

Drew Stump, Masters of Geology, Expected Graduation: Fall 2023

MUDDY SANDSTONE EOR (CCUS), BELL CREEK FIELD, MONTANA



Geologic Background

- Starts during the Early Cretaceous during the Spread of the Western Interior Seaway
- Deposition of the Dakota formation represents the transition from continental to marine depositional environments.
- Muddy Sandstone (Lower Cretaceous) was deposited regionally across the Rocky Mountains including the eastern part of the Powder River Basin
- Sediments of a regressive shoreline were reworked into beaches, offshore bars, and Barrier bars during transgression events to form the Muddy Sandstone (Sharef, 2021).



Burnison et al./ Energy Procedia 00 (2017)

Field Location



 Located Powder River Basin, southeastern Montana, USA





Bell Creek Field Areas



- Split into 9 separate areas
- Areas where determined by:
- 1. Well penetrations with little or no reservoir quality
- 2. Wells with high water cut only a short distance updip from wells with notable oil production
- 3. Significant variability in pressure, volume, and temperature properties of produced hydrocarbons
- 4. Considerable reservoir pressure differences, short and/or long distance across the field (Molnar, 1990)







Structure Map Muddy Sandstone





Isopach Map Muddy Sandstone



4D Seismic of Injection of CO₂

- Map showing amplitude change from baseline 3D seismic to time lapsed 4D seismic
- Injections into the thicker parts of the Muddy Sandstone show an increase in Seismic amplitude from increased saturations of CO₂



Burnison et al./ Energy Procedia 00 (2017)

Gas Saturation through Well Data

- Showing CO₂ migration through two injection wells (05-01, 04-03) to an oil Producing well (04-04).
- Logs showing changes in distribution with respect to fluids.
- Start left most part of log and finish right most part of log



Hamling / Energy Procedia 00 (2017) 000–000)





Gas Recycled Injection from EOR

- Gas impurities can affect the oil recovery rate of oil production in EOR
- Pure CO₂ has low (HCPVI) Hydrocarbon pore volume Injected
- The ideal amount is to have a 20% gas impurity to get maximum oil recovery amounts

(Jin, 2017)



Jin / Energy Procedia 00 (2017) 000–000



Future Work

- Studying 4D seismic to see the migration pattern of injected CO₂ into the Muddy Sandstone
- Using the 3D seismic to find ideal trapping within the Muddy sandstone within the field especially within phase 6
- Analyzing cores to see the reservoir quality and seal quality of the Muddy Sandstone and the seals above
- Studying logs in order to see best potential wells for injection.
- Comparing net sand thickness to oil production



References

- Burnison, S. A., N. W. Bosshart, O. Salako, S. Reed, J. A. Hamling, and C. D. Gorecki, 2017, 4-D Seismic Monitoring of Injected CO2 Enhances Geological Interpretation, Reservoir Simulation, and Production Operations: Energy procedia, v. 114, p. 2748–2759, doi:10.1016/j.egypro.2017.03.1539.
- Sharaf, E. F., and H. Sheikha, 2021, Reservoir characterization and production history matching of Lower Cretaceous, Muddy Formation in Ranch Creek area, Bell Creek oil field, Southeastern Montana, USA: Marine and petroleum geology, v. 127, p. 104996–, doi:10.1016/j.marpetgeo.2021.104996.
- Molnar, PS. Geologic reservoir study of the Bell Creek Field, Carter and Powder River Counties, Montana. Midland, Texas: Exxon Company; 1990
- Jin, L., L. J. Pekot, S. B. Hawthorne, B. Gobran, A. Greeves, N. W. Bosshart, T. Jiang, J. A. Hamling, and C. D. Gorecki, 2017, Impact of CO2 Impurity on MMP and Oil Recovery Performance of the Bell Creek Oil Field: Energy procedia, v. 114, p. 6997–7008, doi:10.1016/j.egypro.2017.03.1841.
- Hamling, J. A., K. A. Glazewski, K. M. Leroux, N. S. Kalenze, N. W. Bosshart, S. A. Burnison, R. J. Klapperich, D. J.
 Stepan, C. D. Gorecki, and T. L. Richards, 2017, Monitoring 3.2 Million Tonnes of CO2 at the Bell Creek Oil Field: Energy procedia, v. 114, p. 5553–5561, doi:10.1016/j.egypro.2017.03.1695.

MUDTOC Consortium Sponsors Spring 2022





Platte River Associates. Inc.