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Facies Heterogeneity and Stacking Patterns Control on Meter-scale, Mechanically Bounded Units: An Example from the Lower Triassic Sulphur Mountain Formation (Montney Equivalent)

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Summary

Fine-grained unconventional reservoirs have significant vertical and lateral heterogeneity. In the subsurface, cores analysis remains the highest resolution dataset to characterized and understand reservoir targets. However, cores only give insight at 10 cm width and are commonly spaced a few kilometers to 10's of kilometers apart making it challenging to upscale reservoirs properties to the meter- or kilometer-scale of the drainage area of horizontal wells. To compensate this scaling issue, outcrop analogues are the best available dataset to understand large-scale characteristics to help minimize uncertainty when building reservoir property models in the subsurface. In this study, well-exposed cliff faces and outcrops within creeks along a 20 km along-strike section of Lower Triassic Sulphur Mountain Formation (Montney-equivalent) provide an opportunity to (1) document the meter- to kilometer-scale vertical (temporal) and lateral (spatial) distribution of facies using drone photography, (2) document facies, facies stacking, depositional environments along well-exposed creeks, therefore providing a multi-scale approach in understanding unconventional reservoir heterogeneities.

The Sulphur Mountain Formation consist of complex facies interbedding and changes in vertical stacking patterns across a range of depositional environments (i.e., offshore/basin floor to shoreface). At the meter-scale, facies interbedding can be grouped into four mechanically bounded units (from stratigraphic bottom to top, I – IV), consisting of sedimentary fabric that are (I) very thinly-bedded, pinstriped laminated siltstone; (II) thin-bedded, heterolithics planar- to cross-laminated siltstone (i.e., upper division turbidites) interbedded with thickly bedded, massive siltstone; (III) thin-bedded, heterolithics planar- to cross-laminated siltstone (i.e., upper division turbidites) with significant increase in carbonate cementation; and (IV) coarsening-upward packages (i.e.,parasequences) suggesting shelfal deposition from offshore to shoreface.

Notably, while bed-parallel mechanical interfaces and natural fractures are common throughout the succession, the dominant large-scale mechanical units are associated with a vertical change in depositional environments. Mechanical unit I and II can be characterized as being mechanically homogenous with tall (> 5 meter), bed-crossing fractures and minor bed-bounded natural fractures. Unit III is mechanically heterogeneous and exhibit common bed-bounded mechanical interfaces and little to no tall fractures, whereas unit IV exhibit bed-bounded interfaces in between parasequences giving it a moderate mechanical homogeneity.

The observed vertical and lateral variability in the Sulphur Mountain Formation provides insight into changing depositional environments and the resultant heterogeneity in

unconventional reservoirs. These begs to question which scale of heterogeneity matters and is influencing the presence or absence of significant bed-parallel mechanical interfaces and effective fracture height growth.

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