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Analyzing the Relationship between Hydraulic Fracture Pressure vs Time Curves and Geological Properties of the Montney

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Summary

Hydraulic fracturing is vital to optimize production in unconventional reservoirs like the Lower Triassic Montney Formation in the Western Canada Sedimentary Basin. There is significant uncertainty surrounding the variety of breakdown pressures seen in the Montney Formation and what geological factors influence hydraulic fracturing. Hydraulic fracture injection curves (HFIC) are pressure vs time plots, which is a robust dataset reported for each stage of a horizontal well and might act as a useful dataset to determine fluctuations in facies and their geomechanical properties, but also intersections of natural fractures and faults along the wellbore, with the latter having the potential to be used as a precursor warning for induced seismic events.

Within this study, an investigation of representative stages from multiple wells in the Pouce Coupe field is described to show general trends in HFIC within the Upper, Middle, and Lower members of the Montney Formation. The curves presented display different overall patterns for wells drilled within each of the members, which may reflect subtle differences in facies or geomechanical properties of the rock. Investigating HFIC provides insight into how the different geological properties of each Montney zone impact hydraulic fracturing and how hydraulic fracturing can differ throughout the formation. Understanding the impact of geological factors in hydraulic fracturing assists in optimizing production and limiting unpredictable events during drilling, as well as addressing environmental concerns surrounding hydraulic fracturing and induced seismicity.

Theory / Method / Workflow

This project was conducted using public well data and Frac Analysis data from horizontal Montney wells in geoSCOUT. The frac analysis data was used to obtain fracture injection curves for the wells and these curves were overlapped to find the average trends for each member of the Montney. Star Steer was utilized to determine which zones the different wells are landed in and what unit is being hydraulically fractured. Core was also used to correlate the changes in breakdown curves with the variation in facies present within the field. The integration of all these datasets allows for the analysis of different patterns observed in the fracture injection curves, which are used to determine the trends associated with different zones and what might be impacting these trends. These methods are also applied to areas that contain high rates of induced seismicity to understand patterns associated with these events, so they can be predicted and prevented in future wells.

Observations and Conclusion

Within this study, representative stages from wells in Pouce Coupe are described to show general trends in HFIC within the Upper, Middle, and Lower members of the Montney Formation. The curves presented display different overall patterns for wells drilled within each of the members, which may reflect subtle differences in facies or geomechanical properties of the rock. Although the Montney Formation is thought to be homogenous, subtle lithological heterogeneities and geomechanical properties have been observed (Furlong MIC 2021; Fraino et al., 2022).

Based on the data within this study, it is apparent that there are trends seen in the HFIC that are independent of data influenced by hydraulic fracturing parameters during drilling, such as fluid injection rate, fluid viscosity and technical difficulties steering the well. The different patterns observed for the Upper, Middle, and Lower Montney members have some similar characteristics, but also have significant variation between them. These trends are likely caused by facies variations and the presence of faults and natural fractures within the stimulated reservoir volume. Plotting only the breakdown pressure values is not enough to observe any changes in trends between the different members. However, the trends are visible when examining how pressure changes with time throughout fluid injection. Possible attributes influencing the shape of injection curves may include pore pressure, geomechanical properties of the reservoir, reservoir volume and sedimentary heterogeneities. Determining what is causing these differences in pressure to occur between each zone provides insight into what could be leading to induced seismicity and why it is only occurring in certain areas and members of the formation. This understanding, and the shapes of these curves and how they vary as the well is fractured, can be used to predict facies changes and any fractures present, as well as the extent which sedimentological heterogeneities and fractures impact hydraulic fracturing.

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