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# The Relationship between Sedimentological Heterogeneities, Structural Fabric, and Induced Seismicity in the Montney Formation from the KSMMA (Kiskatinaw Seismic Monitoring and Mitigation Area), Northeastern British Columbia, Canada

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## Summary

Sedimentological and structural fabrics are inherently linked to geomechanical properties and likely play an important role in understanding the behavior of hydraulic fracturing within unconventional reservoirs. In this study, we investigate subsurface drill-cores around the KSMMA (Kiskatinaw Seismic Monitoring and Mitigation Area) region in Northeastern British Columbia, to identify and describe sedimentological heterogeneities, natural fractures, and bedding plane features (slicken lines, polished surfaces, and microjoints/cleavage) within the Lower Triassic Montney Formation to understand their relationship to the occurrence of induced seismic events.

## Sedimentological Heterogeneities

The Lower Triassic Montney Formation is often referred to as the “Monotoney” due to its seemingly monotonous appearance dominated by planar laminated grey siltstone. However, sedimentological heterogeneities are prevalent throughout the formation as facies variability and depositional processes subtly change both spatially and temporally. The majority of facies within the study area have been interpreted to represent deposition below fair weather wave base within the offshore and offshore transition. Similar facies and depositional environments have been interpreted for the Montney Formation in a variety of studies (e.g. Crombez et al., 2016, 2020; Davies et al., 2018; Prenoslo et al., 2018; Zonneveld and Moslow, 2018). Facies descriptions included grain size, sedimentary structures, color, trace fossils, and body fossils, and heterogeneities were described. Sedimentological heterogeneities were qualitatively assessed and ranked as being low, moderate, or high based on the visible degree of lithological variability within a 50 cm interval of core. Intervals with abundant lithological fluctuations were more common to exhibit increased structural fabric complexities.

## Structural Fabric

Documentation of bedding plane features requires the examination of the ends of all core segments. Each core segment that exhibited bedding plane features were identified and feature type was assigned (e.g. slicken line, polished surface, microjoint/cleavage). The most abundant type of bedding plane features were surfaces that exhibited microjoints/cleavage. At each microjoint/cleavage surface, the following data was collected: core depth, number of microjoints/cleavage lines on the bedding plane, maximum and minimum spacing of microjoints/cleavage lineations, and preservation of the sample. The number of bedding plane surfaces with microjoints/cleavage and the number of core segments per half-meter length are also recorded to construct a structural fabric log. Microjoints/cleavage features were interpreted as being naturally occurring when the microjoints/cleavage extended to the edge of the core, whereas microjoints/cleavage that terminated before the core edge, or were curved, were interpreted to have been produced during coring, and commonly are confined to an oval shaped centered on the core bedding plane (Gillen et al., 2019).

Bedding plane features have been described from a variety of formation within the Western Canada Sedimentary Basin, within siltstone-mudstone reservoirs, including the Second White Specks, Fish Scales, Montney, Duvernay, and Muskwa formations (Davies et al., 2014). Specifically within the Montney Formation, studies on structural fabric have been conducted within the Farrell Creek Field (Rogers et al., 2014; McLellan, 2014), Middle Montney of the Karr-Kakwa area (Davies et al., 2014, 2016), and other non-disclosed locations (Roger, 2018; Gillen et al., 2019). In this study, structural fabric was integrated with detailed geological attributes to better understand where and why bedding plane structural fabrics exist. Lithological description, associated sedimentary structures, and overall facies were also identified and described for the intervals directly underlying and overlying each bedding plane exhibiting structural fabrics.

## Induced Seismicity

Over the last few years, the KSMMA region has experienced an increase in felt seismic events potentially related to hydraulic fracturing in the Montney Formation, which resulted in the BC Oil and Gas Commission implicating special orders in 2018 (BC Oil and Gas Commission, 2018). Since early 2020, 13 broadband seismometers and 2 accelerometers have been added to KSMMA's original public monitoring array to enhance real-time monitoring capabilities (Salvage et al., 2021). Data collected from the monitoring stations have been used to determine location and magnitude of seismic events and were compared against sedimentological and structural fabric trends. Although it is likely that numerous variables influence the occurrence of induced seismic events (e.g. proximity to faults, stress state, pore pressure, depth of targeted formation, etc.), sedimentological characteristics and structural fabrics may provide an additional proxy to use to predict zones more prone to seismic activity and assist in mitigating risk.

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