2011 CSPG CSEG CWLS Convention

Sedimentological Characterization of the Upper Devonian - Lower Mississippian Bakken Formation: From Deposition to Reservoir

Solange Angulo*
University of Saskatchewan, Saskatoon, Canada
solange.angulo@usask.ca
and
Luis Buatois
University of Saskatchewan, Saskatoon, Canada

In recent years the Upper Devonian – Lower Mississippian Bakken Formation has become one of the hottest oil plays in North America. In Saskatchewan unprecedented land sale and drilling activity of the Bakken have been taking place in the last few years. Although several sedimentologic analysis have been carried out in the Bakken Formation, detailed isopach maps and a petrophysical characterization of the sedimentary facies have been made for the first time in southeastern Saskatchewan. For this study, sixty two well cores were analyzed. Eleven sedimentary facies (facies 1 to 11) and five subfacies (subfacies 3A, 3B, 8A, 8B and 8C) were defined. In contrast with previous interpretation which suggested fully marine conditions for the entire formation, the integration of sedimentological data and ichnological data reveals two paleoenvironmental settings for the unit: open marine and brackish-water marginal marine. Accordingly, the Bakken Formation has been subdivided in this study into three intervals: a lower open-marine interval which comprises de lower member and the lower part of the middle member (facies 1, 2, 4, and subfacies 3A), a brackish-water marginal marine interval which embraces the middle part of the middle member (facies 5, 6, 7, 9, 10 and subfacies 8A, 8B and 8C), and an upper open-marine interval composed of the upper part of the middle member and the upper member (facies 1, 11 and subfacies 3B). Sedimentary facies isopach maps from the open-marine intervals show a wide distribution covering the entire study area, while isopach maps of the brackish-water marginal marine facies display a much more restricted, complex and heterogeneous distribution. For the petrophysical characterization of the sedimentary facies, core analyses from thirty two wells were used. Results obtained revealed that facies 6 (high/low angle cross stratified fine-grained sandstone), 7 (flaser-bedded very fine-grained sandstone), 4 (high bioturbated interbedded very fine-grained sandstone and siltstone) and subfacies 8A (wavy-laminated very fine-grained sandstone) display the best reservoir qualities (highest porosities (7.86% to 10.96%) and permeabilities (0.46 mD to 4.35 mD)). Although facies 4 and 7, and subfacies 8A consist of very fine-grained sandstone, these can be very good reservoir rocks for light oil, especially if horizontal drilling and large sand-fracture completions are made. Facies 6, in spite of being the cleanest and coarsest facies, is not the best rock reservoir as a result of common calcite cement and its heterogeneous distribution of porosities and permeabilities. Bioturbation may have played an important role enhancing the petrophysical properties in facies 4. These two facies are characterized by abundant *Nereites missouriensis* and *Phycosiphon montanus*, which can promote oil transmisivity in low-permeability reservoirs. When considering the spatial distribution of the sedimentary facies, facies 4 outstands for its good reservoir potential due to its wide distribution and thickness and its relatively good porosities and permeabilities. A better understanding of the processes that prevailed during deposition, geometry of the sedimentary facies, and distribution of porosities and permeabilities within these facies is key to optimize the exploration and production of new reserves in this complex unit.