

Bakken Formation: Facies, Stratigraphy, Sequences/Cycles, and a New Stratigraphic Subdivision

Sven O. Egenhoff¹, Neil S. Fishman¹, Mauricio Vasquez Pinto¹, and Jim Sorensen¹

¹University of North Dakota

Abstract

The Devonian-Mississippian Bakken Formation, Williston Basin, North Dakota, consists of four informal members, which in ascending order are the Pronghorn, lower shale, middle, and upper shale members. Collectively they were deposited during at least six sea-level oscillations in an intracratonic basin setting. A detailed sedimentological study of about 160 cores across the basin shows that these members are not time-equivalent throughout the basin but instead are largely time-transgressive. Additionally, there are numerous hiatuses that occur predictably. The Pronghorn is subdivided into a lower siliciclastic unit I (both transgressive and regressive), a middle carbonate unit (transgressive), and an upper siliciclastic unit II (both transgressive and regressive). The lower shale shows a variation from coarse-grained facies at the base to fine-grained facies in the middle, and again relatively coarse-grained facies at the top of the unit, representing both a transgression and an overlying initial regression. The regression culminates in a green shale that is present at the very top of the lower Bakken shale indicating the regressive nature of the upper part of this unit, and a basin-wide (?) unconformity. The base of the middle member is commonly a centimeter-thick carbonate that is mostly a mudstone but in places a wacke- or packstone. This carbonate which represents an initial transgression prior to a regression contains up to five parasequences representing a time during which much of the middle member was deposited. Nevertheless, another three parasequences are observed in the overlying transgressive (or retrograding) interval of the middle member. A basin-wide carbonate occurs at the top of the middle member. The upper shale consists of a lower transgressive part, a maximum flooding surface, and a regressive upper portion, which are reflected in up to 18 parasequences. The upper boundary of the Bakken is time-transgressive, and some of the upper shale units are time-equivalent to overlying Mississippian Lodgepole carbonates at the basin margin. This detailed analysis of the Bakken Formation highlights the complexity of sedimentation in an intracratonic basin setting. Furthermore, this sedimentological characterization of the formation facilitates an improved understanding of the distribution of both source and reservoir rocks in this major petroleum system.