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Integrating high resolution core analysis with sedimentological and stratigraphic attributes: Implications for improved oil recovery (IOR) in the Bakken Formation

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Summary

The Bakken Viewfield Pool in SE Saskatchewan contains an estimated 1.3 billion barrels (2016) of stratigraphically trapped migrated oil in a tight siltstone reservoir. This play has been recently the subject of further investigation for enhanced oil recovery (EOR) techniques (i.e. water-flooding; Ghaderi et al., 2017), and research into the viability of miscible CO_2 injection has yielded promising results. To better understand the reservoir characteristics for EOR application, an intensive single core study was conducted using routine core analysis, profile permeability, pulse-decay permeability, X-ray fluorescence (XRF), X-ray diffraction (XRD), mechanical (rebound) hardness, and scanning electron microscopy. These datasets have been integrated into a broad stratigraphic framework and implemented for a wide range of studies including quantitative mineral evaluation and recovery simulations.

Routine core analysis and profile permeability data show several potential flow units within the target reservoir interval (Cronkwright et al., 2016). In addition to the permeability heterogeneity of the reservoir unit, a significant natural fracture system has developed in the area. These natural fractures have been identified in core, horizontal well logs, and seismic data. This has significant implications for the implementation of enhanced oil recovery and associated simulations. A simplified examination of a water-flooding pilot study from the pool shows a two-fold increase in projected recoveries when compared with the initial expected primary recovery.

The high-resolution XRF data were used to establish high-resolution mineralogical composition profiles along the core – the latter can be used to infer reservoir sweet-spots based on the established relationships between mineralogy and reservoir properties. Quartz is positively correlated with porosity and permeability while feldspar and clay content are negatively correlated with mechanical competency. Increased calcite and dolomite contents are positively correlated with mechanical harness, but negatively correlated with porosity and permeability. This data also proves useful for identification of lithological facies and stratigraphic surfaces that are difficult to recognize from core, and especially from drill cuttings, and bolsters the stratigraphic interpretation.

This study primarily serves as a useful analog for the applicability of these datasets to any tight oil reservoir and demonstrates the viability of water-flooding for Middle Bakken Formation in SE

Saskatchewan. Secondly, it demonstrates the need for micro-scale observations to fully appreciate and understand the macroscale controls on production schemes.

References

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