Enhancing Recovery from Mature Oil Fields by CO_2 Injection

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CO_2 Injection and EOR

- First tried in 1972 in Scurry County, TX
- CO_2 injection used successfully throughout the Permian Basin of West Texas and eastern New Mexico
- Most of the CO_2 used for EOR has come from natural sources (St. John’s and McElmo dome)
- CO_2 EOR now pursued in multiple other states.
- Light oil reservoirs primarily (> 25 °API)
- Gas injection accounts for ~ 50% of US EOR

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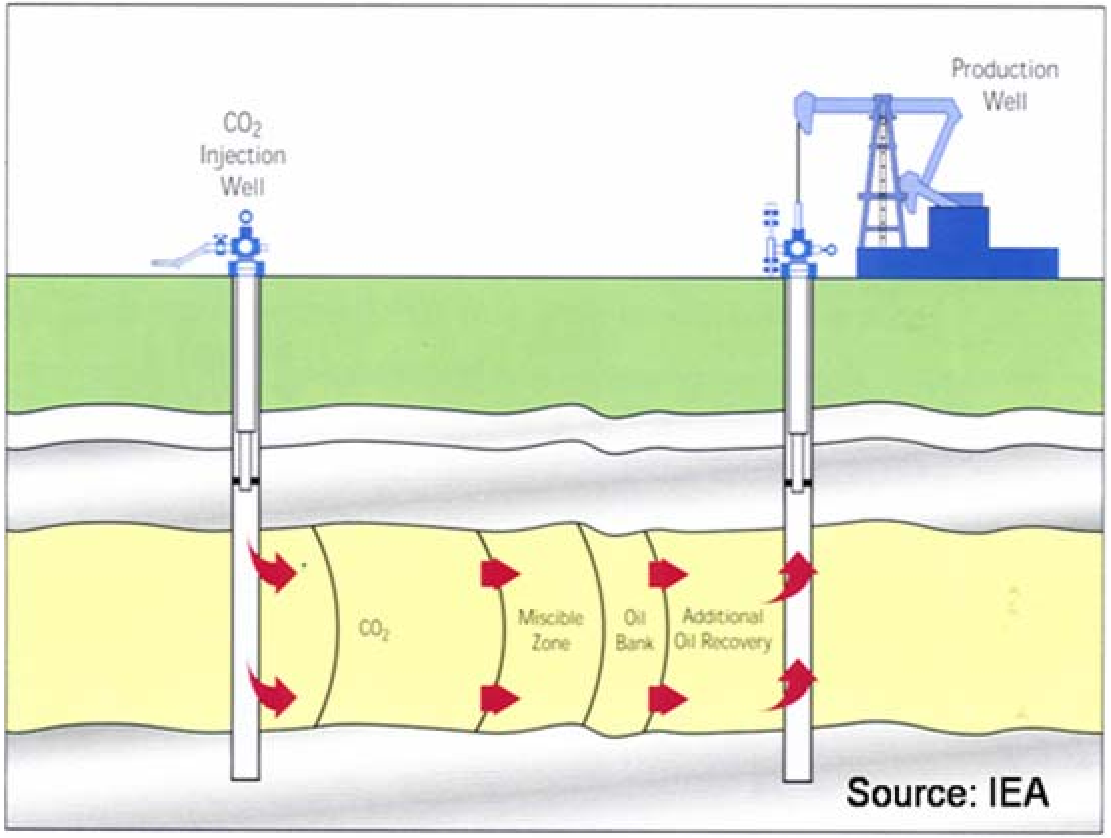
CO_2 EOR in essence

Mechanisms

- Miscible/immiscible
- Swelling of oil
- Viscosity reduction
- Lower residual oil

Potential benefit

- From 20-40% OOIP
- To 30-60% OOIP



Significant Potential of CO_2 EOR

Technology Advances Offer Promise to Boost U.S. Oil Supplies to 430 Billion Barrels

Original, Developed and Undeveloped Domestic Oil Resources (Billion Barrels)*						
				Future Recovery**		
	Original Oil In- Place	Developed to Date	Remaining Oil In-Place****	Conventional Technology	EOR*** Technology	Total
I. Crude Oil						
1. Discovered	**582**	**(208)**	**374**	-	**110**	**110**
• Light Oil	482	(189)	293	-	90	90
• Heavy Oil	100	(19)	81	-	20	20
2. Undiscovered	**360**	-	**360**	**119**	**60**	**179**
3. Reserve Growth	**210**	-	**210**	**71**	**40**	**111**
4. Residual Oil Zone	**100**	-	**100**	-	**20**	**20**
II. Tar Sands	**80**	-	**80**	-	**10**	**10**
TOTAL	**1,332**	**(208)**	**1,124**	**190**	**240**	**430**

Source: DOE February 2006

Challenges of CO_2 EOR

Need a CO_2 source (at low cost)

- Natural reservoirs
- Industrial sources (power plants etc.)
- Infrastructure to target reservoirs

Lower risk of EOR projects

- Research needed to improve our understanding
- Pilot tests of new technology/strategies

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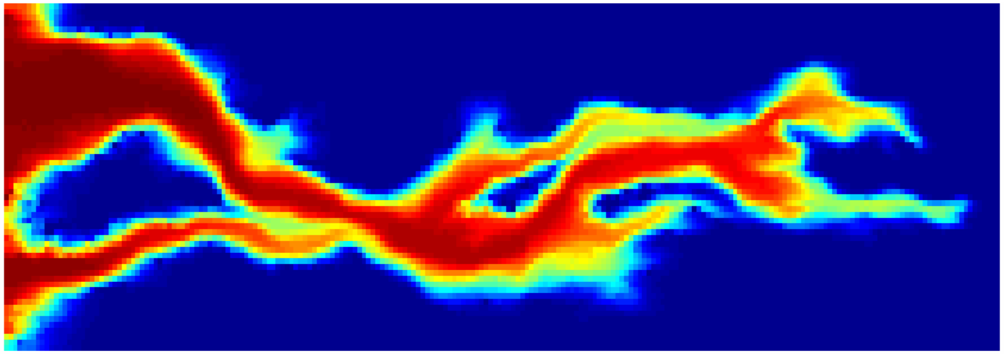
Challenges of CO_2 EOR (cont.)

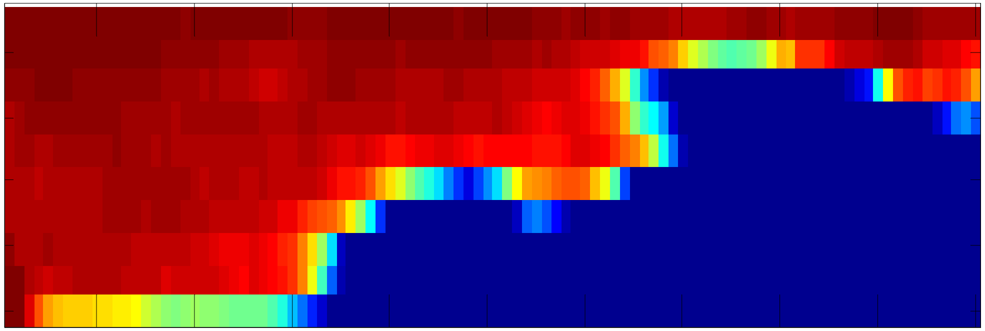
Mobility control

- Low viscosity CO_2
- Adverse mobility ratio
- Foams (new or better)
- WAG schemes



Gravity segregation

- Top-down injection
- WAG (injectivity?)



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Challenges of CO_2 EOR (cont.)

Extend application of CO_2 to lower API

- Gravity stable displacements
- Immiscible CO_2 processes

New Injection strategies

- Horizontal wells
- Top-down injection

Monitoring displacement performance

- Input to control/allocation of injection rates

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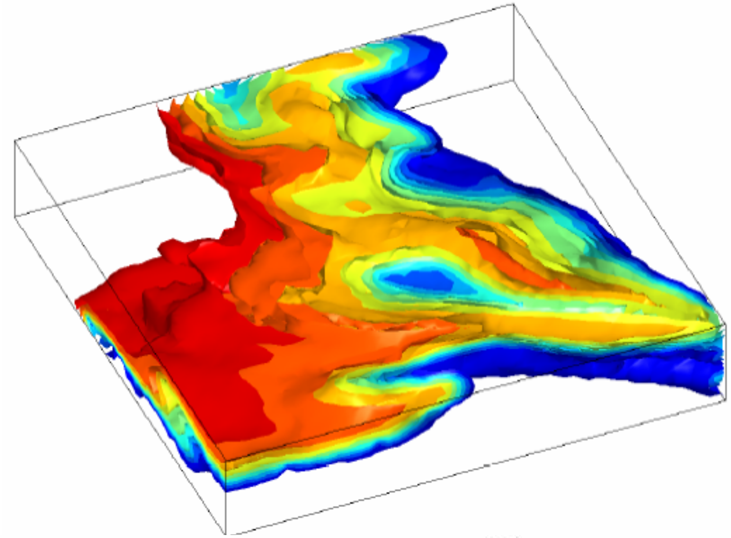
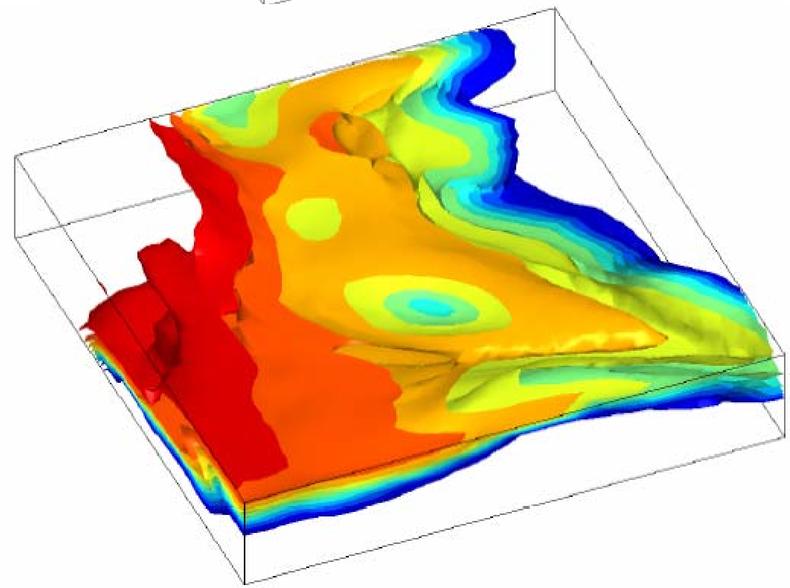
Challenges of CO_2 EOR (cont.)

Predictive tools

- Compositional reservoir simulation
- Is state-of-the-art good enough?
- Sweep efficiency often over-predicted by conventional tools
- Need more efficient and more accurate simulators
- Real-time decisions





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Summary

Significant CO_2 EOR potential

- Billions of barrels candidate for CO_2

Miscible as well as immiscible projects

- Target lower API reservoirs (< 20)

Research is needed

- Injection strategies and control
- Predictive tools

Collaboration

- Industry and academia (from lab to pilot to field)