



# North Dakota EOR Opportunities

**Lignite Energy Council  
2017 Fall Conference**

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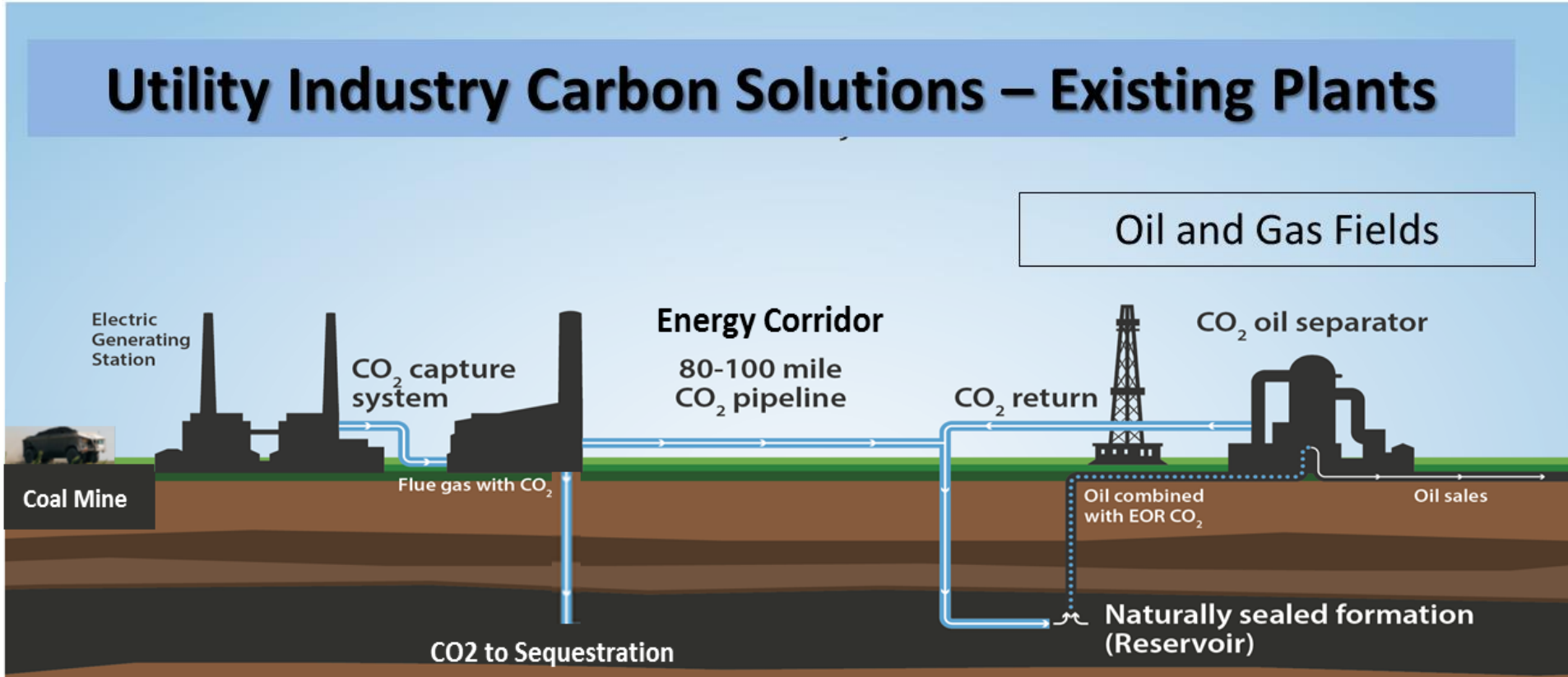
# Our Integrated Solution

## – A Broad Vision –

- Demonstrate the existing plant and new technology solutions in North Dakota using local lignite.
- Transport CO<sub>2</sub> from electric plants to the Bakken for Enhanced Oil Recovery and storage (in conventional oil fields).
- Develop a solution for utilization of the CO<sub>2</sub> in the Bakken Petroleum System (tight oil fields).

*A sustainable solution for coal coupled with a sustainable solution for additional oil recovery and CO<sub>2</sub> storage.*

# Our Integrated Solution – A Broad Vision –



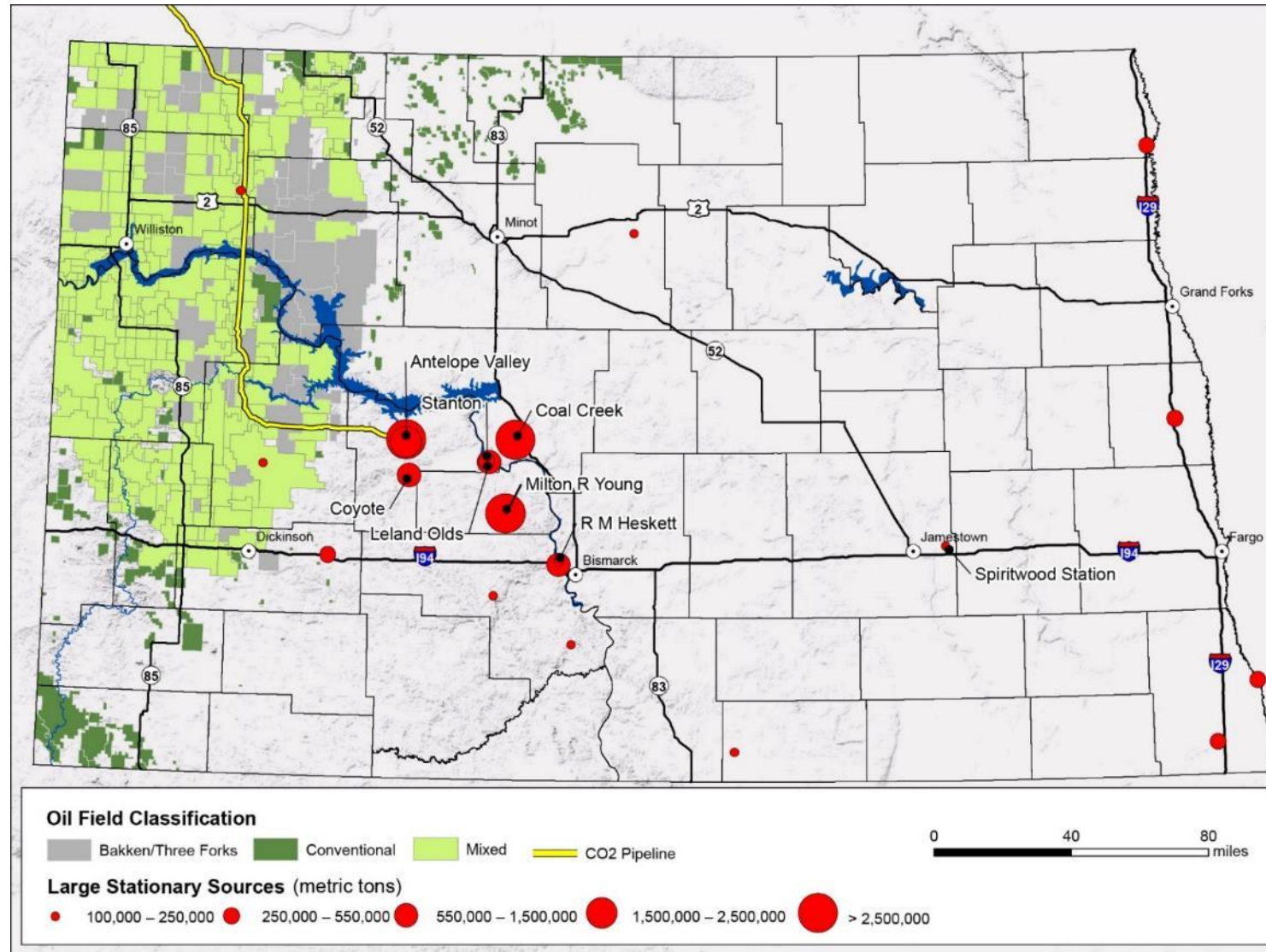
# Carbon Utilization: Much Promise in North Dakota

## Through the Plains CO<sub>2</sub> Reduction Partnership

- Extensive investigation into associated storage of CO<sub>2</sub> in the Bell Creek oil field of SE Montana.
  - ◆ Successful integration of research efforts with an active CO<sub>2</sub> EOR project
  - ◆ Modeling, dynamic simulation, MVA, 4-D seismic, reservoir saturation logging
  - ◆ Accurately predicting the movement of CO<sub>2</sub>
  - ◆ Accurately documenting the storage of the CO<sub>2</sub>
  - ◆ **Experience readily transferred to other states!**
- Regional characterization efforts examined multiple saline formation options for CO<sub>2</sub> storage
  - ◆ Gigatonnes of storage potential in western North Dakota
    - Broom Creek, Deadwood, Inyan Kara, Madison Formations
  - ◆ Prime formations underlay the lignite-fired power generation facilities



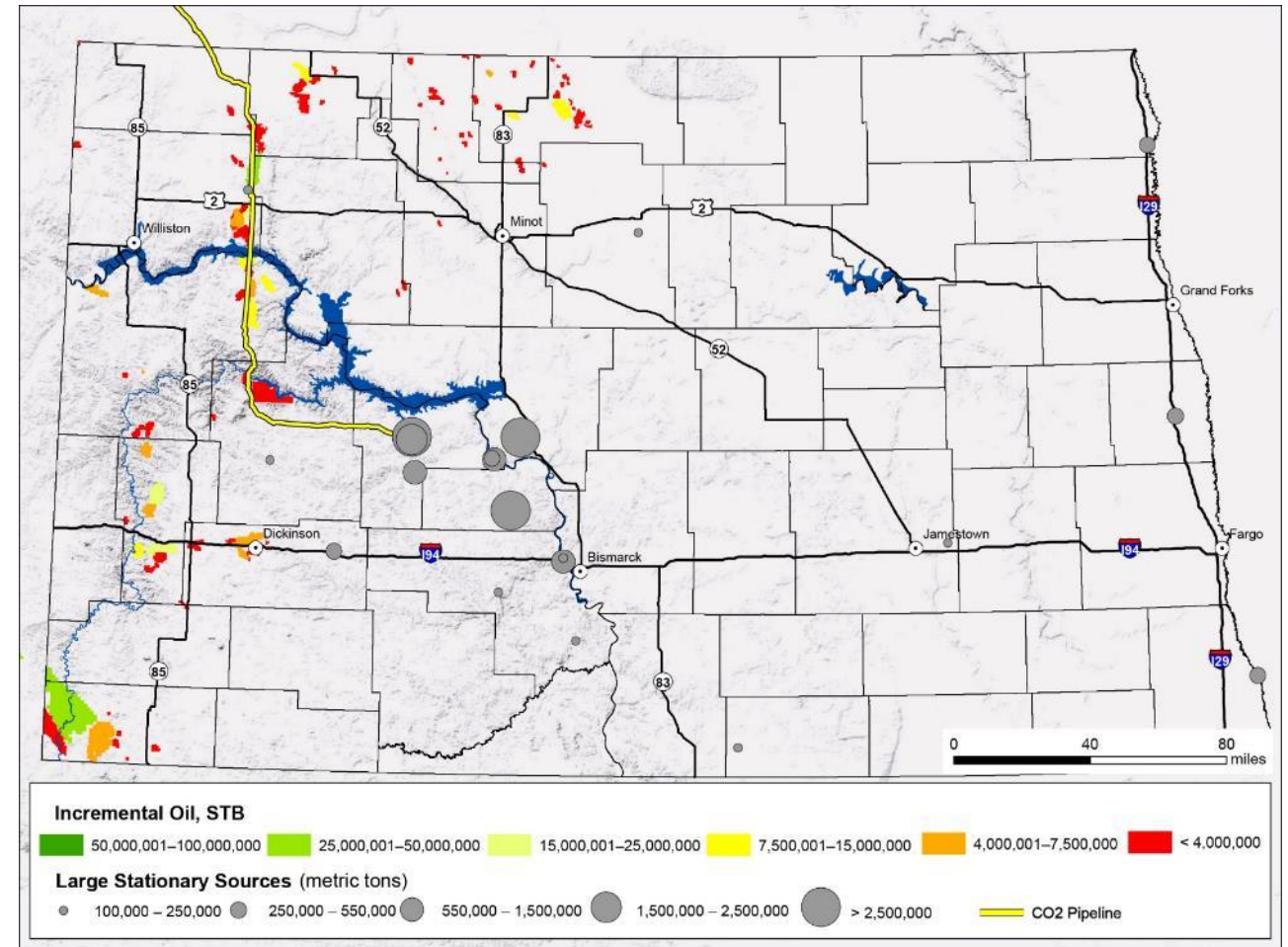
# North Dakota Oil Fields





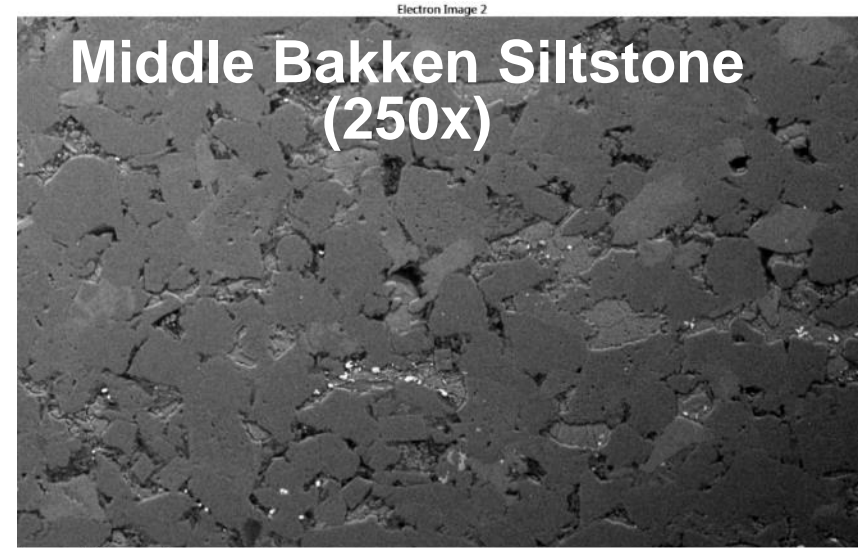
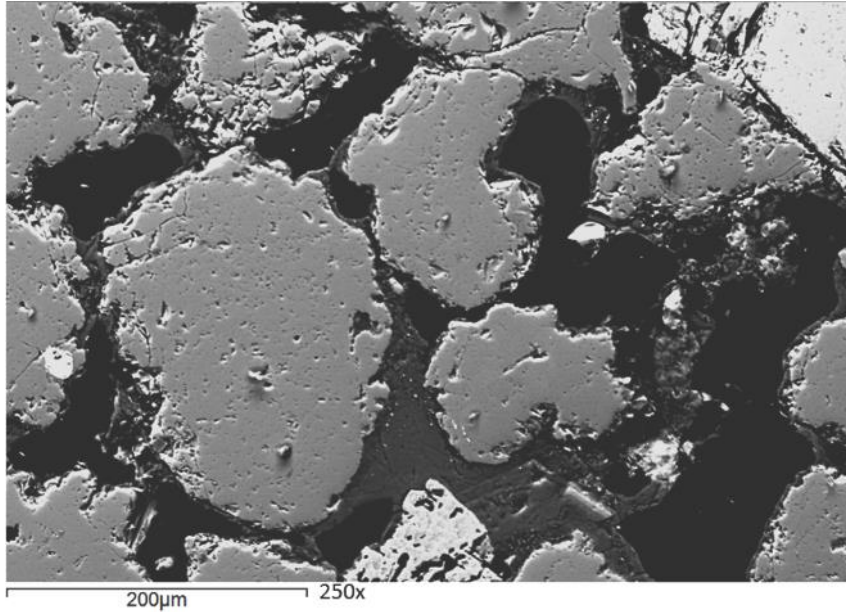
# Top Conventional Oil Fields for CO<sub>2</sub> EOR

- KLJ (2014) report lists:
  - In 86 North Dakota conventional oil fields:
    - ◆ 47 to 283 million metric tons of CO<sub>2</sub> storage.
    - ◆ 280 to 631 million barrels of oil recovered.
- Potential to store a decade of North Dakota's coal-fired CO<sub>2</sub> emissions.

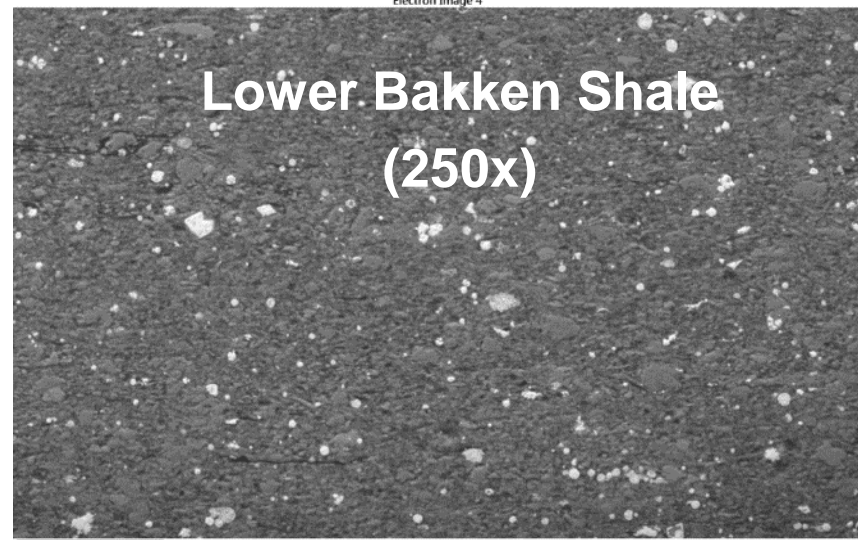


# Conventional Sandstone Reservoir vs. Bakken

**Muddy Fm Sandstone  
(250x)**



**Middle Bakken Siltstone  
(250x)**

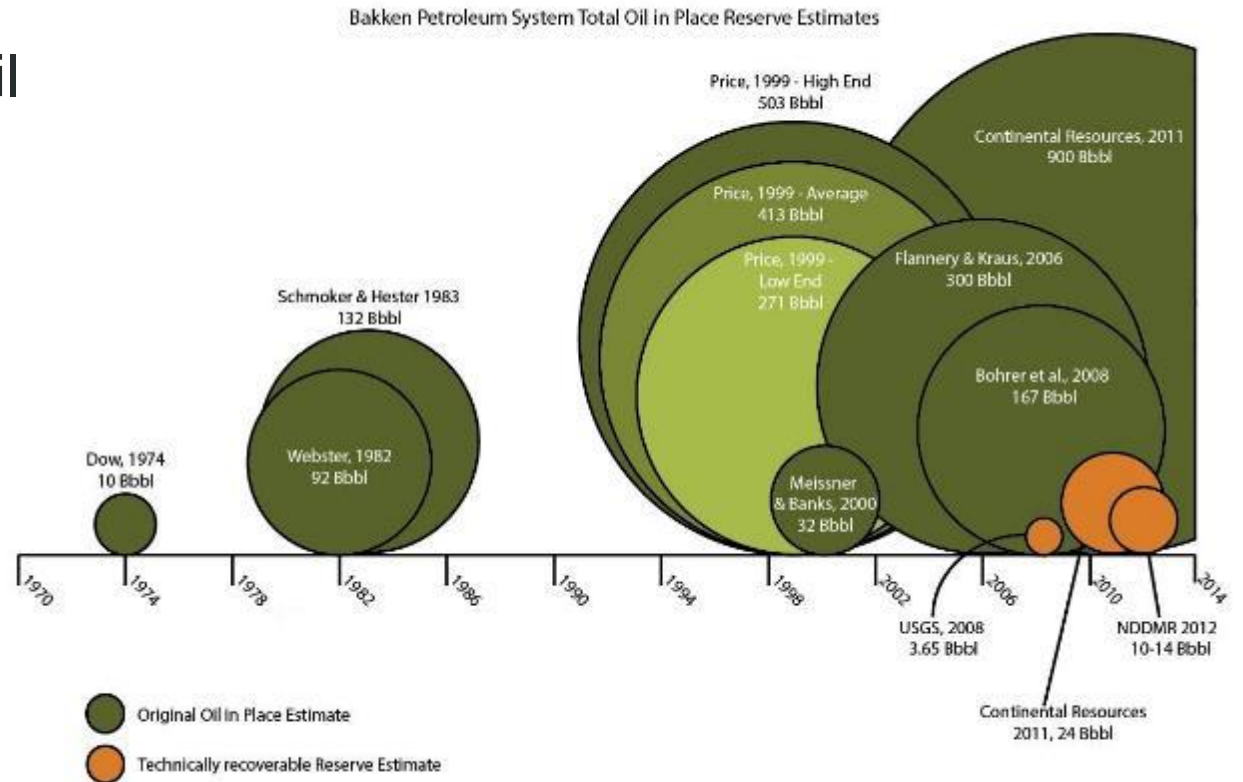


**Lower Bakken Shale  
(250x)**

**Black in the images  
represents pore  
spaces.**

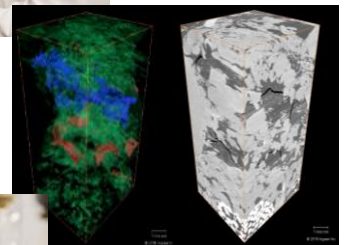
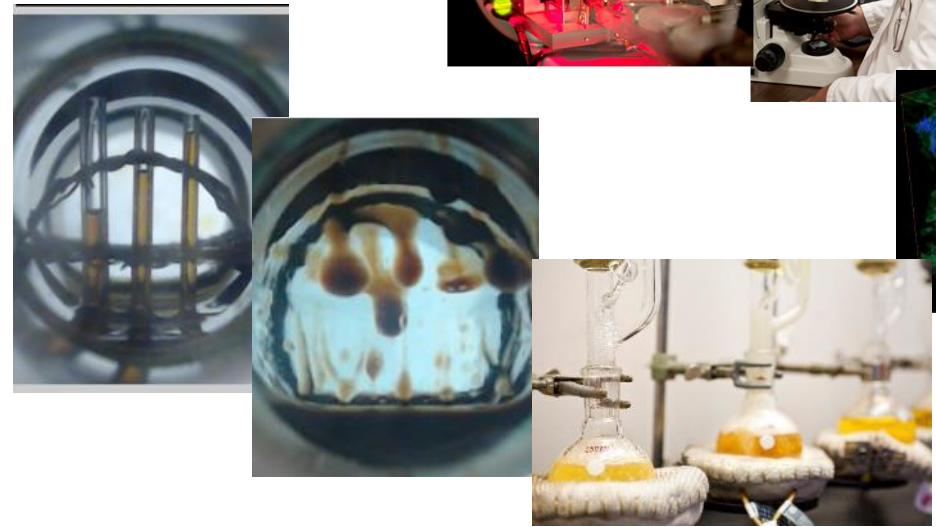
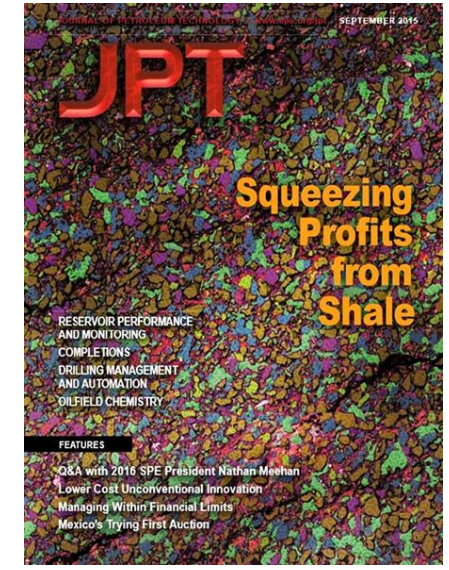
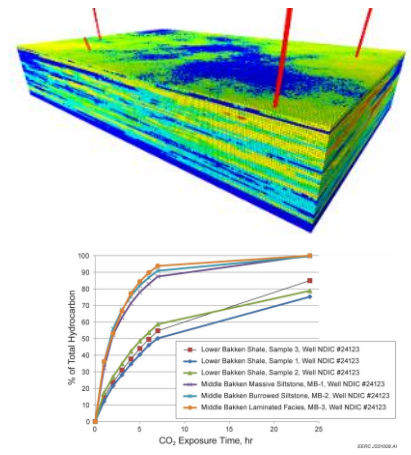
# How Do We Get More Out of the Bakken?

- The more we understand about the Bakken petroleum system, the more oil we recognize is in it.
- Currently, only a 3%–10% recovery factor.
- Small improvements in recovery could yield over a billion barrels of oil.
- **Can carbon dioxide be a game changer in the Bakken?**





# EERC Efforts to Address Bakken EOR Challenges

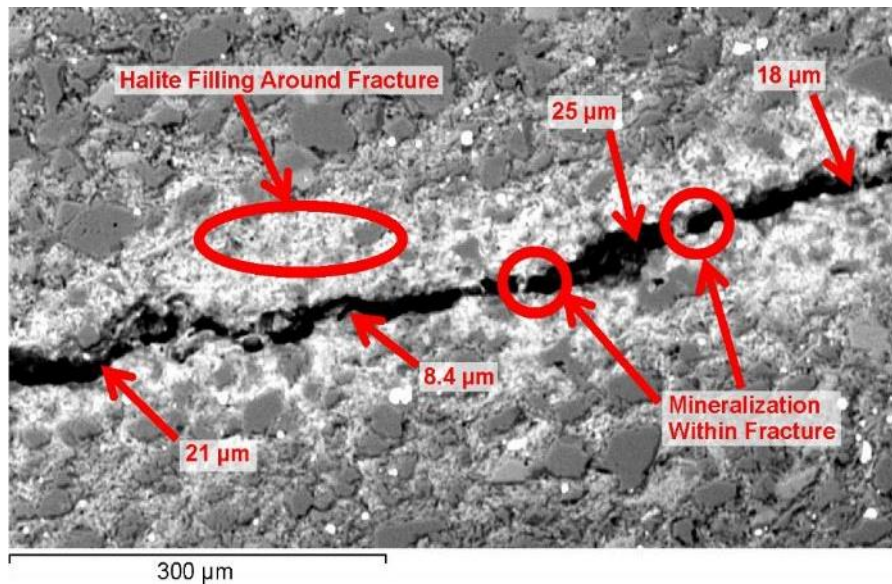




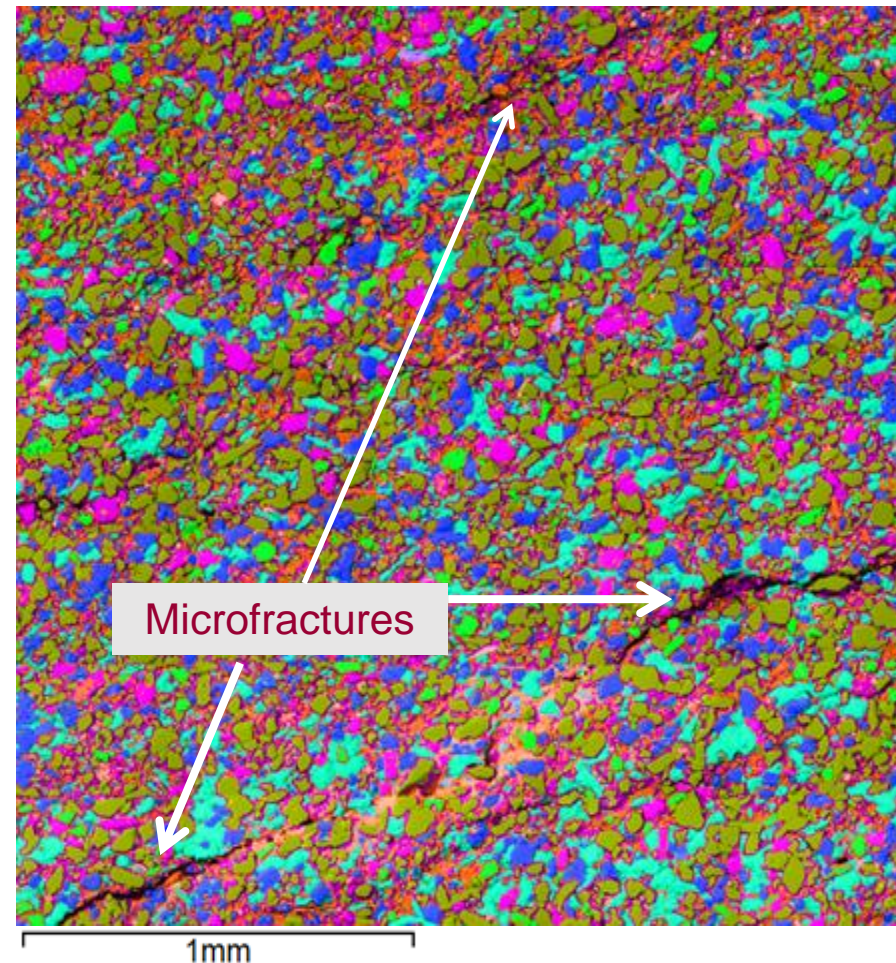
# Reservoir Characterization

## Key Lessons Learned

- Movement of fluids (CO<sub>2</sub> in and oil out) relies on fractures.
- Microfractures account for most of the porosity in the productive Bakken zones.
- Integration of natural fracture data into modeling are essential to develop effective EOR strategies.



Scanning Electron Microscopy (SEM) Mineral Map of a Middle Bakken Sample (colors represent minerals; black represents porosity)



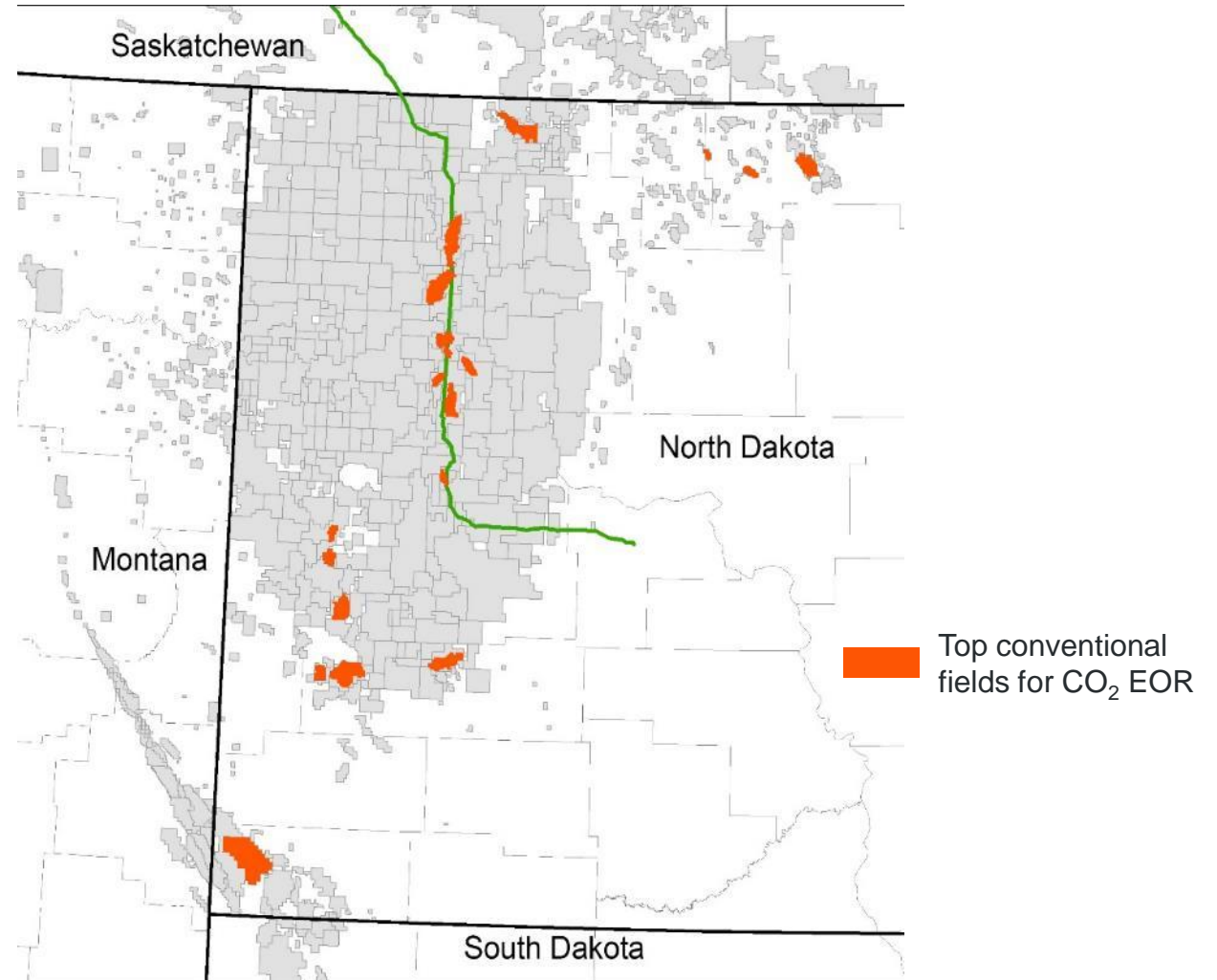
# Bakken CO<sub>2</sub> Demand in North Dakota – A 30,000-ft View

- Based on the following:
  - Traditional evaluation techniques
  - North Dakota Industrial Commission OOIP (original oil in place) estimates
  - 4% incremental recovery
  - Net utilization of 5000 and 8000 ft<sup>3</sup>/bbl
- 2 to 3.2 billion tons of CO<sub>2</sub> needed.
- Could represent 50 to 100 years of North Dakota's current CO<sub>2</sub> emissions from coal-fired power!



# Carbon Utilization: Infrastructure and Needs

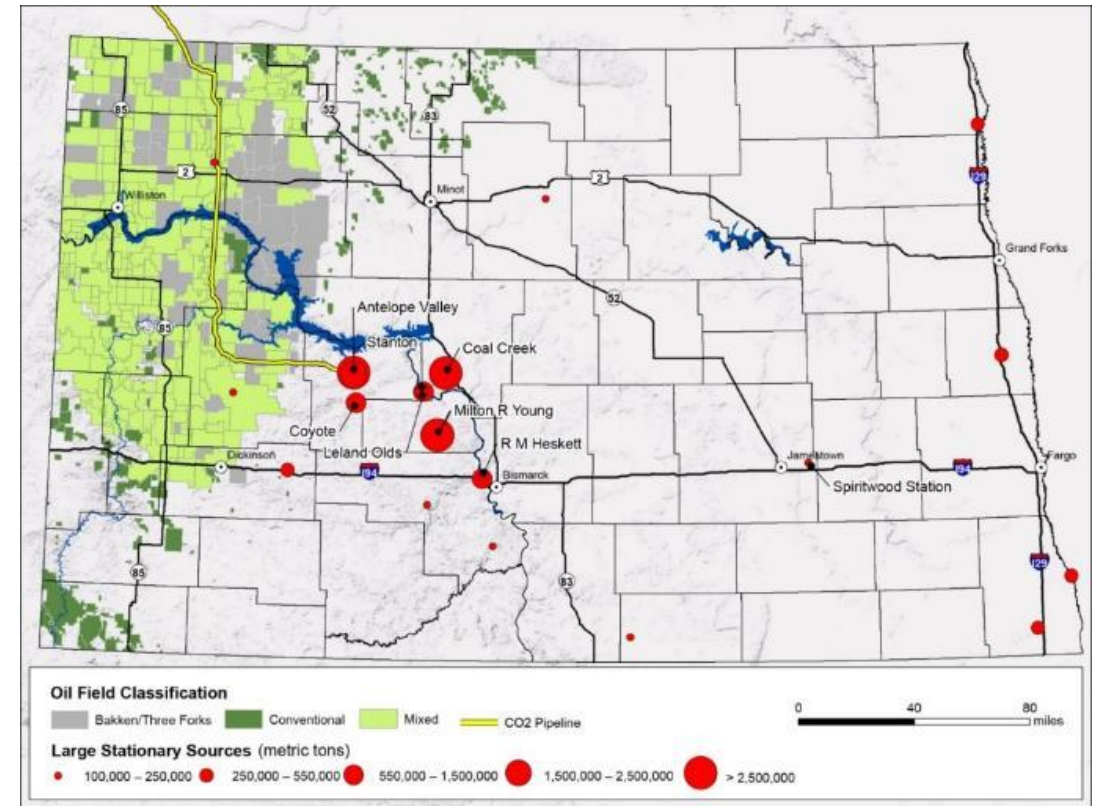
- One CO<sub>2</sub> pipeline in the region.
  - Delivers CO<sub>2</sub> to Weyburn-Midale field in Saskatchewan
  - Well planned route
  - Limited additional capacity





# North Dakota – Ideally Suited

- North Dakota has an ideal situation for CO<sub>2</sub> management.
  - CO<sub>2</sub> emission sources are in close proximity to CO<sub>2</sub> storage targets.
  - Between 23 and 78 Gt of storage available within the state between saline formations and oil reservoirs.

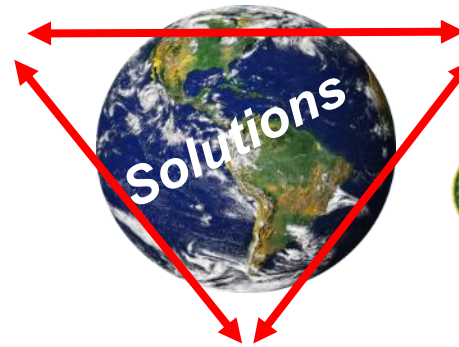


# Our Partnerships – Working Together to Create a Pathway for Carbon Solutions

## Energy Industry



## Government & Research



## Technology Industry



# Contact Information

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