

Project Profile

Project Name:	Pressure, Stress and Fault Slip Risk Mapping in the KSMMA
Project Number:	ER-Seismic-2020-01
Proponent:	Enlighten Geoscience Ltd.
Funding Envelope:	Environmental Research—Seismicity Research and Monitoring
Timeframe:	November 15, 2019, to August 31, 2020

Project objectives

The objective of this project is to increase the understanding of induced seismicity in the Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA)—including better delineation of pore pressure and effective stress compartments (“terranes”) and how they might be related to seismic activity potential.

This project links to the BC Government’s Scientific Review of Hydraulic Fracturing in B.C. (February 2019):

- Section 5.2.4 Recommendations (Susceptibility to Anomalous Induced Seismicity):
 - Develop susceptibility map and regional fault model based on collaboration and data sharing between operators, industry and researchers.

Project description

This project is a continuation of a project started in early 2019 to identify key or common factors coincident with induced seismicity and/or to delineate areas of higher seismic activity potential within the KSMMA.

This project picks up on the recommendations of the first phase—specifically to carry out additional technical analysis using public data sets and any available proprietary data, including 2D and 3D seismic:

1. Perform a detailed analysis of existing injection test (DFIT) data for pore pressure and minimum stress determination in the KSMMA Montney.
2. Use the enhanced pore pressure data set, as well as any additional data that have become available since the Phase I study, to refine our understanding of pore pressure and effective stress distribution/compartmentalization.
3. Map stress orientations from all available data types.

Project approach

The project will be divided into four phases:

1. Phase 1: Diagnostic Fracture Injection Tests (DFITs or minifrac) analysis. Create a database of quality-controlled and reinterpreted (where required) DFIT data from the Lower Middle

Montney across the KSMMA in order to map minimum stress, pore pressure and effective minimum stress. Stratigraphy to be provided by the BC Oil & Gas Commission.

2. Phase 2: Pressure/stress mapping. Generate detailed pressure maps, particularly of the Lower Middle Montney, by incorporating the results of the DFIT analysis and any new buildup tests (contingent on completion of the DFIT analysis). Mapping of pressure into distinct compartments will be enhanced by the availability of mapped faults from seismic data and/or locations of detected seismic events. Additionally, minimum stress data from the DFIT analysis will be mapped and used along with the pressure data to generate a map of effective minimum stress.
3. Phase 3: Geomechanical analysis and fault slip potential mapping involving the following:
 - Horizontal stress orientations will be mapped in detail across the KSMMA by analyzing all available stress direction indicators including shear anisotropy and sonic scanner logs and oriented caliper logs. These will be compared to stress orientations determined from inversion of earthquake focal mechanisms.
 - Vertical stress will be mapped for the Lower Middle Montney by integrating at least one high-quality density log per township (or equivalent area).
 - Based on data availability, key wells will be chosen throughout the KSMMA in which maximum horizontal stress will be determined in the Lower Middle Montney using wellbore data. Results will be verified against drilling experience and then used to create a Lower Middle Montney maximum horizontal stress map across the KSMMA.
 - A critically stressed fault analysis – determination of how much increased fluid pressure is expected to initiate slip on a given fault – will be performed for all mapped faults, contingent on the availability of such fault data. Fault orientations may be sourced from seismic interpretations performed outside of the scope of this study, either provided by KSMMA operators or by a third party. If data are sufficient, a map of relative slip risk may be generated.
4. Phase 4: Reporting and delivery.

Project deliverables

The deliverables from this project include the following:

1. Final report with supporting tables, plots and maps.
2. Large-format maps of pore pressure, minimum stress, effective minimum stress and, if data are sufficient, fracture/fault slip risk in the Lower Middle Montney (included in report appendices).