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Geochemical signatures of subtle sequence stratigraphic surfaces: A case study from the late Albian Viking Formation

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ABSTRACT

The late Albian Viking Formation has been mapped sequence stratigraphically throughout central Alberta using the 4-systems tract nomenclature. In this model, surfaces that have an erosional expression in paleogeographically proximal positions of the basin have a correlative gradational expression in distal positions of the basin. In this study, the basal surface of forced regression (BSFR) and the correlative conformity (CC) typically have a gradational expression and are commonly expressed as “sand-on-sand” or “mud-on-mud” contacts, making the recognition of these surfaces in the rock record challenging. This study focuses on six cores from the Kaybob, Fox Creek and Judy Creek fields in central Alberta where the BSFR and CC have been identified based on subtle changes in trace fossil suites, sedimentology and grainsize across the contacts.

In this study, a geochemical approach was applied to evaluate whether elemental trends occur at sequence stratigraphic surfaces and within systems tracts. X-ray fluorescence (XRF) analyses were conducted at 10 cm spacing across all cores through mudstone-dominated facies and at 20 cm in sandstone-dominated facies. Targeted X-ray diffraction (XRD) sampling at interpreted BSFR intervals in two Judy Creek wells was supported by thin section petrography to validate mineralogical interpretations.

Results indicate that subtle but consistent geochemical signatures are associated with both the BSFR and CC. The BSFR is marked by sharp reductions in detrital proxies (e.g., Si and Zr) alongside enrichment in sorting-sensitive indicators (e.g., feldspar and mafic proxies), reflecting sediment partitioning during forced regression. Authigenic trace-metal proxies (e.g., Mo, V, Co) show minimal enrichment, indicating that the BSFR represents a physical stratigraphic boundary rather than a redox-driven surface.

In contrast, the CC is characterized by muted, gradational shifts, including slight increases in detrital proxies, grain-size trends (e.g., an initial decrease followed by an increase in Si/Al), and reduced trace-metal enrichment. These trends reflect the trapping of coarser sediment in proximal basin settings during the lowstand systems tract.

This study demonstrates that an integrated sedimentological-geochemical dataset can be useful in shallow marine settings to resolve the identification of subtle sequence stratigraphic surfaces that can be difficult to identify in core. The application of this approach to units that are being mapped sequence stratigraphically has the potential to improve high-resolution subsurface correlations and be used in predictive modeling when building a refined reservoir model.

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