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Comparative Fracture Characterization of the Upper Cretaceous Second White Specks Formation, Southwestern Alberta.

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Introduction

Detailed analysis of natural fracture network geometry is an important aspect in the geomechanical modeling and characterization of unconventional tight reservoirs as fractures provide preferential flow pathways for hydrocarbons and other fluids in the subsurface as well as influence hydraulically induced fracture development. The potential of unconventional tight oil plays such as the Upper Cretaceous Second White Specks Formation, within the Colorado Group across southwestern Alberta, has received increased interest recently and the analysis of natural fracture networks is a necessary step in their characterization. Analyzing subsurface fractures is challenging since boreholes provide a limited view, but outcrops provide useful 3D subsurface analogs. Exposed outcrops of the Second White Specks and overlying Jumping Pound Sandstone located along the Highwood River in southwestern Alberta provide the opportunity for a detailed analysis of the natural fracture networks present. The primary objective of this project is to assess and compare the natural fracture characteristics between sedimentary facies in the Second White Specks Formation.

Methods

Outcrops of the Second White Specks Formation along the Highwood River in southwestern Alberta were divided into three major intervals based on their sedimentary facies: 1) the Jumping Pound Sandstone; 2) interbedded finely laminated siltstones and mudstones; and 3) black organic-rich mudstone. The three sampled stratigraphic intervals are outlined in the photograph in Figure 1 and in the stratigraphic column in Figure 2. Natural fracture parameters were recorded from each facies interval using scanlines and additionally using the circular estimator method on the bedding plane of the Jumping Pound Sandstone. This allows for the acquisition of a number of parameters such as fracture intensity (the number of fractures per unit length), spacing between fractures, average fracture height and orientation of fracture planes (Zeeb et al. 2013). These sampling methods were combined with rock hardness data to characterize the natural fractures and mechanical stratigraphy of the Second White Specks Formation.

Figure 1 – Panoramic photograph of Highwood River study area taken in September 2013. Intervals 1, 2 and 3 represent the three sampled intervals.

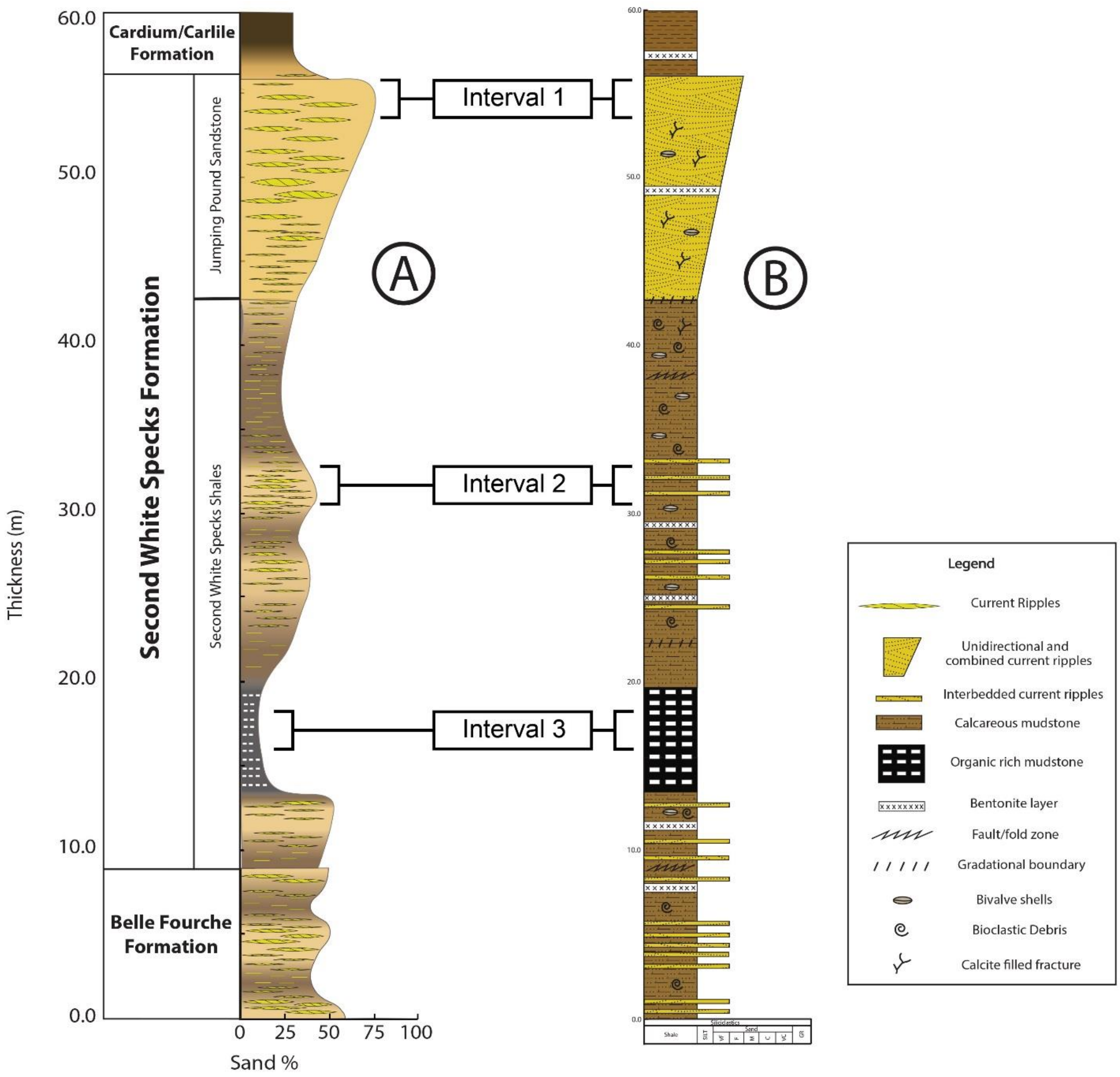

Figure 2 – Stratigraphic column of Highwood River corresponding to the outcrops in Figure 1. Intervals 1, 2 and 3 represent the three sampled intervals. (Modified from Zajac, 2012)

Conclusions

The results from this project emphasize the mechanical heterogeneity of the Second White Specks Formation. The Jumping Pound Sandstone contains compressional conjugate shear fractures that occur at relatively low intensity (2.56–4.7 fractures per meter) with relatively tall heights (0.79–3.38 meters). The interbedded finely laminated siltstones and mudstones contain extensional fractures that occur at relatively high intensity (29.2 fractures per meter) with relatively short heights (0.18 meters), the latter being related to the finely interlaminated siltstone-mudstone fabric. The black organic-rich mudstone contains fractures that are conjugate to the underlying thrust fault in addition to extensional fractures that both occur at relatively low intensity (4.88–7.4 fractures per meter) with relatively tall heights (1.18–1.25 meters). Elevated fluid pressures resulting from hydrocarbon generation within the two mudstone facies could have altered the stress field in such a way that promoted the formation of extensional fractures compared to the compressional shear fractures that occur in the overlying Jumping Pound Sandstone. The results from this analysis suggest that sedimentary facies characteristics such as lithology, heterogeneity and mechanical bed thickness have a strong influence on fracture generation and propagation in the Second White Specks Formation outcrops along the Highwood River that are also likely to be present in the subsurface.

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