

CO2 Foam EOR Field Pilots in Texas and Mississippi

by

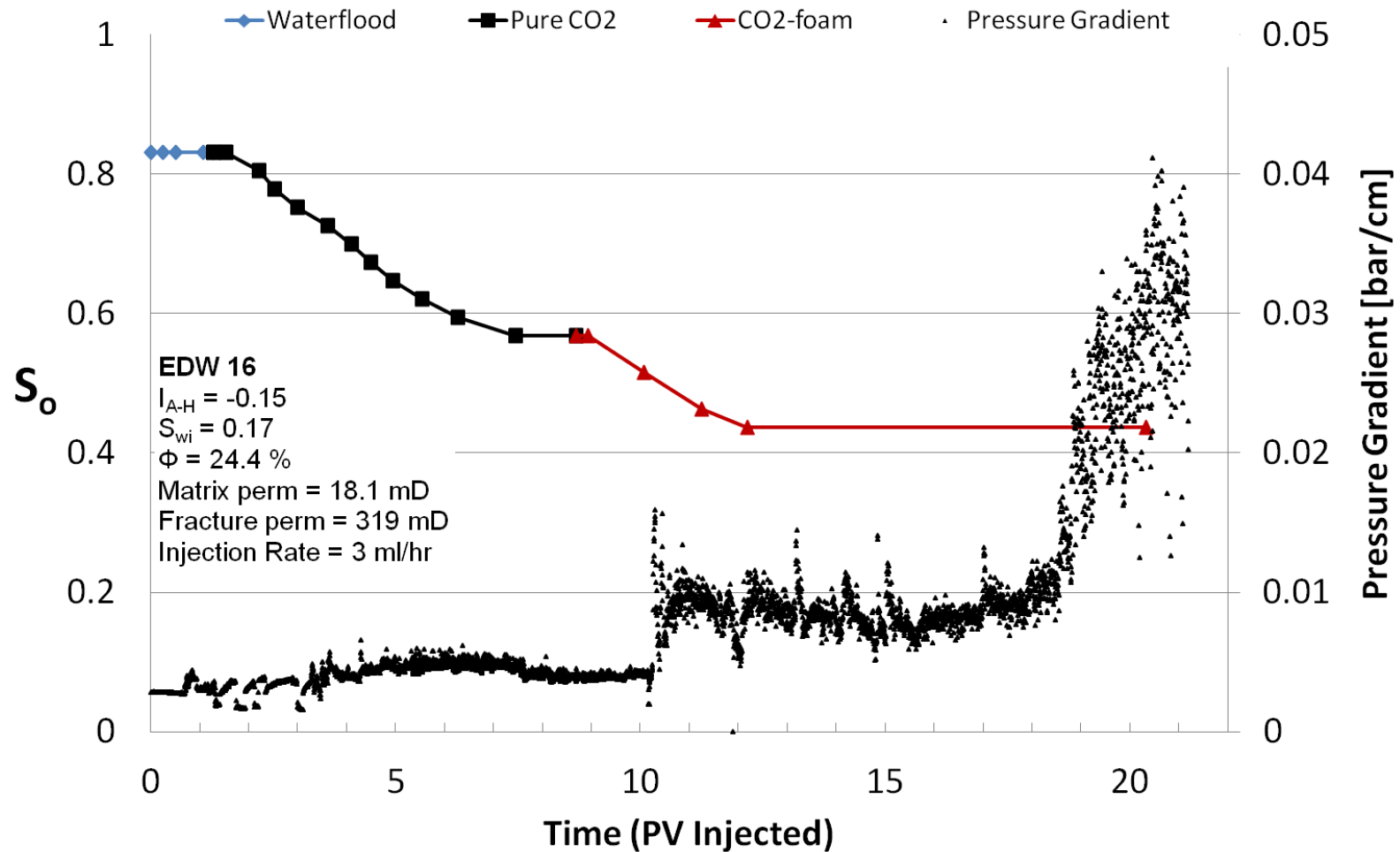
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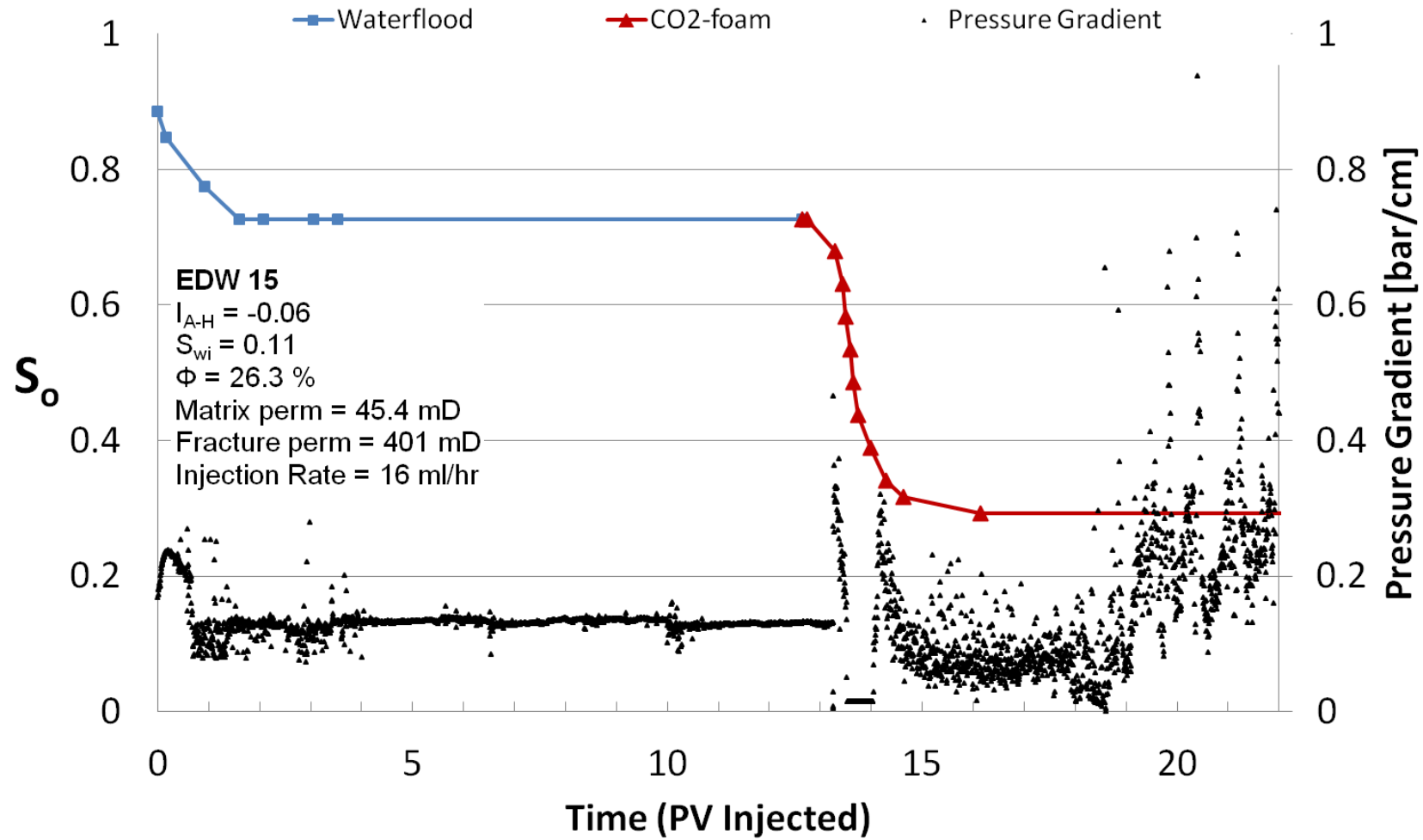
Next Generation CO₂ Flooding

- Main challenges in CO₂ EOR:
 - Early CO₂ breakthrough and poor sweep efficiency
 - Up-scaling laboratory EOR to field performance
- US White Paper:
 - Mobility control in CO₂ EOR, USDOE/Advanced Resource International Inc.
 - Target: 137 Billion bbl
- US import of foreign oil may be reduced by 30%
- "Next generation CO₂ EOR technology" based on mobility control
- 68 billion barrels of oil: 1,35 billion bbl of oil every year for 50 years
- Similar results in the North Sea; pilot in the Snorre Field
- Economic at oil price of US\$ 85 and CO₂ price of US\$ 40/ton
- Need more CO₂
- Carbon Capture Utilization and Storage (CCUS) a win-win situation

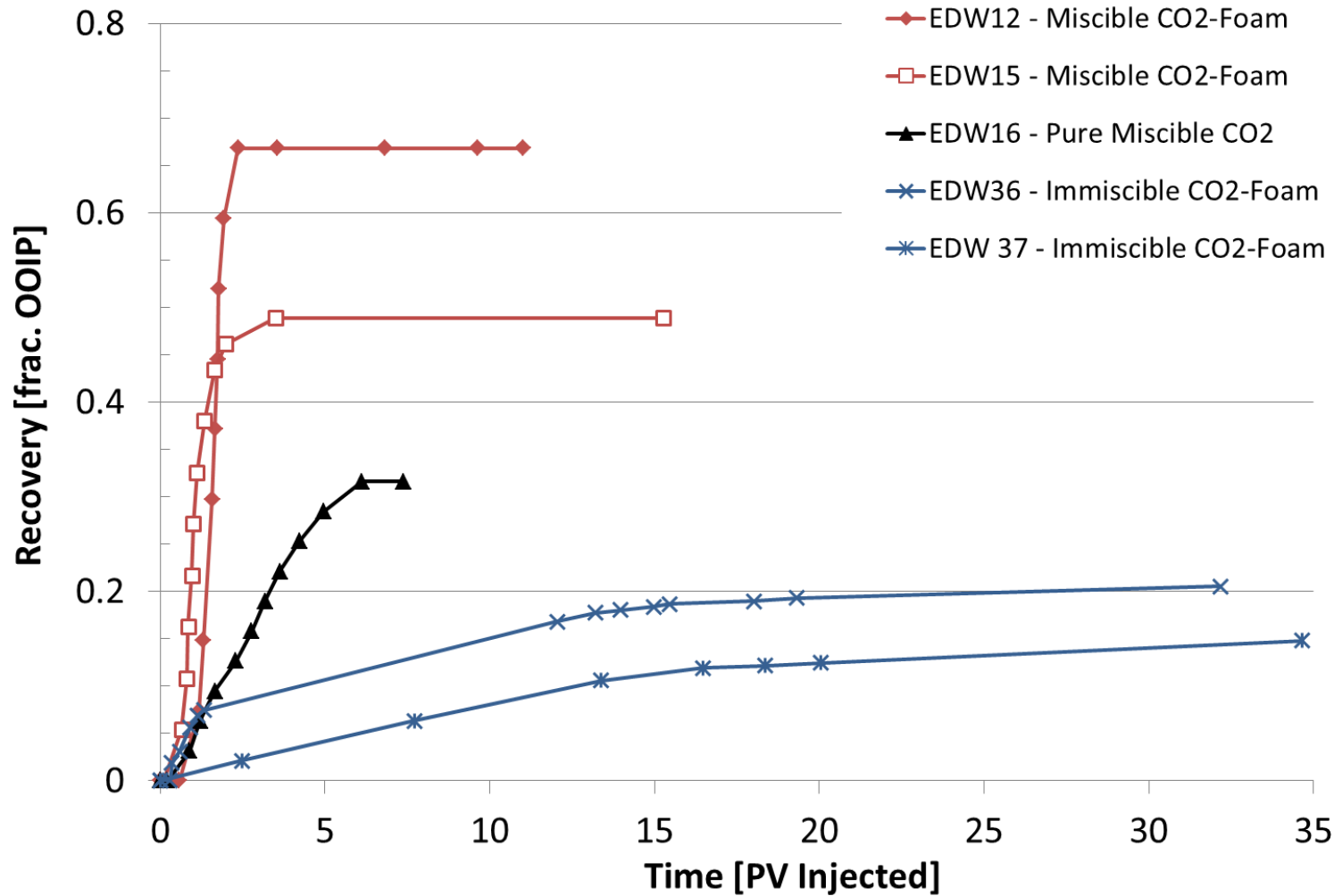
Oil-Wet Carbonate Core Plugs: IEOR (WF + CO₂ + CO₂-foam)



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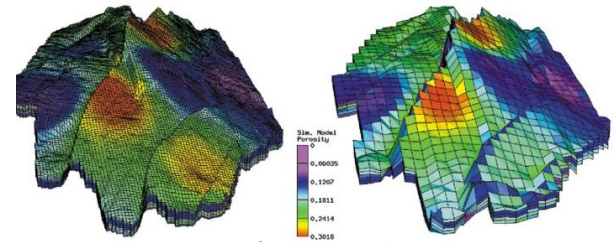


Comparison between miscible CO₂ injection and immiscible and miscible CO₂-foam

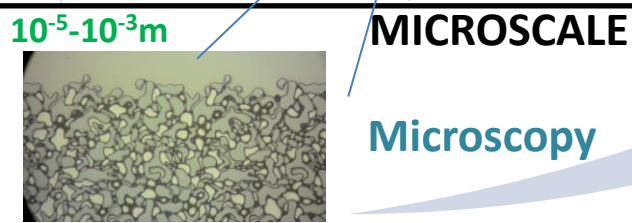
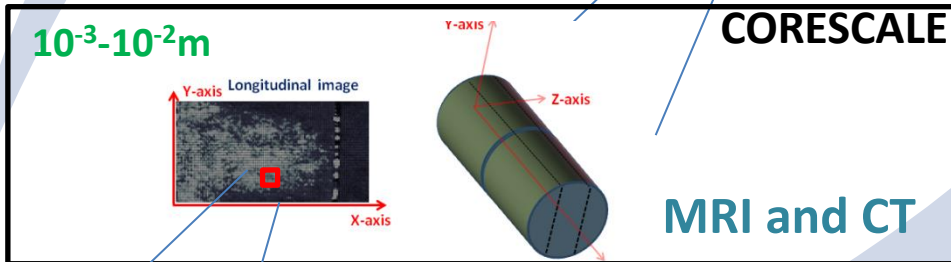
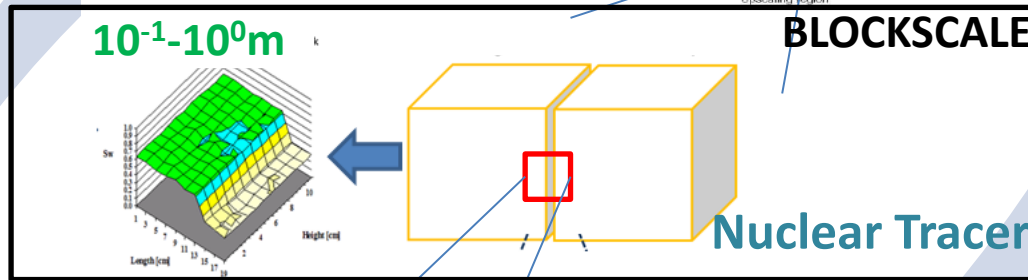
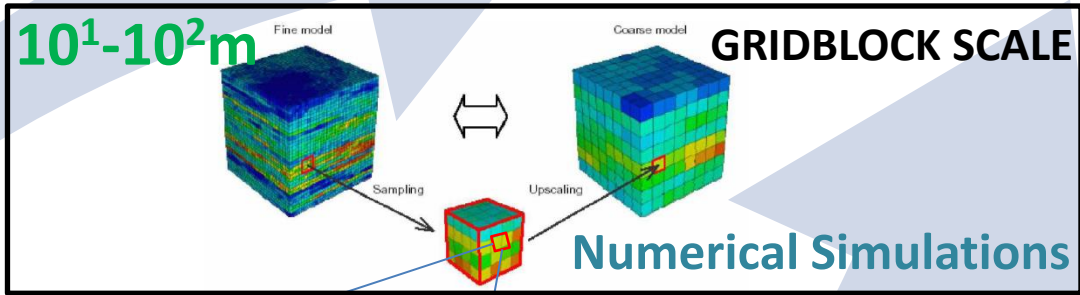


Length Scales

10^3-10^4m



Petroleum Geo-Services Homepage
www.pgs.com



Imaging techniques

Upscaling:

➔ - Field Pilots

➔ - Grid Block

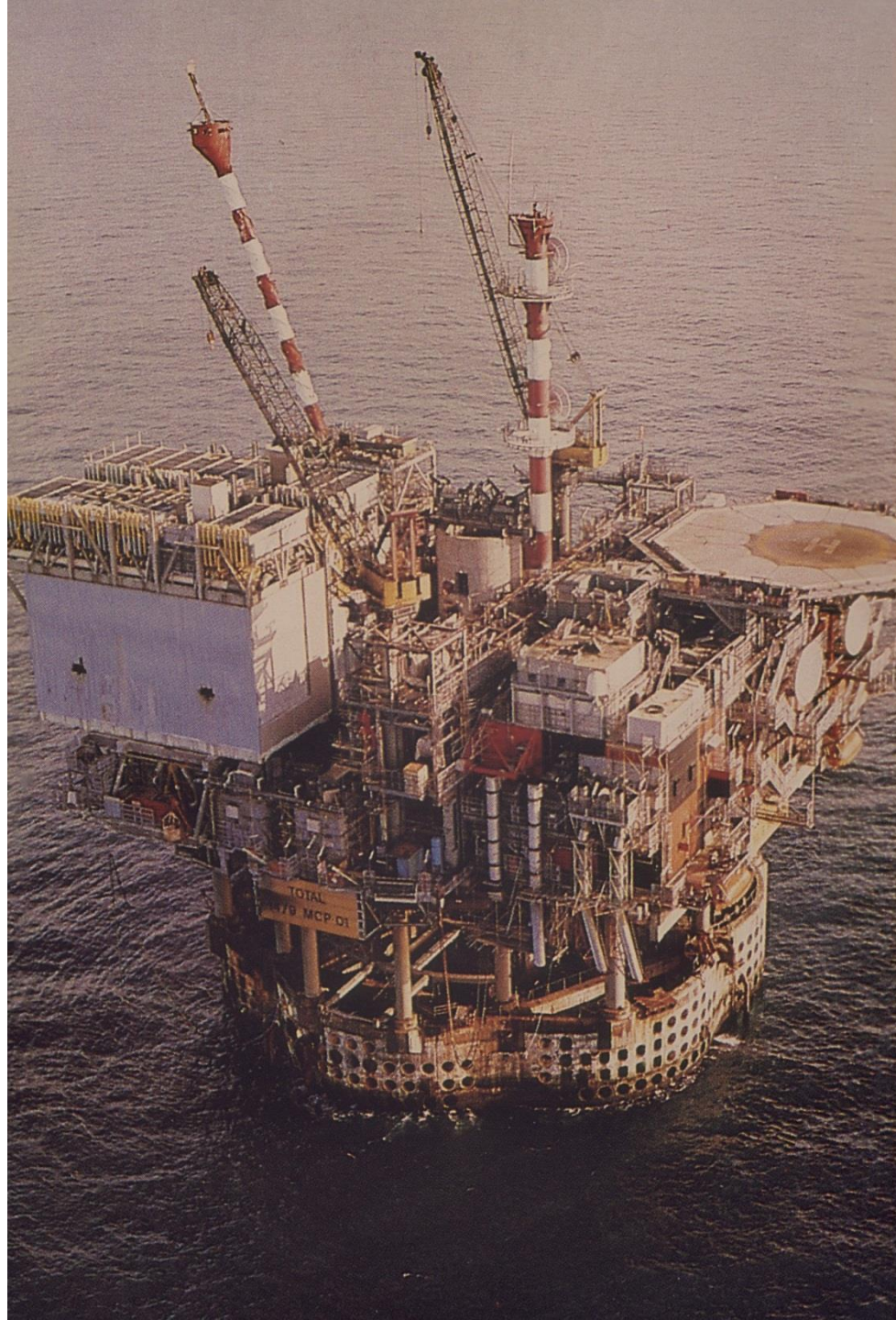
➔ - Large Volume Blocks

➔ - Core Plugs

➔ - Micromodels

Is this what oil is supposed to look like?







CO₂ Foam for Mobility Control for EOR in Fractured Reservoirs in Texas

Project advantages:

- CO₂ is commercially available
- Foam as mobility control
- Researchers from 11 reputational universities
- Up-scaling; major challenge in oil recovery
- Fraction of costs of off-shore field tests
- Fast results: short inter-well distances
- 30 years experience in Texas on CO₂ EOR
- 4D seismic establishes a field laboratory

Large Scale Collaboration Emphasizing Mobility Control and CO2 EOR in Field Pilots in Texas

Collaboration: 11 universities

- Rice University**
- University of Texas at Austin**
- Texas A&M U.**
- Stanford U.**
- Imperial College, London**
- TREFLE, Bordeaux, France**
- U. of Kansas**
- New Mexico Tech**
- TU Delft, The Netherlands**
- NTNU , Trondheim, Norway**
- University of Bergen, Norway**

EOR Enables CCUS: *Integrated EOR (IEOR) for CO₂ Sequestration* CO₂ Foam for Mobility Control for EOR in Fractured Reservoirs in Texas

Collaboration: 11 Universities in France, The Netherlands, UK, USA and Norway

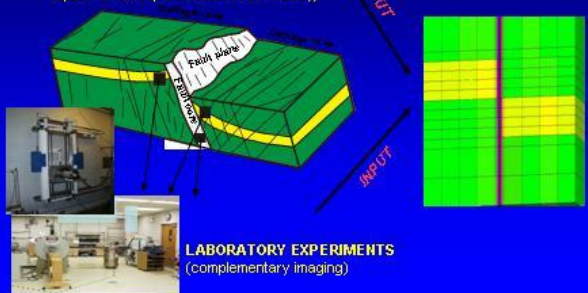
Coordinator: Arne Graue, Dept. of Physics, University of Bergen, NORWAY

Funding: The Research Council of Norway and oil companies

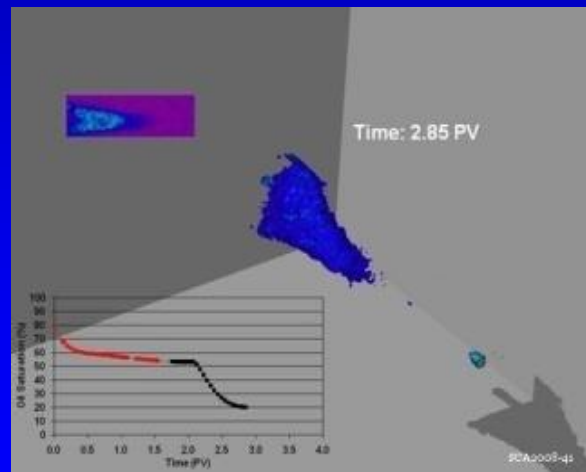
Integration of Geology, Mathematical Modeling and Laboratory Experiments

GEOLOGICAL ANALYSIS
(structural configuration & geometry, spatial and temporal deformation history)

NUMERICAL SIMULATION
(domain decomposition, grid refinement, parallelization)



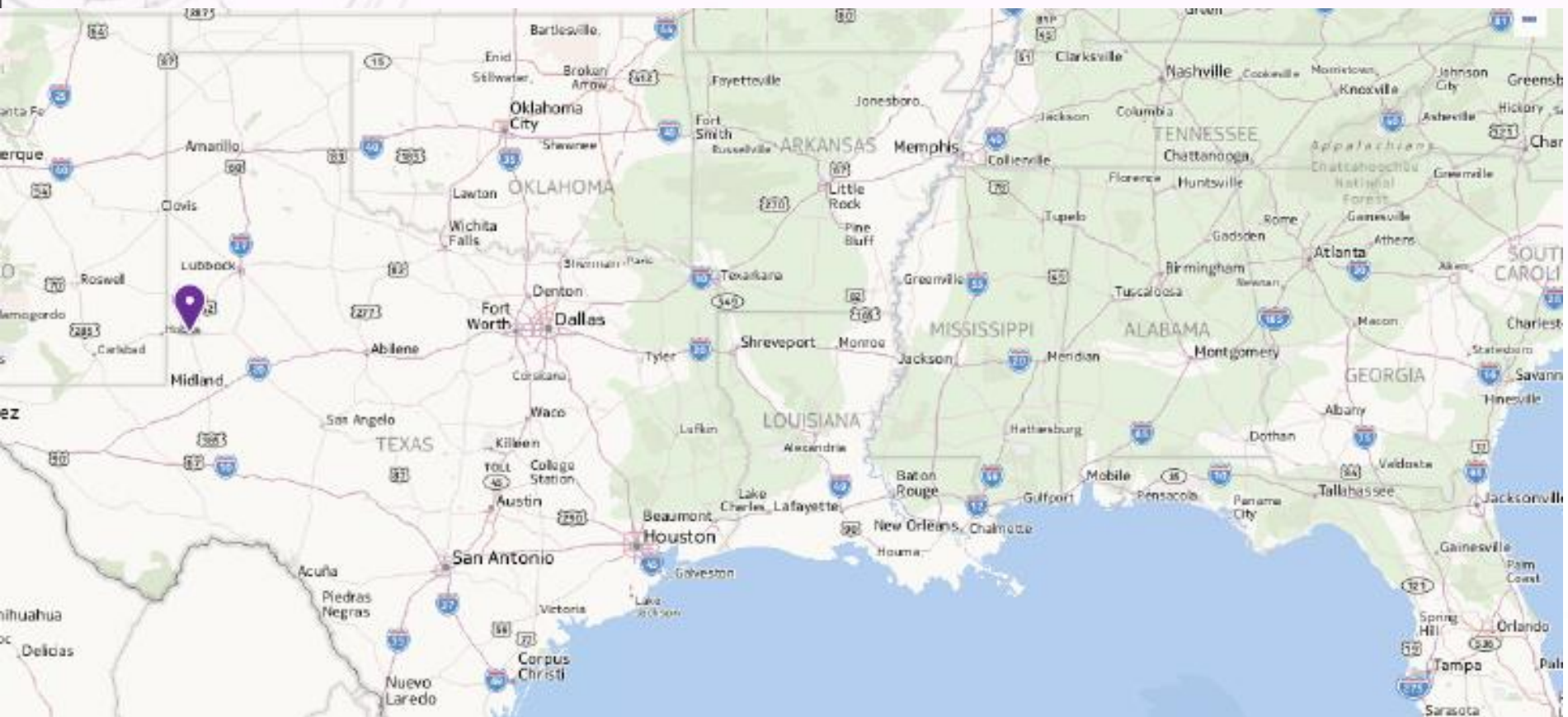
Lab to pilot field test

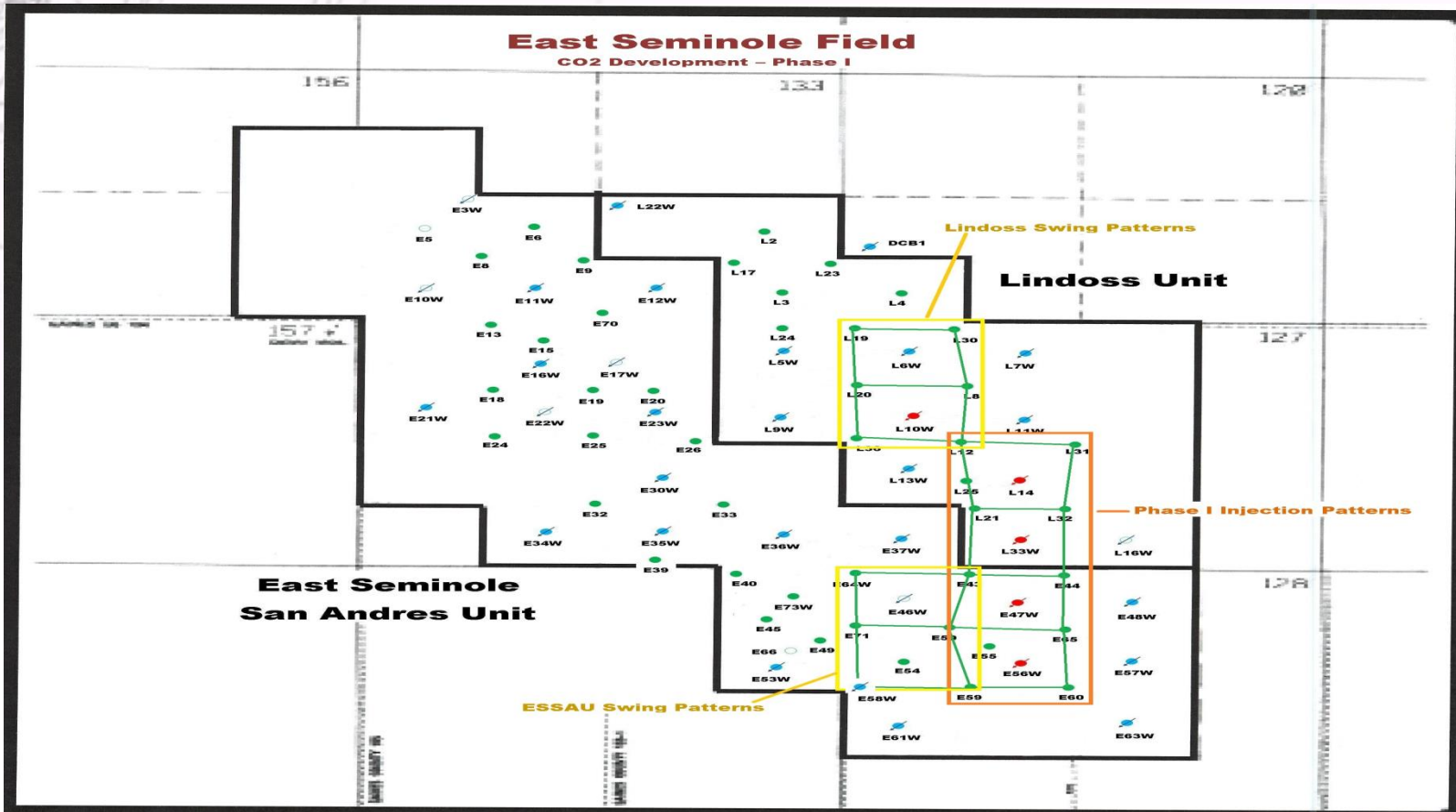


MRI of CO₂ injection



Complementary NTI & MRI facilities

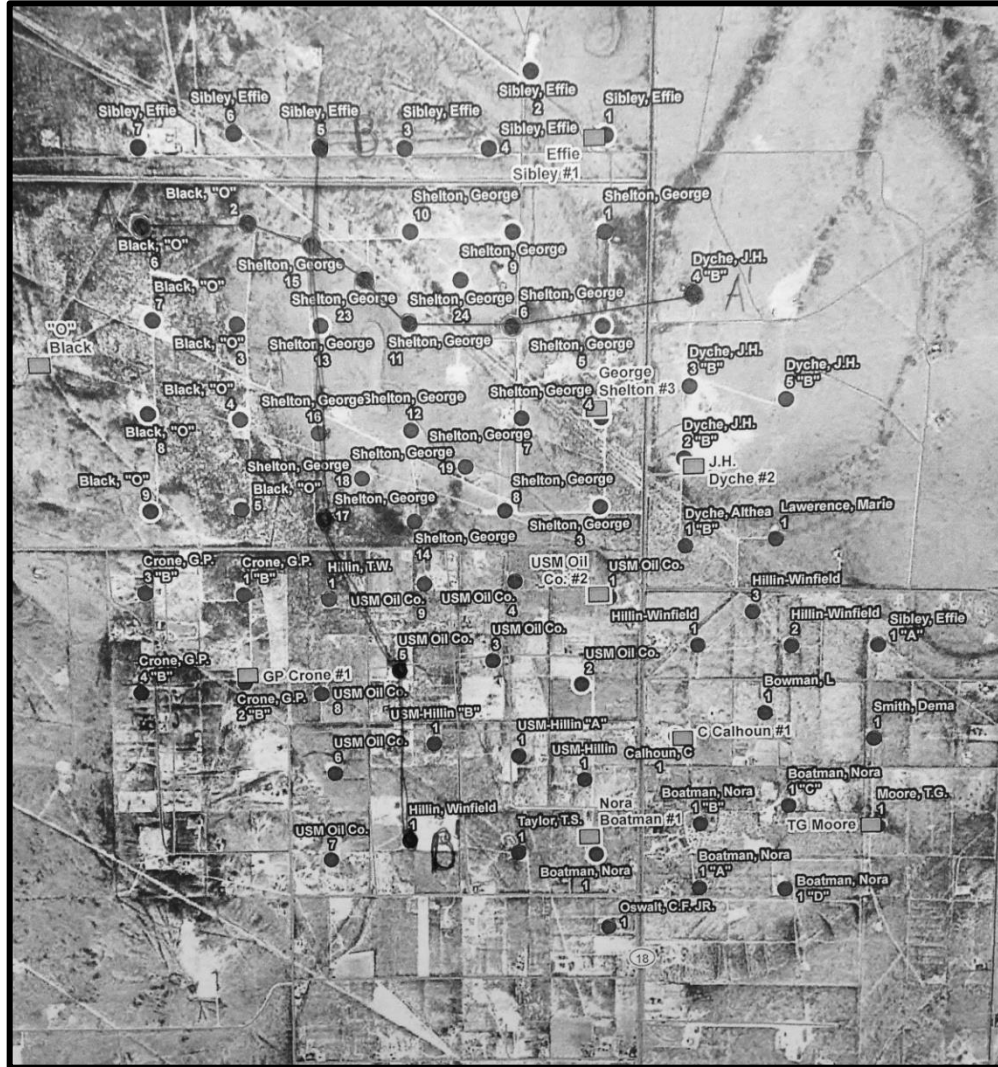




Tabula Rasa
ENERGY

- Oil Producer - Active
- Oil Producer - Inactive
- Water Injector - Active
- Water Injector - Inactive
- CO2 Injector

Ft. Stockton Well Location Map



NorTex Partners:

4 Universities in Texas, USA

- Rice University, Houston, TX, USA
- University of Houston, Houston, TX, USA
- University of Texas at Austin, Austin, TX, USA
- Texas A&M University, College Station, TX, USA

3 Universities in Norway:

- University of Bergen, Bergen, Norway
- University of Stavanger, Stavanger, Norway
- NTNU, Trondheim, Norway

Industry Board Members

- Statoil Petroleum ASA, Schlumberger, OneSubsea

Industry Partners

- Denbury, Natl. Oil Well Varco, FMC, Kinder Morgan, Hess, BP, Total, Oxy, Shell, Wintershall, Tabula Rasa, American Res. and Chevron

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Thank you!