

Offshore Sand Ridge Accumulation in a Low Accomodation Setting, Bakken Formation, West-Central Saskatchewan

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ABSTRACT

The Devonian-Mississippian (Fammenian-Tournaisian) Bakken Formation is a widespread, predominantly siliciclastic, hydrocarbon-producing, marine unit that occurs throughout the Williston Basin. Utilizing the exceptional well control within the study area (Twp. 32-36; Range 22-29W3), this high-resolution stratigraphic analysis reveals a facies architecture represented by six lithofacies comprising four unconformity-bounded depositional sequences. The basal, transgressive black mudstone facies was deposited in an offshore, anoxic, epicontinental sea and unconformably overlies carbonates of the Big Valley Formation. A carbonate-dominated facies consisting of both shallow and offshore marine sub-facies unconformably overlies the basal black mudstone facies, and is, in turn, unconformably overlain by interbedded to interlaminated mudstone, siltstone, and sandstone facies that was deposited in a shallow marine, shelf to deltaic setting. These shelf to deltaic sediments are truncated regionally above by a significant unconformity that locally downcuts into the basal, black mudstone. An ensuing transgression reworked underlying units, predominantly the shelf to deltaic facies, providing a source of sand that was subsequently re-deposited as shallow-marine, linear, sub-parallel sand ridges separated by intervening swales. Hydrocarbon production from the Bakken Formation in this region is almost exclusively limited to the ridges. Continued relative sea-level rise resulted in ridge abandonment represented by a transgressive depositional continuum from ridge sand to heavily burrowed, silty sandstone, to green mottled siltstone, and ultimately, to black mudstone.

The ridge and swale morphology of the Bakken Formation is analogous to Holocene shelf sand ridges in the North Sea and East China Sea where sand ridge accumulation and orientation is strongly controlled by tidal currents. The internal architecture of the Bakken Formation sand ridges is also consistent with that of modern, active and moribund offshore tidal sand ridges. Some of the Bakken Formation ridges display a subtle, transverse asymmetry with the steeper stoss slopes facing toward the southeast. Moreover, the internal ridge architecture is characterized by multiple master bed sets that contain southeasterly-dipping markers that parallel the orientation of the stoss slope.