

Comparative Fracture Analysis and Characterization of the Upper Cretaceous Jumping Pound Sandstone and Second White Specks Formation, Southwestern Alberta.

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Introduction

Detailed analysis of fracture network geometry is an important aspect in the characterization of unconventional tight reservoirs as fractures provide preferential flow pathways for hydrocarbon fluids. 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 reservoir characterization. Analyzing subsurface fractures is challenging since boreholes provide a limited view, but outcrops provide useful subsurface analogs. Exposed outcrops of the Second White Specks Formation and overlying Jumping Pound Sandstone located along the Highwood River in southwestern Alberta provide the opportunity for an in-depth analysis of the natural fracture networks present. The primary objective of this project is to assess the estimated fracture intensities based on a number of sampling techniques applied to the Second White Specks Formation and the Jumping Pound Sandstone outcrops exposed along the Highwood River.

Methods

A number of methods exist to characterize fracture networks in outcrop such as scanline sampling, window sampling and others as described by Zeeb et al. (2013). Scanline sampling is the primary method applied in this study and is based upon the collection of data from all fractures that intersect a line along an outcrop. This method 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 length and orientation of fracture planes (Zeeb et al. 2013). The scanline sampling method was applied to the Jumping Pound Sandstone, and two separate stratigraphic intervals within the Second White Specks Formation in order to evaluate the variation of fracture characteristics based on lithofacies. The three sampled stratigraphic intervals are outlined in the photograph in Figure 1 and the stratigraphic column in Figure 2.

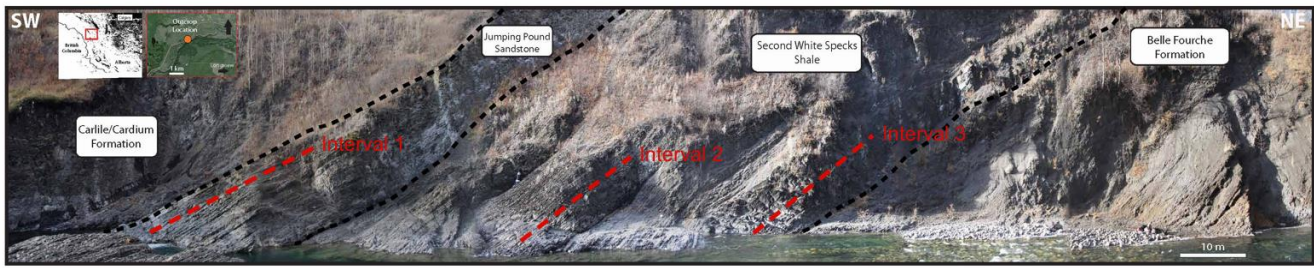


Figure 1 – Panoramic photograph of Highwood River study area. Intervals 1, 2 and 3 represent fracture sampling intervals. Modified from Zajac, 2012.

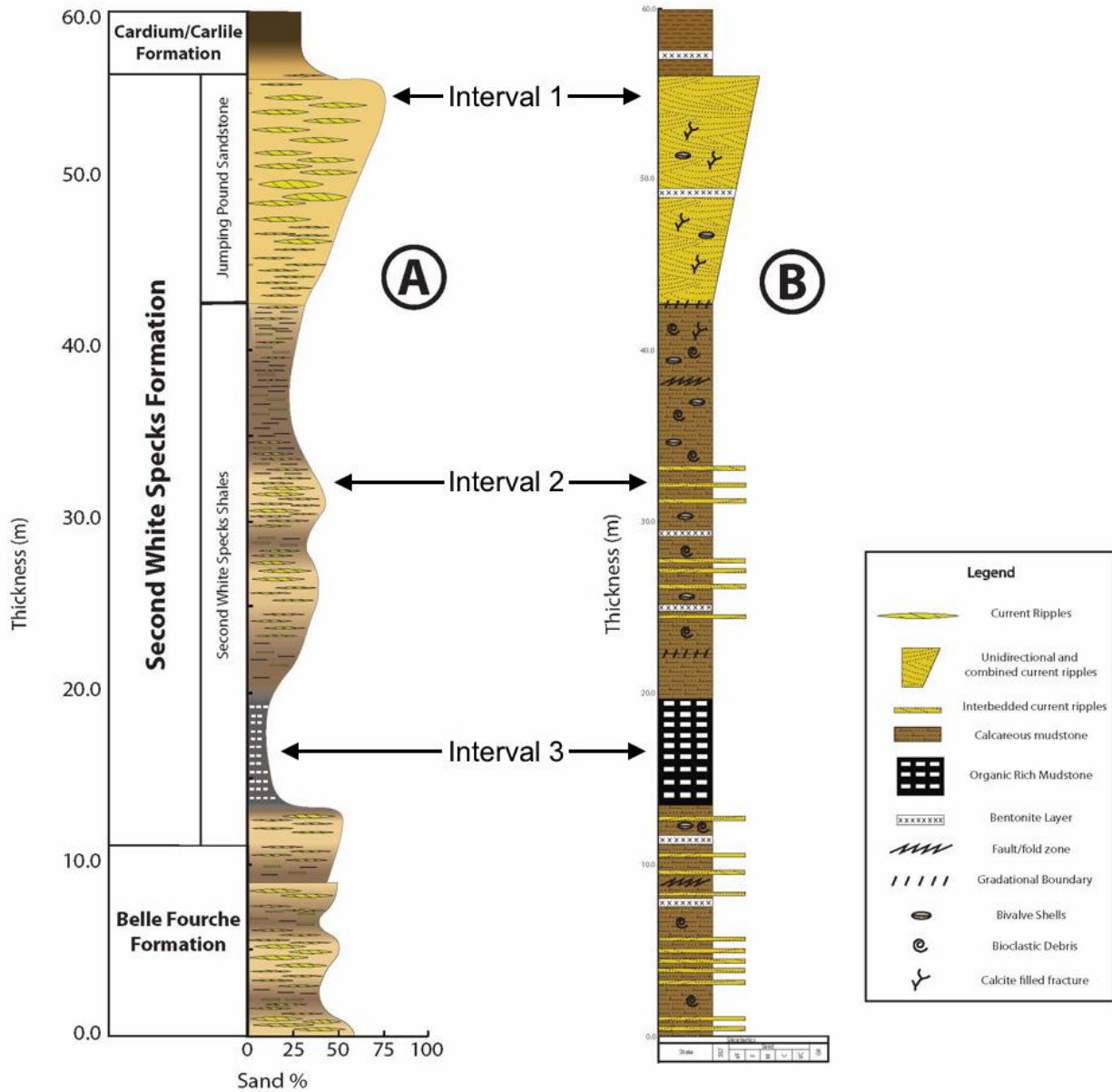


Figure 2 – Stratigraphic column of Highwood River corresponding to outcrops in Figure 1. Intervals 1, 2 and 3 represent scanline sampling intervals. Modified from Zajac, 2012.

At interval 1, within the Jumping Pound Sandstone, scanline sampling was carried out along an exposed bedding plane and along a wall outcrop. At intervals 2 and 3, bedding planes were not exposed and so only scanlines along a bed were done. Multiple scanlines were completed at different orientations at intervals 1 and 3 in order to observe the potential bias of scanline orientation.

High-resolution photographs of the exposed Jumping Pound Sandstone bedding plane at interval 1 were analyzed, window sampling and scanline sampling techniques were applied to the photographs to provide an in-depth study of the fracture geometry which requires significant manpower and time to perform in the field. High-resolution photographs provide an efficient alternative to the time and cost required to complete detailed sampling in the field.

Conclusions

Data results emphasize the bias of orientation when the scanline sampling method is applied, as even a slight change in the orientation of the scanline can result in an entire fracture set being missed or under sampled. Since scanlines are analogous to boreholes, this emphasizes the potential limitation of borehole data to fully encompass fracture characteristics in the subsurface. Results also highlight the dependency of fracture characterization on lithofacies as the two sampled intervals within the Second White Specks Formation have distinct fracture intensities and mean fracture lengths.

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References

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Zeeb C, Gomez-Rivas E, Paul DB, Philipp B. 2013. Evaluation of sampling methods for fracture network characterization using outcrops. AAPG Bulletin. 97(9): 1545-1566.