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Cyclic Sedimentation Patterns of the Mississippian-Devonian Bakken Formation, North Dakota

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The Devonian-Mississippian age Bakken Formation records at least two episodes of rising sea level. The vertical and lateral lithofacies left by both transgressive events suggest a pattern of cyclical sedimentation that coincides with the transition between shallow tidal dominated carbonates of the Upper Devonian Three Forks Formation and the open marine platform to platform slope carbonates of the Lower Mississippian Lodgepole Formation. The basal deposits of both transgressions contain thin discontinuous nearshore or beach sandstones that grade upward into the organic-rich, oxygen-stratified hemipelagic muds that make the two Bakken shales world class source rocks.

The initial transgression is represented by basal sandstone that unconformably overlies the Three Forks Formation and is informally referred to as the “Sanish Sand”. The basal sandstones typically grade upward into a regionally extensive siltstone that is usually found in depositional lows along the basin margin. Farther into the basin the Three Forks grades directly into the organic-rich portion of the lower Bakken with no obvious unconformity. Maximum transgression culminated with the deposition of the lower Bakken shale.

The lower portion of the middle member consists of carbonate-siliciclastic rocks that coarsen upward from sediments dominated by mud-sized material through a thinly bedded or laminated algal section and into a very fine- to fine-grained sandstone that forms a conspicuous “clean gamma-ray” bench within the middle Bakken that is referred to as Lithofacies 3 in North Dakota. The vertical distribution of facies within the middle Bakken below Lithofacies 3 (L3) is consistent with a gradual fall in sea level, with L3 marking the lowstand of this regressive period.

A repeat of the initial transgressive sequence is observed in the rocks overlying L3. A series of finely laminated algal-bearing siltstones grade upward into silty lime mudstones that are ultimately capped by the upper Bakken shale as the Bakken seas reach their maximum transgression.