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Bakken Sequence Stratigraphic model for the Williston Basin

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Contrasting sequence stratigraphic models have the last years been proposed for the Bakken Formation within the Williston Basin. We will based on our observations integrated with data from previous published studies models present a comprehensive sequence stratigraphic model. In the Vevfield area located on the the northern Canadian margin of the Williston Basin there is a gradational and thereby genetic relationship between the organic rich mudstones (up to 25% TOC) of the Lower Bakken Member and the intensely bioturbated muddy siltstones of the basal part of the Middle Bakken Member. Thus, these organic rich mudstones accumulated in a relatively shallow, low relief setting seaward of the prograding clastic shoreline. This conflict with several previous interpretations that the organic rich mudstones were deposited in a deep water setting and that the boundary is a sequence boundary reflecting a major drop in sea level. We instead propose that these contrasting interpretations reflect the different locations of the study areas and that the the lower and middle members depending on location within the basin are part of highstand or falling stage system tracts. This explains the lateral changes in reservoir properties observed within these stratigraphic units. During the sea level lowstand, significant erosion of subaerially exposed older deposits occurred in the basin marginal areas with the sequence boundary cutting into lower Bakken organic rich mudstones, and further landward into Big Valley (Sanish/Pronghorn) and Three Forks strata. While the sequence boundary in the basinal areas is overlain by lowstand sandstones (Unit B), towards the basin margin the transgressively reworked sequence boundary is overlain by oolitic sandstones (Unit B) or dolomitic mudstone (Unit C). These deposits form the transgressive system tract with a maximum flooding within the organic rich mudstones (up to 32% TOC) of the Upper Bakken Member. The Upper Bakken Member is gradationally overlain by shallow water Lodgepole Formation carbonates. This, together with the fact that several organic rich beds (False Bakken beds) drape the toe sets of carbonate clinoforms, demonstrates a genetic relationship between Upper Bakken Member organic rich mudstones and a prograding carbonate system. This sequence stratigraphic model facilitates a better characterization of the lateral variability in reservoir properties within the Williston Basin. Further, this study demonstrates that the highly organic rich mudstones of the Upper and Lower Bakken Members were deposited as the distal facies of two different depositional systems, clastic versus carbonate respectively.

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