

EPRI
EPRI's Utility Partners
Advanced Resources International
Geological Survey of Alabama
Alabama Power
Southern Company
Denbury Resources
Mitsubishi Heavy Industries

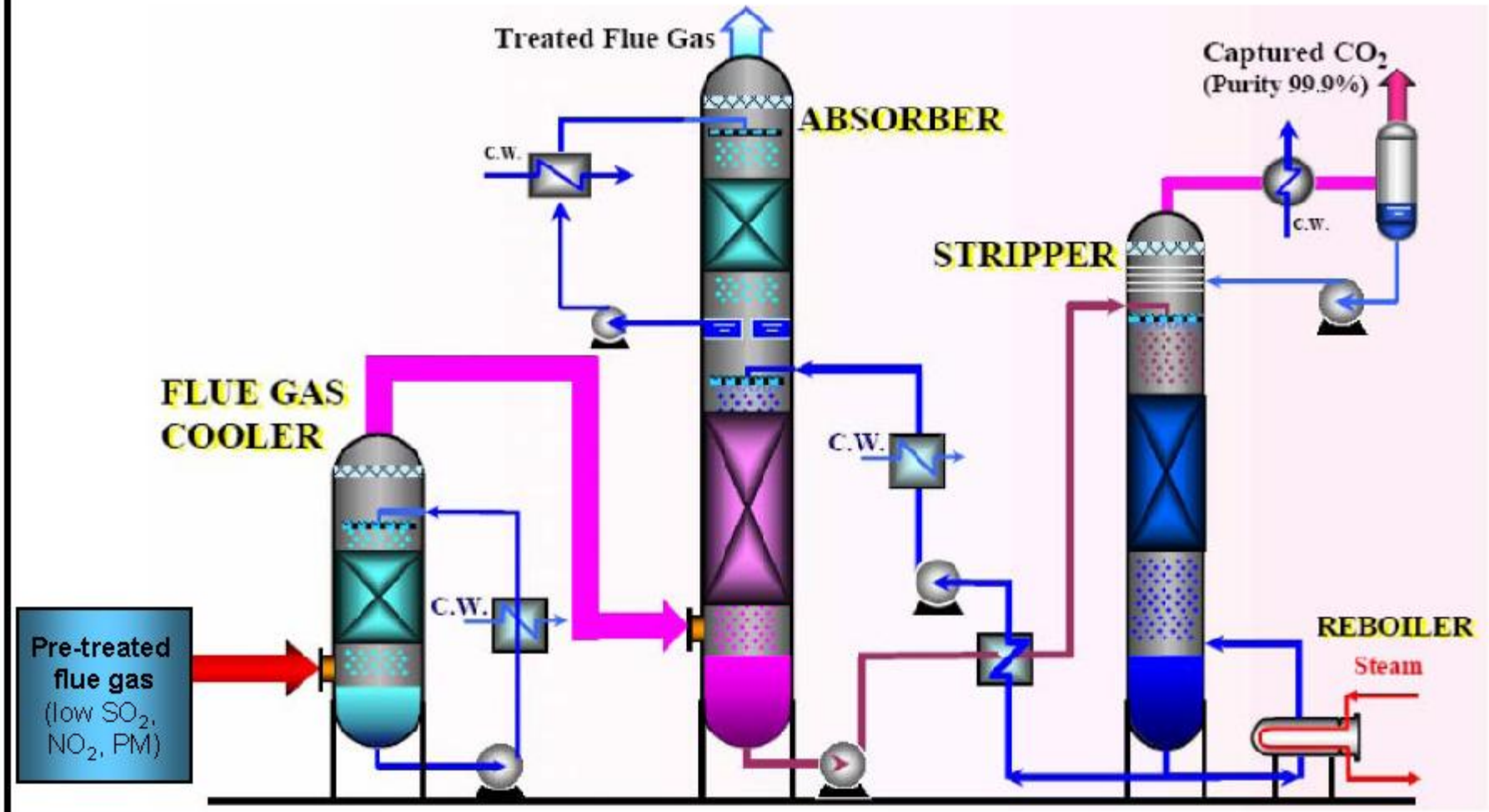
Capture Unit at Alabama Power's Plant Barry

MHI advanced amine capture unit

- 25 MW post combustion slip stream
- Fabricate off-site and barge to Plant Barry
- Compress CO_2 to 2000 psi
- Scheduled start up First Quarter, FY2011
- Separately funded; CO_2 provided to SECARB for sequestration at Citronelle Field



Simplified CO_2 Scrubbing Process (Amine)

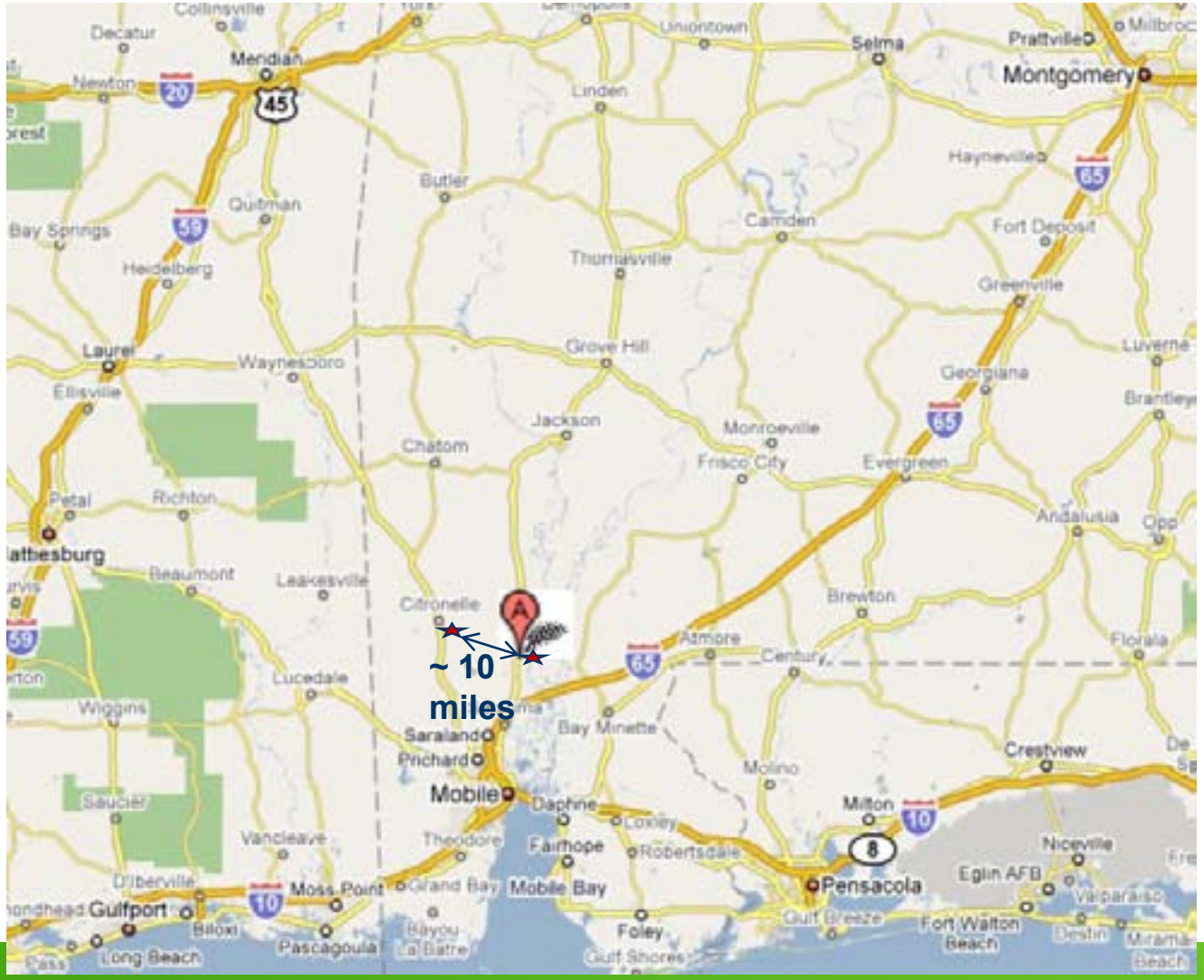


Key Points: needs >99% SO_2 removal; consumes process steam

CO_2 Transportation from Plant Barry to Citronelle Field

~10 mile pipeline, separately planned and financed by Denbury Resources

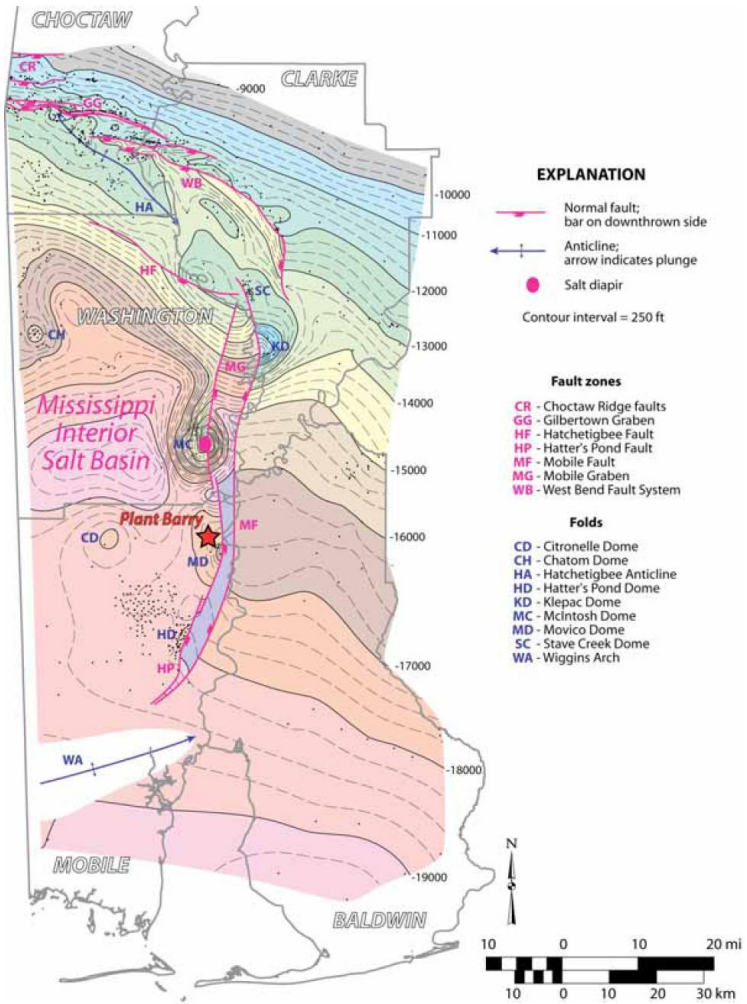
125 TPY of pipeline capacity for SECARB Phase III CO_2



Geologic Overview for Plant Barry and Citronelle Field

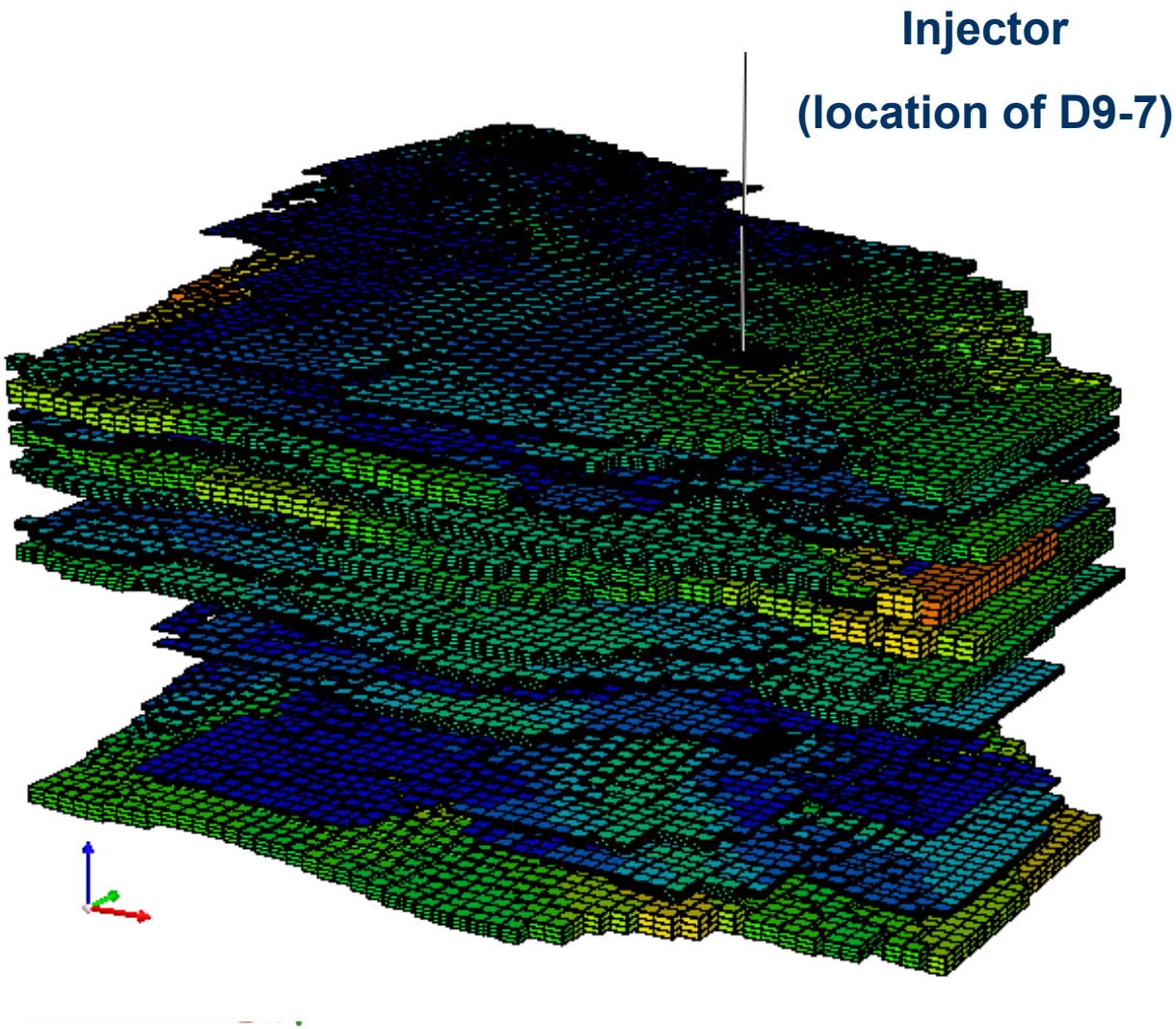
Proposed sequestration site is on the southeast flank of the Citronelle Dome

- Proven four-way closure
- No evidence of faulting or fracturing
- Multiple confining units between potential injection targets and base of USDW
- However, historic oil and gas wells and a lack of local characterization of saline reservoirs presents challenges



Structural contour map of the top of the Smackover Formation (Upper Jurassic) in southwest Alabama (GSA 2008)

Model 3-D View: Citronelle Field Phase III Injection Site



- 17 sand bodies from geological model
- Average permeability of 88 mD
- Average porosity of 19.3%
- Identical permeability and porosity in all layers

Expected Reservoir Intersection Depths at Citronelle

Formation Tops	Anticipated Depth Feet	Interval Thickness Feet
Bottom of Fresh Water (<1,000 mg/l)	~ 1,000	1,000
Bottom of Potable Water (<10,000 mg/l)	Max ~ 2,000	1,000
Selma Chalk Group	4,550	1,150
Eutaw Group	5,700	300
Upper Tuscaloosa Formation	6,000	700
Marine Tuscaloosa Formation	6,700	250
Lower Tuscaloosa Formation	6,950	300
Washita-Fredericksburg Undifferentiated	7,250	2,150
Paluxy Formation	**9,400**	**1,100**
Mooringsport Formation	10,500	250
Ferry Lake Anhydrite	10,750	200
Rodessa Formation (oil reservoir)	10,950	-

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