



Project 07123-03 Near Miscible CO₂ Application to Improve Oil Recovery for Small Producers

Golden, CO.
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TECHNOLOGICAL KEYS TO UNLOCKING ADDITIONAL RESERVES
RPSEA ONSHORE PRODUCTION CONFERENCE



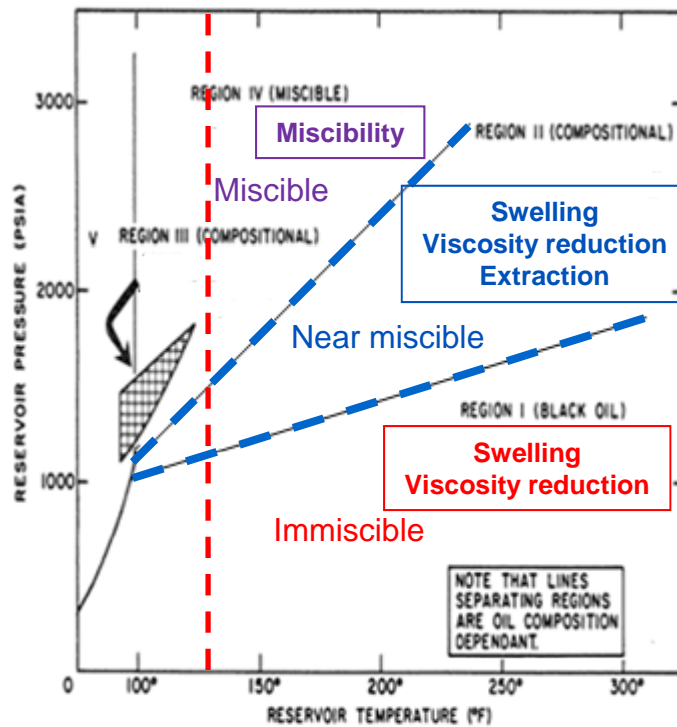


Overview

- **Project was administered through RPSEA to address the technology challenges of near miscible application. It was completed in October, 2010.**
- **Many Kansas reservoirs operated by small producers are not candidates for CO₂ miscible application.**
- **The target Arbuckle formation was chosen for the project as it represents a significant resource for improved oil recovery.**

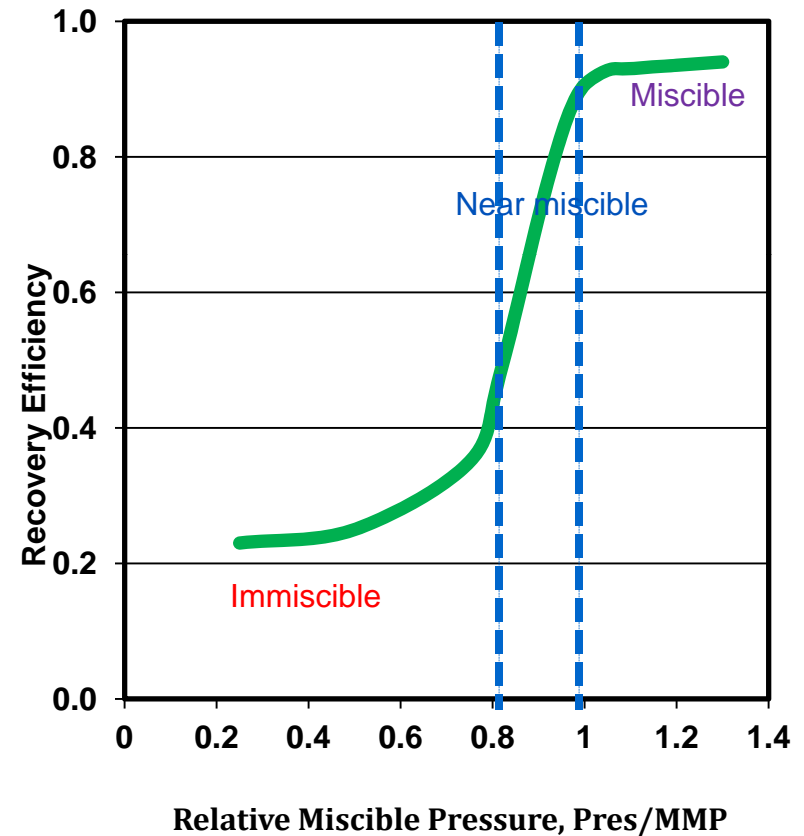
CO₂ for Enhanced Oil Recovery

CO₂ EOR mechanism



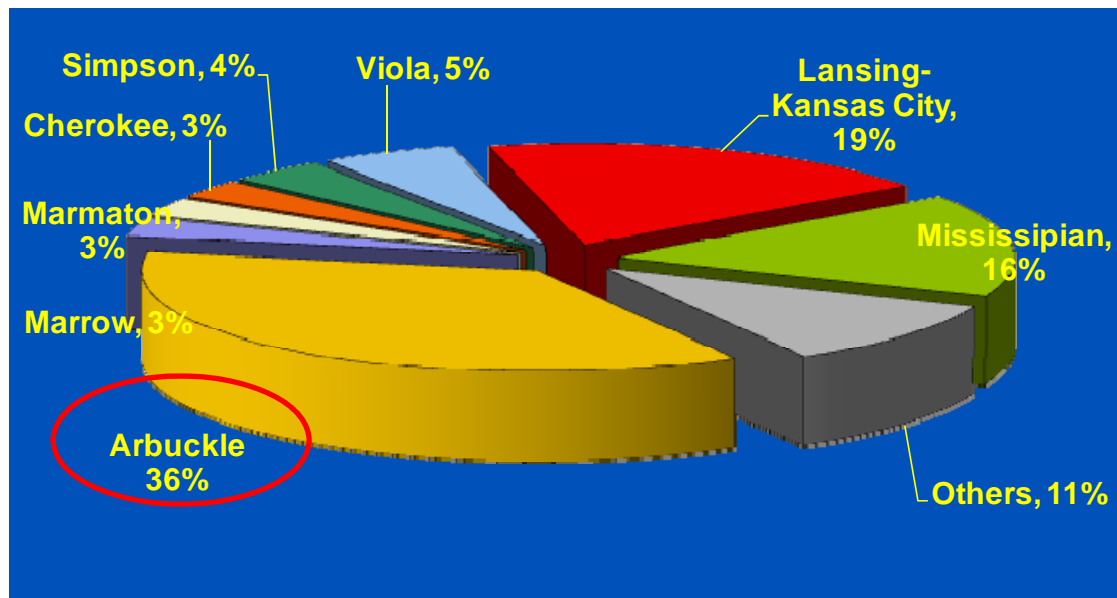
(Mark Kline, Carbon Dioxide Flooding, 1984)

Recovery response to pressure



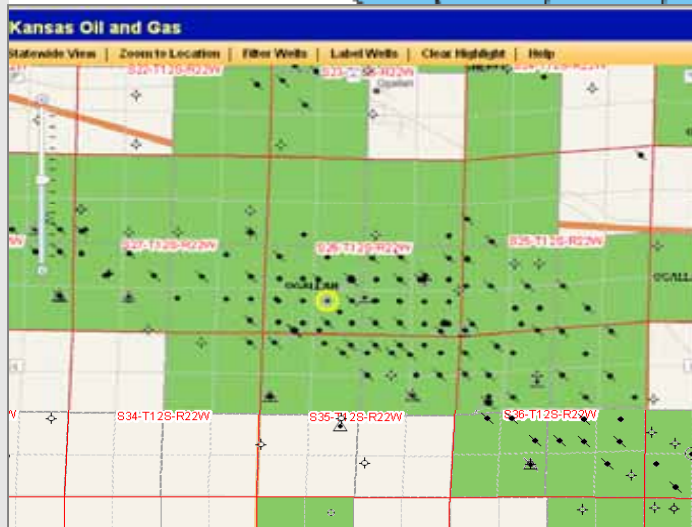
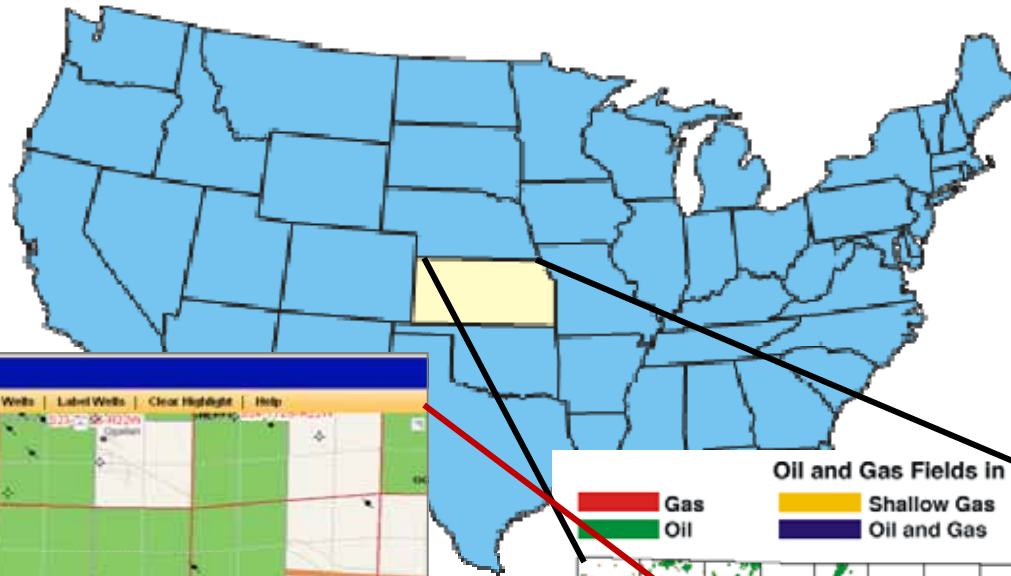
Arbuckle Formation

- Produced 36%(2.2 BBO) of total Kansas oil production
- Dolomite formation covers most of Kansas
- Geology is not well understood
- Underlain by a strong aquifer
- 90 % of wells producing < 5 bbl/day

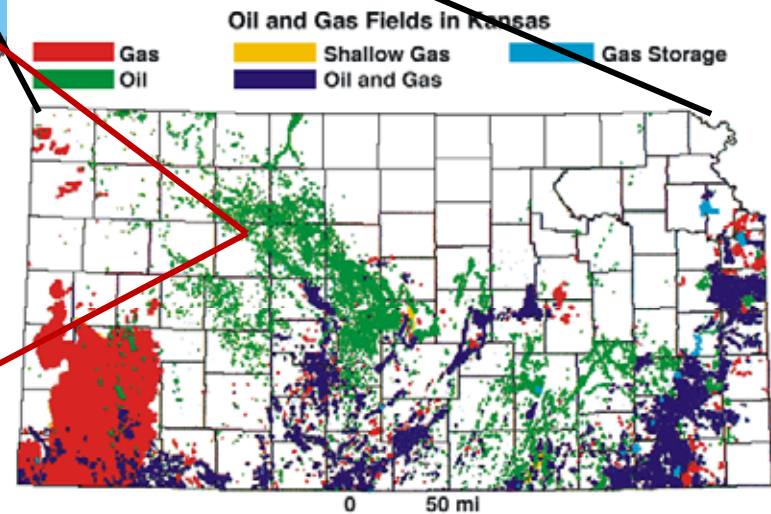


Source: Kansas Geological Survey

Project Location

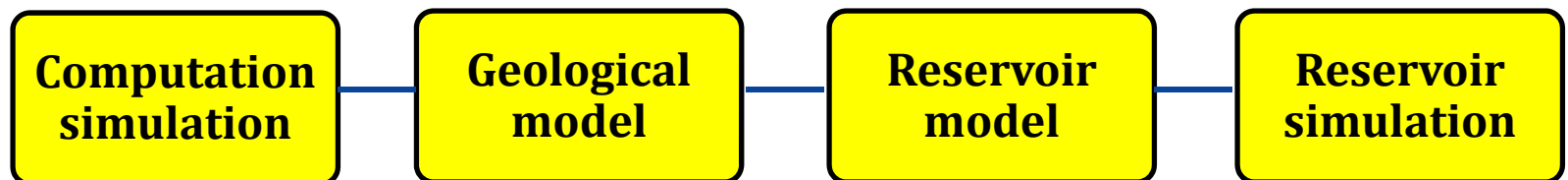
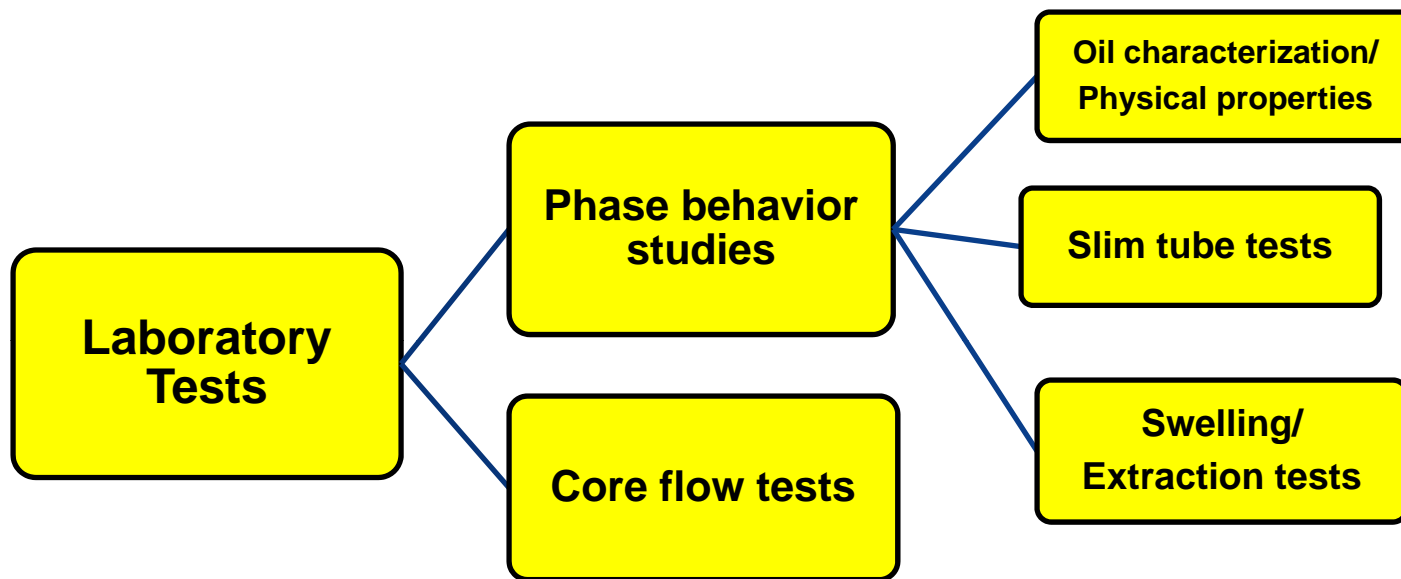


**Ogallal unit
Trego county, Kansas**

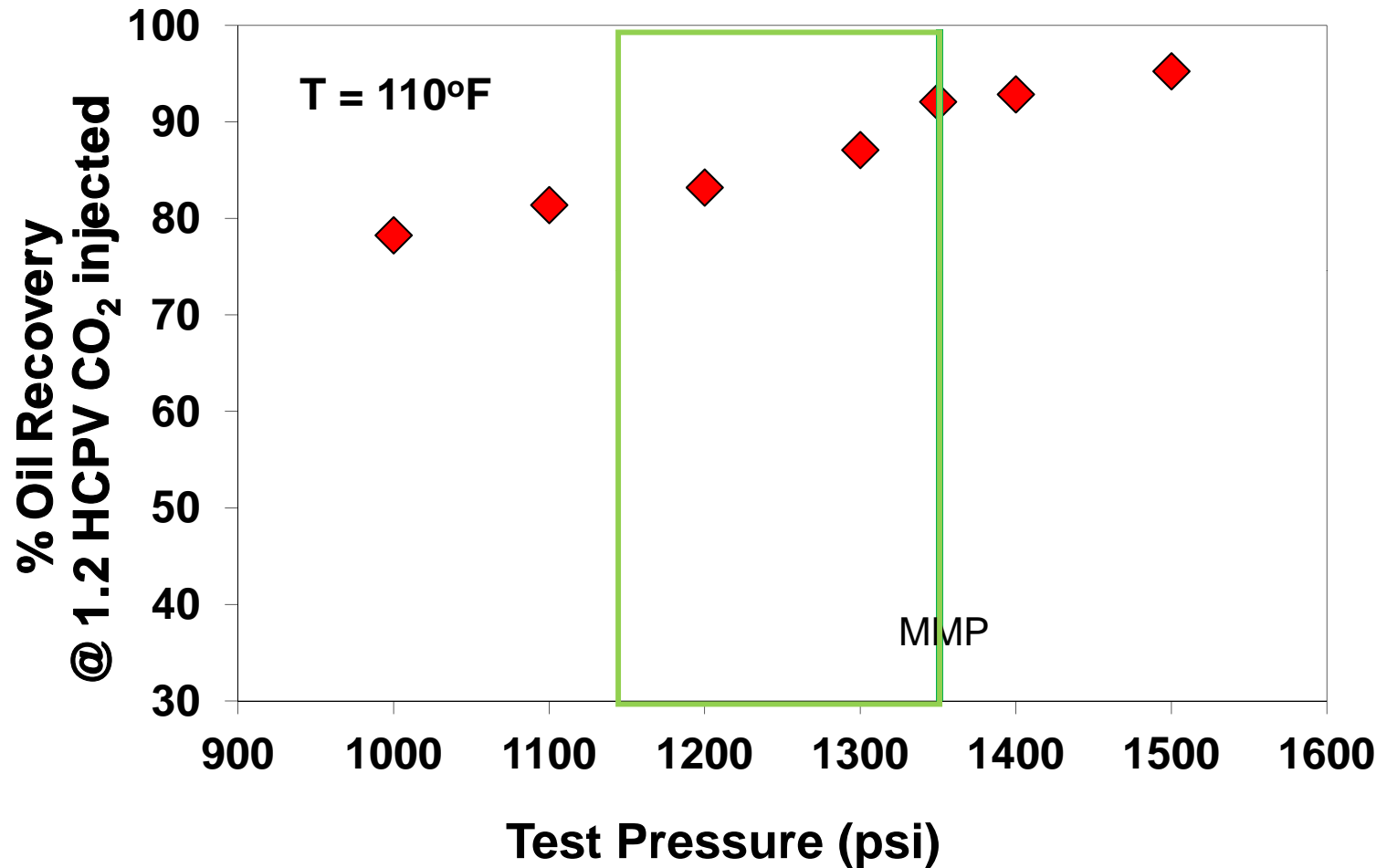


Source: Kansas Geological Survey

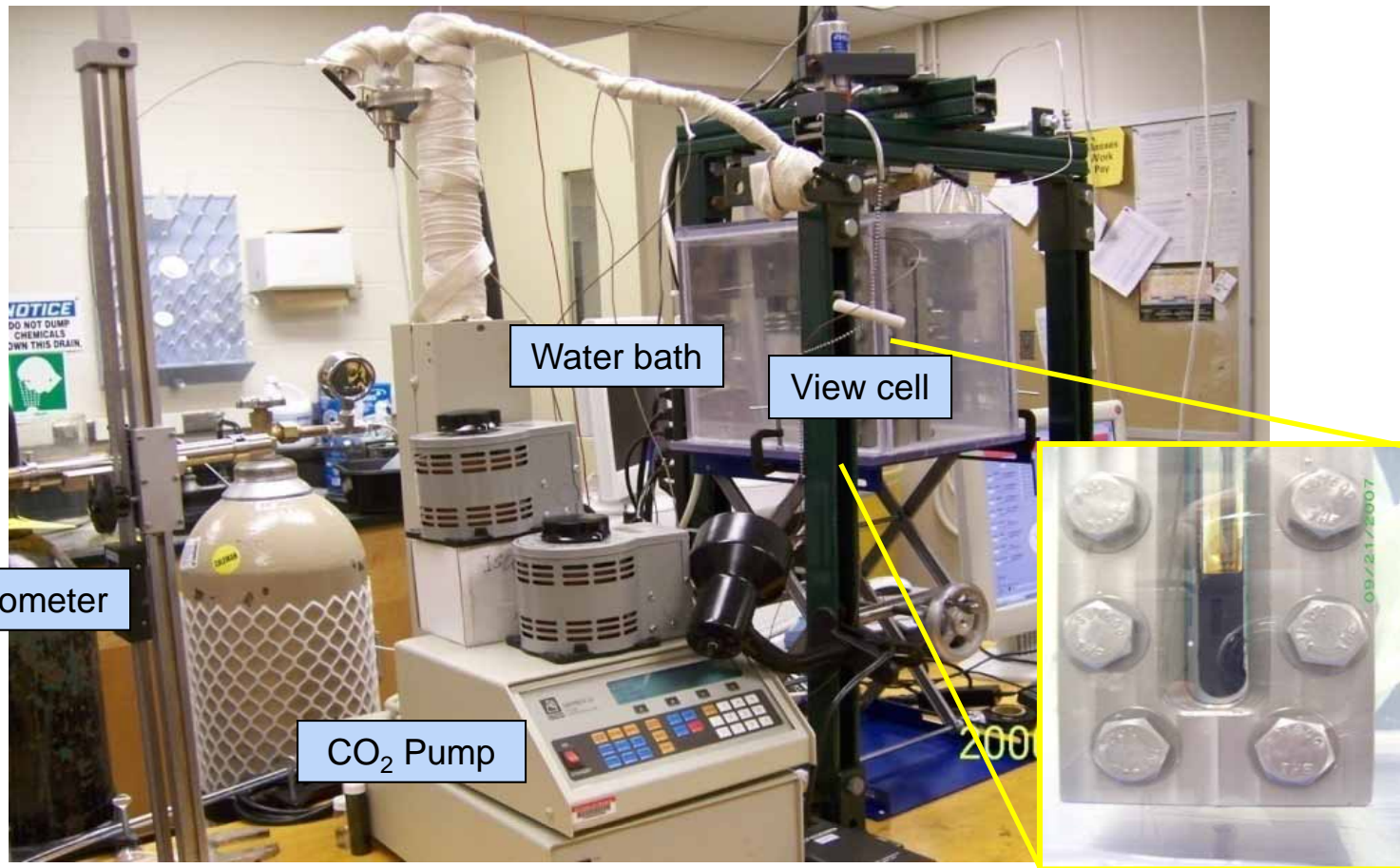
Research Tasks



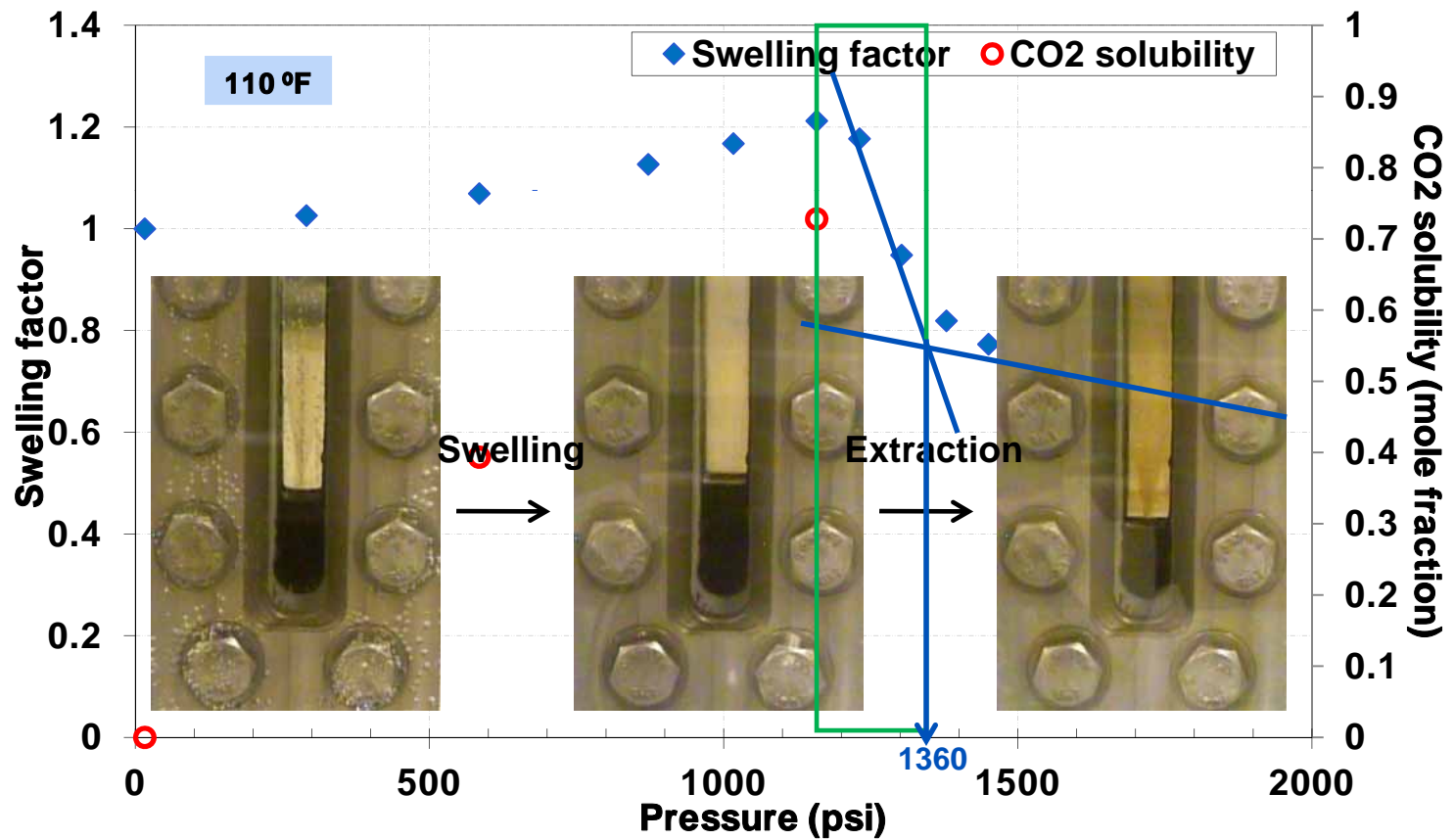
MMP and Near Miscible Pressure Range



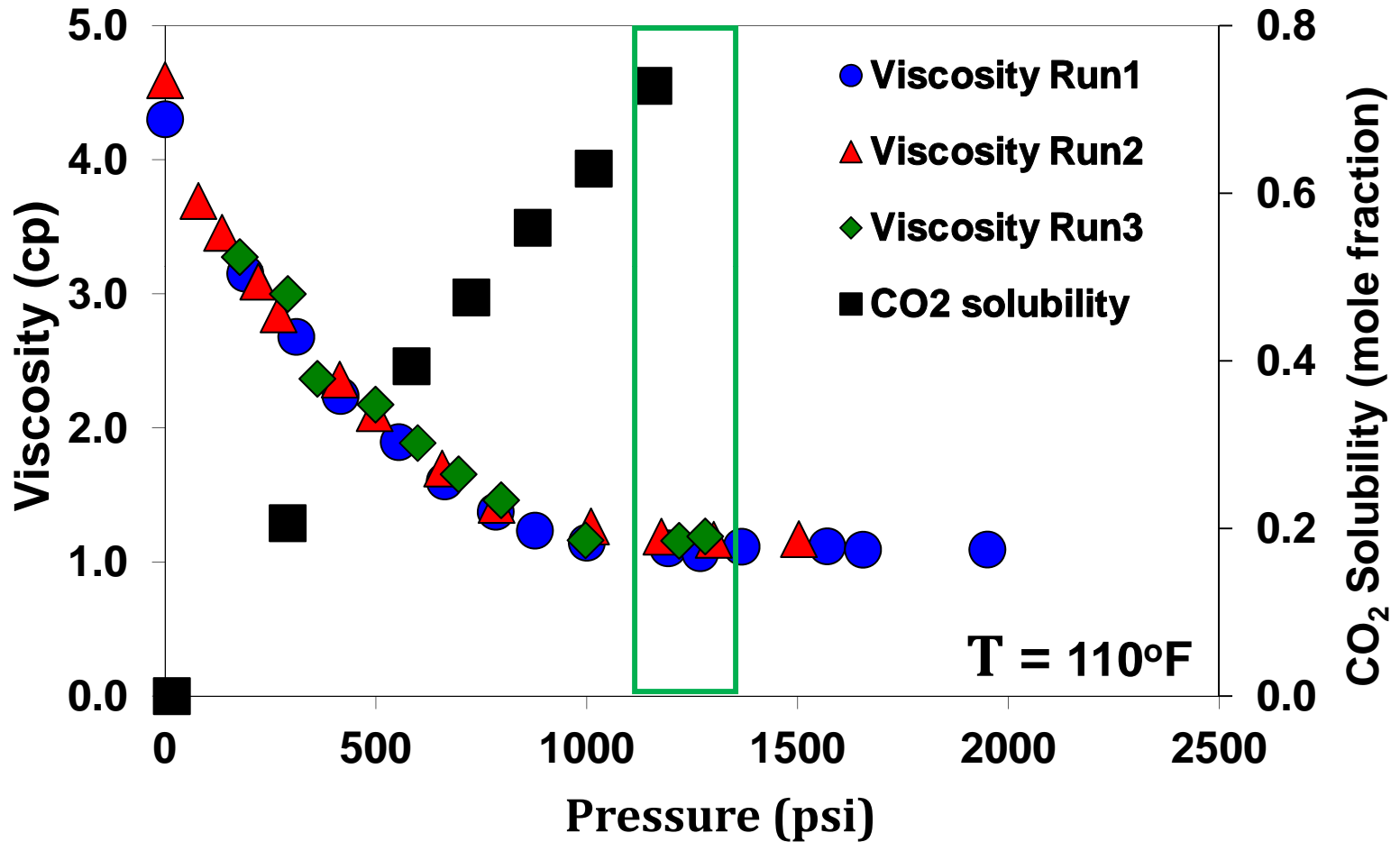
Swelling/Extraction Test Apparatus



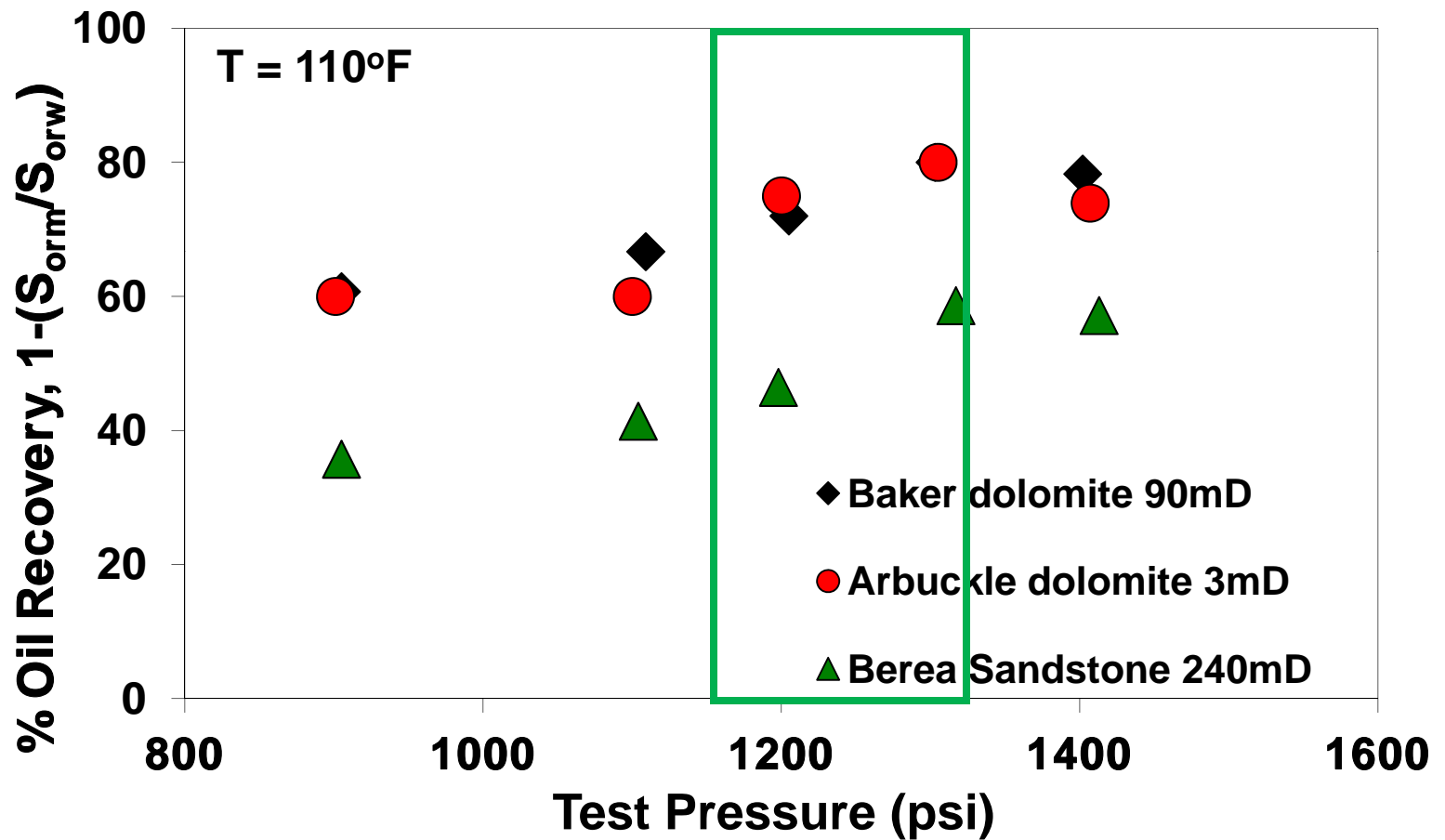
Typical Swelling/extraction Results



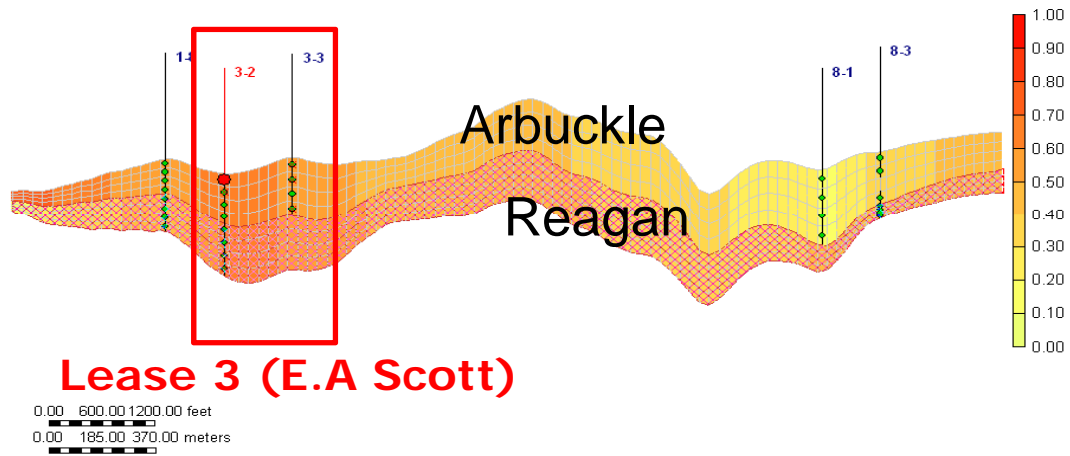
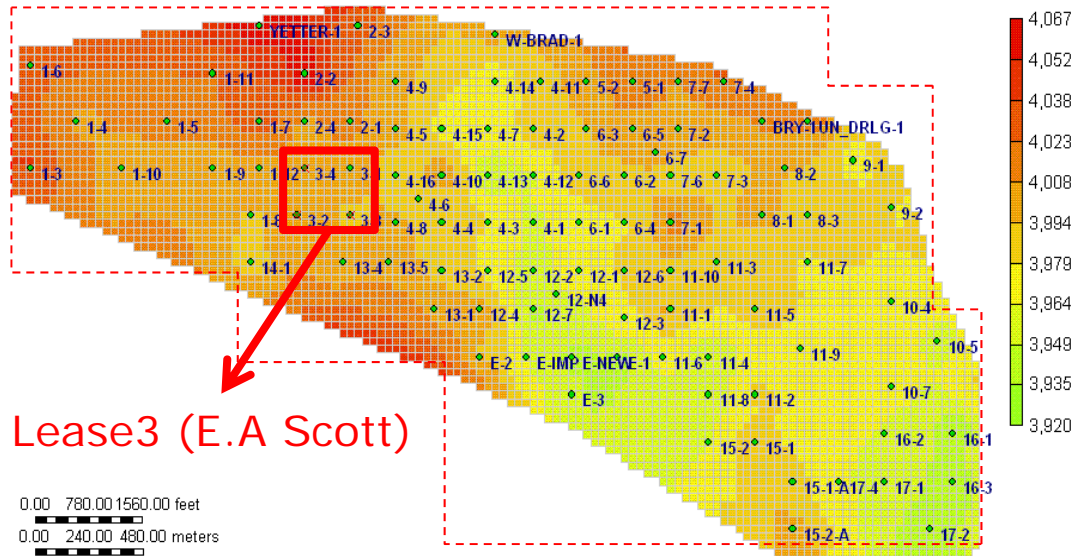
Effect of CO₂ Dissolution into Crude Oil



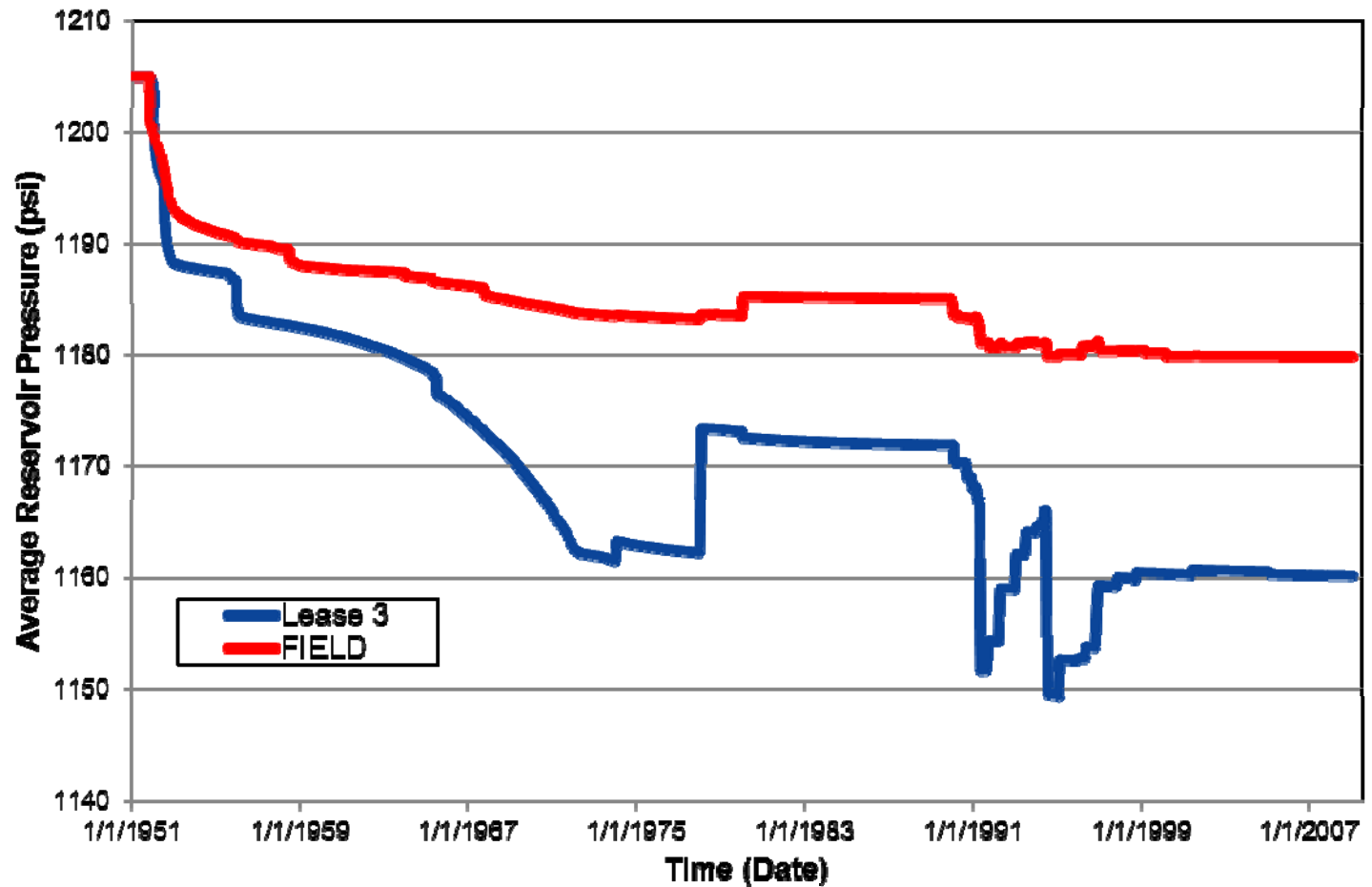
Recovery Efficiency



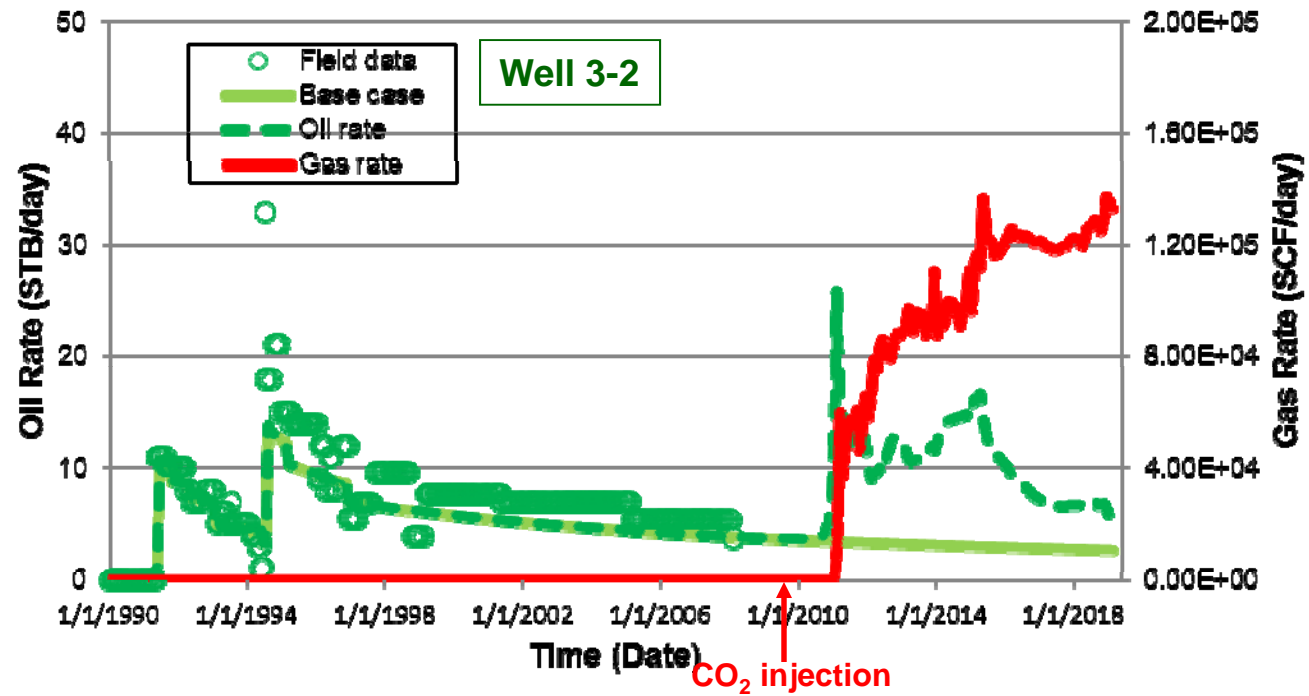
Case Study



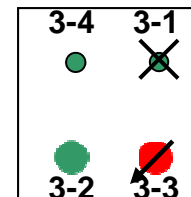
Reservoir Average Pressure



Case Study (one CO₂ injector)



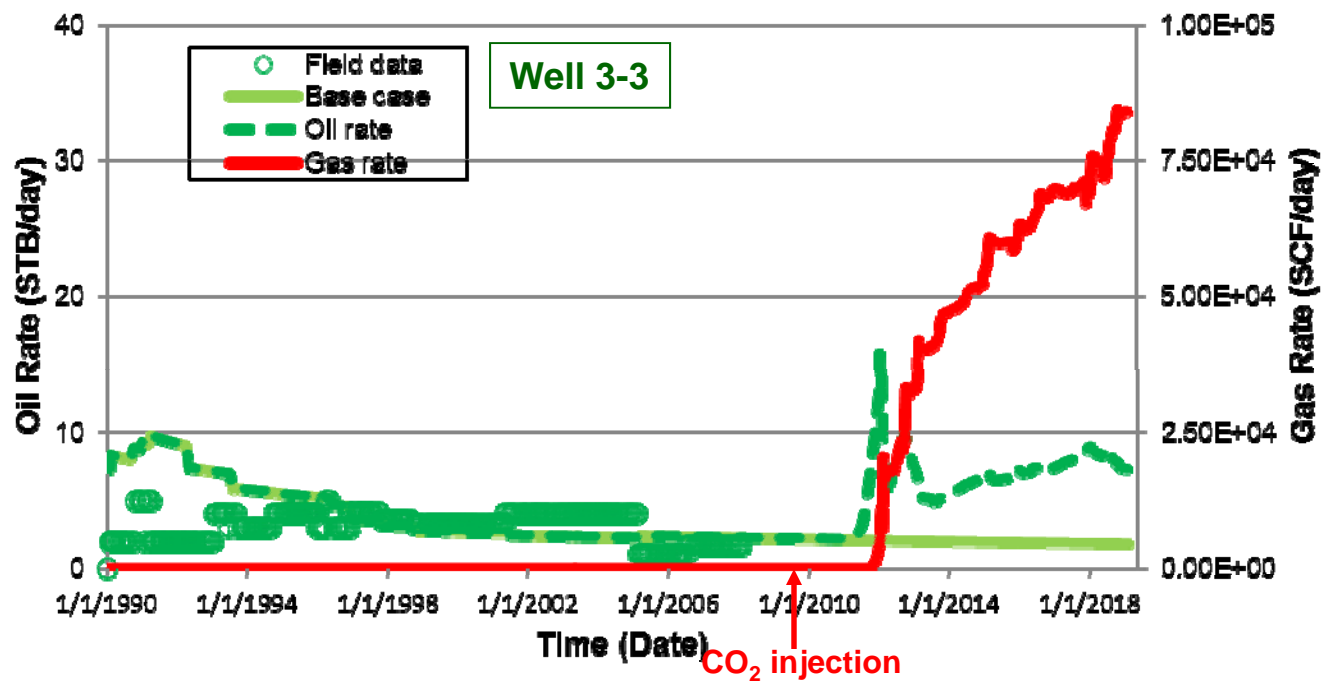
Production in 10 years (STB)	Well 3-2
Natural water flooding	11237
CO ₂ injection @ 1200 psi	28412
CO ₂ injection @ 1300 psi	34205



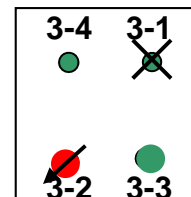
CO₂ injection at well 3-3

Oil produced from well 3-2

Case Study (one CO₂ injector)



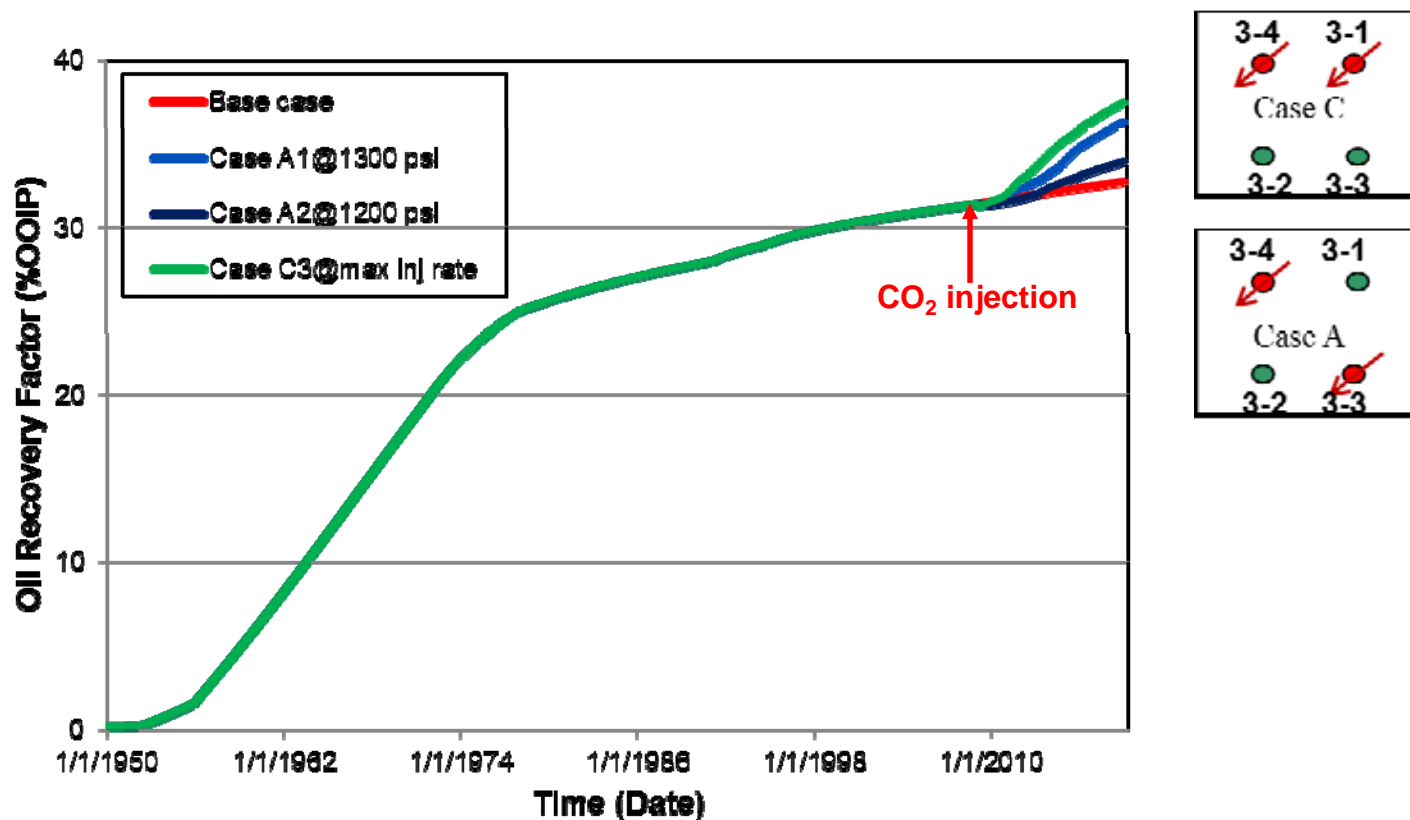
Production in 10 years (STB)	Well 3-3
Natural water flooding	7266
CO2 injection @ 1200 psi	19809
CO2 injection @ 1300 psi	21895



CO₂ injection at well 3-2

Oil produced from well 3-3

Case Study (two CO₂ injectors)



Net utilization of CO₂ in IOR process: 8 to 18 MSCF/STB



Summary

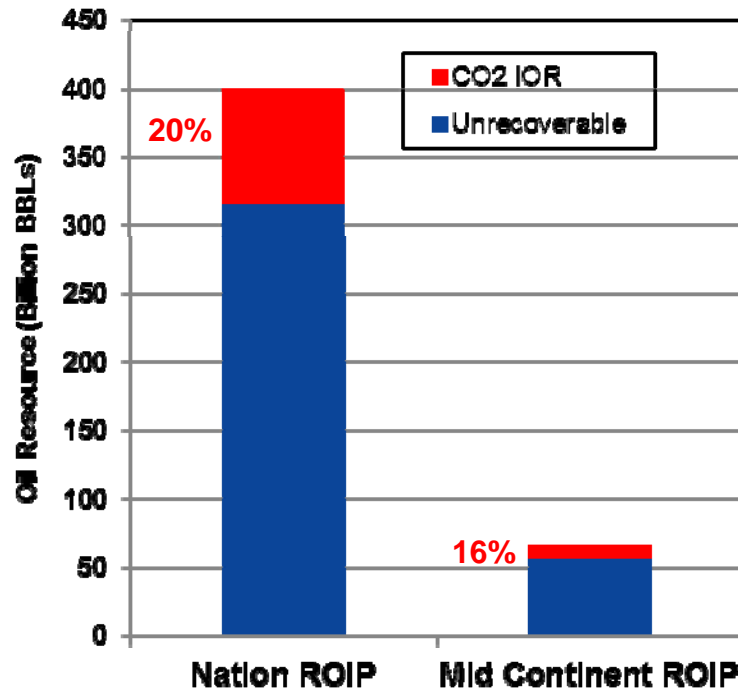
- **Laboratory results shows a favorable mechanism to improve oil recovery with CO₂ injection at near miscible condition .**
- **Extraction/Vaporization of light hydrocarbon constituents into the CO₂ rich vapor phase & reduction of oil viscosity are the primary mechanisms for the near miscible displacement process.**
- **CO₂ injection mobilizes more than 50% of the water-flood residual oil in the near miscible condition.**



Summary

- Reservoir average pressure was maintained by the pressure support of the underlying aquifer.
- Reservoir simulations indicate injection of CO₂ at near miscible pressure improves oil recovery.
- **Maximum recovery efficiency** can be achieved by **proper design** and **implementation** of CO₂ injection.

Recoverable Oil Resources from CO2-IOR



CO₂ injection could greatly increase production and permanently store carbon dioxide.

Near-Miscible flooding in Arbuckle formation would help small producers tap additional domestic resources

(U.S. Oil Production Potential From Accelerated Deployment of Carbon Capture and Storage, Advanced Resources International, Inc. Arlington, VA, USA, March 10, 2010)

Acknowledgements



Carmen Schmitt Inc.



▪ **Project Team**

- Mark Ballard
- Ly Huong Bui (GRA)
- Don Green
- Jenn-Tai Liang
- Dwayne McCune
- Carmen Schmitt
- WoanJing Teh (GRA)
- Paul Willhite

▪ **Others**

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- Bill Guy
- Bob Kiker
- Chandra Nautiyal
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- Dana Wreath

