Detailed Reservoir Characterization of the Middle Member Bakken Formation – Viewfield Pool, SE Saskatchewan

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Summary

The Bakken Formation is a prolific self-sourced oil reservoir within the Williston Basin occurring over Saskatchewan, Manitoba, North Dakota and Montana. The Middle Bakken Member consists of coarser silt and sand facies that are sandwiched between two organic rich black shales of the Upper and Lower Bakken. The Middle Bakken has been the focus of massive horizontal drilling programs in recent years with highly variable success. This study aims to characterize reservoir properties of the Viewfield Pool in SE Saskatchewan, located between TWP6-12, and R12W2- 5W2. Previous studies focused on more regional areas and have been unable to determine the factors causing the highly variable fluid production within the Viewfield Pool. In order to better understand this pool a detailed reservoir characterization study integrating a variety of datasets will be conducted to evaluate the main controls on both production and the efficacy of enhanced oil recovery.

Introduction

The Bakken Formation is late Devonian to early Mississippian in age. It conformably overlies the Big Valley Formation and unconformably overlies the Torquay Formation and is conformably overlain by the Lodgepole Formation (Kholruss & Nickel, 2009). The Bakken Formation can be divided into lower and upper shale members and a middle member consisting of siltstone and sandstone, which have been variably cemented by dolomite and calcite (Staruiala et al. 2013). Despite a simple well log signature, the lithology and depositional history of the Middle Bakken Member is quite complex (Staruiala et al. 2013). In the Viewfield area, the middle member can be divided into distinct units using gamma ray logs and can be further sub-divided into facies when examining core. The main drilling target is a very fine sandy siltstone directly overlying the Lower Bakken member with porosities averaging from 9 to 13% and permeability values up to .6 mD. The thickness of this interval ranges from 9m in the southern parts of the pool to less than 3m at the northern edge of the pool. Structurally, the Bakken Formation shallows from a subsea elevation of -1100m near the SW boundary of the pool to -565m subsea near the NE pool edge. There are currently 2128 active wells in the Viewfield Pool with 174 new wells completed in 2013.

Method

Eight cores were carefully examined and used to correlate distinct rock units to petrophysical wireline logs in order to map their thickness and distribution throughout the Viewfield Pool. The Middle Bakken Member can be divided into four distinct units; A, A1, B, and C using the parameters set by Kreis et al. (2006). As in a further study by Kohlruss and Nickel (2009), units A and A1 will collectively be referred to as unit A because they are indistinguishable on most wireline logs in the area (Figure 1). Petrographic analyses were conducted on numerous thin sections taken from potential reservoir facies to determine controls on porosity and permeability. These datasets were then compared to core analysis and production data to try and delineate the primary factors effecting production.

Discussion

Unit A consists of a basal greenish grey siltstone, highly bioturbated with common brachiopod and crinoid fragments. This coarsens upwards into silty fine grained sandstone with high bioturbation and rare shell fragments. The unit is variably cemented by dolomite and contains abundant authigenic pyrite. The dominant trace fossils identified in core examination were *Nereites* and *Phycosiphon*. This unit has a maximum thickness of 11m near the southern boundaries of the pool and thins towards the north eastern pool boundary to less than 3m. The porosity of this unit ranges from 5 to 14% with permeabilities in the .02 to .6 mD range based on routine core analysis data. Porosity generally increases upwards with the upper half of the interval averaging around 11% and the lower half of the interval averaging around 8% porosity.

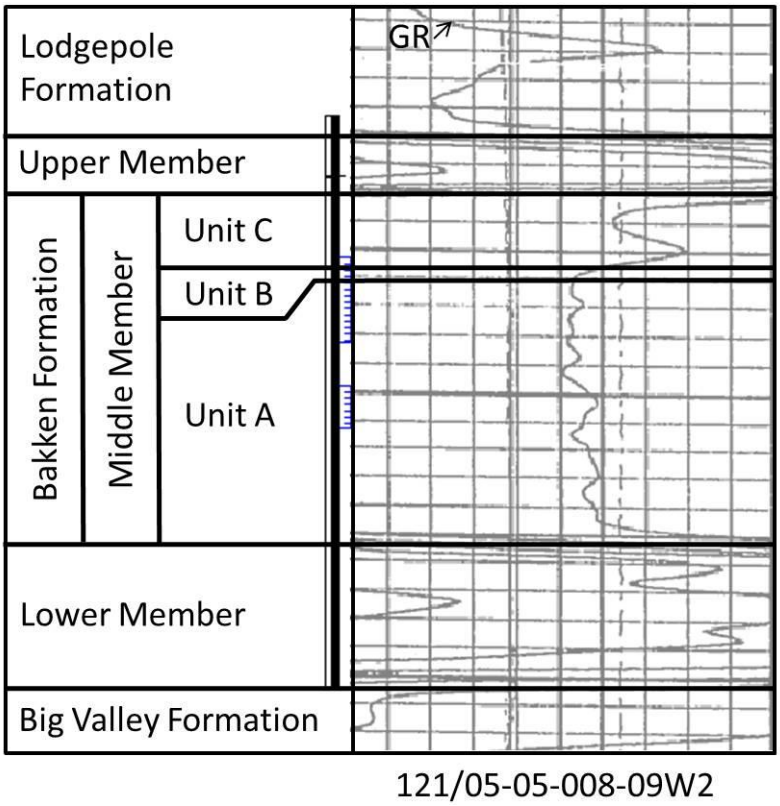

Figure 1 - A typical gamma ray log profile from within the Viewfield Pool, depicting simple stratigraphic divisions.

Unit B consists of planar to cross bedded sandstone reaching a thickness as high as 1.5m. Although this unit is undefined from well logs over most of the Viewfield Pool, a facies with similar lithology is present in cores from across the pool. It has a sharp basal contact with unit A and a gradational contact with the overlying unit C. This unit has little to no bioturbation and contains abundant framboidal pyrite and calcite cement.

Unit C consists of a basal section of heavily bioturbated sand and silt which grades upwards into a more massive, heavily bioturbated dolomitic siltstone. Dominant trace fossils include *Teichichnus* and *Planolites*. A poorly sorted coquina bed occurs locally (Angulo & Buatois, 2009). Unit C increases in thickness from 1.5m near the southern pool boundary to more than 4m near the northern pool boundary. Porosities are much lower in this unit as compared with Unit A, likely due to pervasive dolomitic cements contributing to poor reservoir performance.

Conclusion

Heterogeneities within reservoir units inhibit the effectiveness of enhanced oil recovery, and ultimately have a significant impact on production. A detailed reservoir characterization with a focus on facies distribution within the Viewfield Pool will help delineate the factors causing such high production variability. This will facilitate more efficient hydrocarbon recovery from the Middle Bakken Member.

Acknowledgments

I would like to thank Dr. Per Kent Pedersen and Dr. Ron Spencer for providing invaluable support and supervision for this project. I would also like to extend thanks to my fellow students in the CABS group at the University of Calgary for their support.

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