Comparative fracture characterization from geological media, Cretaceous Mannville Group, Livingstone Falls, Southwest Alberta

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Summary

Fractures and fracture networks are key outlets for migration of hydrothermal fluids, water and contaminants in groundwater systems, and oil and gas in petroleum reservoirs. Comprehensive analysis of natural fracture network geometry is an essential step in the realistic modeling and characterization of reservoir targets as fractures can provide preferential flow pathways, impact wellbore stability, and influence hydraulically induced fractures. This study highlights the complexity of natural fracture networks in heterogeneous reservoirs. Furthermore, the results provide guidelines for accurate fracture model generation and fractured reservoir characterization.

Introduction

Mechanical discontinuities within Earth's crust are essential in understanding reservoir properties such as petroleum storage and extraction, contaminant transport and fluid flow. These structures govern the flow regimes that arise in the subsurface by acting as preferential flow pathways for subsurface fluids. Exposed bedding pavements of the Cretaceous Mannville Group along Livingstone River in southwestern Alberta were the focus of this study as they provided detailed multi-dimensional fracture network data in a heterogeneous reservoir analog. At the study site, the lower Cretaceous succession consists of a complex interfingering of marine and non-marine siliciclastic and volcanic sediments deposited during several transgressive and regressive cycles (Leckie and Burden, 2001). The Mannville Group was deposited across the Cordilleran-derived clastic wedge of the foreland basin and record the first basin-wide sedimentation (Hayes, B.J.R., Christopher, J.E., and Rosenthal, R.L., 1994) that correlates with the Blairmore Groups westward.

Methods

Fracture networks were characterized using several geometric parameters including length, orientation, and intensity. Analyses are based on:

- Measurements of fractures at outcrop through classical field methods such as scanline and window sampling
- Aerial photographs and video using Unmanned Aerial Vehicles (UAV)
- 3D modeling software that produces high-resolution orthophoto data for digital fracture characterization
- Quantification of fracture patterns using MATLAB: FracPaQ software
- Mechanical character of the section was defined using rock hardness rebound values and compared to the distribution of fractures within the section

Conclusions

This study highlights both traditional and modern technological field methods to analyze fracture networks which can provide key data for subsurface reservoir models. Based on the two methods, modern techniques, with the aid of UAV's, are more accurate and efficient on a macro scale because it can correct sampling bias's compared to traditional field methods. However, traditional field techniques can help define finer details such as fractures found in outcrop too minor for drone footage to capture. By analyzing the results, a combination of both techniques provides the best models.

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References

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