

Facies Distribution and Paleoenvironmental Interpretation of the Upper Devonian – Lower Mississippian Bakken Formation of Subsurface Saskatchewan: Integrating Sedimentologic and Ichnologic Data

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With 25 billion barrels of oil estimated in Southeastern Saskatchewan according to the USGS, the Upper Devonian – Lower Mississippian Bakken Formation constitutes one of the most important oil-bearing units in the province. Although several sedimentologic studies have been carried out on the Bakken Formation, all of them have suggested open-marine conditions for the whole unit. However, integration of ichnologic data with conventional sedimentologic analysis reveals a much more complex depositional history involving not only open marine but brackish-water marginal-marine conditions and comprising several sea-level changes. The Bakken Formation is subdivided into three members: the Lower and Upper organic-rich shaly members and a calcareous sandy-silty Middle Member. Sixty cores have been slabbed and described in detail for this study (1371 meters) in Southeast Saskatchewan. According to the facies analysis, three intervals were recognized in the Bakken Formation. A lower open-marine interval which comprises the Lower Member and the lower part of the Middle Member, a middle brackish marginal-marine interval which consists of the middle part of the Bakken Middle Member, and an upper open-marine interval which corresponds to the upper part of the Middle Member and the Bakken Upper Member. The lower open-marine interval is interpreted as having been deposited in a transgressive to highstand systems tract. A subsequent sea-level fall followed by a sea-level rise is represented by brackish marginal-marine deposits. The base of this interval is interpreted as a coplanar surface representing both a sequence boundary and a transgressive surface. As the transgression proceeded, brackish marginal-marine conditions gave place to deposition in fully marine settings. The middle brackish marginal-marine interval and the upper open-marine interval comprise a transgressive systems tract. Preliminary maps of the eleven sedimentary facies defined in this study reflect two different patterns: a more extensive and homogeneous distribution for the open-marine intervals and a more restricted and heterogeneous distribution for the brackish marginal-marine ones. Isopach maps of the open-marine facies from the lower interval show a series of northwest-southeast trending facies belts with distal deposits reaching their maximum thickness in the southwest and more proximal deposits being increasingly thick toward the northeast, suggesting a regular shoreline farther northeast from the study area. Isopach maps of the brackish marginal-marine facies, however, reflect a much more complex distribution pattern, revealing an irregular and embayed shoreline which resulted from a sea-level drop.