

# Simulation of Carbon Sequestration at Cranfield Incorporating New Physical Models

## Scientific Achievement

Developed new computational tools to advance the capability to accurately simulate very large problems

## Significance and Impact

Represent essential features of large-scale behavior that emerge from small-scale phenomena and build confidence in our predictions by validating models against field injection observations

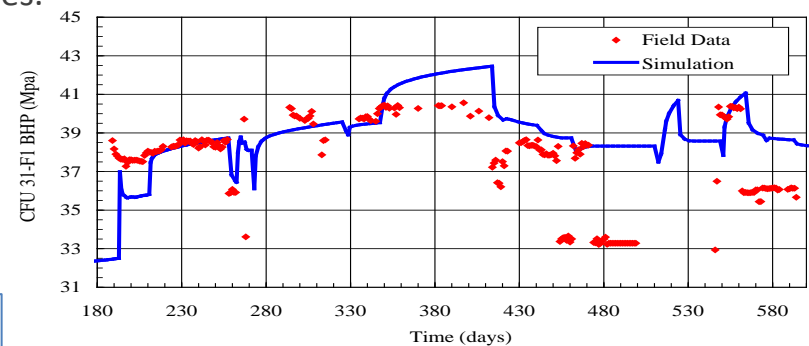
## Research Details

- Developed and implemented models to include pressure, temperature, and salinity effects on CO<sub>2</sub> properties of solubility and interfacial tension (IFT). Modeled capillary pressure and relative permeability including IFT and contact angle.
- Set up a geomodel of Cranfield site using IPARS, history matched field observations, and simulated post injection.
- Demonstrated the significance of geomechanics for rock integrity.
- Demonstrated the importance of CO<sub>2</sub>/brine relative permeabilities.

CO<sub>2</sub> Injection in Cranfield, Mississippi



Delshad, Kong, Tavakoli, Hosseini, and Wheeler, "Modeling and Simulation of Carbon Sequestration at Cranfield Incorporating New Physical Models," International Journal of Greenhouse Gas Control, 10.1016/j.ijggc.2013.03.019



Comparison of simulated injection BHP with field data



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**ENERGY**

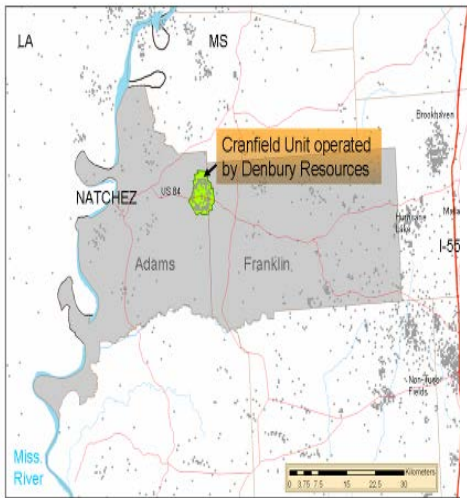
Office of  
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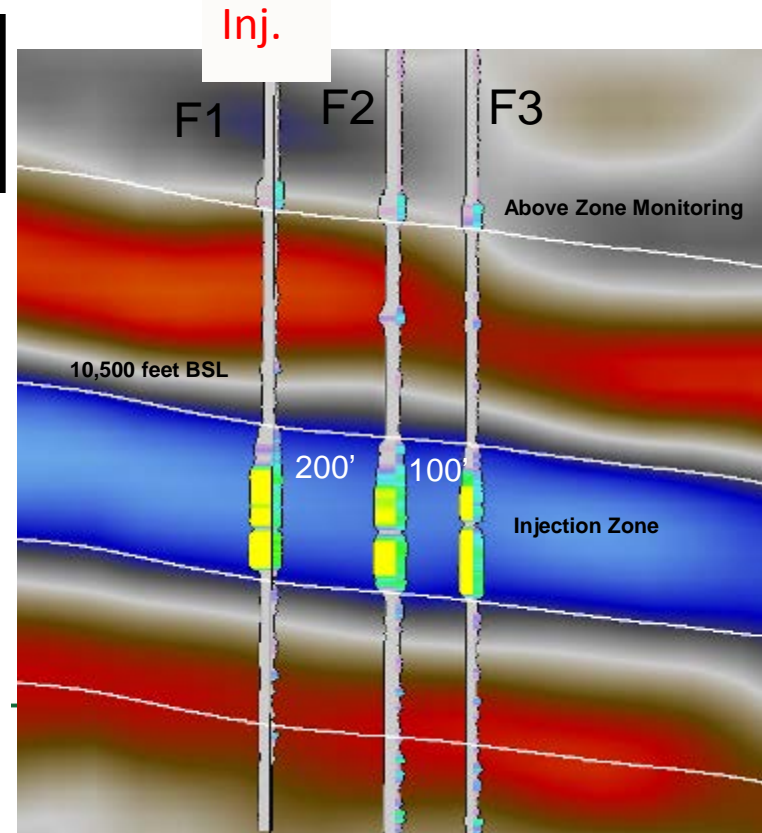
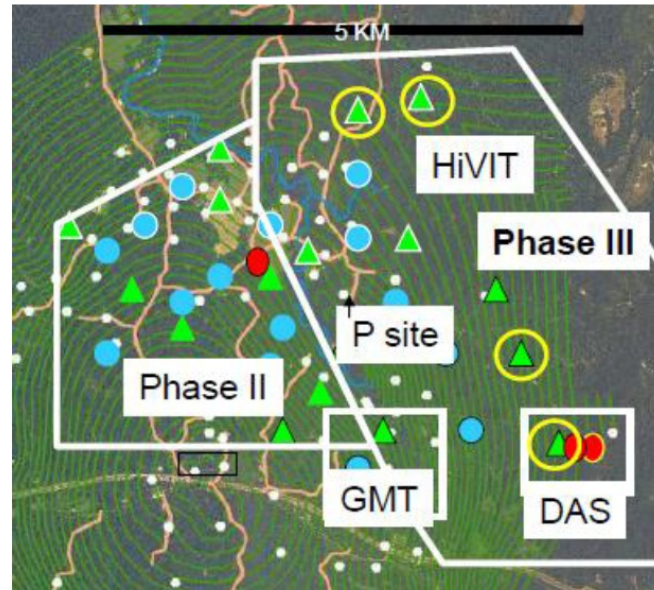
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# CO<sub>2</sub> Injection in Cranfield, Mississippi



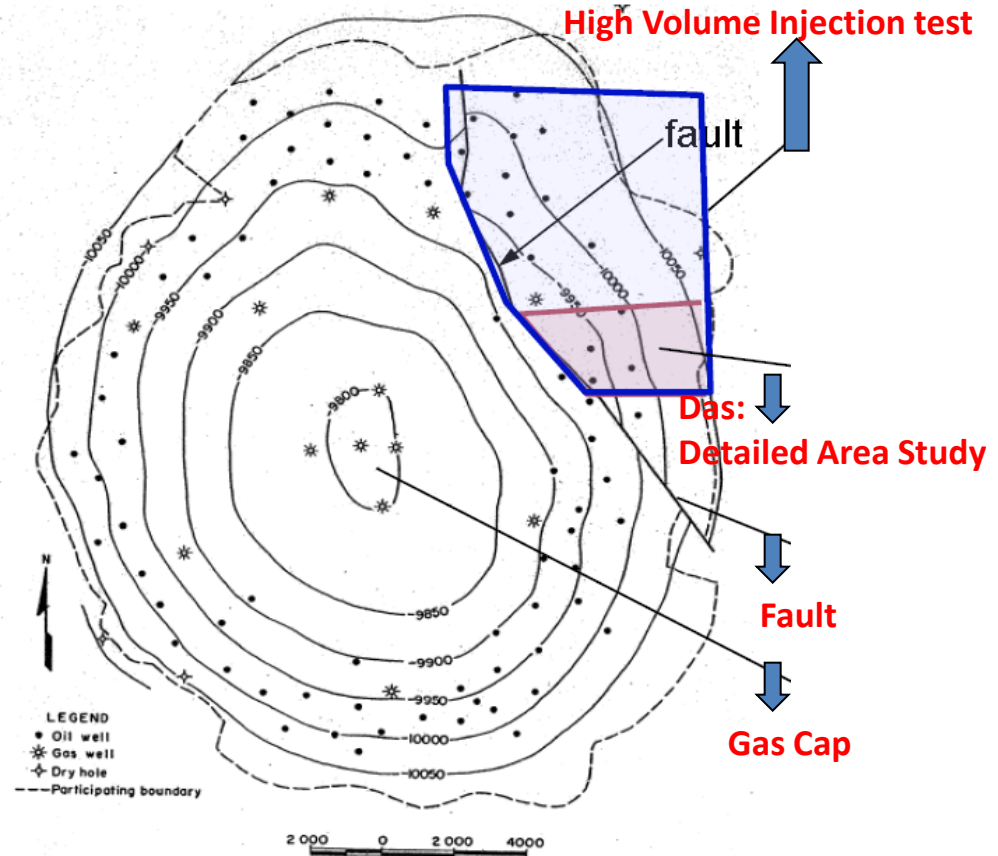
**3,000 m deep**  
**Inj. Rates of 5-10 MMSCFD**  
**Started in December 2009**



**Gulf Coast  
Carbon Center**

# Cranfield Pilot CO<sub>2</sub> Injection Test

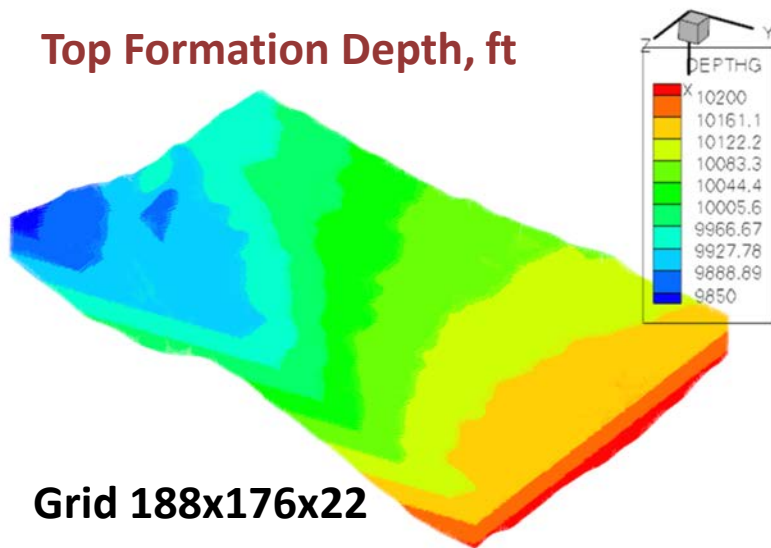
- Lower Tuscaloosa ~9800 ft (3000 m ) deep
- Thickness: 80~100 ft
- Porosity : 0.20-0.30
- Permeability: 50 - 1000 md
- Temperature and Pressure: 257 F, 4650 psi
- Brine salinity: > 150,000 ppm
- CO<sub>2</sub> injection started in July 2008
- 1 million metric ton/year rate
- Total 1.5 M metric tonnes injected in 1.5 years



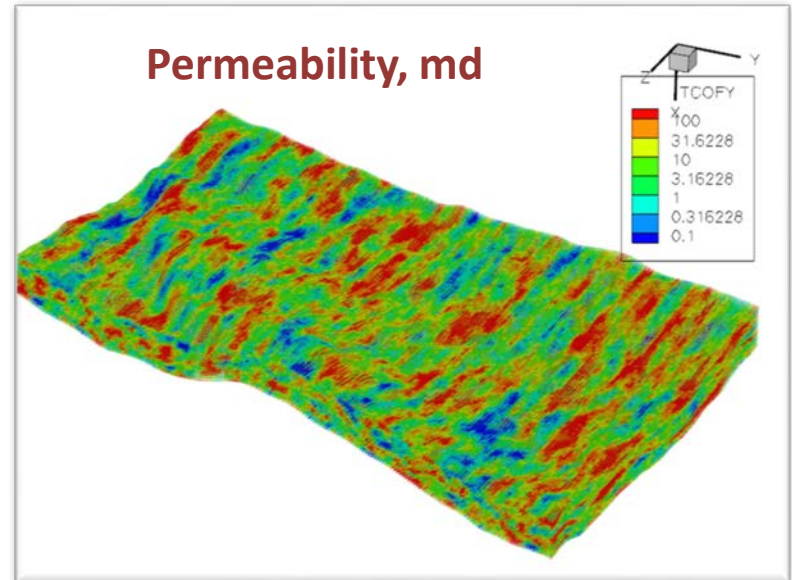
- Field data, 18 million grid
  - depth variation,  $K$ ,  $\Phi$ ,  $K_p$ ,  $P_c$ , etc

# Cranfield Model in IPARS

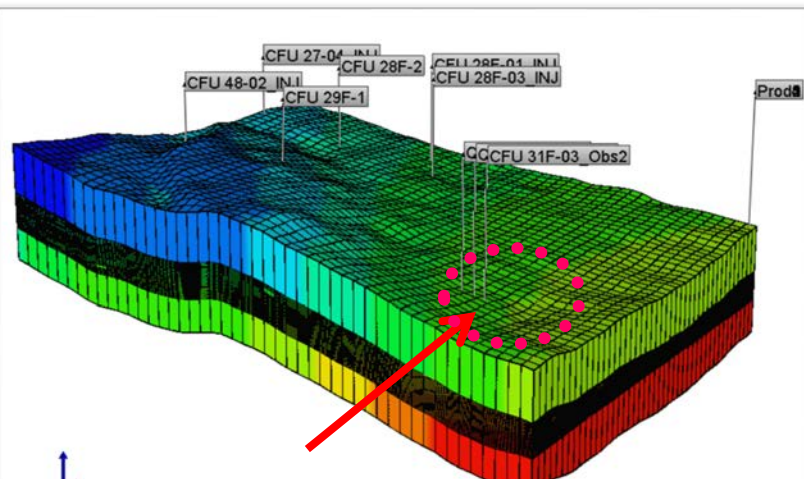
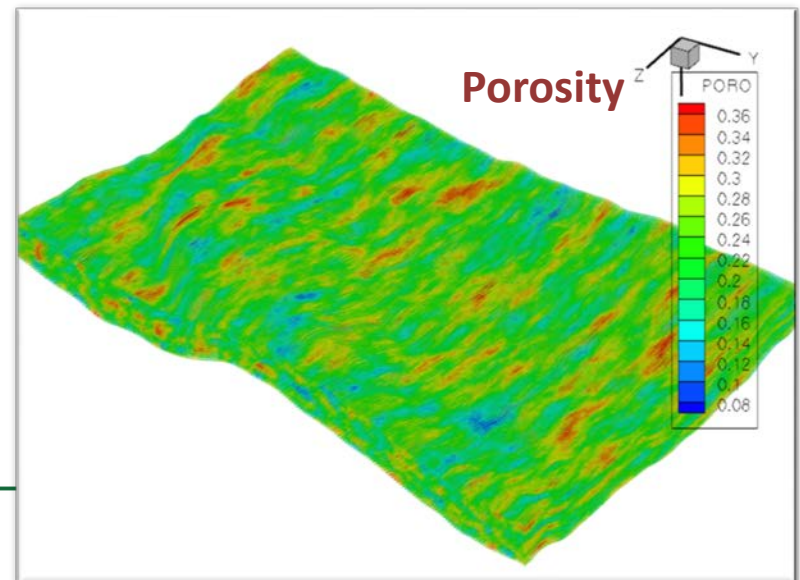
Top Formation Depth, ft



Permeability, md

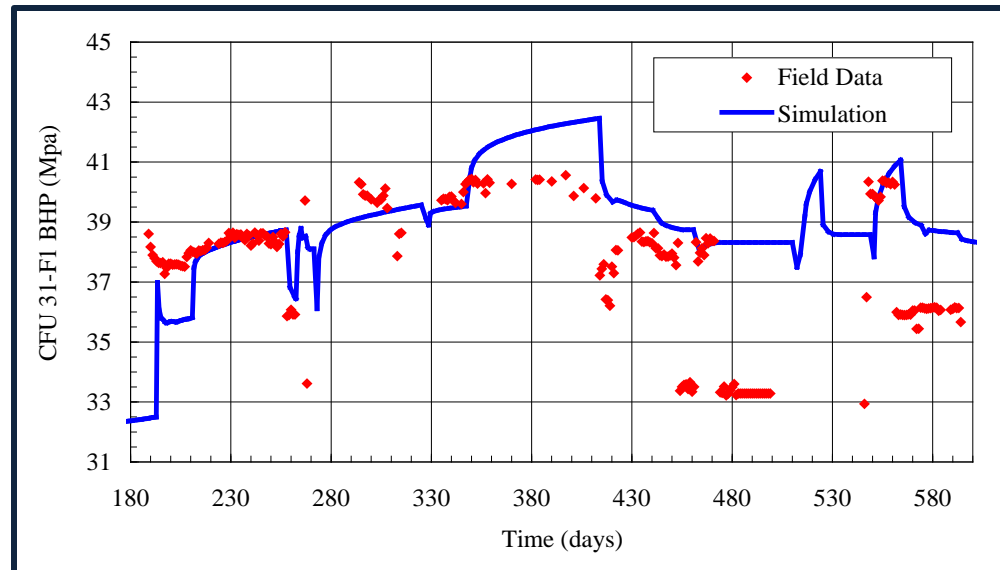
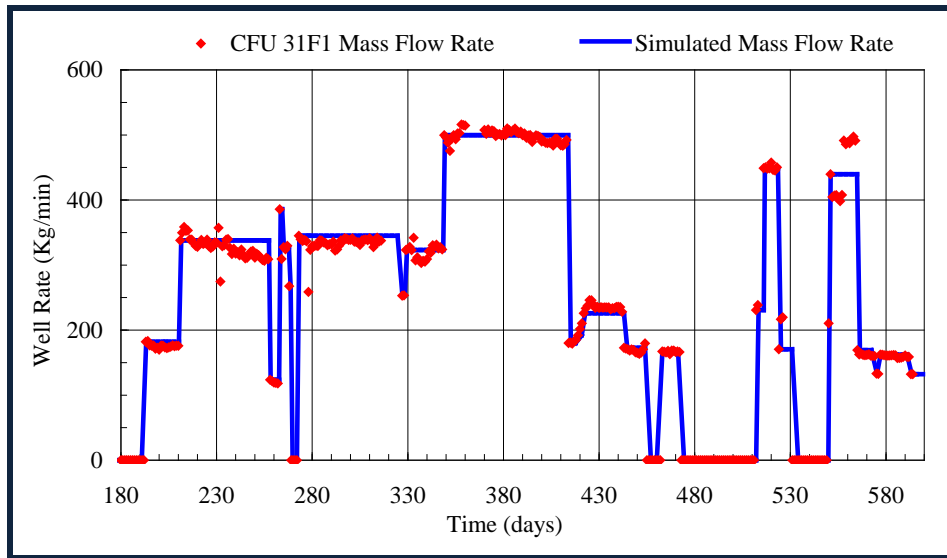


Porosity



Detailed area of study (DAS)

# Injection Rate and Bottomhole Pressure



# Effect of Relative Permeability on Injection Pressure

