

North Dakota Department of Mineral Resources

Taxation Committee 07/28/2015

11:00 a.m. Presentation by Mr. Lynn Helms, Director, Department of Mineral Resources, on the various phases of oil production, the current methods utilized in oil and gas recovery, and future recovery methods that may be employed in this state.



<http://www.oilgas.nd.gov>

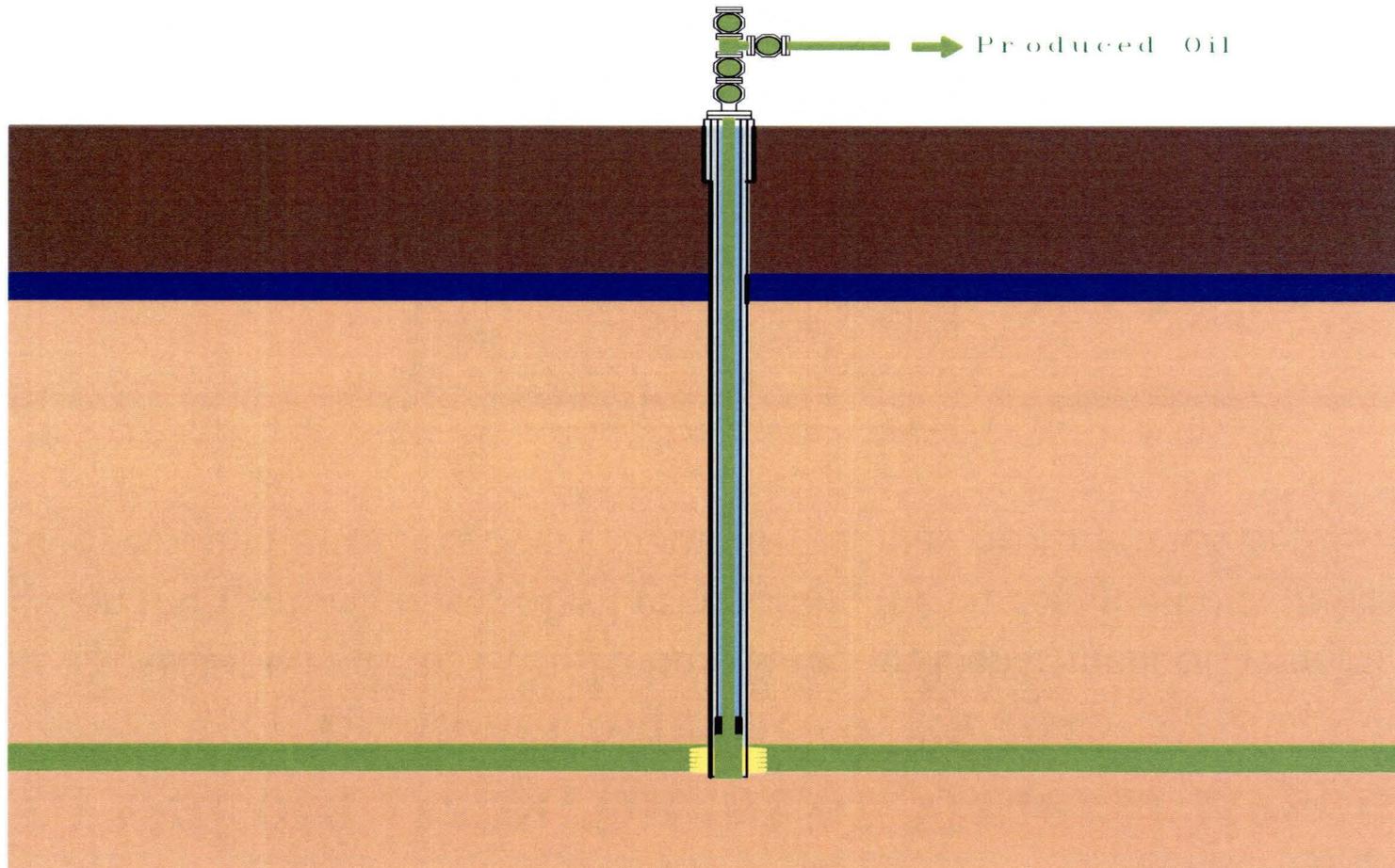
<http://www.state.nd.us/ndgs>

600 East Boulevard Ave. - Dept 405

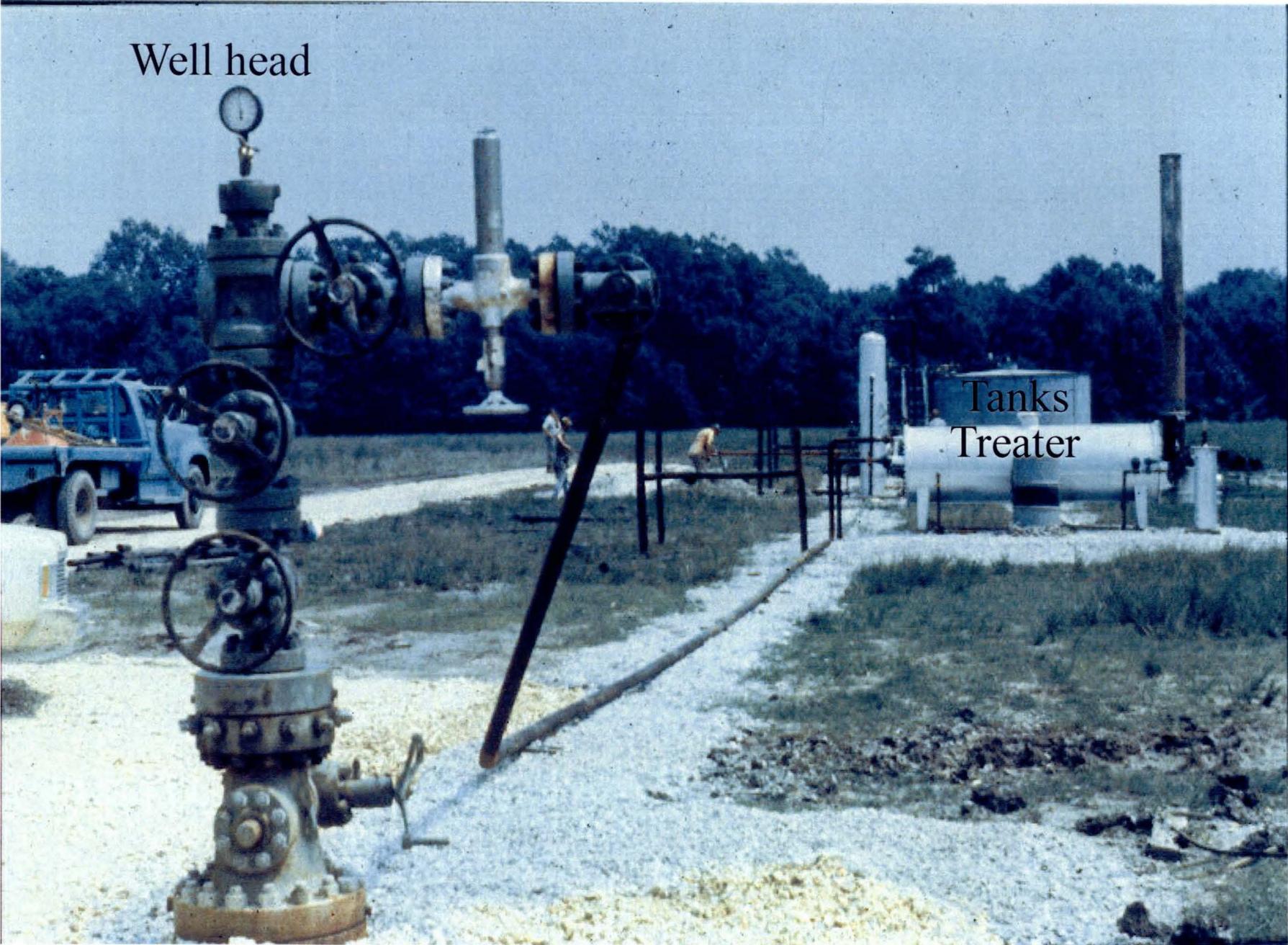
Bismarck, ND 58505-0840

(701) 328-8020 (701) 328-8000

FLOW OIL/WATER/GAS UNTIL RESERVOIR
PRESSURE IS DEPLETED

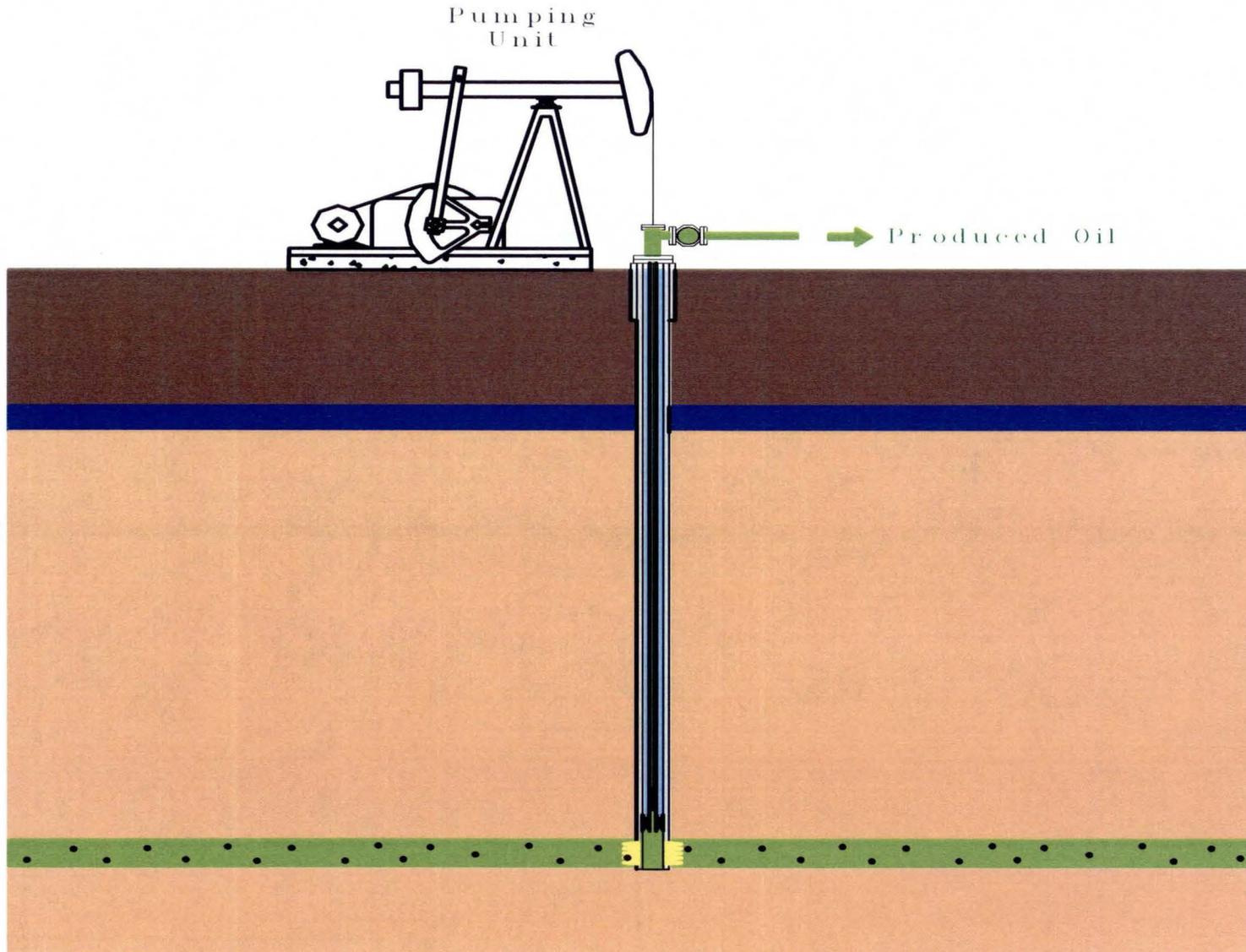


Well head



Tanks
Treater

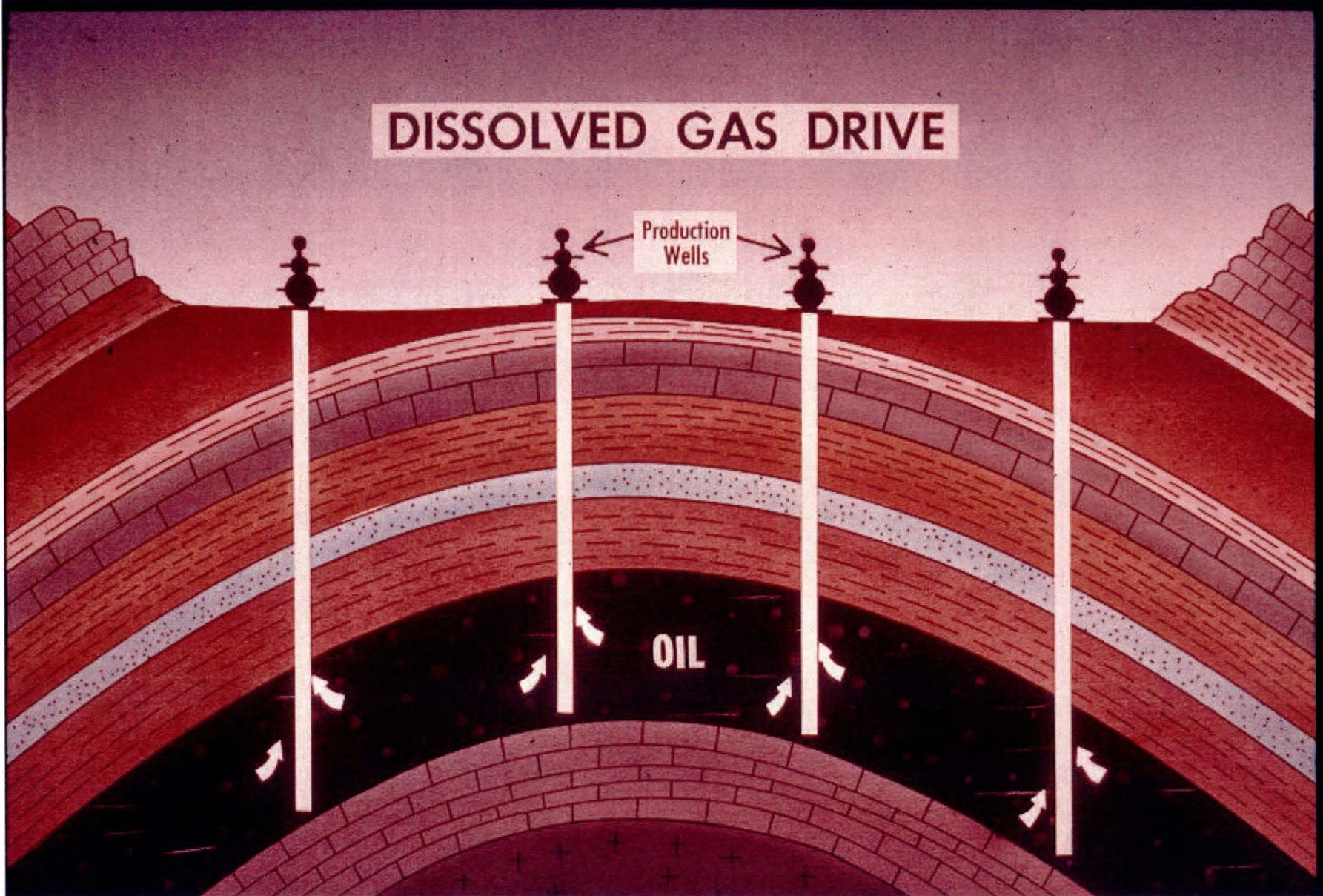
USING ARTIFICIAL LIFT AND ENHANCED OIL RECOVERY
TO PRODUCE OIL UNTIL WELL IS NO LONGER ECONOMICAL



DISSOLVED GAS DRIVE

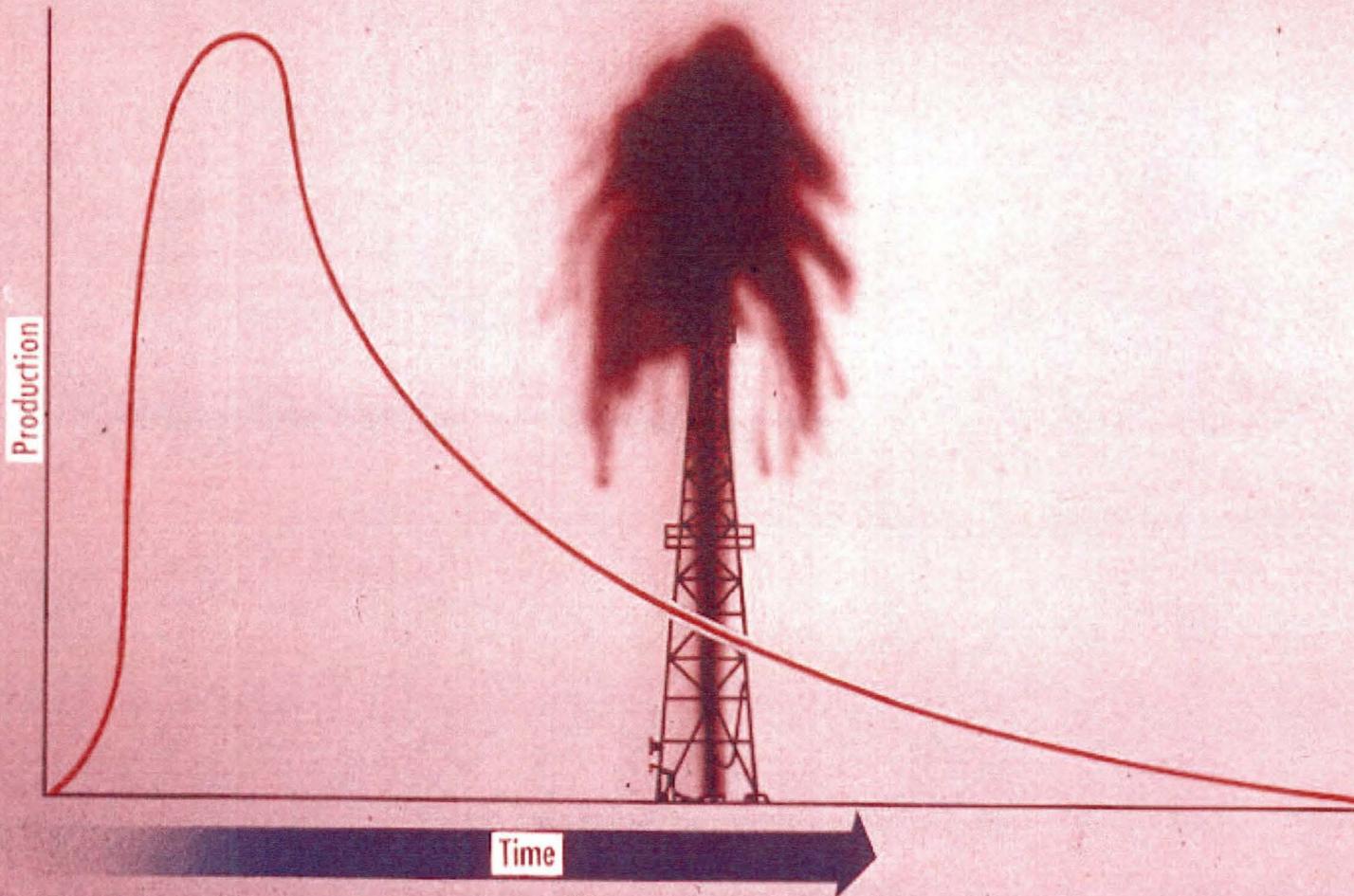
Production Wells

OIL

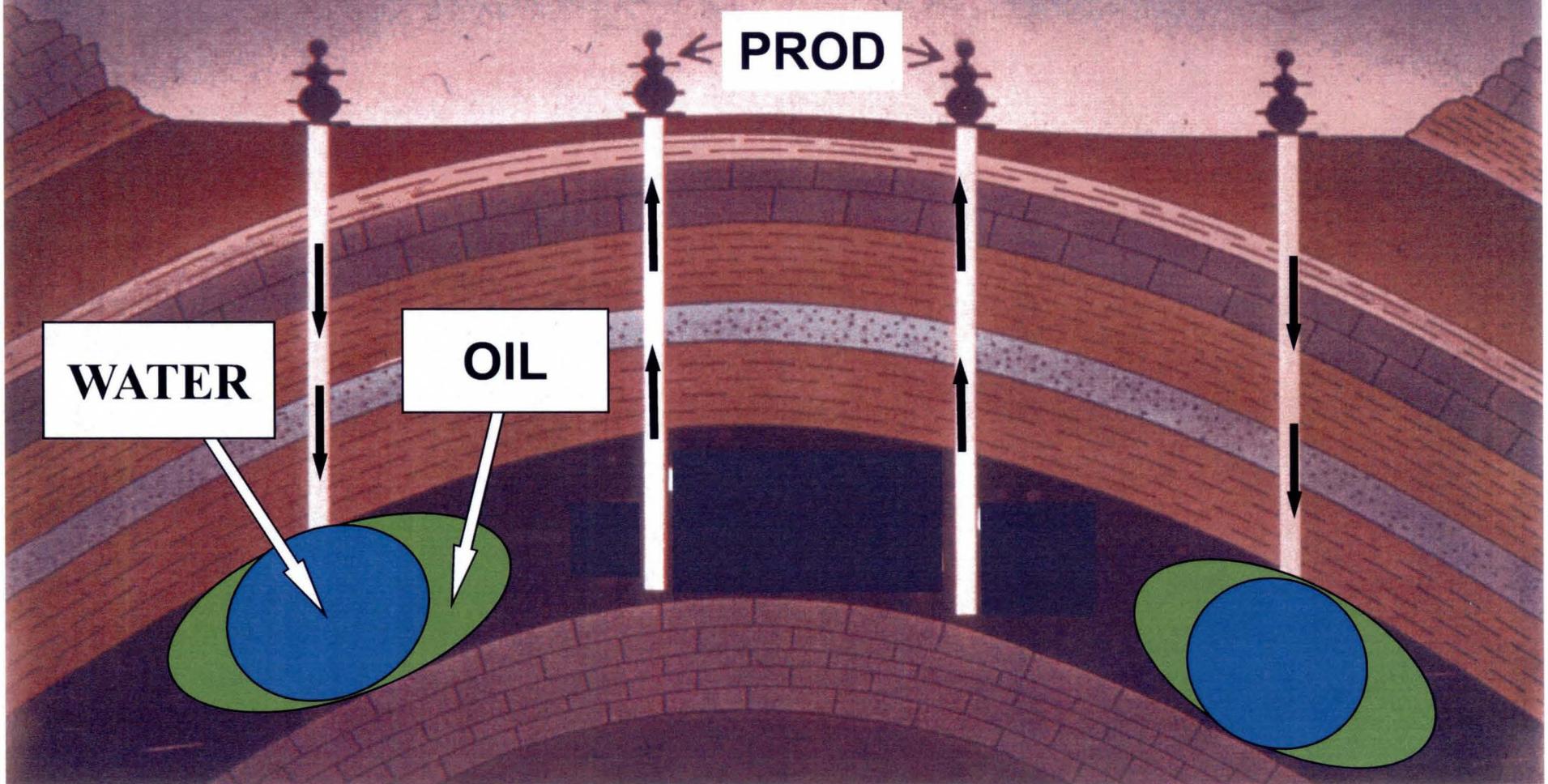


Natural pressure decline recovers only 10%-30% of the oil in a conventional reservoir, and 2%-12% in an unconventional reservoir (95% of ND [5% EOR]).

Primary Production Decline

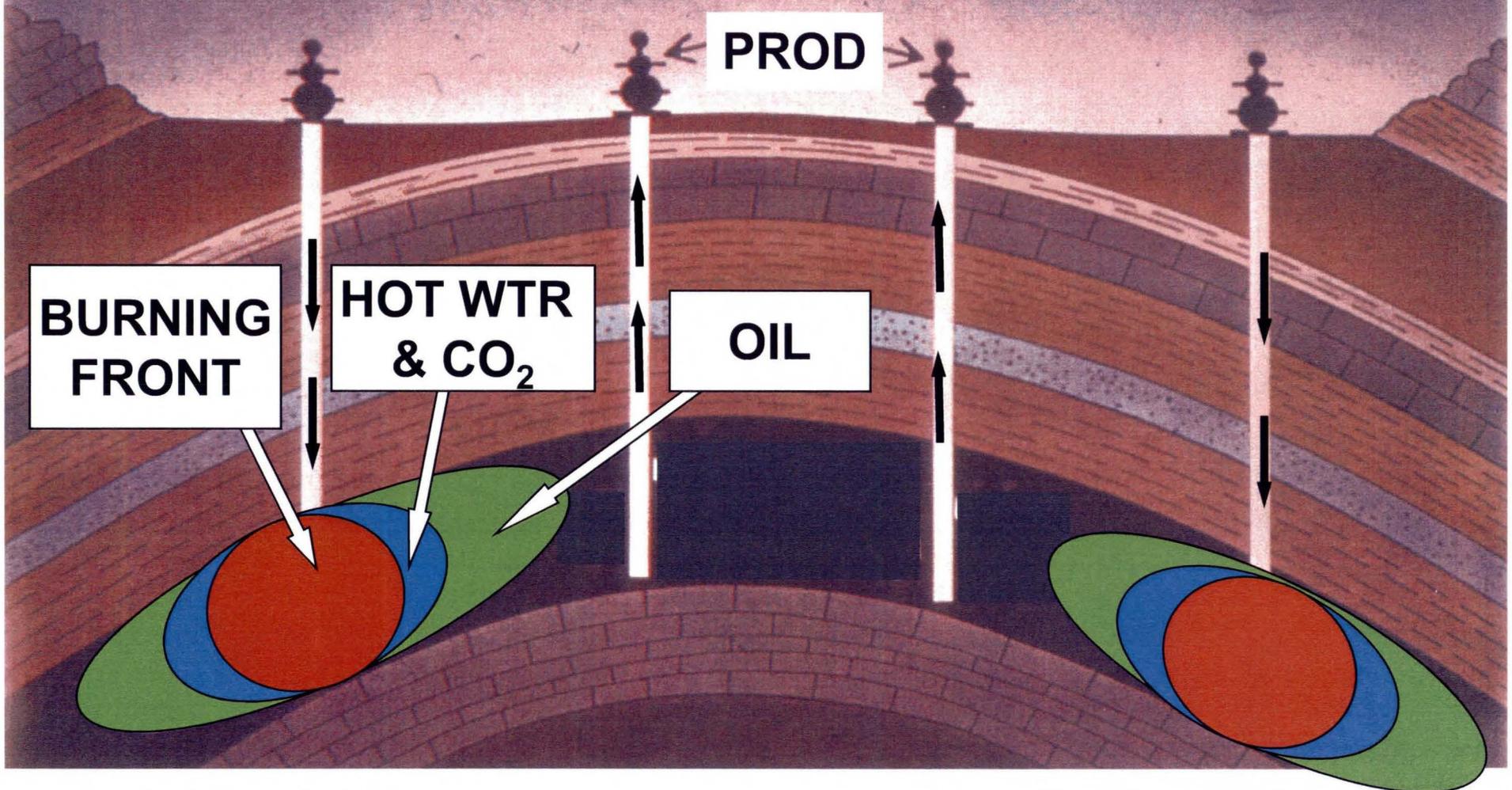


WATER INJECTION PROCESS

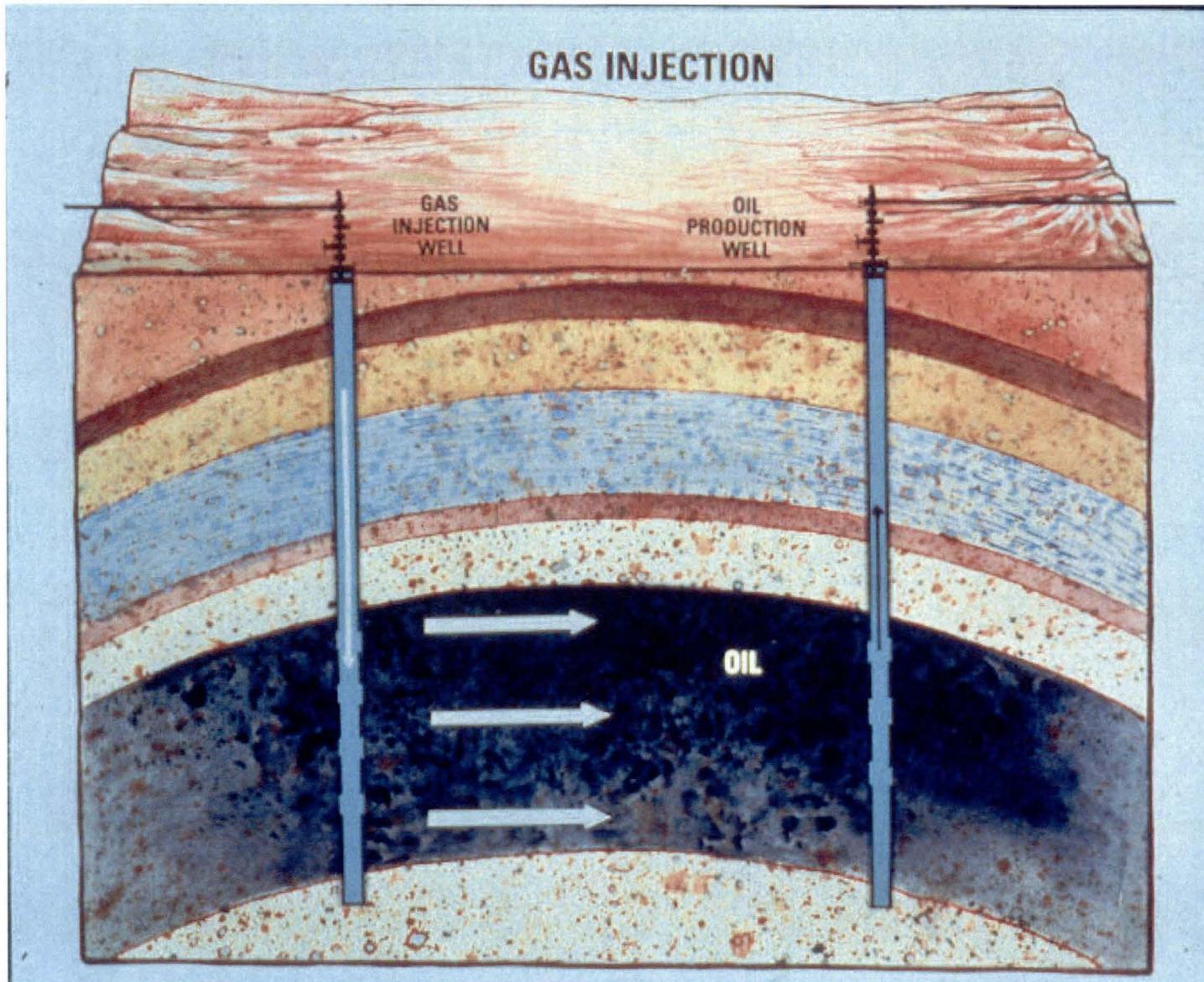


Using water to boost pressure and move oil can recover 30 - 50% of the oil in a conventional reservoir (71).
The Bakken water injection tests maintained pressure with no incremental oil recovery.

AIR INJECTION PROCESS

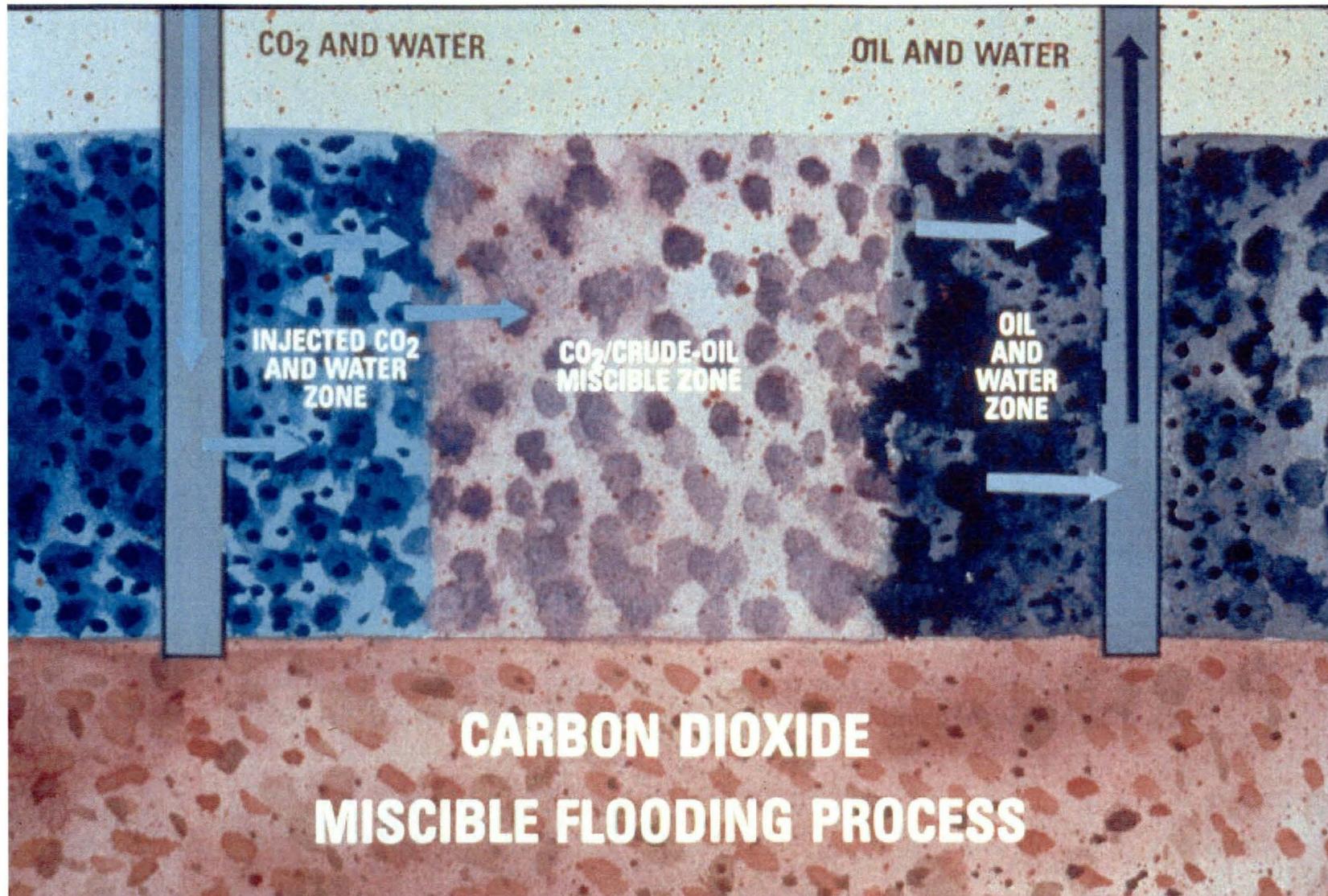


Using high pressure air to boost pressure and move oil can recover 25% - 35% of the oil in a low permeability reservoir (6).



Rich gas EOR can recover 55-65% of the oil in a conventional reservoir (2 IA).

A Bakken rich gas injection test has been approved but not conducted.



Modern CO₂ EOR can recover 55-65% of the oil in a conventional reservoir (0).
 The Bakken CO₂ injection tests cycled CO₂ with no incremental oil recovery.

Selected Saskatchewan Oil Fields

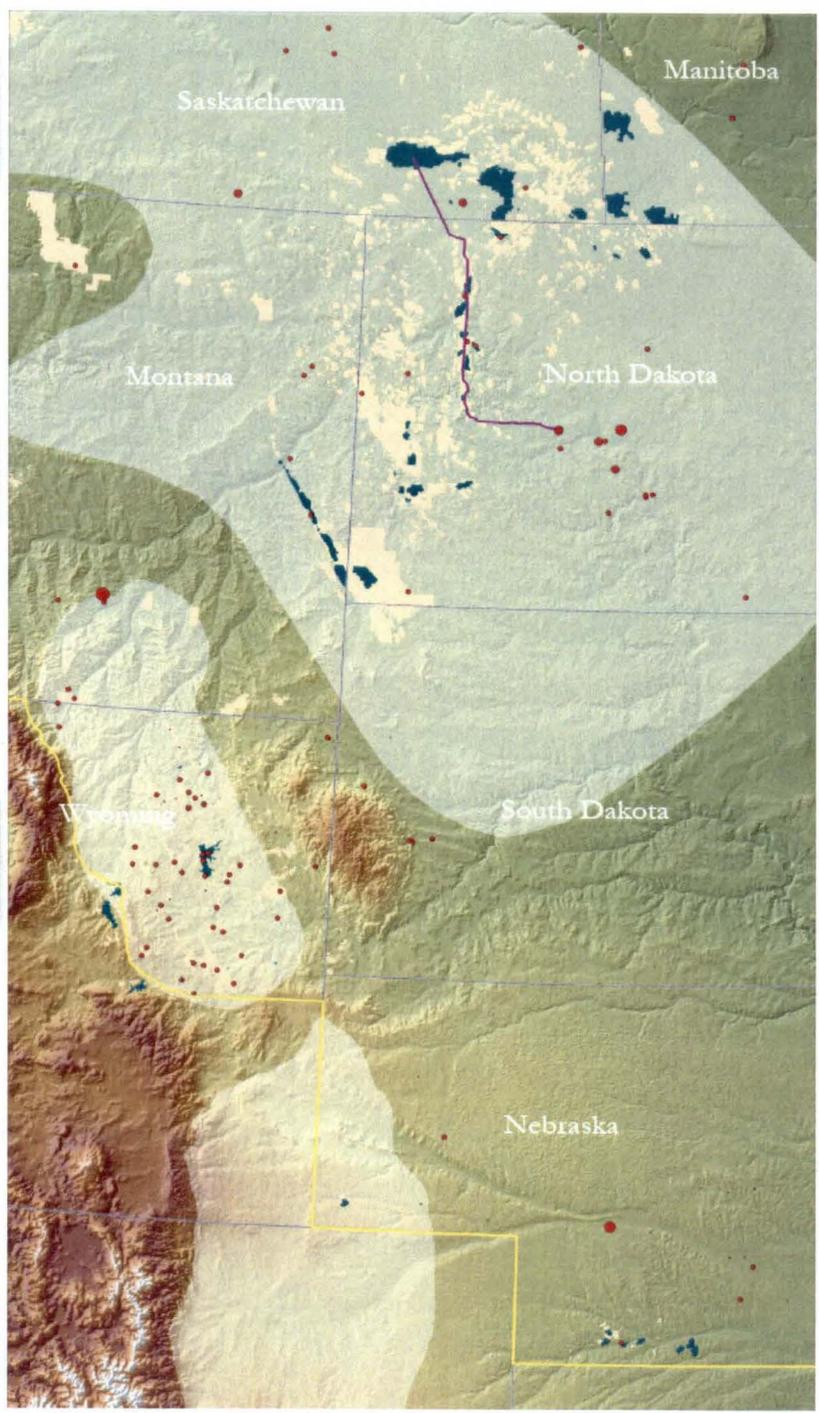
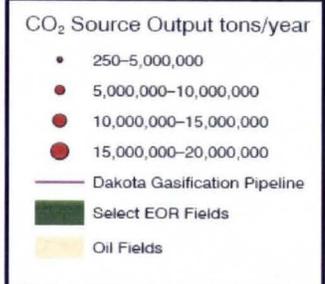
- 11 unitized fields
- Total OOIP = 2762 million bbl
- Potential incremental oil = 331 million bbl
- Total CO₂ needed for EOR = 2652 Bcf

Selected Montana Oil Fields

- Ten unitized fields
- Total OOIP = 3250 million bbl
- Potential incremental oil = 390 million bbl
- Total CO₂ needed for EOR = 3120 Bcf

Selected Wyoming Oil Fields

- 17 fields
- Total cumulative production = 1524 million bbl
- Potential incremental oil = 381 million bbl
- Total CO₂ needed for EOR = 3049 Bcf



Selected Manitoba Oil Fields

- Three unitized fields
- Total OOIP = 332 million bbl
- Potential incremental oil = 39 million bbl
- Total CO₂ needed for EOR = 319 Bcf

Selected North Dakota Oil Fields

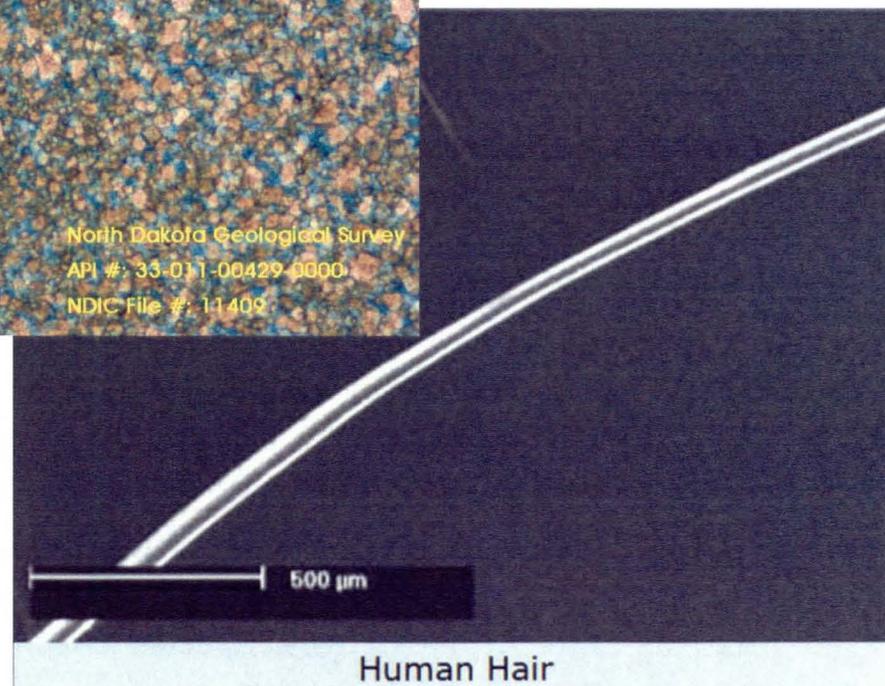
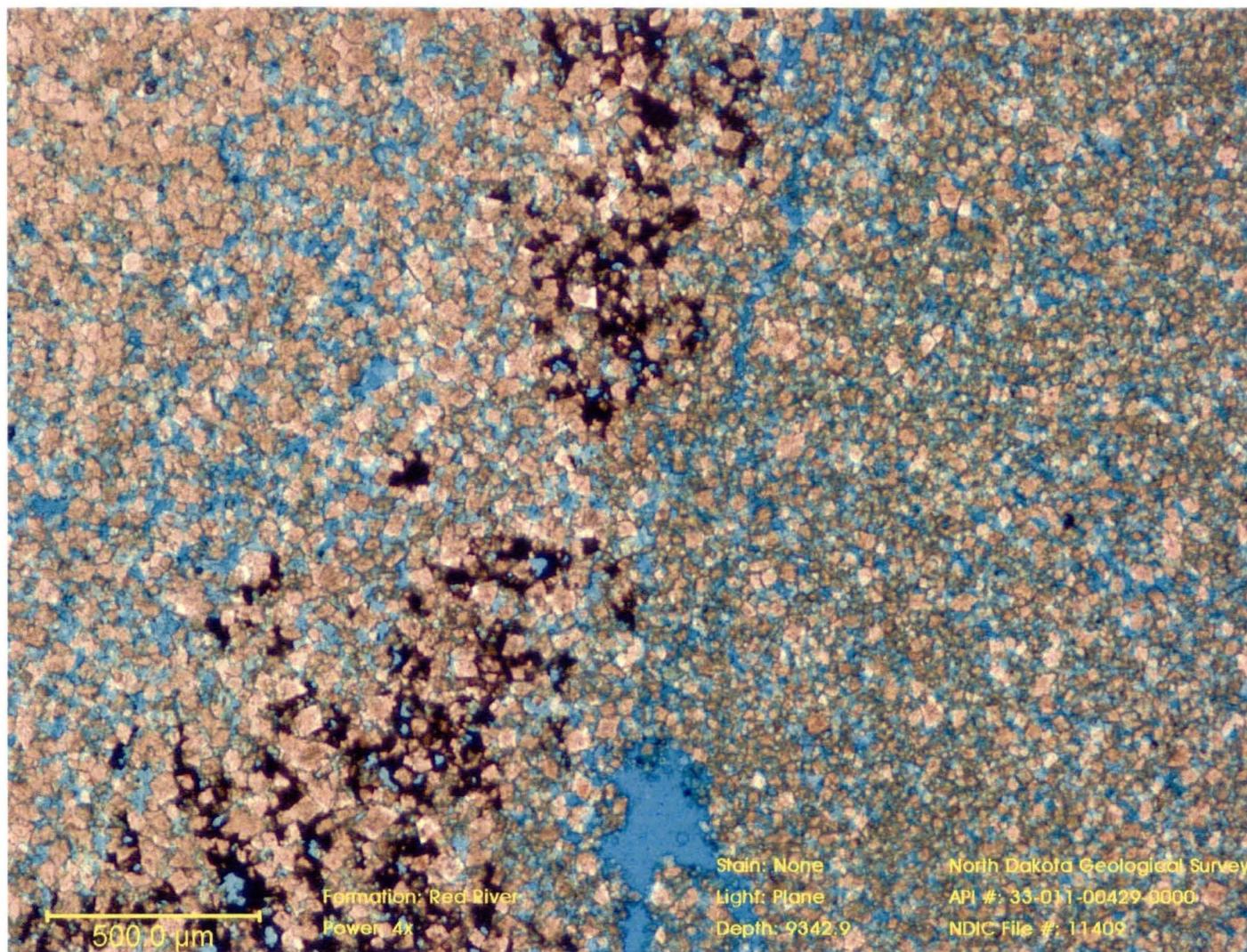
- 28 unitized fields
- Total OOIP = 2183 million bbl
- Potential incremental oil = 262 million bbl
- Total CO₂ needed for EOR = 2095 Bcf

Buffalo Field, South Dakota

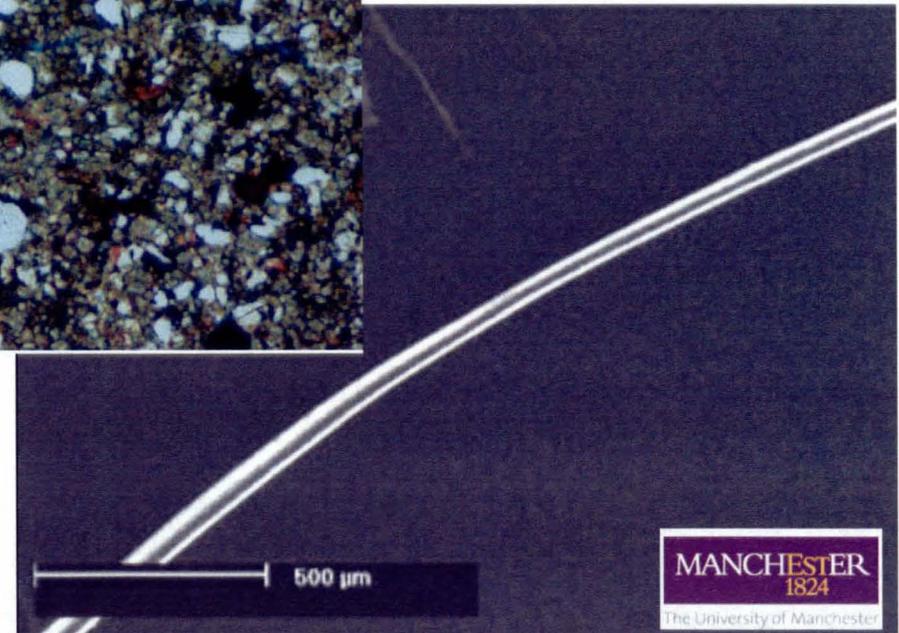
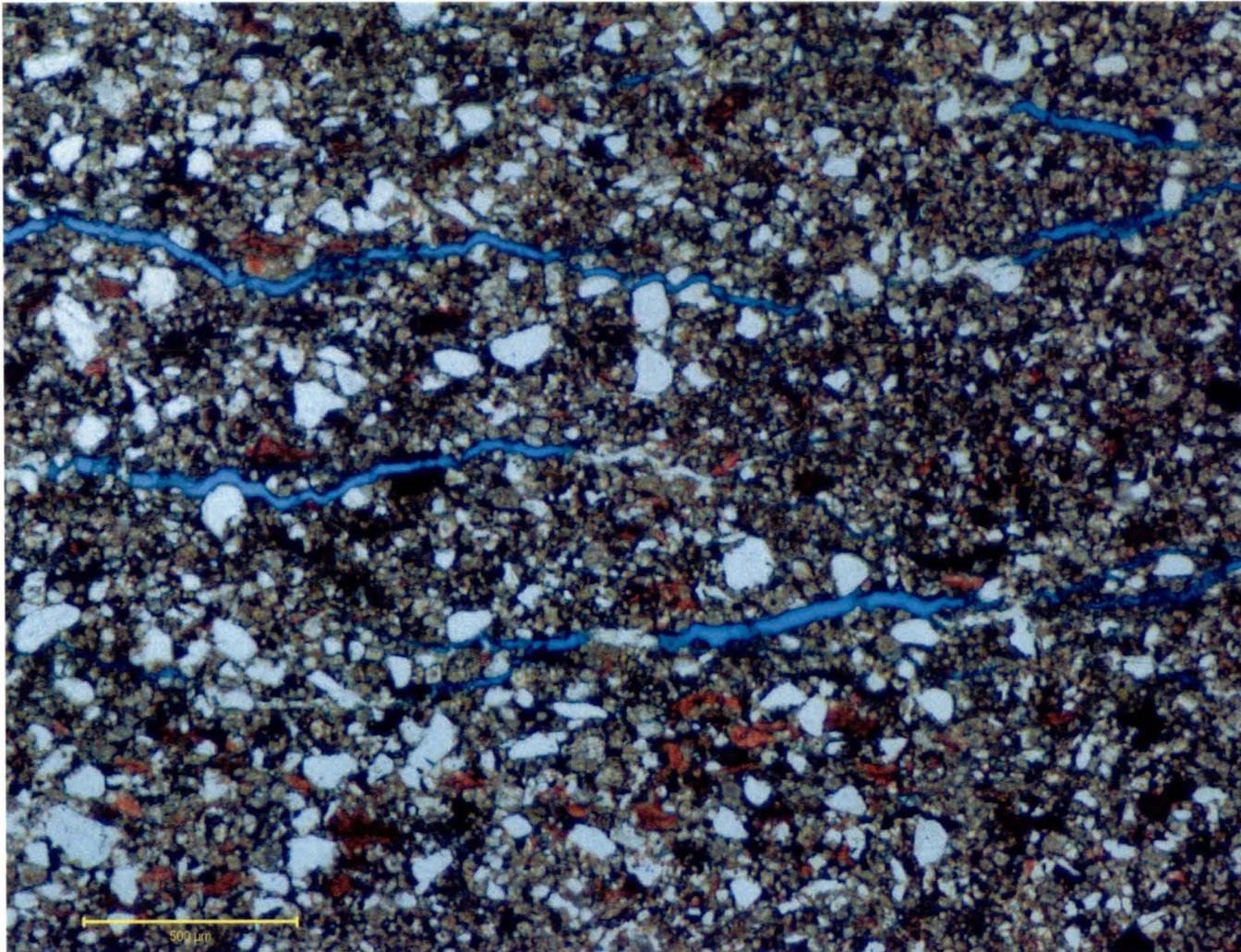
- Portions of this field are currently undergoing tertiary recovery operations using air injection.
- CO₂-based EOR may be technically feasible.

Selected Nebrasks Oil Fields

- Ten fields
- Total cumulative production = 100 million bbl
- Potential incremental oil = 25 million bbl
- Total CO₂ needed for EOR = 199 Bcf



Cedar Hills Red River 'B'



Parshall Bakken

Human Hair

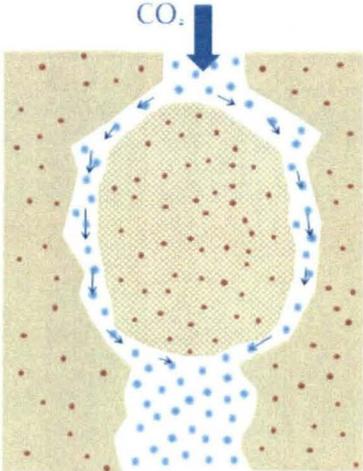


JJ Kringstad - North Dakota Pipeline Authority

CO₂ Extraction of Oil from Bakken Rocks

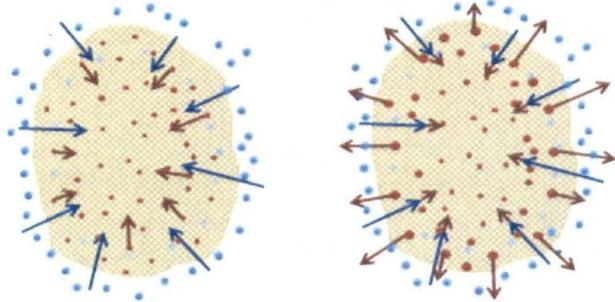
Step 1

Initial injection: CO₂ flows rapidly through fractures.



Step 2: CO₂ starts to permeate rock based on pressure gradient.

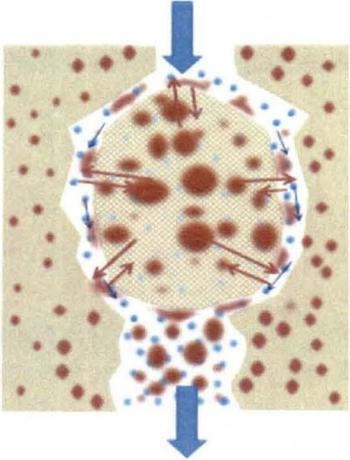
CO₂ carries oil into the rock (bad) *and or* CO₂ swelling pushes oil out of the rock (good).



Step 4

CO₂ pressures equalize inside of rock.

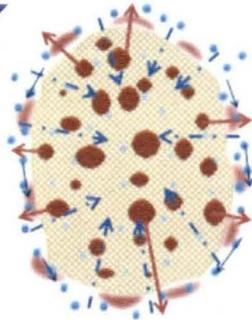
- Oil production is now based only on concentration gradient driven diffusion.
- Oil in bulk CO₂ is swept through fractures to production well.



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Step 3

As CO₂ permeates into the rock, oil migrates to bulk CO₂ in fractures based on swelling and lower viscosity.

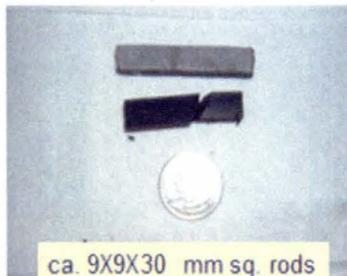


CO₂ Extraction of Oil from Bakken Rocks

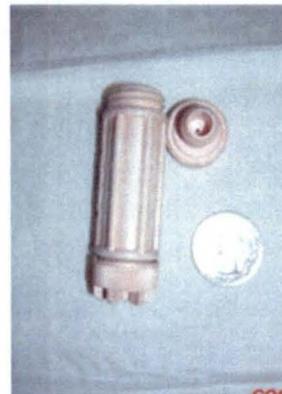
ca. 3X9X9 mm chicklets



ca. 9 mm dia rod



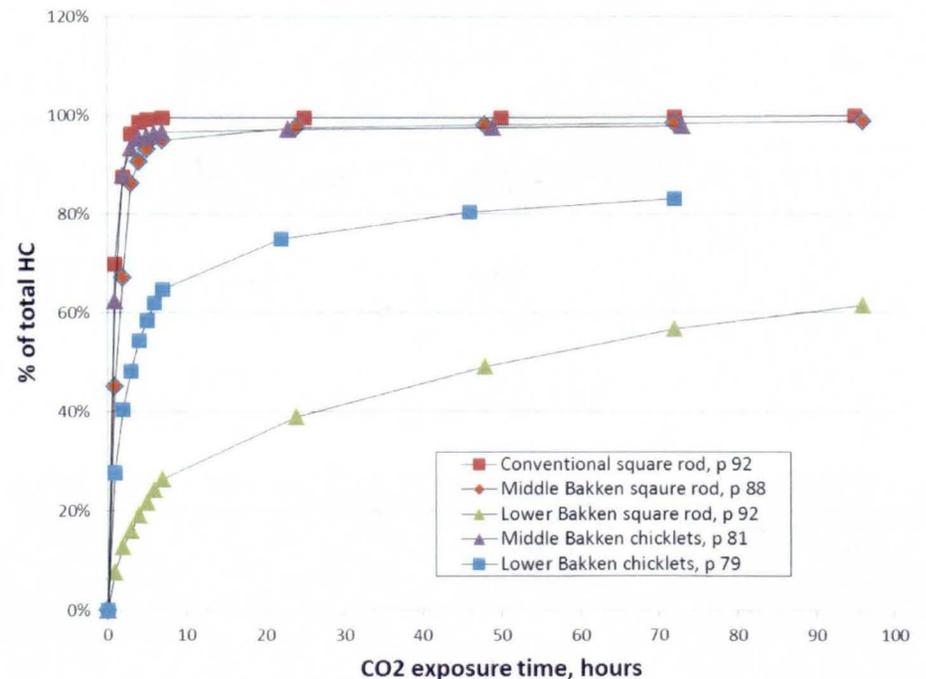
ca. 9X9X30 mm sq. rods



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CO₂ extraction of oil from samples of Middle and Lower Bakken rock. 5000 psi, 110°C (230°F) – examine effect of “unit cell” rock size and matrix lithology.

Results indicate that CO₂ can effectively extract hydrocarbons from both Middle and Lower Bakken rock matrix.



Bakken CO₂ Demand for North Dakota – A 30,000-ft View

- Based on the following:
 - Traditional evaluation techniques
 - North Dakota Industrial Commission original oil in place estimates
 - 4% incremental recovery
 - Net utilization of 5 and 8 mcf/bbl
- 2 to 3.2 billion tons of CO₂ needed.
- North Dakota currently produces ~33 million tons CO₂/year.

