SECARB 5th Annual Stakeholders' Briefing

Southern Company CCS
Project Portfolio

By

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SOUTHERN COMPANY

Geologic Sequestration Research Initiatives

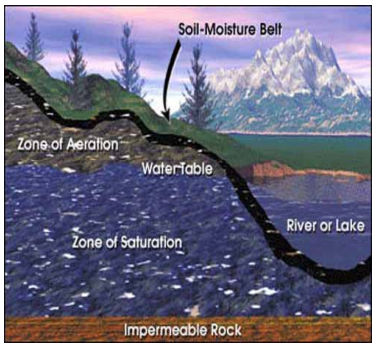
Site Characterization of Promising Geologic Formations for CO_2 Storage (DE-FOA-0000033)

- Host Site: Alabama Power - Plant Gorgas
- Partners: UofA (Chemical Eng.); Geologic Survey of Alabama (Energy Investigations); Rice University (Petroleum Eng.); Schlumberger Carbon Services
- Objective: Evaluate site-specific sequestration geology, expand regional characterization, and source-sink matching through drilling a stratigraphic test well
- Duration: 36 months (2010 - 2012)

Geologic Sequestration Training and Research (DE-FOA-0000032)

- Host Site: University of Alabama at Birmingham (UAB)
- Partners: UAB (Mechanical Eng.)
- Objectives: Facilitate research by students for assessment of the sealing capacity of confining layers and allow participation by students in the evaluation of geologic sequestration
- Duration: 24 months (2010 - 2011)

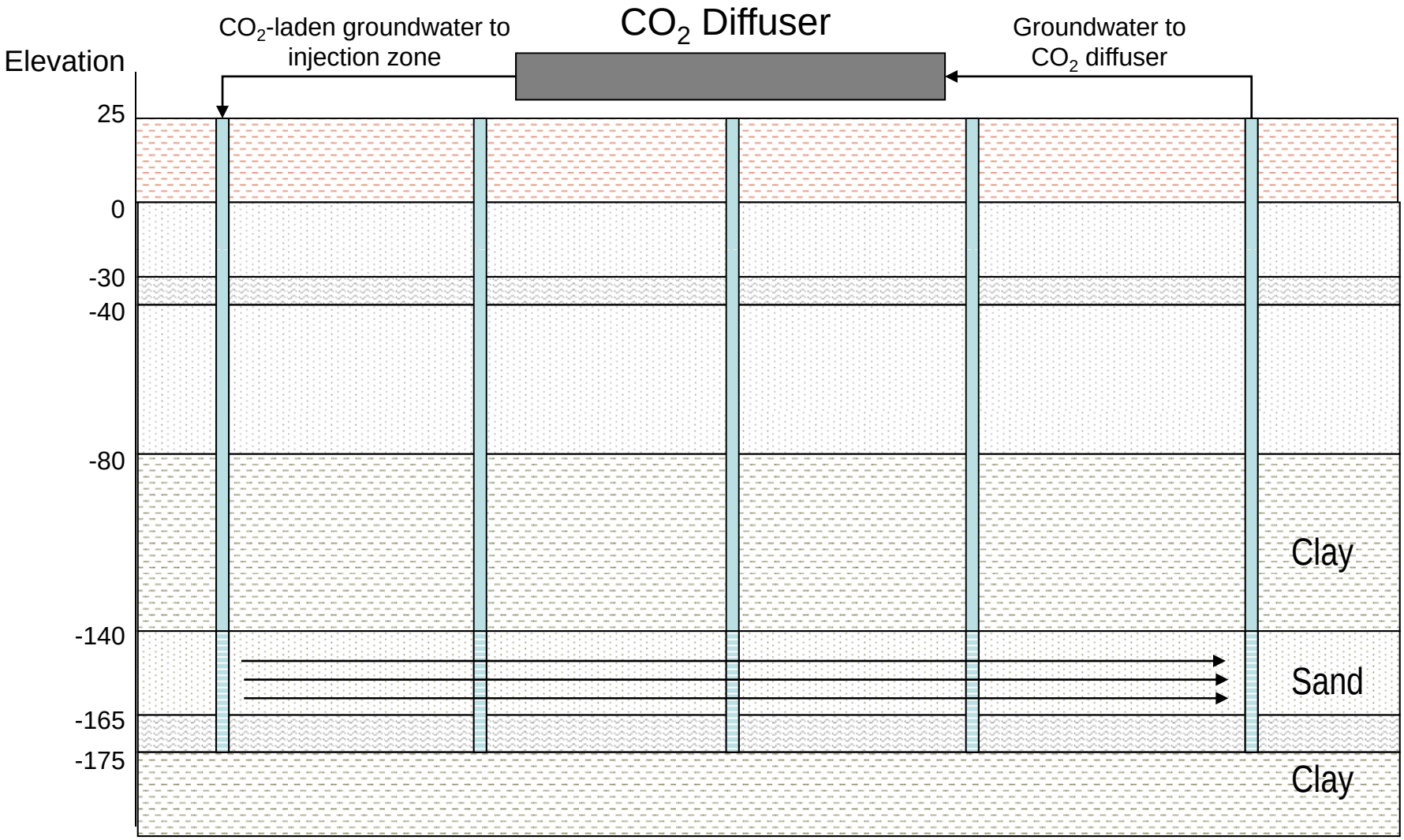
Geologic Sequestration Research Initiatives



CO_2 Impacts on Shallow Groundwater Field Test

- Host Site: Mississippi Power - Plant Daniel
- Partners: Electric Power Research Institute; Lawrence Berkley National Lab
- Objectives: Study the potential impacts of CO_2 on potable groundwater under field conditions typical of a drinking water aquifer
  - Identify key reactive transport mechanisms and processes
  - Calibrate and validate flow and reactive transport models
  - Test ability of existing models to predict transport behavior and improve models for commercial use
  - Engage regulators and public in the protection of groundwater resources
- Duration: 36 months (2010 -2012)

Field Test Injection Design

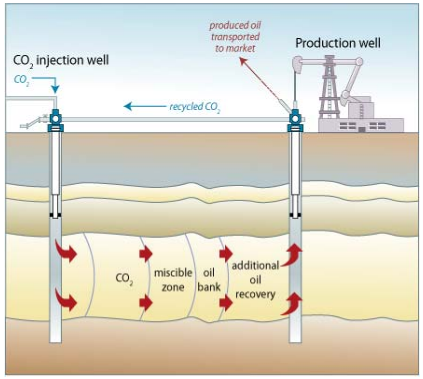


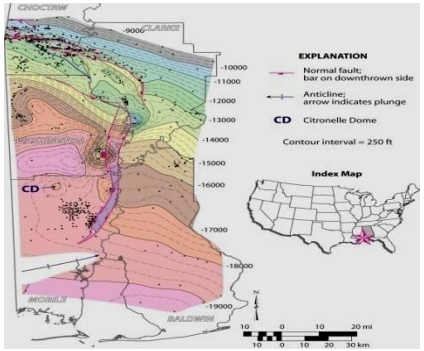
Geologic Sequestration Research Initiatives

Warrior Basin ECBM/Sequestration Coal Seam Pilot

- Host Site: El Paso Blue Creek ECBM Field
- Partners: UofA (Chemical Eng.); Geologic Survey of Alabama (Energy Inv.); Electric Power Research Institute, UofBC, ORNL, Denbury Onshore
- Objectives:
  - To study the interactions of enhanced methane recovery and geologic sequestration in coal seams
  - Establish source - sink relationships and storage capacity with north-central Alabama CO_2 emitting facilities
  - Validate coal sequestration in the Warrior Basin including commodity CO_2 for ECBM
  - Understand monitoring to verify permanence and sequestration safety in coal
- Duration: 36 months (2007 -2010)

Geologic Sequestration Research Initiatives





CO_2-Enhanced Oil Production and Sequestration in the Citronelle Oil Field

- Host Site - Citronelle Oil Field, Citronelle, Alabama
- Partners - DOE Strategic Center for Natural Gas and Oil; UAB (Mechanical Eng); Denbury Onshore; Geologic Survey of Alabama (Energy Investigations); UofA (Chemical and Biological Eng; UNCC (Civil and Environmental Eng)
- Objectives: Evaluate EOR and geologic sequestration potential of the Citronelle Field through CO_2 pilot injections
  - Establish market opportunities for commercial CO_2 in South Alabama
  - Defining source - sink relationships for geologic CO_2 sequestration with Alabama Power - Plant Barry
  - Gaining experience with CO_2 injection in SE geology
- Duration: 48 months (2007 - 2011)

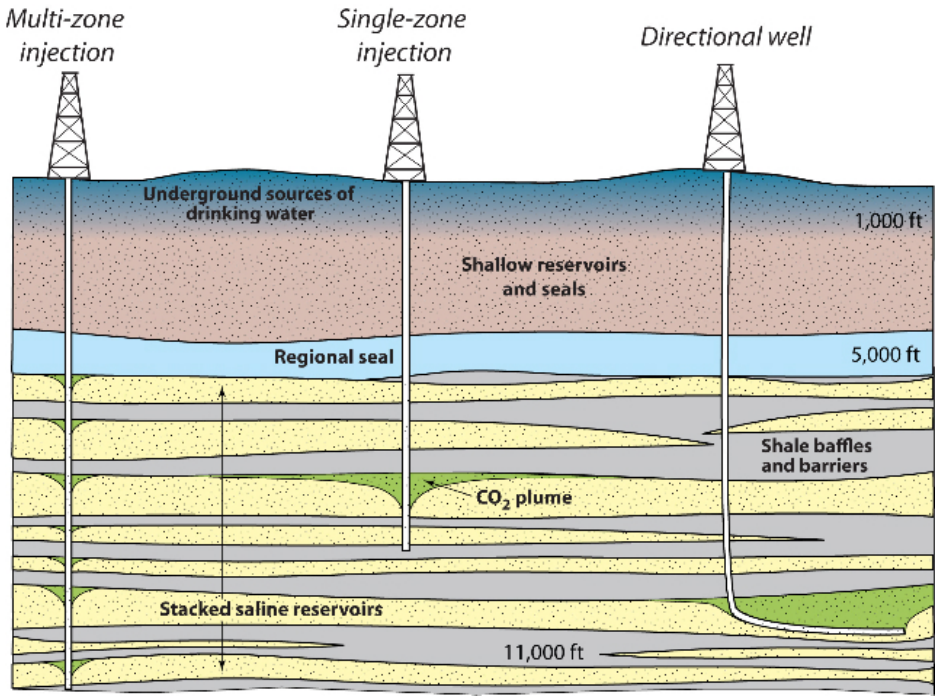
Geologic Sequestration Research Initiatives

SECARB Saline Reservoir CO_2 Pilot Injection Test Site

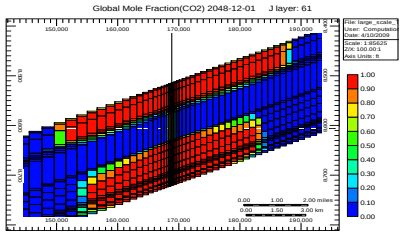
- Host Site: Mississippi Power - Plant Daniel
- Partners: DOE Fossil Energy; SSEB; EPRI; ARI; Denbury
- Objectives: To test deep saline reservoirs located near large coal-fired power plants along the Mississippi Gulf Coast for geological storage of CO_2
  - Better understand the logistics of geologic storage site activities at coal-fired power plants
  - Site characterization methods and validation of saline reservoirs through injection testing
  - Identify monitoring and verification protocols for geologic sequestration
  - Address regulatory and permitting issues
  - Foster public education and outreach (both internal & external)
  - Duration: 36 months (2007 - 2009)

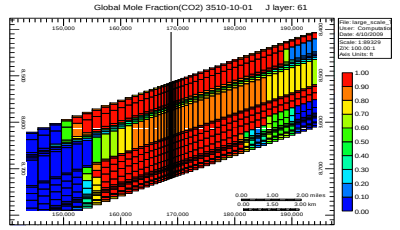
Modeling Study Objectives and Background

- Understand plume dynamics and extent associated with utility-scale and duration CO_2 injection
- Understand how multi-zone injections compare to single-zone injections in reduction of footprint
- Injection was modeled with GEM-GHG (compositional reservoir simulation) using petro-physical data gathered from the SECARB CO_2 injection test
- To do so, a CO_2 injection was modeled using data gathered from the Mississippi Test Site at Plant Daniel
  - 5MM tons of CO_2 were injected for 40 years
  - The CO_2 plume was monitored for 1,500 years



GSA, 2009



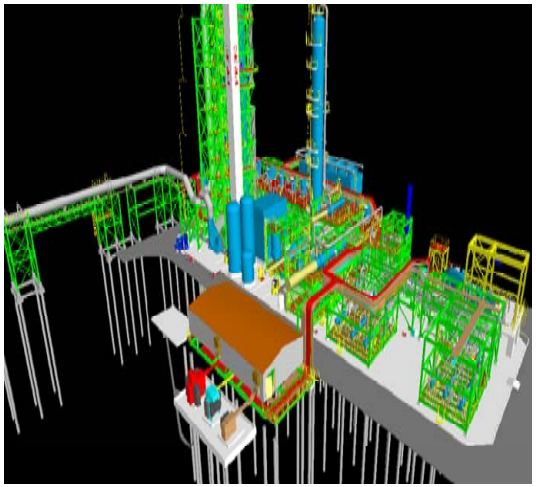


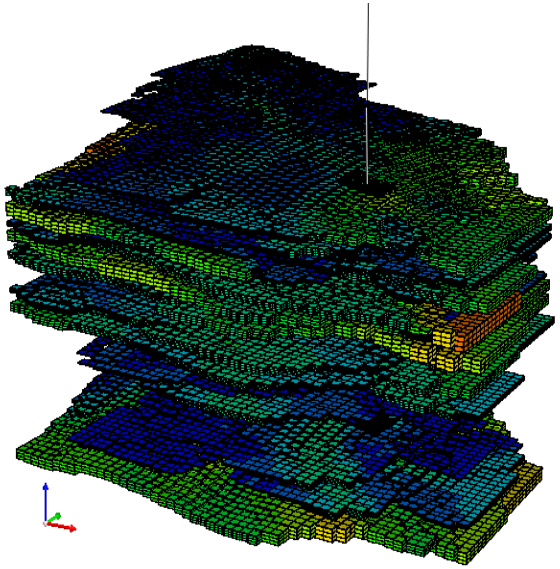
Modeling Exercise - Two scenarios

- **Case 1 modeled injection in the Lower Tuscaloosa Formation Massive sand:** ***Total sand thickness of 125ft***
  - Physical plume reaches an area of 139mi^2 at the end of the monitoring period of 1,500 years (plume radius reaches 13 miles up-dip from plant) (16mi*11mi)

- **Case 2 modeled injection in the Lower Tuscaloosa Formation plus Washita-Fredricksburg Formation sands:** ***Total sand thickness of 600ft***
  - Physical plume reached an area of 100mi^2 at the end of the monitoring period of 1,500 years (plume radius reaches 11 miles up-dip from plant)
  - 30% reduction compared to case 1 at an area of 102mi^2 (14mi*9mi)

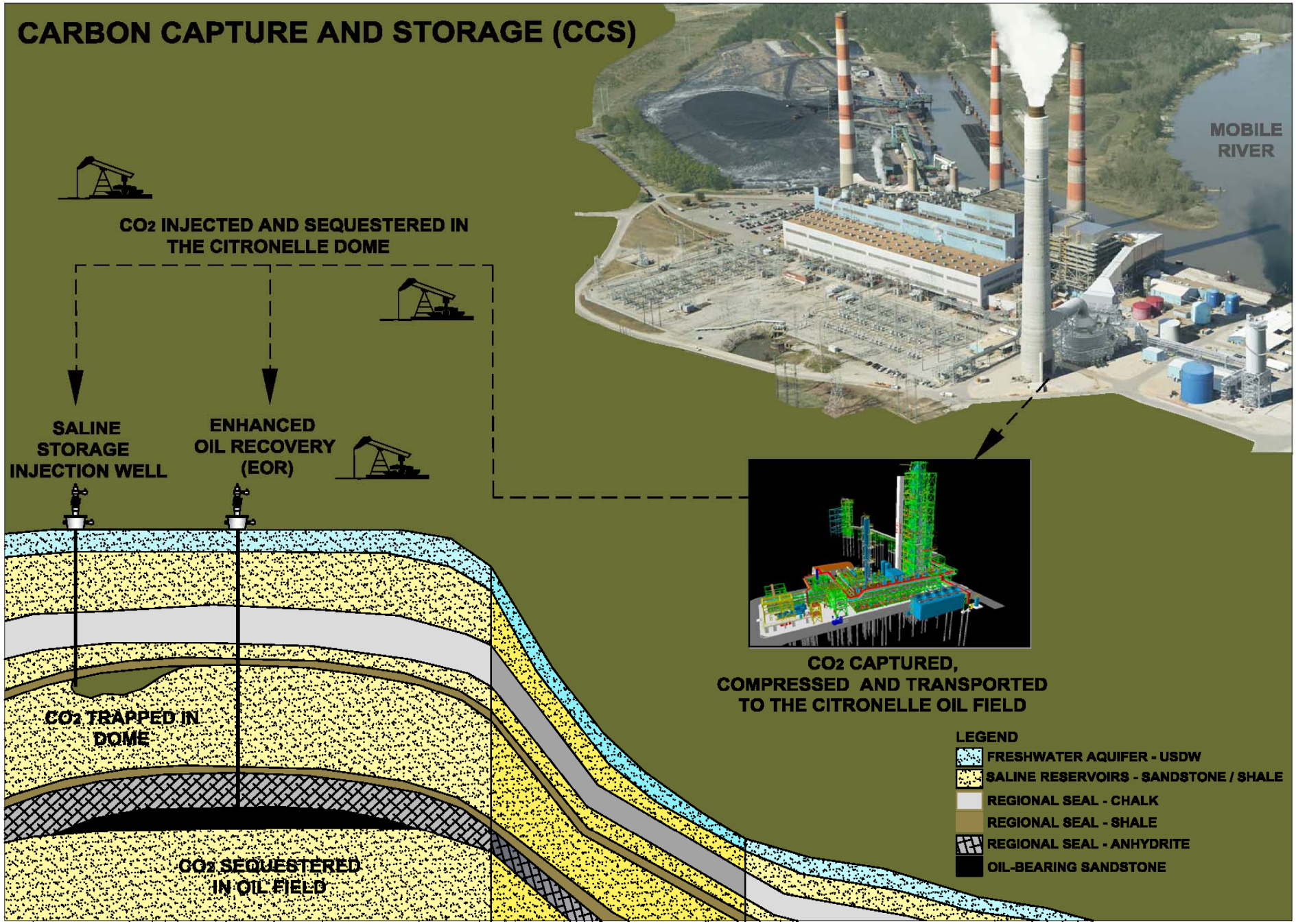
Carbon Capture and Sequestration Initiatives





SECARB Phase III Anthropogenic Field Demo

- Host Site: Alabama Power - Plant Barry will host a 500 tpd (25 MW) pilot demonstration capture unit
- Partners:
  - Capture: Southern Company, MHI America
  - Sequestration: DOE Fossil Energy, SSEB, EPRI, ARI, Denbury Onshore, Geologic Survey of Alabama
- Objectives:
  - Site characterization and permitting
  - Integration of coal-fired captured CO_2 with transportation and injection with parametric studies
  - Relationship - building
  - Inject 500 tpd (400,000 t) over 3 years; monitor and verify secure storage in saline reservoirs
- Duration: 2009 - 2017


CARBON CAPTURE AND STORAGE (CCS)
MOBILE RIVER
CO2 INJECTED AND SEQUESTERED IN THE CITRONELLE DOME
SALINE STORAGE INJECTION WELL
ENHANCED OIL RECOVERY (EOR)
CO2 CAPTURED, COMPRESSED AND TRANSPORTED TO THE CITRONELLE OIL FIELD
CO2 TRAPPED IN DOME
CO2 SEQUESTERED IN OIL FIELD
LEGEND
FRESHWATER AQUIFER - USDW
SALINE RESERVOIRS - SANDSTONE / SHALE
REGIONAL SEAL - CHALK
REGIONAL SEAL - SHALE
REGIONAL SEAL - ANHYDRITE
OIL-BEARING SANDSTONE

U.S. Department of Energy

National Carbon Capture Center

at the Power Systems Development Facility

PARTICIPANTS:

SOUTHERN COMPANY

EPRI ELECTRIC POWER RESEARCH INSTITUTE

AEP AMERICAN ELECTRIC POWER

Luminant

Peabody

ACI ARCH COAL, INC.

RioTinto

Managed by Southern Company Services, Inc.

Beliefs

- The Southeast has excellent storage capacity and good source-sink matching.
- Sequestration can be both safe and permanent with proper site characterization and injection operations.
- Uncertainties associated with sequestration will be resolved over time as experience is gained with CCS technologies and the implementation of EPA's UIC regulations.
- For CCS to be in a utility's generation mix, cost reductions must be achieved through R&D especially with capture.
- A legal framework for access to pore space must be available, risk mitigation options must be developed, and public acceptance must continue to improve.
- The issues are too great for any one group or utility to resolve and will need to be addressed by a consortium of industries and collaborators with support from DOE and other agencies.