

Facies, Environments, Diagenesis and Sequence Stratigraphy of the Bakken, SE Saskatchewan and North Dakota: Role of Residual Structure Mapping as Framework

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Examination of about 100 Bakken cores from SE Saskatchewan and North Dakota has provided a regional framework for facies, depositional environments, early diagenesis and sequence stratigraphic comparisons and interpretations. Third-order residual structure mapping of the top Paleozoic surface becomes a key paleostructural base. Nine major facies and multiple subfacies are recognized in the Bakken. A basal sandstone ('Sanish') and three deeper subfacies are placed in an initial transgressive phase of the Bakken succession. The Lower Shale/kerogen-rich mudstone of the Bakken is divided into three units that differ in geographic distribution, mineral composition, petrophysical characteristics, and TOC. The Lower Shale is interpreted to have been deposited in a dysaerobic, density and chemically stratified basin of moderate depth, with a fluctuating pycnocline. Silt-sand filled fractures in the Lower Shale show an apparent structural alignment, and suggest sediment source from below. The Middle Member of the Bakken, with 7 main facies, records a complex succession of stressed offshore to storm wave influenced environments, to distal shoreface, ooid bars (adjacent to paleohighs), tidally-dominated settings with local stromatolites, and stressed 'estuarine' environments. At least two ravinement surfaces/sequence boundaries are recorded in the Middle Bakken, with deep truncation below one. Distribution of fine bioclastic sediment and early diagenetic calcite cements show a correlation to paleobathymetry defined by residual structure. Trends of storm-wave driven HCS-like bedforms and bioclastic event beds indicate a westerly-directed wind-wave system. The Upper Shale/mudstone is again placed in a stratified basin setting. Bakken reservoir trends within this framework also show relationships at various levels to paleotopography documented by residual structure.