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

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Southern Company

Mississippi Power

SOUTHERN STATES ENERGY BOARD

Advanced Resources International, Inc.


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Disclaimer

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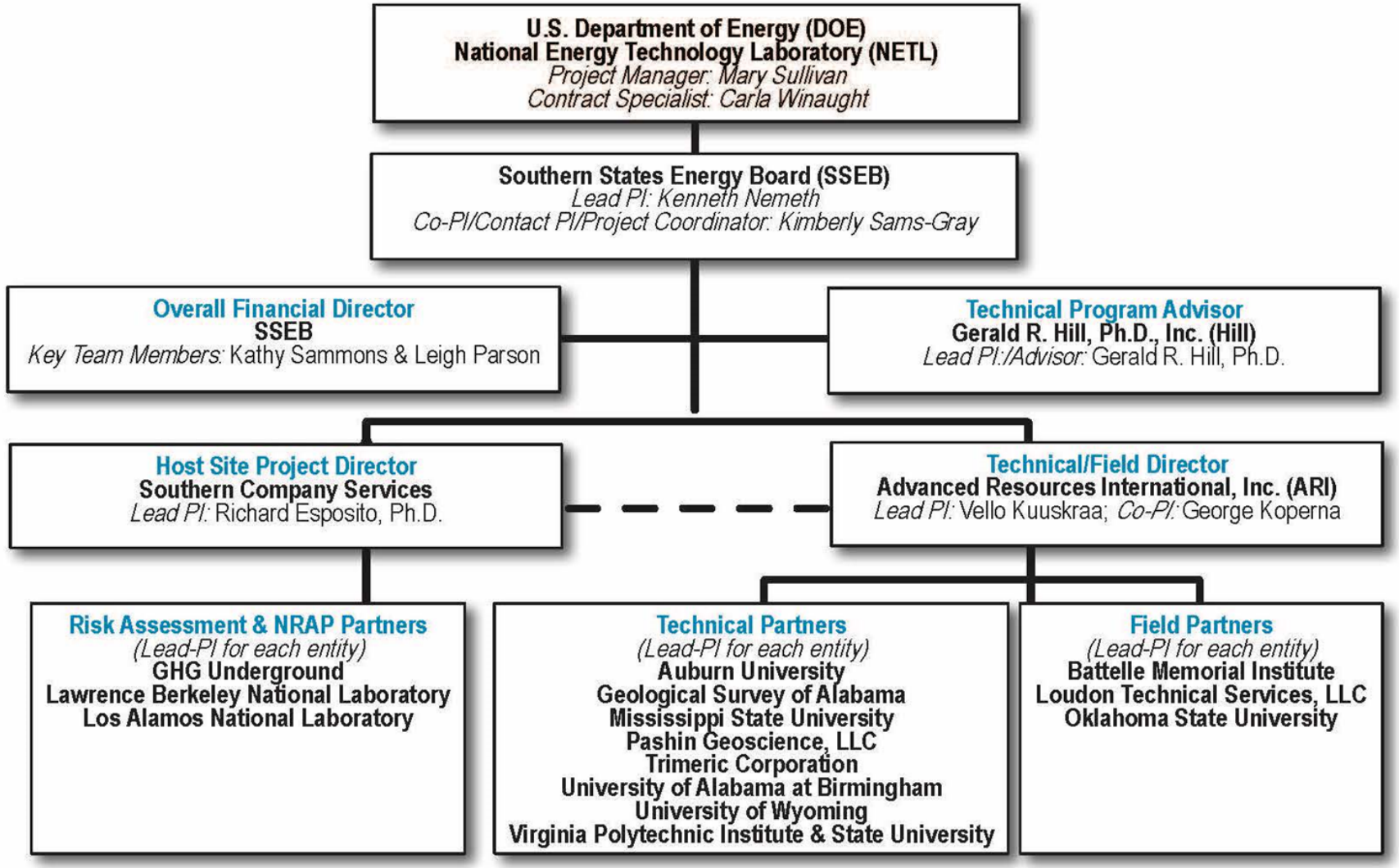
Project ECO_2S Org Chart

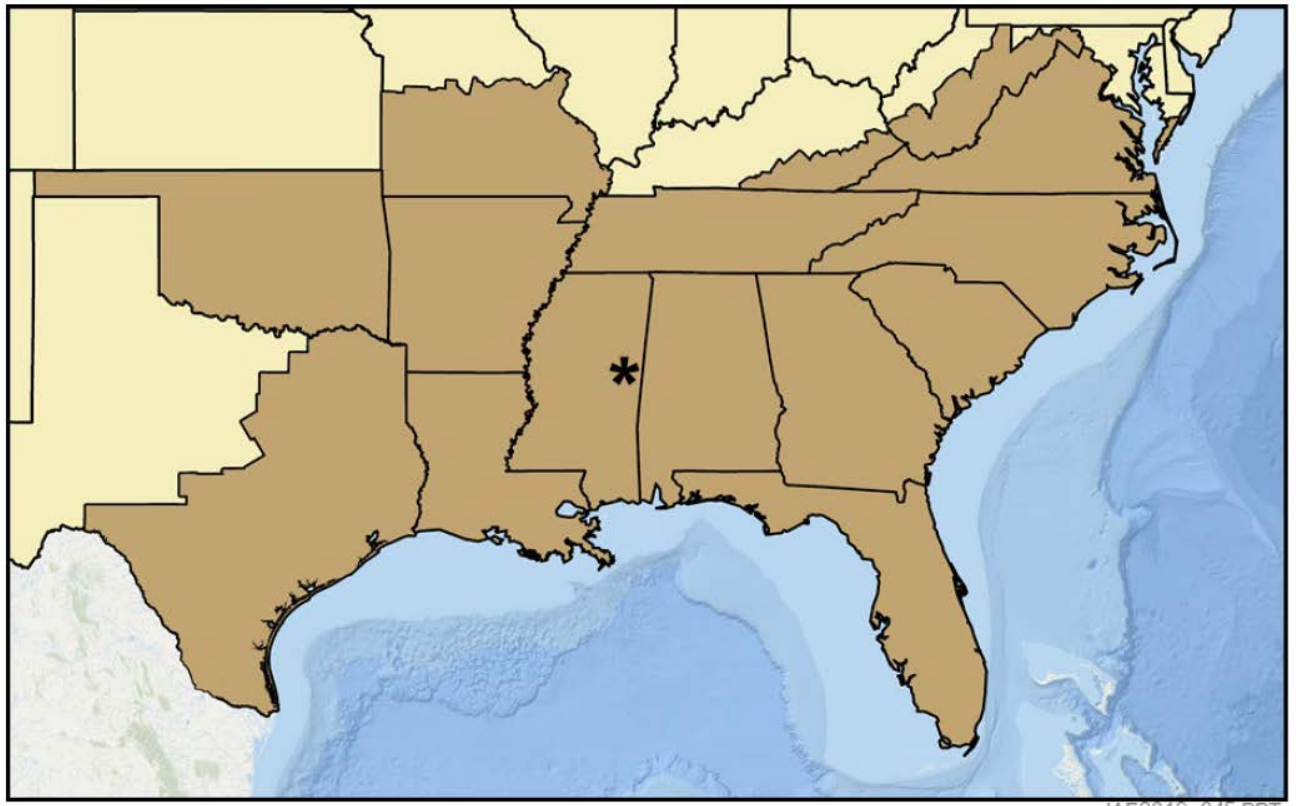


Setting the Stage

- 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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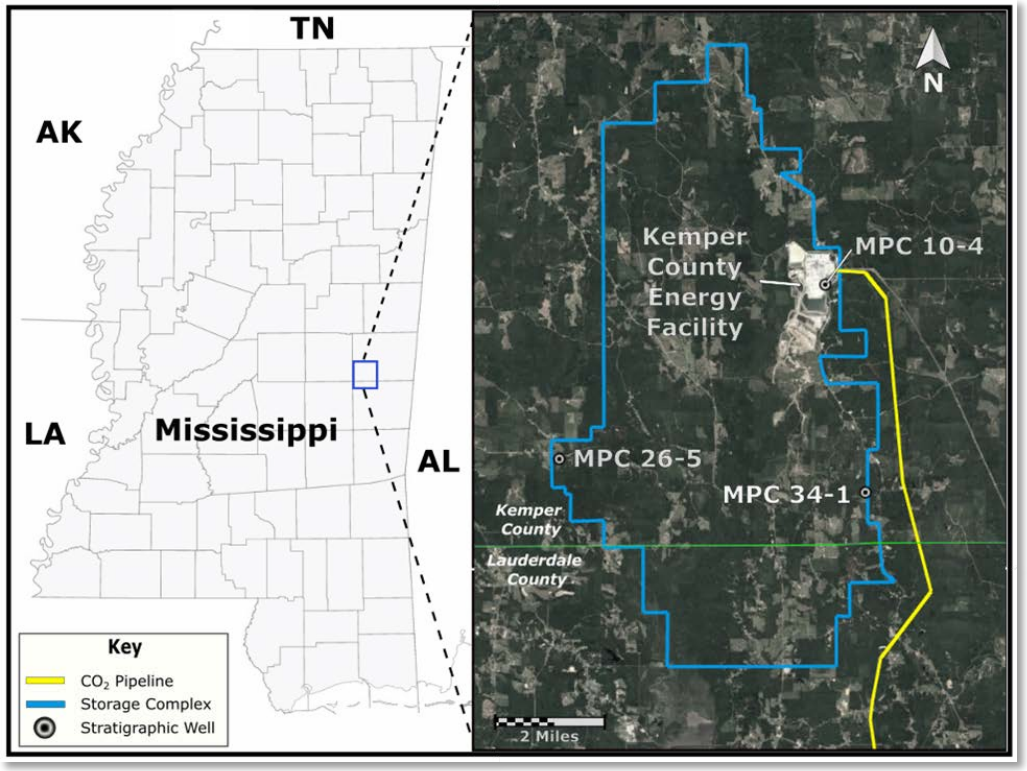
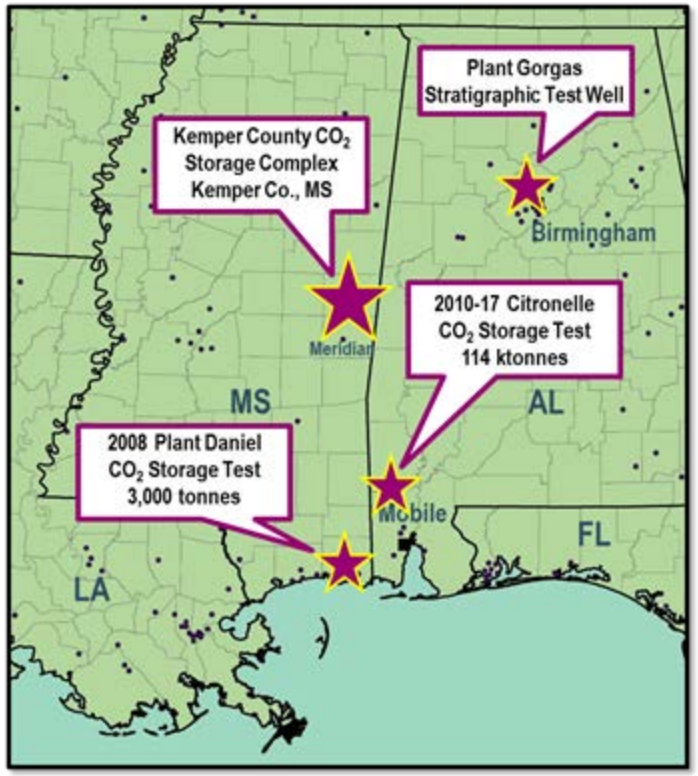
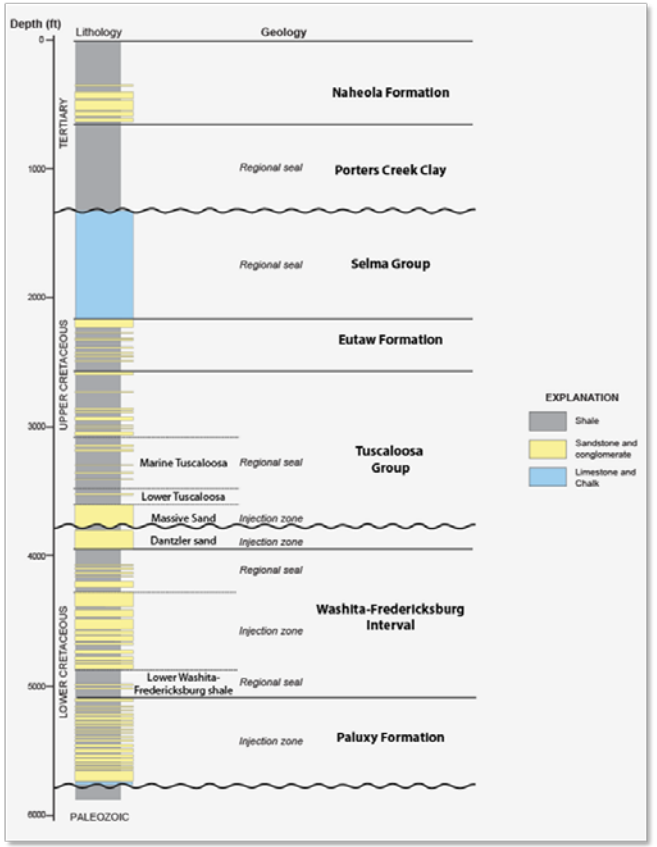
CarbonSAFE Project ECO$_2$S



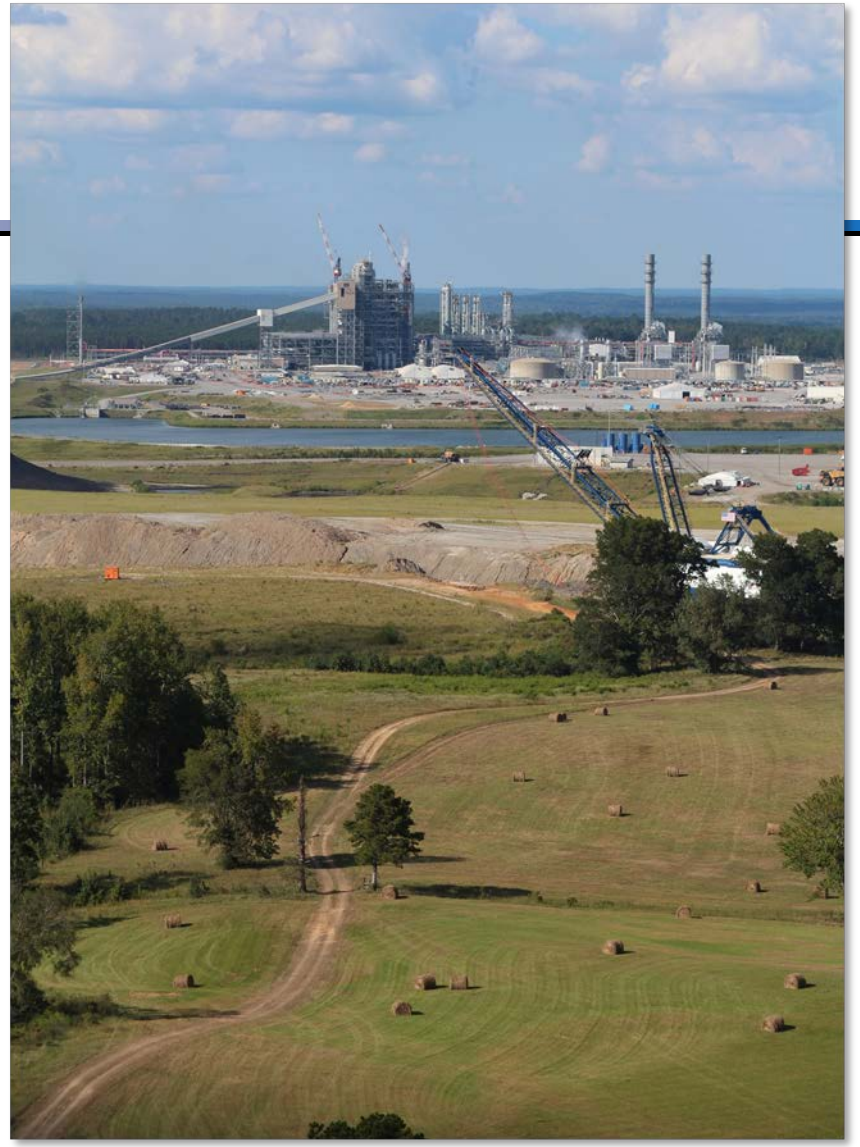




- The goal of Project ECO$_2$S is to demonstrate that the subsurface at Kemper can safely and permanently store commercial volumes of CO$_2$
- The project team has established a 30,000 acre area of interest which contains gigatonne CO$_2$ storage potential
- Continued Southern Company support for CCS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



Southern Company

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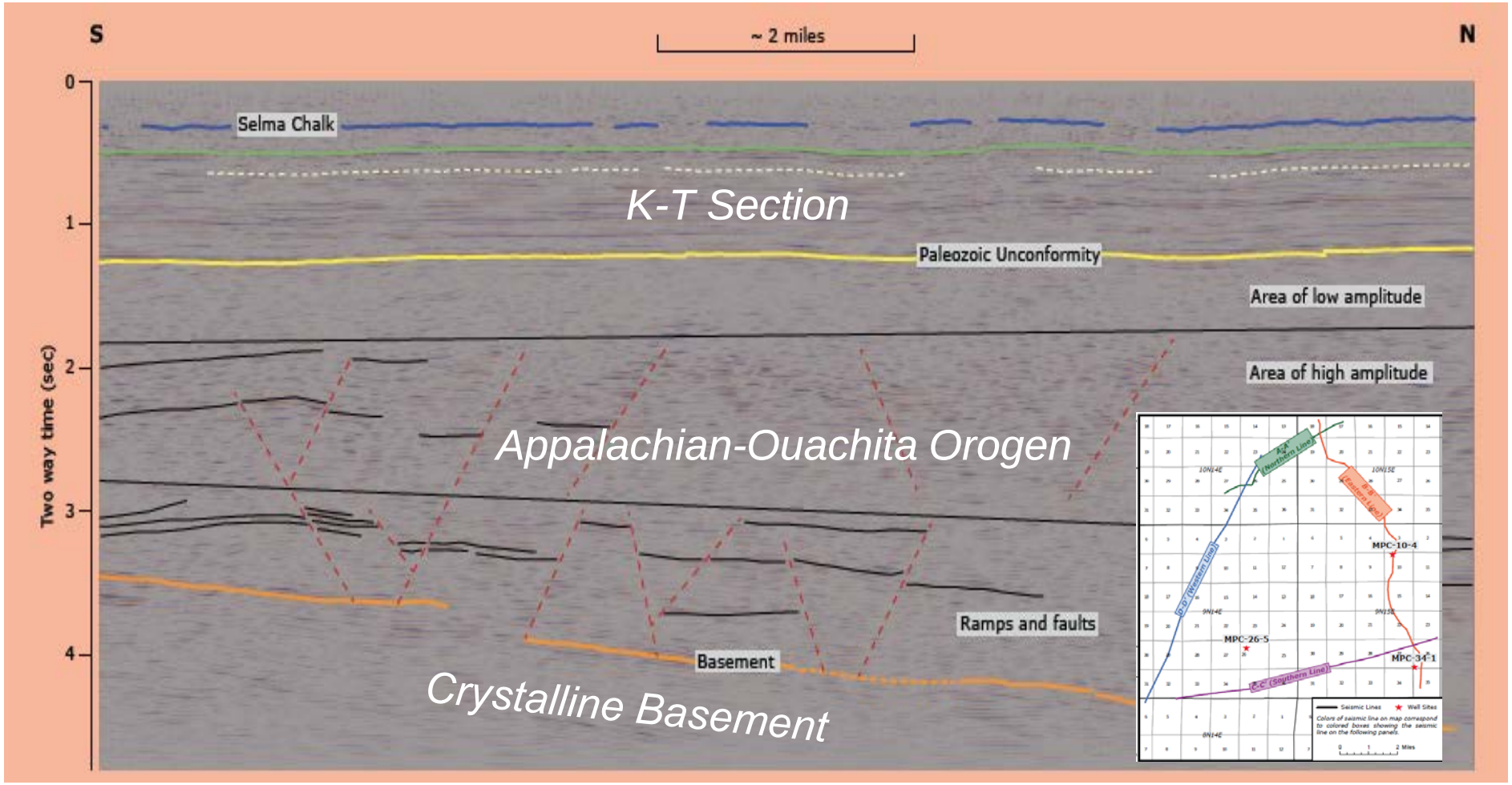
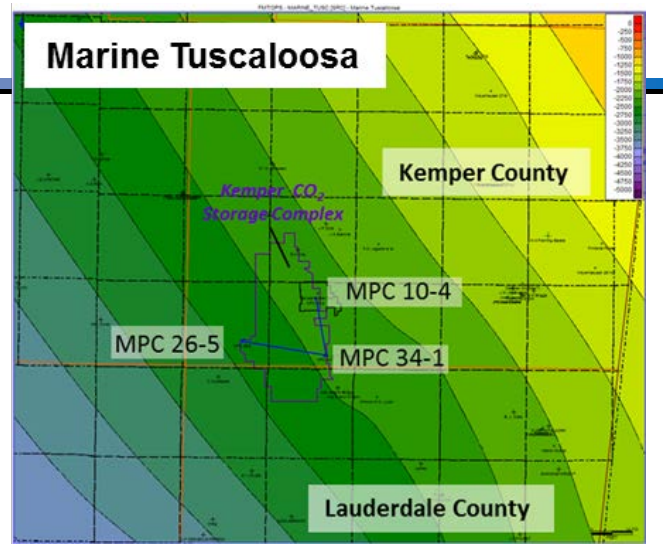
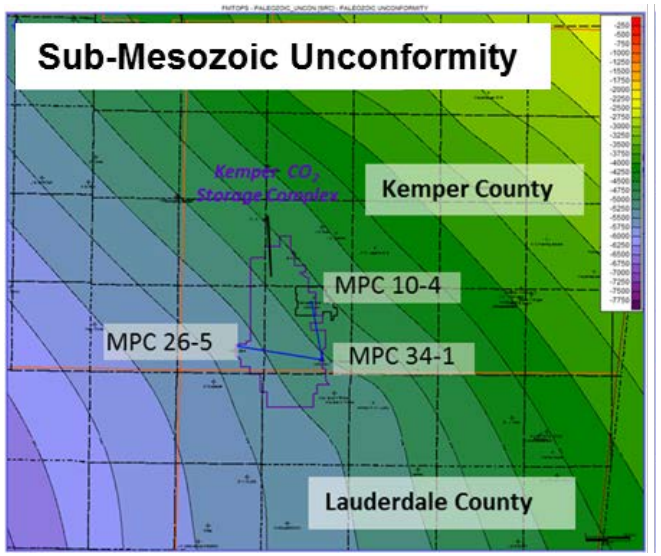
ECO_2S Data Collection

- 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



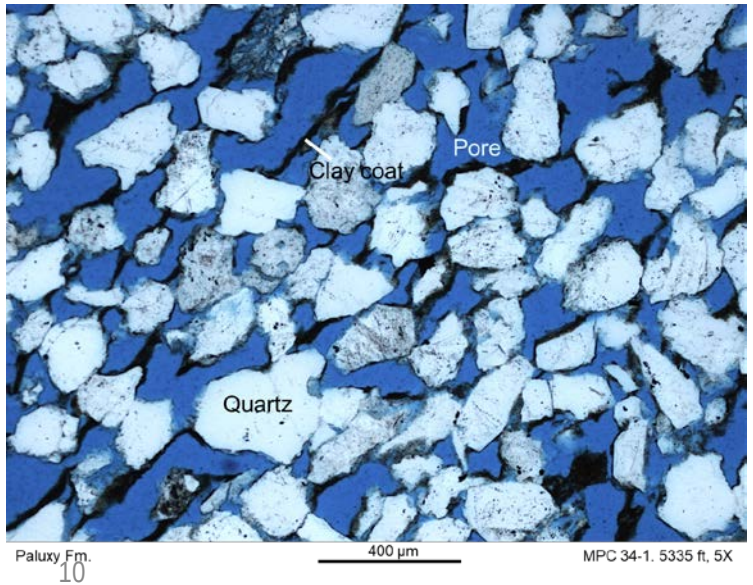


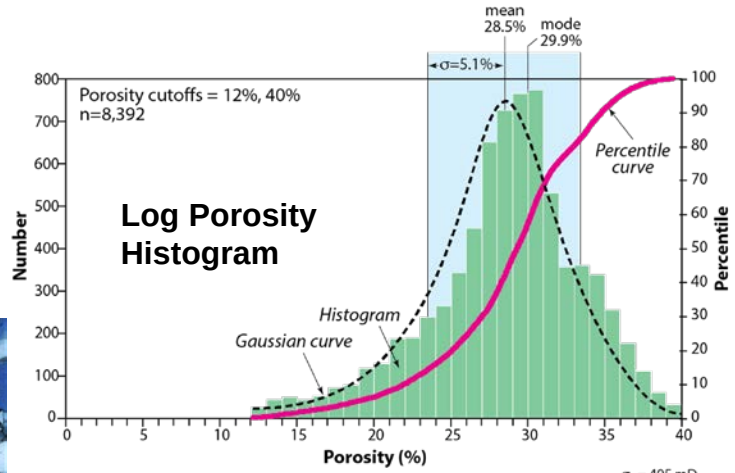


The Reservoirs Rock!!!

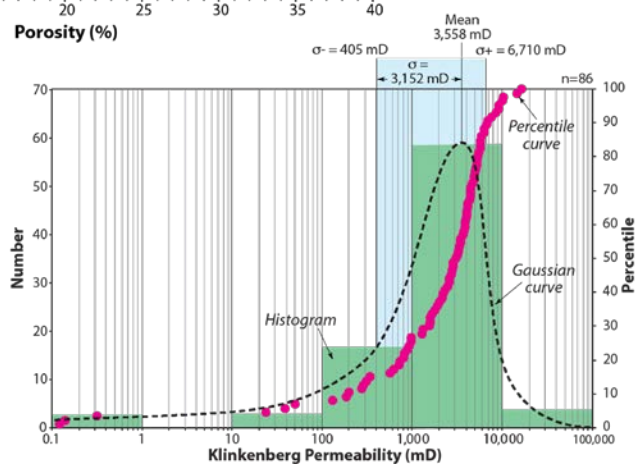
- Major stacked storage potential with >1,300 net feet of sandstone.
- Logs and core show sandstone mean porosity of 29%
- Mean permeability of 3.6 Darcies

Dissolution Porosity, Paluxy Formation

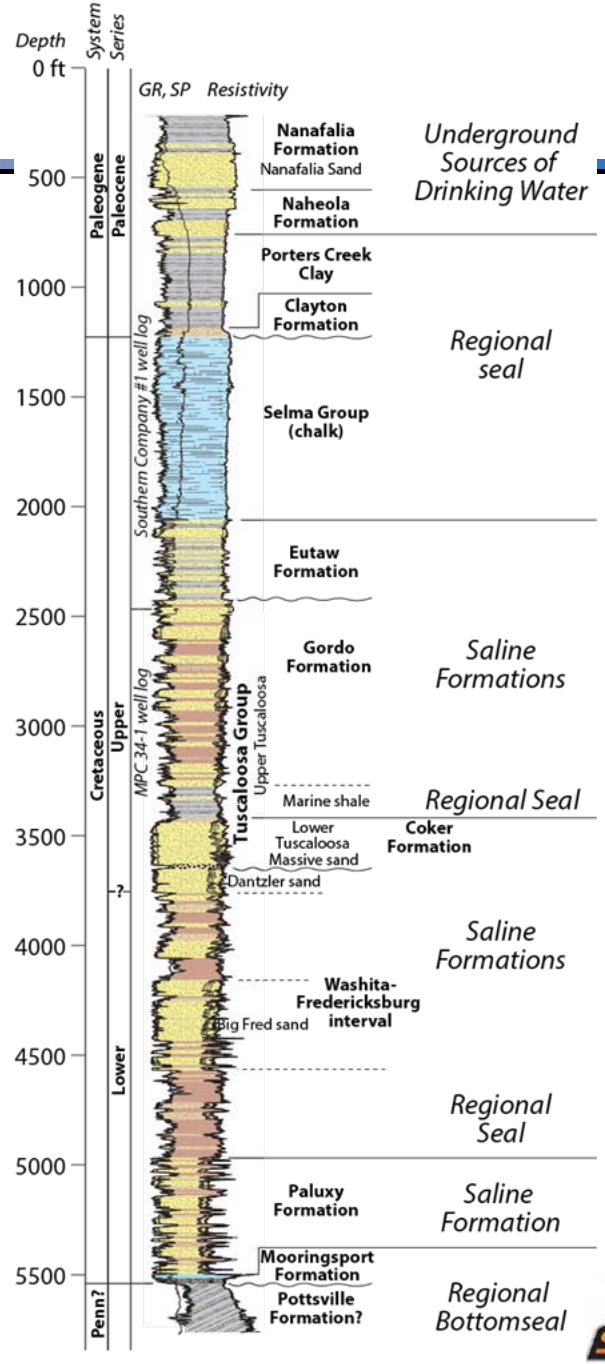




Log Porosity Histogram



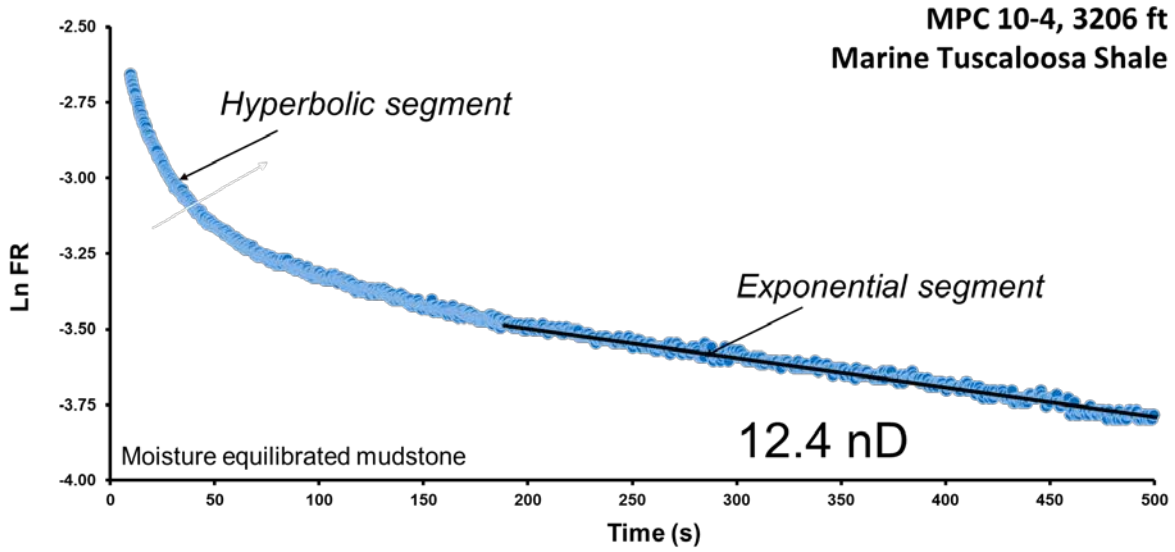
Core Perm Histogram

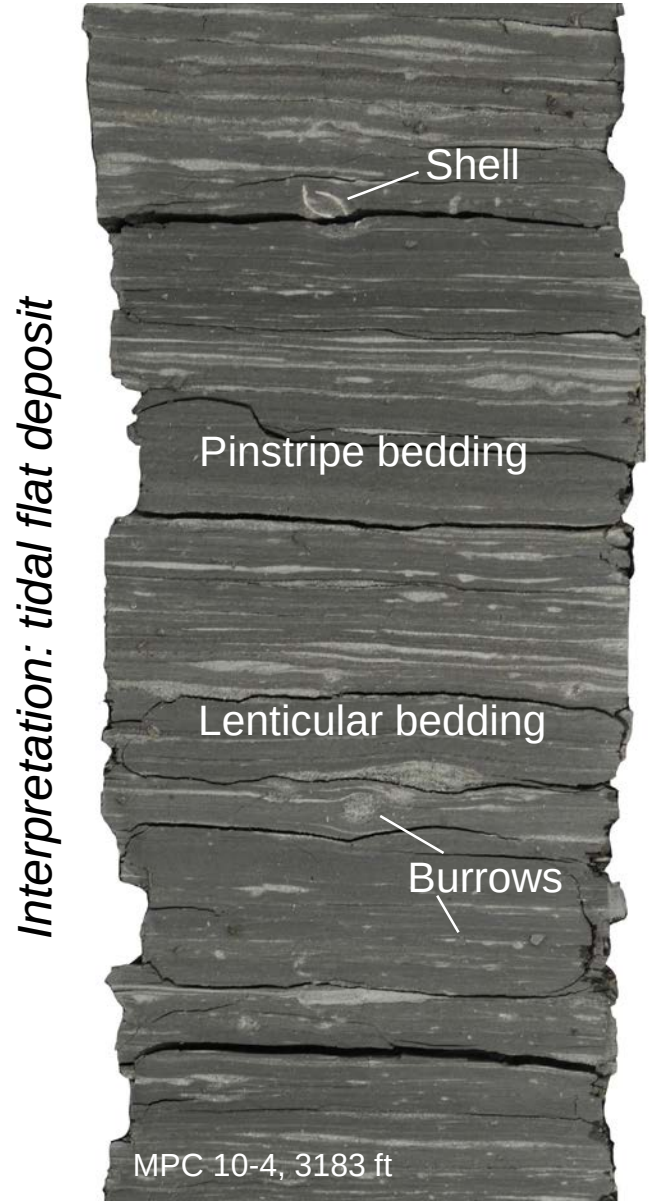


Confining Units

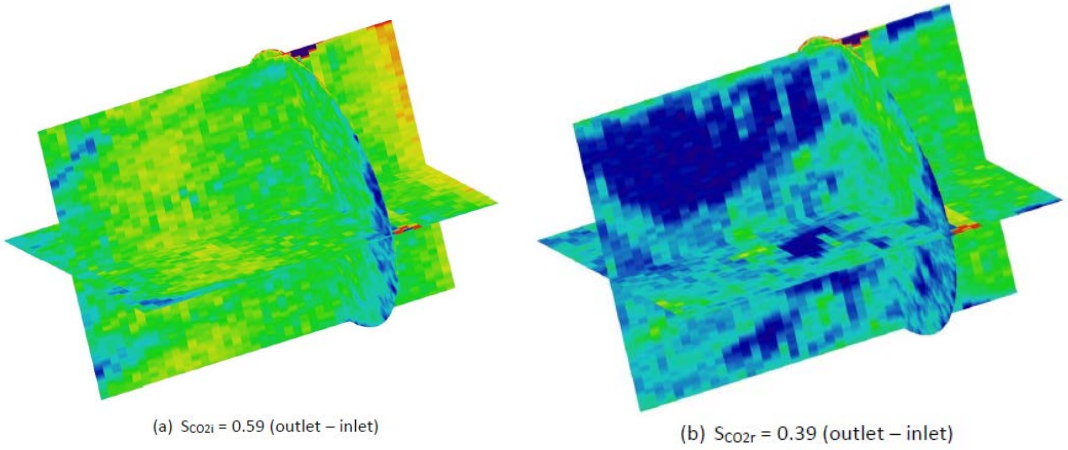
Marine Tuscaloosa Shale

- Seals include mudrock and chalk
  - Smectititic clay in all units with large amounts of bound water
  - Soft and pliable and thus very difficult to fracture
- 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
- Micro-fluidics - impacts of CO_2 foam on conformance

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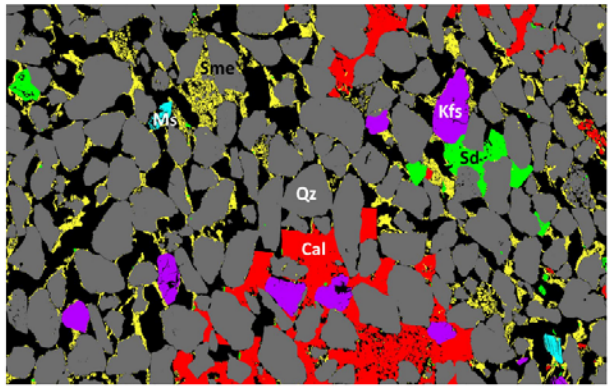
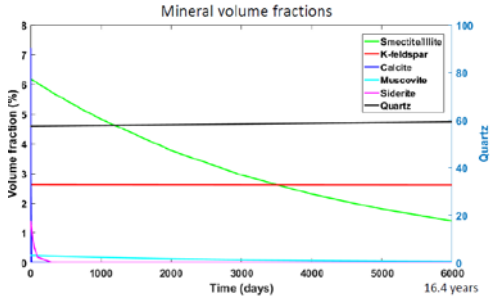
Reactive Transport Modeling

- 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





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

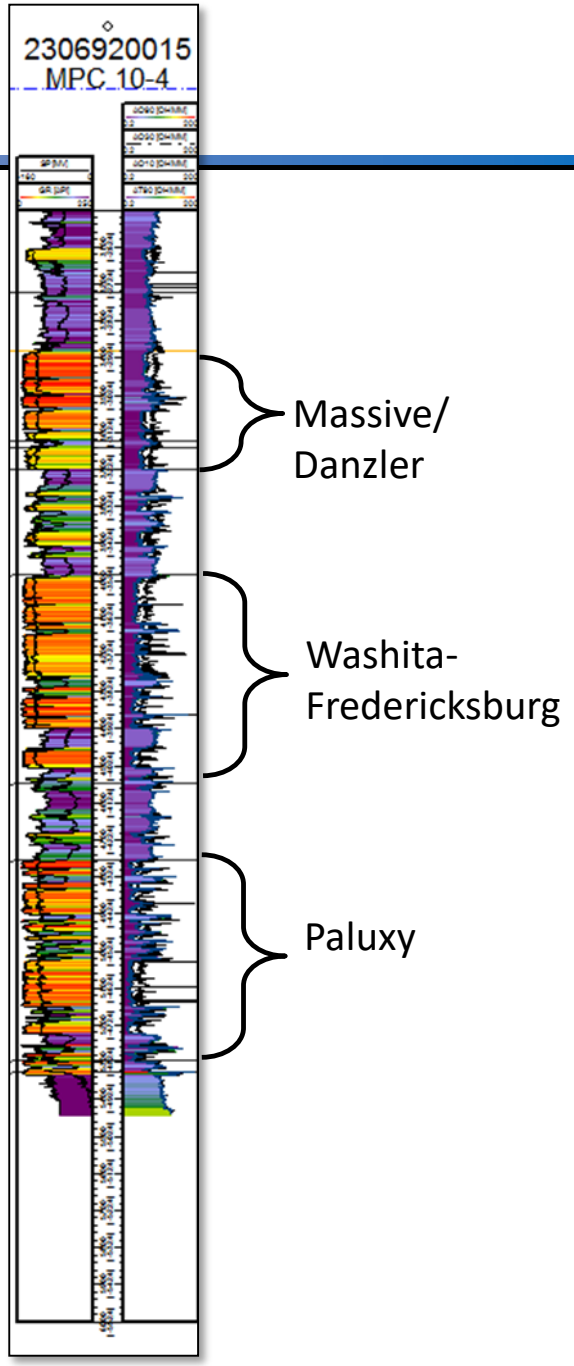
*Kozeny-Carman approach

ECO2$_S$ Storage Complex Capacity

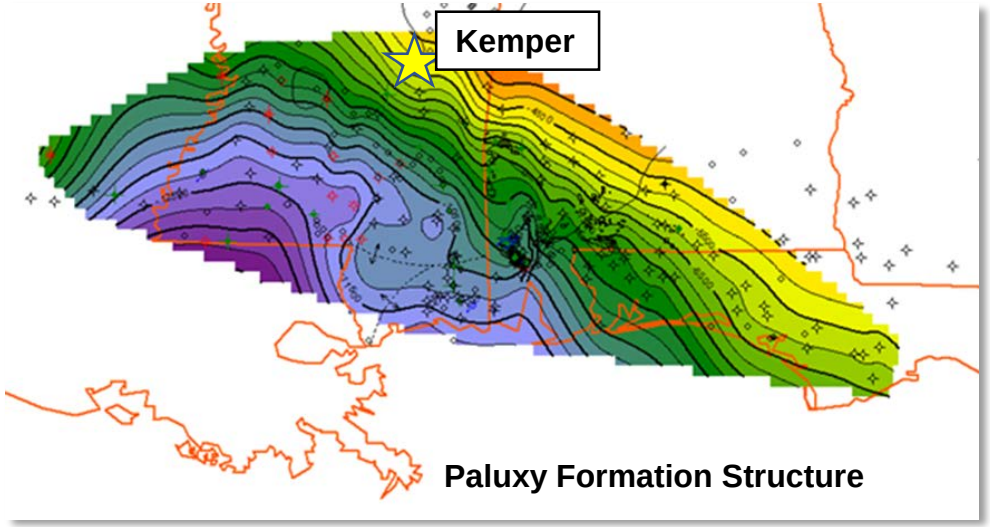
- Each of the three potential storage zones have commercial capacity
- Together the three storage zones result in a gigatonne capacity storage complex that has the potential to act as a regional hub

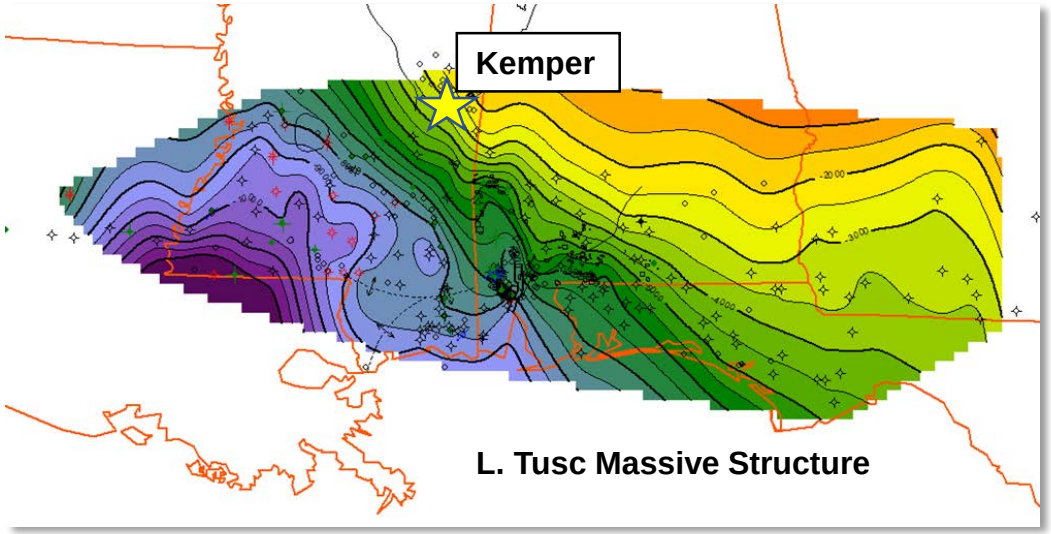
CO_2 Storage Reservoir	P_{10} Capacity (MMmt)	P_{50} Capacity (MMmt)	P_{90} Capacity (MMmt)
Massive/Dantzler	60	120	200
Wash.-Fred.	280	540	920
Paluxy	160	310	530
TOTAL	**510**	**970**	**1,660**

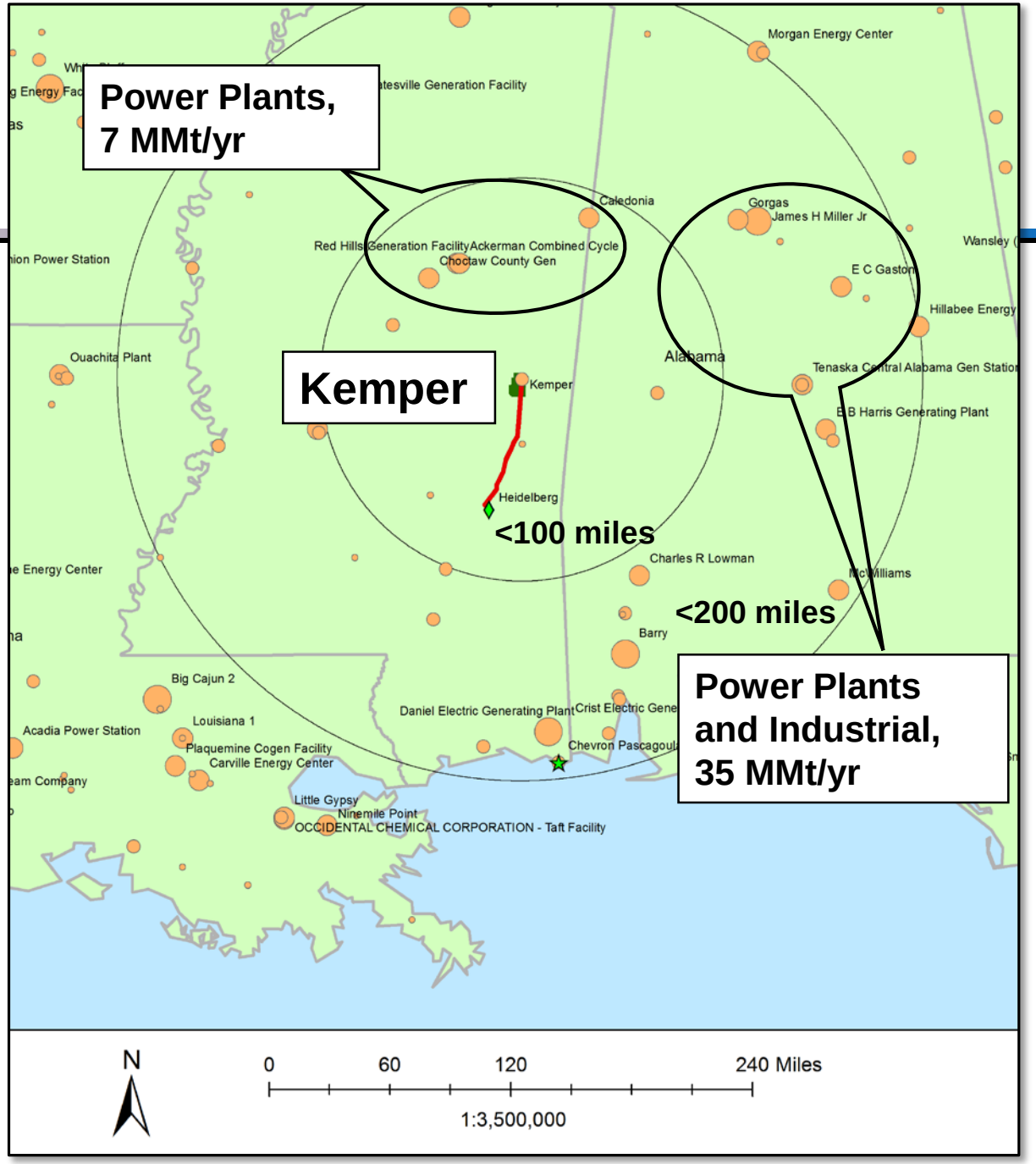
DOE methodology for site-specific saline storage efficiency calculation based on fluid displacement factors for clastic reservoirs where net pay, net thickness and net porosity are known of 7.4% (P_{10}), 14% (P_{50}) and 24% (P_{90}) (Goodman et al., 2011)



Regional CO_2 Sources







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 proposed
- **ECO_2S storage site commercialization plan** – where does a large regional storage hub fit in the southeast's CO_2 footprint
- **Define an MVA system**
- **Outreach**