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Sedimentary fabric control on hydraulic fracture stimulation, tight light oil sandstone reservoirs of the Cardium Formation, SW Pembina Field, western Alberta

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Abstract

Estimation rock mechanical properties in unconventional reservoirs are often computed based on composition from core and well log data or microseismic. However, outcrop data show that sedimentary fabric exhibit a strong influence on natural fracture dimensions. 3D fracture characterization in the subsurface is limited by the 2D character of well data or the relatively low resolution of microseismic. In this study we document a strong relationship between hydraulic fracture stimulation parameters and sedimentary facies for individual stages along the length of horizontal wellbores.

The Late Cretaceous Cardium Formation is comprised of stacked, upward shallowing shoreline deposits comprised of three main facies; intensely bioturbated sandy shelf to offshore mudstones and muddy sandstones these are overlain by up to several meters of proximal offshore deposits of interbedded mudstones and sandstones, which in turn are overlain shoreface sandstones that in places are capped by a transgressive conglomerate. While the sandstones and conglomerates were the primary legacy reservoir, the play was revitalized in 2008 with multistage hydraulically fractured horizontal wells targeting the interbedded and bioturbated facies. In this study observations of natural fractures in outcrops of the Cardium within the fold and thrust belt established that the three lithofacies correspond to three mechanical facies with unique fracture spacing and heights. The highest fracture intensities and shortest fracture heights occur in the medial interbedded sandstone and mudstone facies due to abundant bed-confined fractures

Fracture characterization of natural fractures in 266 cores within the southwestern part of the Cardium Pembina Oil Field in west-central Alberta, Canada show that the relative abundant fractures within the subsurface area. For 14 horizontal multi-stage hydraulically fractured wells, the facies that each hydraulic fracture stimulation stage was completed in was identified. Plots of hydraulic fracture stimulation parameters showed that although the interbedded sandstone and mudstone represent a transitional facies between the under and overlying facies it has the highest breakdown pressures and average pumping pressures, likely reflecting the strata bound character of the induced fractures. These results reveal that sedimentary fabric has a stronger influence than composition on hydraulic fracture stimulation parameters in these light oil, tight Cardium shoreline reservoirs.

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