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Architecture and Facies Analysis of Allomember F, Upper Cretaceous Horseshoe Canyon Formation, Alberta, Canada

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Summary

Mixed-influence, marginal-marine deposits are typified by complex heterogeneous architectures that are challenging to model in the subsurface. Utilization of outcrop analogs, however, can serve to mitigate these limitations. Marginal-marine successions of the Horseshoe Canyon Formation near Drumheller, Alberta are well exposed in continuous outcrops for 15 km down depositional dip (NW to SE along the Red Deer River Valley) and 3.5 km along depositional strike (SW to NE along Willow Creek). This study incorporates 30 outcrop sections, 75 wireline logs, and 4 subsurface cores to classify the deposits in terms of facies, identify element complexes (EC), and evaluate heterogeneities within a single T-R sequence.

Two major element complexes (EC) are present in the study area. To the northwest in the Red Deer River Valley and Willow Creek, EC1 is characterized by 4 – 6 m thick coarsening-upward successions, comprising mudstones that pass upwards through silty sandstones with sharp-based mudstone interbeds, and into fine- to medium-grained sandstones. Mudstones are lenticular bedded with combined-flow ripple lamination throughout. Silty sandstones show low-angle undulatory parallel laminae, interpreted as micro-hummocky cross-stratification, and wave ripples. Overlying sandstones are trough cross-stratified with combined-flow ripples, aggradational current ripples, wave ripples, and current ripples. Lithological and textural heterogeneities in EC1 occur within silty sandstones as laterally continuous mudstone drapes, and as channels associated with overlying sandstones. Facies show a bioturbation index (BI) of 0-1. The ichnological suites are stressed, with rare navichnia, *Planolites*,

Thalassinoides, and *Ophiomorpha.* EC1 is interpreted as a wave-dominated, fluvial-influenced (**W**f) Lobe Element Complex.

EC2 occurs to the southeast of the Red Deer River Valley, and is characterized by 6 – 13 m thick coarsening-upward successions consisting of mudstone near the base, overlain by fine- to medium-grained sandstone. Mudstones are typically lenticular bedded with intercalated wave ripples. Sandstones are trough cross-bedded and contain locally abundant carbonaceous debris. Overlying units show low-angle planar lamination and high-angle trough cross bedding. Continuous and discontinuous carbonaceous drapes constitute the dominant heterogeneities in EC2. BI values vary from 0-5, dominated by firmground *Thalassinoides* marking the base*,* rare *Ophiomorpha*, and a well-developed "toe-of-the-beach" suite of *Macaronichnus segregatis*. EC2 is interpreted as a wave-dominated, tide-influenced, fluvial-affected (**W**t*f*) Beach Element Complex.

Determining the interplay of depositional processes is critical for evaluating heterogeneities and predicting subsurface geometries of these units. High-resolution analysis of successions in a relatively small study area has permitted us to determine potential reservoir heterogeneities and how bed geometries can help predict reservoir architectures with a single flow unit.

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