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Analysis of the Relationship between Hydraulic Fracture Pressure Curve Patterns and Facies of the Montney Formation

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Summary

Hydraulic fracturing is an important method required to extract oil and natural gas from low-permeability reservoirs. This process involves the injection of fluid into the formation to create fractures that allow for hydrocarbons to flow into the wellbore for production. It is a process required for production from unconventional reservoirs such as the Montney, but it has recently become a controversial practice due to uncertainty surrounding it and its potential environmental impacts. There is a variety of geological and operational factors that impact the propagation and behaviour of these induced fractures. These impacts are reflected by the patterns displayed by the pressure-curves recorded for each stage. The different pressure trends along the curves provide insight into how different properties are influencing the hydraulic fractures. This study investigates how facies heterogeneity, bedding planes, and natural fractures/faults throughout the Montney Formation impact these induced fractures and how the pressure-curves are influenced.

This study is focused on analyzing the pressure-curves of the stages in 12 wells landed in the Montney, within the Pouce Coupe Area in Northwestern Alberta. To accurately analyze the different properties impacting the hydraulic fractures, this study investigates the results of 3 different case studies. The first case study focuses on wells that move in and out of zones with different geological properties, the second compares wells landed in different zones with different properties throughout the formation, and the third analyzes a well that intersects an area with potential faulting. There are unique pressure curve patterns and pressure trends observed between the wells within the different case studies, indicating that the different geological and geomechanical properties are influencing the induced fractures in a variety of ways. Developing an understanding of how these different properties are impacting the overall trends of these pressure curves is important to determine which facies enhance production and which facies limit the efficacy of these induced fractures. This can improve production and the uncertainty that surrounds hydraulic fracturing, as well be used as a method to predict how these fractures will behave throughout the formation and the best practices to ensure safe and reliable results.

Theory / Method / Workflow

This study was conducted using subsurface data from geoSCOUT. Pouce Coupe continued to be the area of interest for this project to keep all the wells analyzed within the same area of study. The horizontal wells and vertical typewells were imported into StarSteer to determine which member of the Montney they are landed in. Once the desired wells were chosen for this study, using the Frac database from geoSCOUT, the corresponding log files were also uploaded into StarSteer. The wells were steered in StarSteer for quality control to determine the specific facies the wells are landed in. The pressure curves from geoSCOUT were analyzed, manually translated into data points, and plotted in excel. This data was compiled and inputted into Tableau to plot the curves and compare the pressure curves and their properties.

Results, Observations, Conclusions

Hydraulic Fracturing is a technology used to enhance the economic recovery of hydrocarbons in unconventional, fine-grained reservoirs. There are many uncertainties surrounding how geological, reservoir and operational properties influence the behaviour of hydraulic fractures. The Montney Formation is often thought to be a thick homogeneous unit of shale and siltstone, but it is evident that there is significant variation in the geologic properties throughout different members of the formation. Lithology and facies heterogeneity (Duenas, 2014; Fraino et al., 2022; Furlong et al., 2021; Mackie et al., 2022), bedding planes (Grasselli et al., 2015; Huang and Liu, 2017; Tang et al., 2018; Woo et al., 2021; Liu et al., 2022; Tabatabaei poudeh, 2023), and natural fractures (Barati and Liang, 2014; Li et al., 1998; Rogers et al., 2014; Taleghani and Olson, 2014; Zhang et al., 2019) are all factors contributing to the heterogeneity present with the Montney that impacts hydraulic fracturing. Based on the case studies discussed above, the different geological properties within different facies of the Montney are impacting the induced fractures which are visible in the patterns displayed by the pressure-curves. There is significant variation in the pressure fluctuations along all the curves, but it is apparent there are patterns they display depending on where in the formation the induced fractures are propagating into.

This study analyzes pressure trends within different case studies focused on select wells in the Pouce Coupe Area of Northwestern Alberta. These different patterns in the pressure curves are correlated with different facies heterogeneity, geomechanical boundaries formed from changing bedding plane frequencies and the presence of natural fractures and faults. This study concludes that:

- Drastic changes in bedding plane frequencies form geomechanical boundaries that create unstable pressure fluctuations along the curves which suggests that it has a significant impact on the propagation of the induced fractures.
- The higher the facies heterogeneity, the more it is required that fluid injection remains at a consistent value to break through the geological barriers present, with more pressure fluctuations.
- Natural fractures may provide pathways for the fluid to enter the formation at lower injection pressures, but it is difficult to determine if they have a significant impact on the behaviour of the induced fractures based on the pressure curves in facies with high heterogeneity and bedding planes present.

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