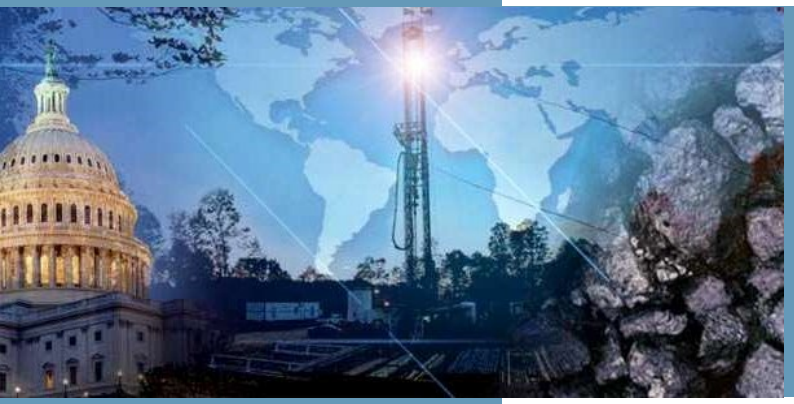

# Establishing an Early Carbon Dioxide Storage Complex in Kemper County, Mississippi: Project ECO2S (FE0029465)


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The Project Team, led by Southern States Energy Board, Mississippi Power Company and Southern Company Services, with technical support from Advanced Resources Inc. and a host of key subcontractors, acknowledge the valuable support provided by the U.S. DOE National Energy Technology Laboratory on this Phase 2 CarbonSAFE field project.
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# Disclaimer


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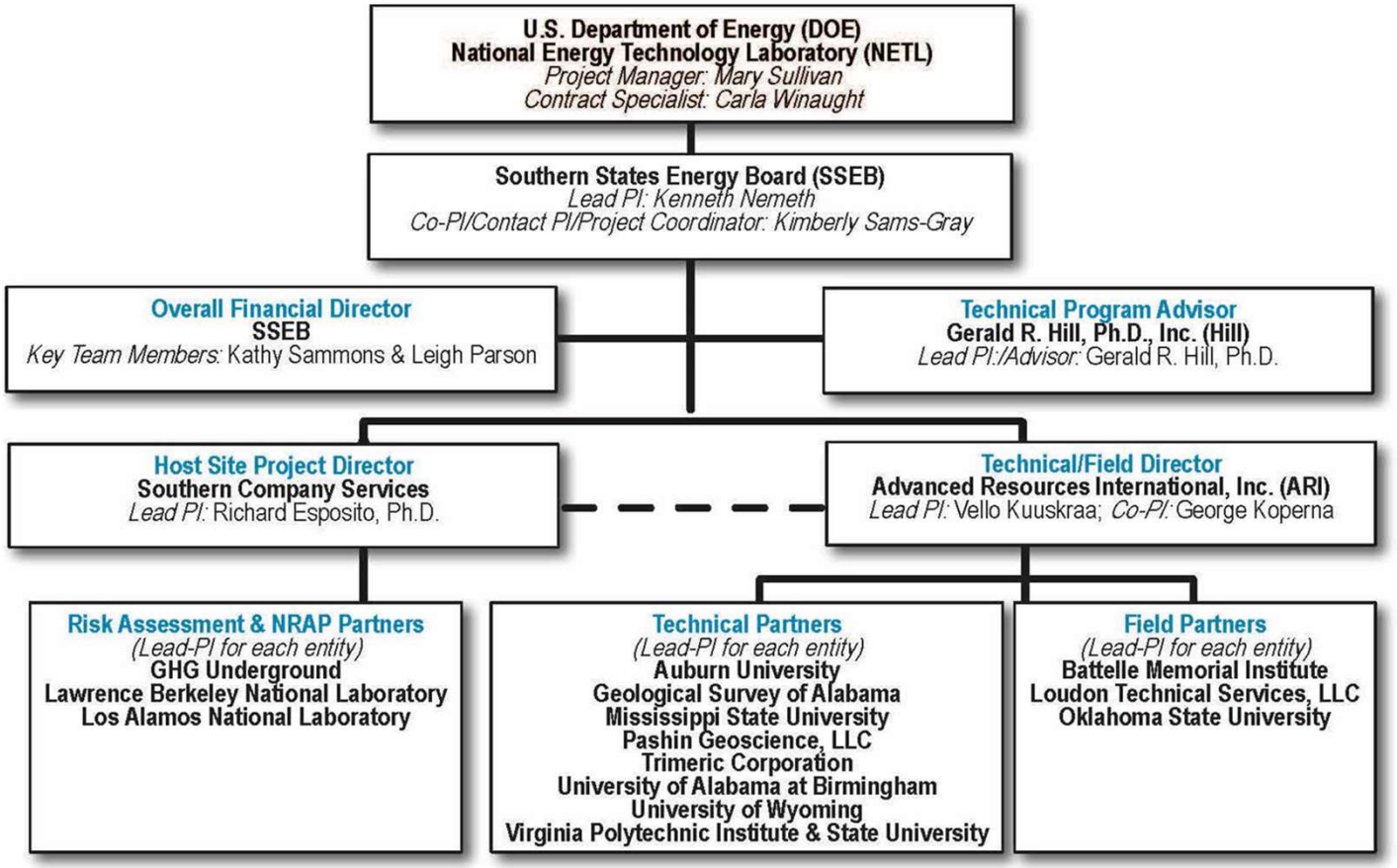
# Project $ECO_2S$ Org Chart



# Setting the Stage

- New natural gas-fueled electric power and potential for retrofit of existing coal-fueled electric power capacity in the southeast.
- Industrial sources of $CO_2$ emissions are increasing sharply (petrochemical and LNG)
- ***Electric and industrial sources emit ~1,000 million metric tons per year***
- Large volume $CO_2$ transportation systems and $CO_2$ storage complexes will be required in the SE region in support of $CO_2$ capture.

| | South Census Region | | U.S. Total (4 Regions) |
|---|---|---|---|
| | Electricity Generation | % of U.S. Total | Electricity Generation |
| Coal | 1,316 (thousand MWh/d) | 42% | 3,141 (thousand MWh/d) |
| Natural Gas | 2,353 (thousand MWh/d) | 59% | 4,022 (thousand MWh/d) |
| **Total** | **3,669 (thousand MWh/d)** | **51%** | **7,163 (thousand MWh/d)** |

*Based on data for Year 2017.


*Project ECO$_2$S and Kemper Regional $CO_2$ Storage Complex.

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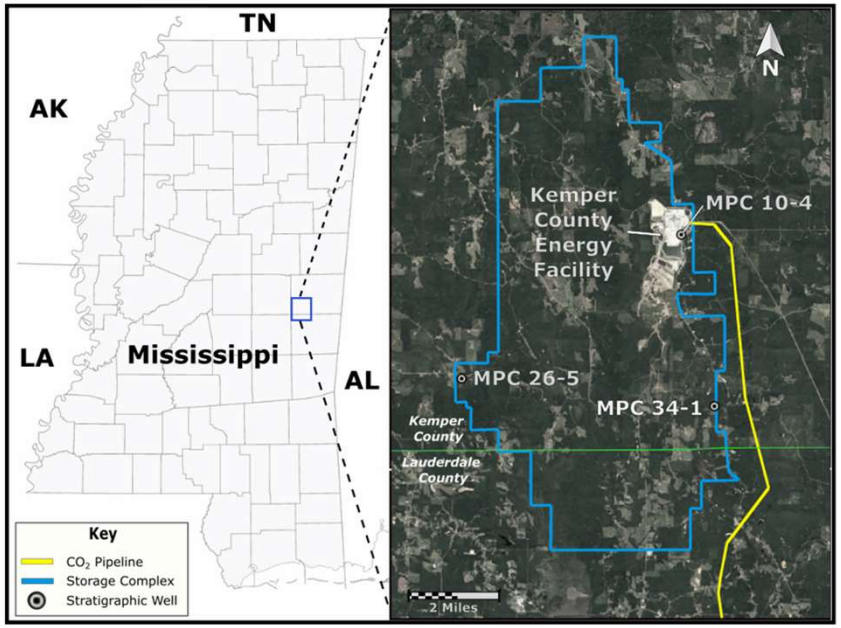
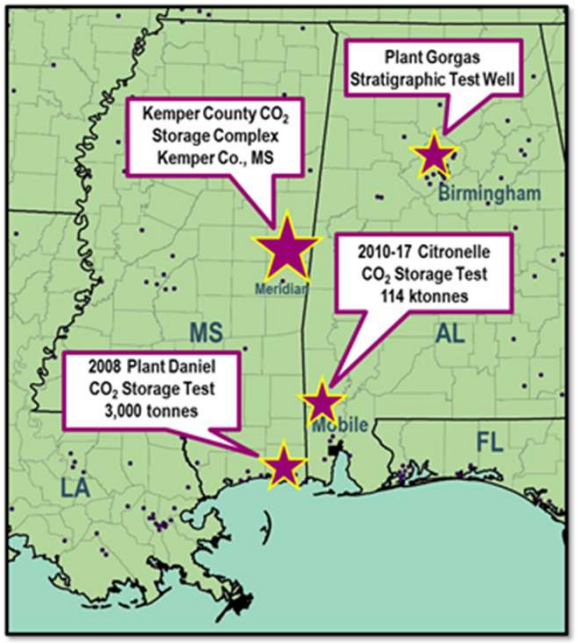
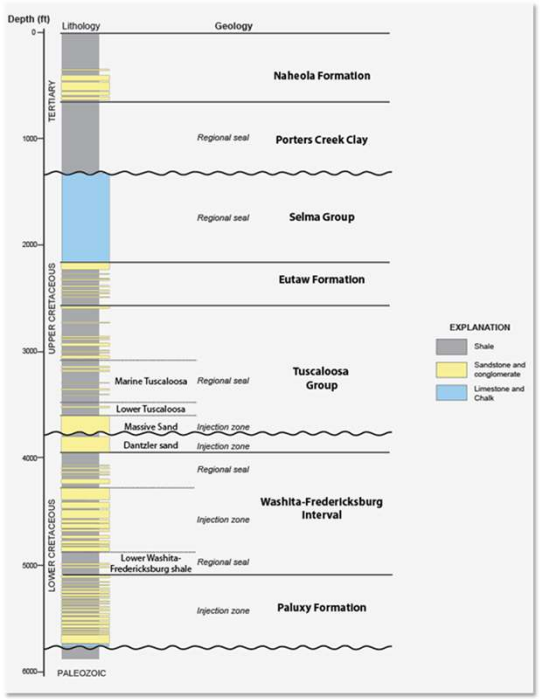
# CarbonSAFE Project ECO$_2$S




- The goal of Project ECO$_2$S is to demonstrate that the subsurface at Kemper can safely and permanently store commercial volumes of $CO_2$
- The project team has established a 30,000 acre area of interest which contains gigatonne $CO_2$ storage potential
- Continued Southern Company support for CCS R&D

# Kemper County Energy Facility

- The Kemper County Energy Facility was designed to be the largest IGCC project undertaken, the first to use lignite as fuel, the first to capture and sell $CO_2$, and the first to produce multiple byproducts from initial startup.
- Kemper *However*, on June 28, 2017, Southern Company and Mississippi Power Company announced they were suspending start-up and operations activities involving the lignite gasification portion of the Kemper County energy facility.
- The net plant capacity is 582 MW of electricity at peak power production and the plant continues to generate electricity using natural gas, producing 780 ktonnes of $CO_2$ per year
- Project $ECO_2S$ continues to characterize the subsurface beneath Kemper and evaluate commercial storage opportunities

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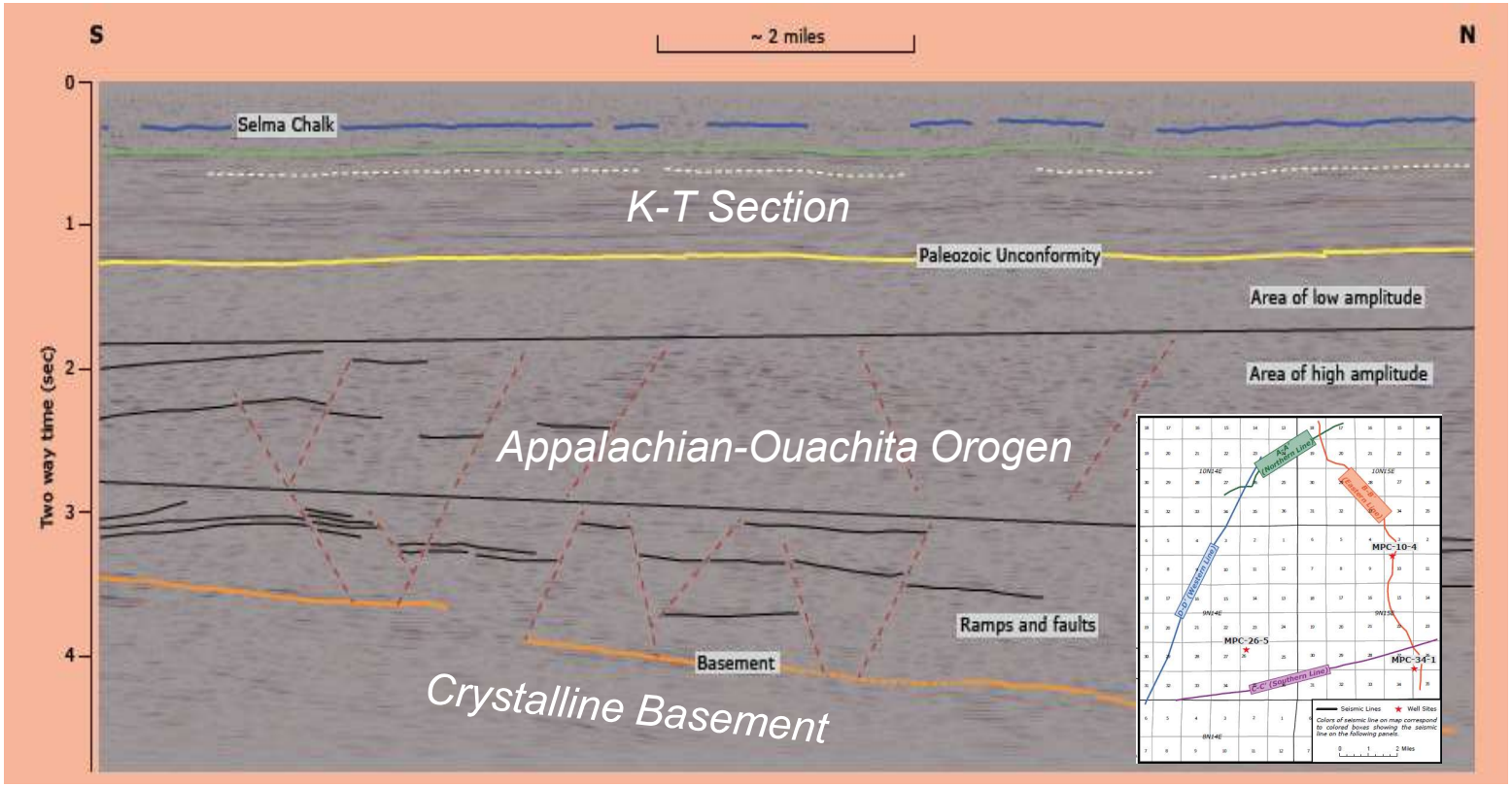
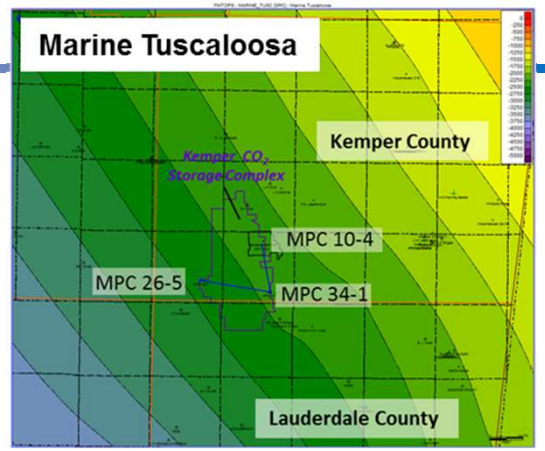
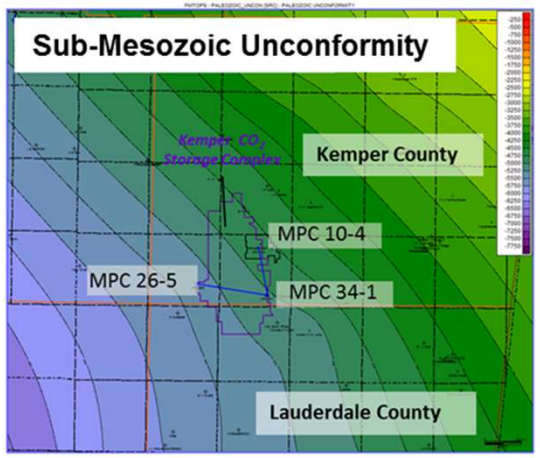
# $ECO_2S$ Data Collection

- Three characterization/monitoring wells were drilled in 2017 to test and characterize geologic properties
- 200 ft of hole core was taken from the Paluxy and Washita-Fredericksburg reservoirs and the Marine Tuscaloosa shale confining unit
- Reservoir fluid sampling and injection tests

# $ECO_2S$ Geologic Structure



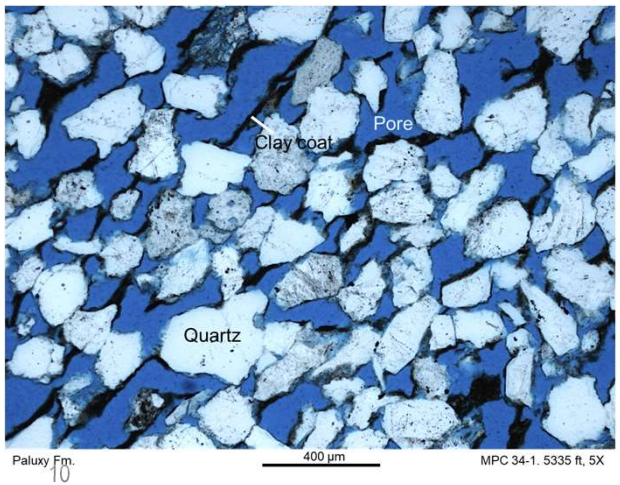



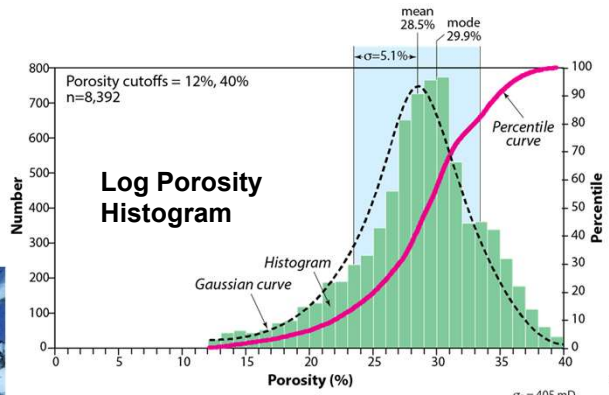



# The Reservoirs Rock!!!

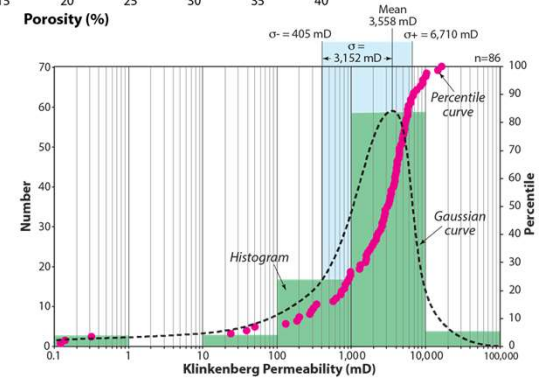
- Major stacked storage potential with >1,300 net feet of sandstone.
- Logs and core show sandstone mean porosity of 29%
- Mean permeability of 3.6 Darcies

**Dissolution Porosity, Paluxy Formation**

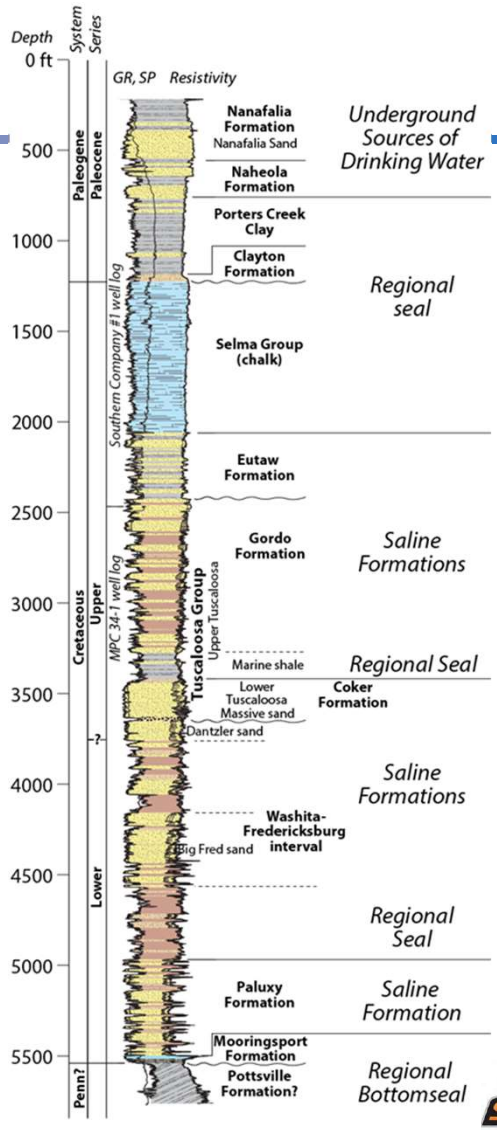



**Log Porosity Histogram**



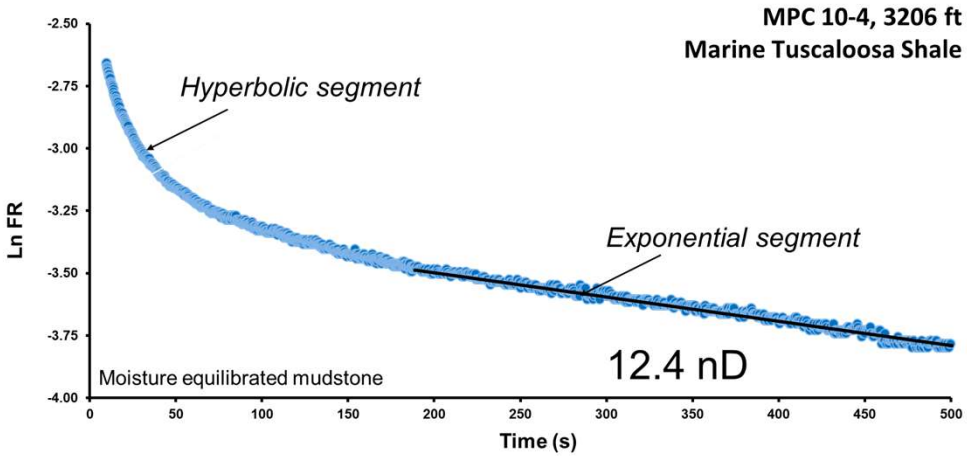

**Core Perm Histogram**

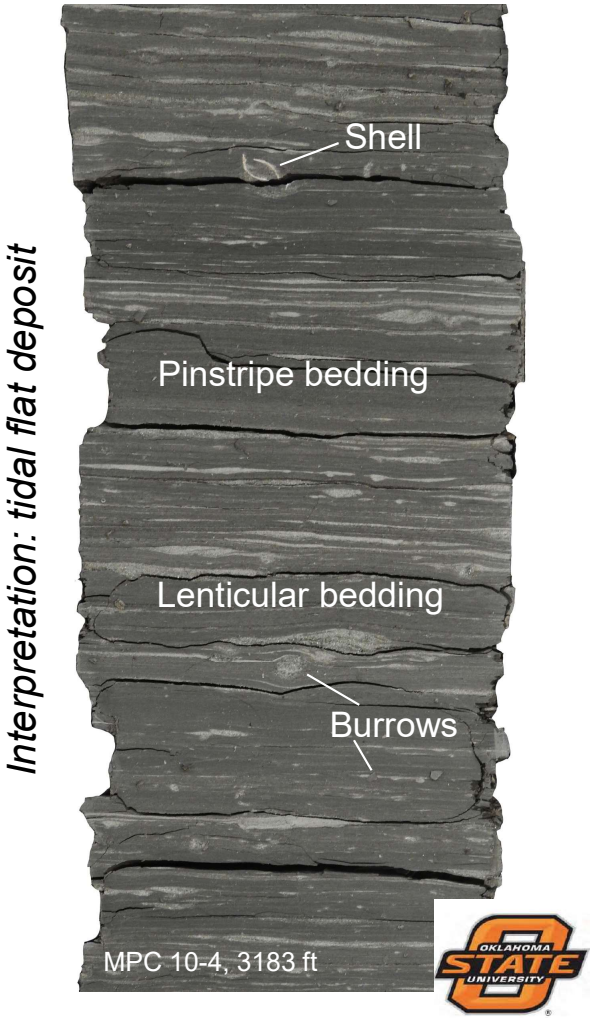


# Confining Units

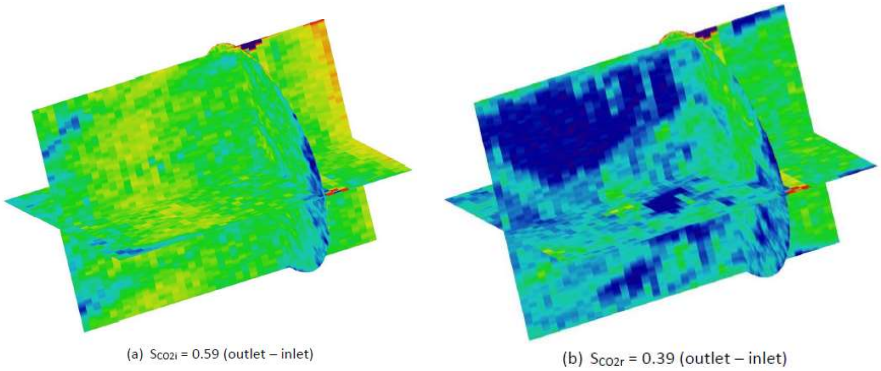
## Marine Tuscaloosa Shale

- Seals include mudrock and chalk
- Mudrock units are likely effective seals; slow permeation of the mudrock pore systems makes significant migration of injected $CO_2$ out of the storage complex unlikely
- Pressure decay permeametry tests indicate nanoDarcy permeability



# But what will happen when we put $CO_2$ in there?



(a) $S_{co2i}$ = 0.59 (outlet – inlet)

(b) $S_{co2r}$ = 0.39 (outlet – inlet)

Initial and residual $CO_2$ saturation along the length of a core sample

## $CO_2$ Flow Studies

- Residual water and $CO_2$ saturations
- Relative permeability curves
- Impacts of $CO_2$ foam on conformance

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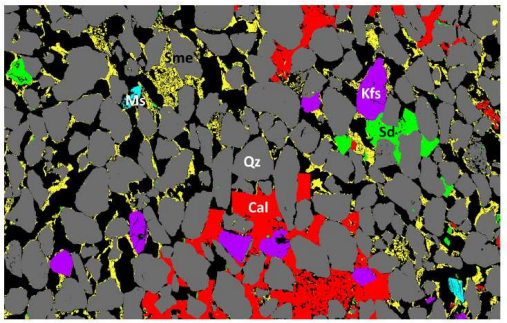
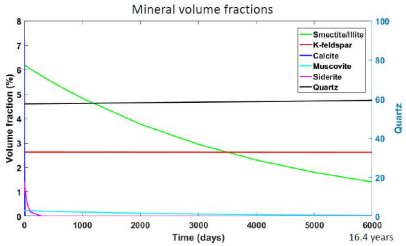
## Reactive Transport Modeling

- Dissolution of calcite, siderite, muscovite and smectite/illite lead to an increase in porosity of ~11%
- Calculated* perm increases 2.6 to 11.5 Darcies

*Kozeny-Carman approach



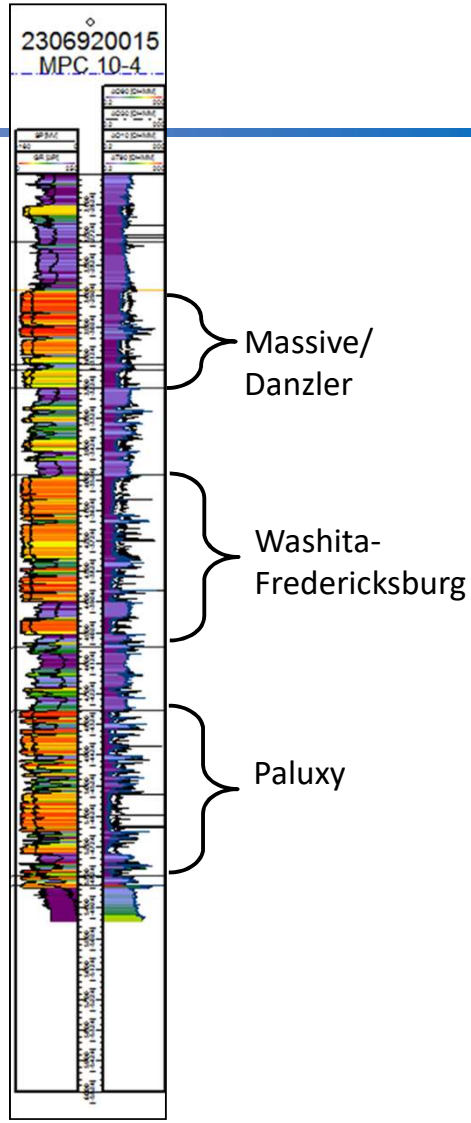

| Mineral | Quartz | K-feldspar | Calcite | Smectite/illite | Muscovite | Siderite |
|---|---|---|---|---|---|---|
| Volume percentage(%) | 76.45 | 3.50 | 9.63 | 8.23 | 0.31 | 1.88 |

# ECO2$_S$ Storage Complex Capacity

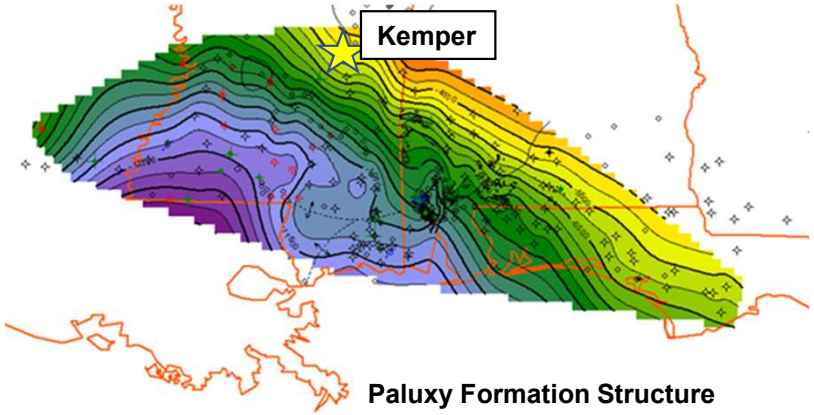
- Each of the three potential storage zones have commercial capacity
- Together the three storage zones result in a gigatonne capacity storage complex that has the potential to act as a regional hub

| $CO_2$ Storage Reservoir | $P_{10}$ Capacity (MMmt) | $P_{50}$ Capacity (MMmt) | $P_{90}$ Capacity (MMmt) |
|---|---|---|---|
| Massive/Dantzler | 60 | 120 | 200 |
| Wash.-Fred. | 280 | 540 | 920 |
| Paluxy | 160 | 310 | 530 |
| TOTAL | **510** | **970** | **1,660** |

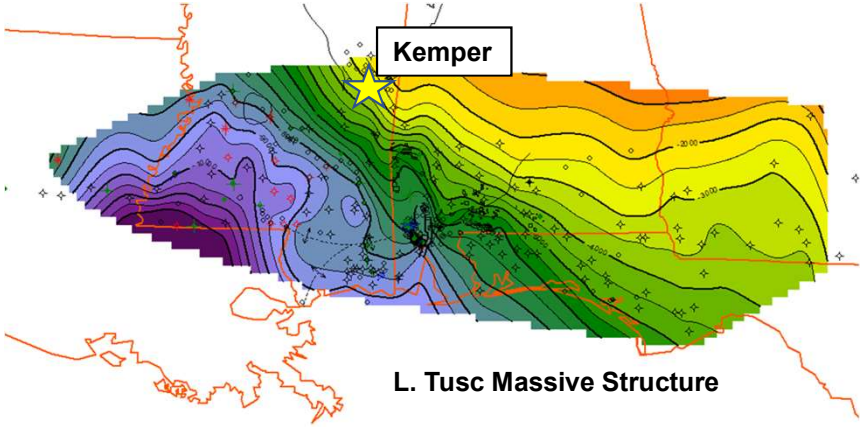
*DOE methodology for site-specific saline storage efficiency calculation based on fluid displacement factors for clastic reservoirs where net pay, net thickness and net porosity are known of 7.4% ($P_{10}$), 14% ($P_{50}$) and 24% ($P_{90}$) (Goodman et al., 2011)*



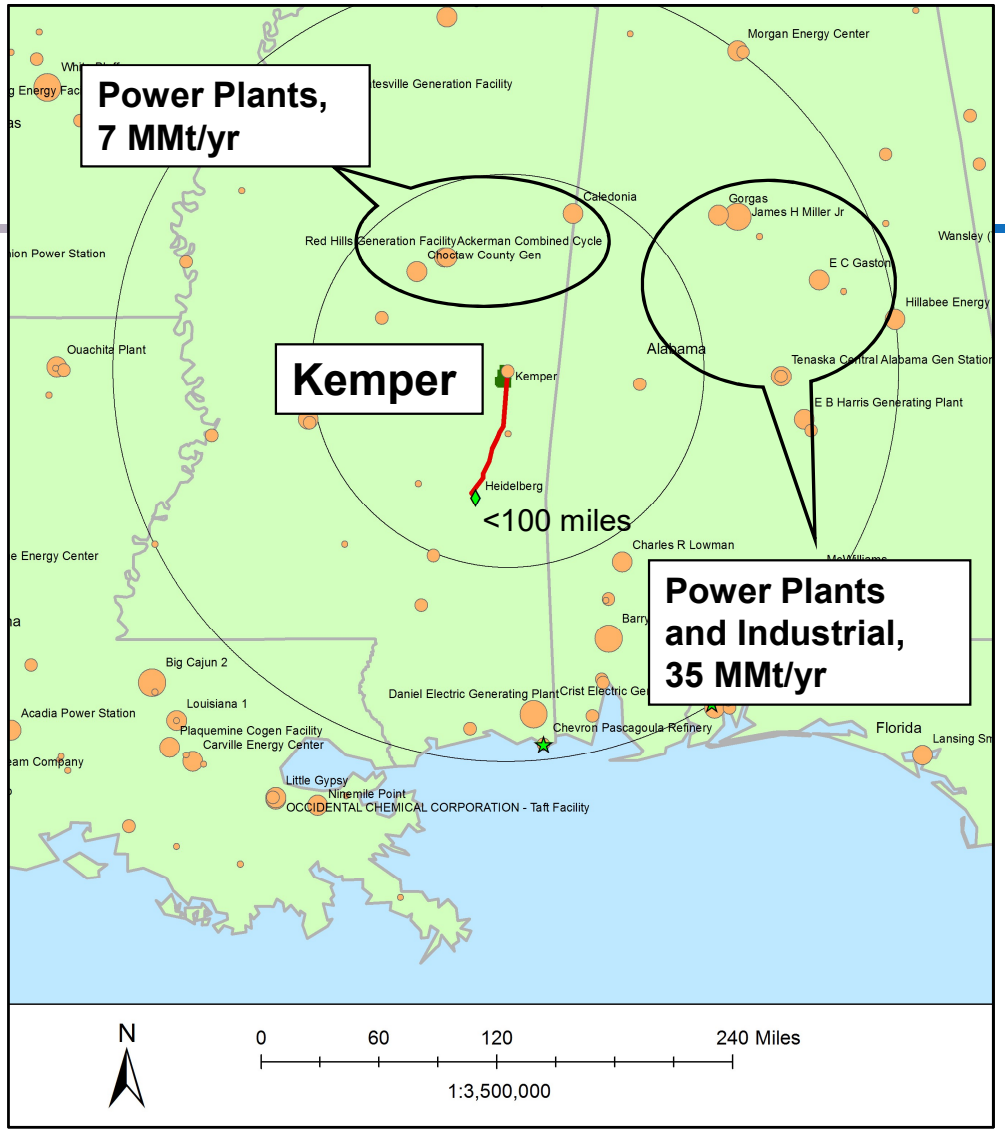
# Regional $CO_2$ Sources




Paluxy Formation Structure




L. Tusc Massive Structure



# Southern Company's Interest

- Projects like $ECO_2S$ inform Southern Company on the benefits and costs associated with CCS.
- Low-cost storage at $ECO_2S$ due to exceptional geology
  - $2.00 - $4.00 USD per metric ton
- Studying natural gas combustion at Kemper makes sense – it's the fuel of the future in the Southeast (e.g. NCCC expanding natural gas capture studies)
- Applying data to internal resource planning and modeling (See Esposito et al., Reconsidering CCS in the U.S. Fossil-Fuel Fired Electricity Industry Under Section 45Q Tax Credits, Greenhouse Gases: Science and Technology *in press*)
- Evaluation of Kemper site as a regional storage hub

# Finishing up our CarbonSAFE Phase II

- **Injection simulation and optimization** – modeling and reservoir simulation studies
- **Comprehensive $ECO_2S$ risk assessment** - two workshops to date, 114 risk scenarios identified, 229 risk treatments suggested
- **$ECO_2S$ storage site commercialization plan** – where does a large regional storage hub fit in the southeast's CO2 reality
- **Define an MVA system**
- **Outreach**

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