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Bitumen & Burrows: Reconstructing the Facies Architecture of the Wabiskaw Member of the Ells River Paleovalley

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ABSTRACT

The Wabiskaw Member of the Clearwater Formation within the Ells River Paleovalley represents a bitumen-bearing reservoir that differs fundamentally from many developed SAGD targets in the Athabasca Oil Sands Region (AOSR). Rather than being fluvial or estuarine in origin, like much of the McMurray Formation, the Albian-aged Wabiskaw records deposition in a marginal- to shallow-marine, mixed-energy embayment through to shoreface–deltaic system. Consequently, the reservoir architecture is governed by a balance of fluvial, tidal, and wave dynamics at or near the shoreline, in addition to storm reworking, leading to complex stratigraphic relationships. This study demonstrates that refined sedimentological, ichnological and stratigraphic characterization is essential for predicting reservoir behavior in the Wabiskaw, which must be assessed within its unique paleoenvironmental context rather than by analogy to fluvial or tidal-fluvial SAGD reservoirs.

The Wabiskaw D unit in the Ells River Paleovalley is primarily composed of laterally extensive, fine- to medium-grained sands interbedded with muddy siltstones. These sands are anomalously thick, continuous, and bitumen-rich relative to Wabiskaw D equivalents elsewhere in the AOSR, interpreted to reflect a localized increase in accommodation and/or sediment supply within a mixed-energy embayment. While this geometry is broadly favorable for SAGD development, internal heterogeneity associated with fluidized mud beds can differentially affect steam chamber growth, vertical connectivity, and thermal efficiency.

Another central focus of this study is the differentiation of shoreface and wave-dominated deltaic facies in a storm-affected setting, which constitute the Wabiskaw A interval. In such environments, sedimentary structures may be subtle or overprinted by bioturbation, making facies differentiation challenging when relying on wireline data alone. Integration of ichnological analysis from core data provides a powerful tool for resolving these ambiguities. Distinct trace fossil assemblages record variations in energy conditions, marine influence, and substrate rheology, allowing reliable discrimination between shoreface sands and wave-dominated deltaic deposits. These distinctions are critical for assessing reservoir potential, as differences in the geometry and distribution of sand versus mud between shoreface and deltaic environments influence reservoir development strategies.

This study also emphasizes the identification and interpretation of regionally extensive stratigraphic discontinuities, including flooding surfaces (FS) and transgressive surfaces of erosion (TSE). In the Clearwater Formation (including the Wabiskaw Member), TSEs frequently mask earlier regressive or lowstand surfaces, forming composite surfaces (e.g., TSE/SB) with significant stratigraphic implications that can affect resource delineation. The identification of trace fossil omission suites (softground, stiffground, firmground) is critical for distinguishing simple transgressive surfaces from those that have overprinted earlier sequence-stratigraphic boundaries. The variability in omission suites along depositional strike and dip reflects changes in substrate rheology and energy regime, explaining why identical stratigraphic surfaces may behave differently across a study area. In wireline-only datasets without core-based sedimentological and ichnological analysis, such surfaces are easily misinterpreted as simple ravinement surfaces. This work highlights the necessity of high-

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resolution core integration for effective characterization of these deposits. Wireline data alone commonly fails to resolve subtle discontinuities and facies juxtapositions; thus, integrating core-scale sedimentology and ichnology with wireline data enables more accurate mapping of reservoir architecture and stratigraphic surfaces.

In summary, refining the sedimentology, stratigraphy, and ichnology of the Wabiskaw Member fundamentally improves paleoenvironmental interpretations and underscores why this unit must be assessed differently from other SAGD targets that commonly exploit fluvial to tidal-fluvial deposits. Beyond its local significance, the Wabiskaw Member in the Ells River Paleovalley serves as an important analogue for Cretaceous mixed-energy embayment deposits and for storm-affected shoreface and wave-dominated deltaic environments worldwide. Such systems are likely underrecognized in the rock record, yet they can host extensive bitumen- or hydrocarbon-rich sand bodies. The methodologies applied here—particularly the use of omission suites and detailed facies analysis across discontinuities—provide a transferable framework for distinguishing simple versus complex transgressive surfaces and for resolving shoreface–deltaic relationships in storm-influenced settings.