

## **Unconventionally Conventional - Facies and Sequence Stratigraphy of the Upper-Devonian-Mississippian Bakken Formation Reservoir, Williston Basin, North Dakota**

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The Upper Devonian-Mississippian Bakken Formation in the Williston Basin is one of the most prolific onshore petroleum systems in the continental U.S. It consists of a middle mixed carbonate-siliciclastic member, sandwiched between the two organic-rich Bakken shales. The focus of this study is to highlight the facies architecture and sequence stratigraphy of the middle Bakken member that forms the reservoir.

The middle Bakken shows ten depositional facies, most of them siltstones, and some sandstones with varying amount of ooids. These ten facies are arranged into four distinct parasequences with the lower three showing an increase in depositional energy up-section; the top parasequence reflects laterally varying stacking patterns and a successive decrease in depositional energy. These four parasequences are traceable throughout the study area, although locally obliterated by bioturbation and/or erosion.

The lower three parasequences show an overall progradation of the sedimentary system, culminating in the deposition of sandstones and ooids. The upper, retrograding portion indicates a deepening of the basin setting the stage for the deposition of the upper member black shales. While the parasequences represent fourth-order cycles, the shallowing from the lower member into the middle and the successive deepening into the upper member are interpreted as a fluctuation of third-order.

The main reservoir facies within the Bakken depositional system are oolites and sandstones representing nearshore sediments, and shoreface laminated and ripple-bedded siltstones. These rock types are concentrated at the tops of each parasequence, although depending on the position within the basin, not every parasequence top may show suitable reservoir characteristics. As the margins developed shallower facies earlier than the center, oil-prone oolites and sandstones occur in different stratigraphic levels along a transect through the basin. A lateral correlation of oolite sandbodies from the basin margin to the depocenter will therefore likely cross time-lines and does not reflect original depositional geometries. The concentration of the oil in the now moderately porous (3-4%), but originally high-energy sandstone and ooid facies at the top of individual parasequences shows that the middle Bakken is a conventional and not an unconventional reservoir throughout the North Dakota portion of the Williston basin.