Project Profile

Project Name:	Modelling and Analysis of KSMMA Induced Seismic Events to Advance Event Mitigation Strategies
Project Number:	ER-Seismic-2022-03
Proponent:	WSP-Golder
Funding Envelope:	Environmental Research—Induced Seismicity
Timeframe:	April 29, 2022, to April 30, 2023

Project description

The research aims to further understand the stresses on faults from injecting pressurized fluids during hydraulic fracturing by thinking about the components required to induce a seismic event—including the following:

- initial conditions at the well (susceptibility);
- the injection of high-pressure fluid;
- the pathway for fluid and pressure to migrate;
- the stresses and pore pressures in the ground; and
- the faults that may be reactivated.

The Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA) has been identified as an area prone to frequent induced seismic tremors. Identification of key controls and influences on induced seismicity will improve the development and effectiveness of mitigation strategies that might be deployed to reduce the frequency of induced seismic events.

Project objectives

The objectives of this project are to:

- understand key mechanisms and controls on KSMMA induced seismicity;
- test and rank mitigation strategies that may improve an operator's ability to moderate IS during operations; and
- develop best practices in the use of advanced numerical modelling applied to specific site conditions.

Project approach

The project will consist of the following four tasks:

1. **Data Collection**
   The research project will use datasets from three operators in the KSMMA where a range of induced seismic events have been observed. Data will be chosen from a variety of well pads to enable the investigation of multiple stratigraphic units within the Montney Formation within the KSMMA.

   The sub-surface data from operators will be integrated with other existing data to take a holistic view of the subsurface involving geology, geophysics, engineering and hydraulics.

2. **Modeling and Analysis**
   Modelling and simulating the behavior of wells will be undertaken in a variety of numerical codes including the discrete fracture network (DFN) simulation code FracMan and as well as 3DEC and XSite. These models will focus on the well completions, well operations, and fracture connectivity. The modelling will attempt to reproduce the observed induced seismicity, honoring well completion, stimulation, structure, geomechanics, and pore pressures as well as simulating hydraulic fracture development.

   Engineering changes (well completions, stimulation style, fluids, etc.), will be studied to identify any mitigation approaches that reduces the induced seismicity whilst also preserving the stimulated reservoir volume.

   During this task, specific research questions will be examined including:

   - Do conventional analyses explain the observed seismicity (e.g., critical stress)?
   - Is there a relationship between the observed seismicity, structural patterns, and completion type?
   - Can the observed response of operational controls on stimulation be modelled to understand the physics of the fault reactivation process and the dynamics of fluid injection?
   - Can advanced numerical models calibrated to field observations be used to inform quantitative rankings of IS mitigation strategies?
   - Can these learnings be used to guide and inform the Province's regulatory environment?

   A PhD student & a Post-Doctoral Fellow at the University of British Columbia will participate in the project to bring experience in both machine learning and advanced numerical modelling applied to the Montney region and KSMMA.

3. **Induced seismic hazard mapping.**

   A hazard map will be drafted for the Montney, building on empirical susceptibility mapping and informed by advanced numerical modelling of induced seismic mechanisms and sensitivity to operational controls to assess severity potential.

4. **Report and discuss findings.**

Project deliverables

The deliverables from this project include the following:

1. Final report—containing guidelines and best practices.
2. Induced Seismicity Hazard Map (Draft).