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An Investigation of Fault Slip Potential in the Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA), Northeast British Columbia

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Summary

The Kiskatinaw Seismic Monitoring and Mitigation Area (KSMMA) was established in the greater Farmington area of British Columbia in response to concerns about induced seismic events that were linked to hydrocarbon resource development in the Triassic Montney play. The KSMMA sits in a strike-slip stress setting where, in some areas, very small increases in pore pressure are enough to theoretically induce slip on mapped fault segments, several of which coincide with locations of known induced seismic events. High pore pressures and/or low minimum horizontal stress values increase slip risk, and detailed mapping of both parameters shows considerable variation throughout the KSMMA. Such variation makes it difficult to perform generalized assessments of fault slip risk over a sizeable area. A new workflow developed in this study allows for detailed, site-specific fault slip risk assessment. The value in this approach is that individual faults or locations can be analyzed using the most local and accurate stress and pressure input values.

Methods

The quantification of slip risk on pre-existing faults requires knowledge of the complete state of in situ earth stress. A comprehensive DFIT analysis across the KSMMA performed as part of the study provided consistently interpreted values for the minimum principal stress, which is horizontal (Figure 1). Vertical stress was calculated from density logs. The maximum horizontal stress was determined from observations of stress-induced wellbore failure in image logs.

The risk of fault slip is usually addressed by determining the frictional state of a fault under known stress and pore pressure conditions. Quantification of slip risk can be done in a variety of ways but is commonly achieved by calculating the change in pore pressure that would cause the fault to become critically stressed, otherwise known as the critical pressure perturbation (CPP). CPP was calculated for several populations of induced events, and several fault slip risk maps for the KSMMA were generated.

The use of traditional slip risk map approaches for the KSMMA was limited by the rapid spatial changes in stresses and pore pressure. A GIS-based approach was thus developed to honour local stress and pressure observations along small fault segments.

Results, Observations, Conclusions

The GIS-based slip risk map was found to be the most consistent with documented induced seismic events across the KSMMA. Overall, the study demonstrated the value of rigorous geomechanical characterization through the detailed analysis of subsurface data sets. It also

illustrated the geomechanical variability often encountered in areas with a complex structural geologic history.

Additional Information

A complete report documenting the KSMMA study is available via the website of the B.C. Oil and Gas Research and Innovation Society: http://www.bcogris.ca/projects/complete.

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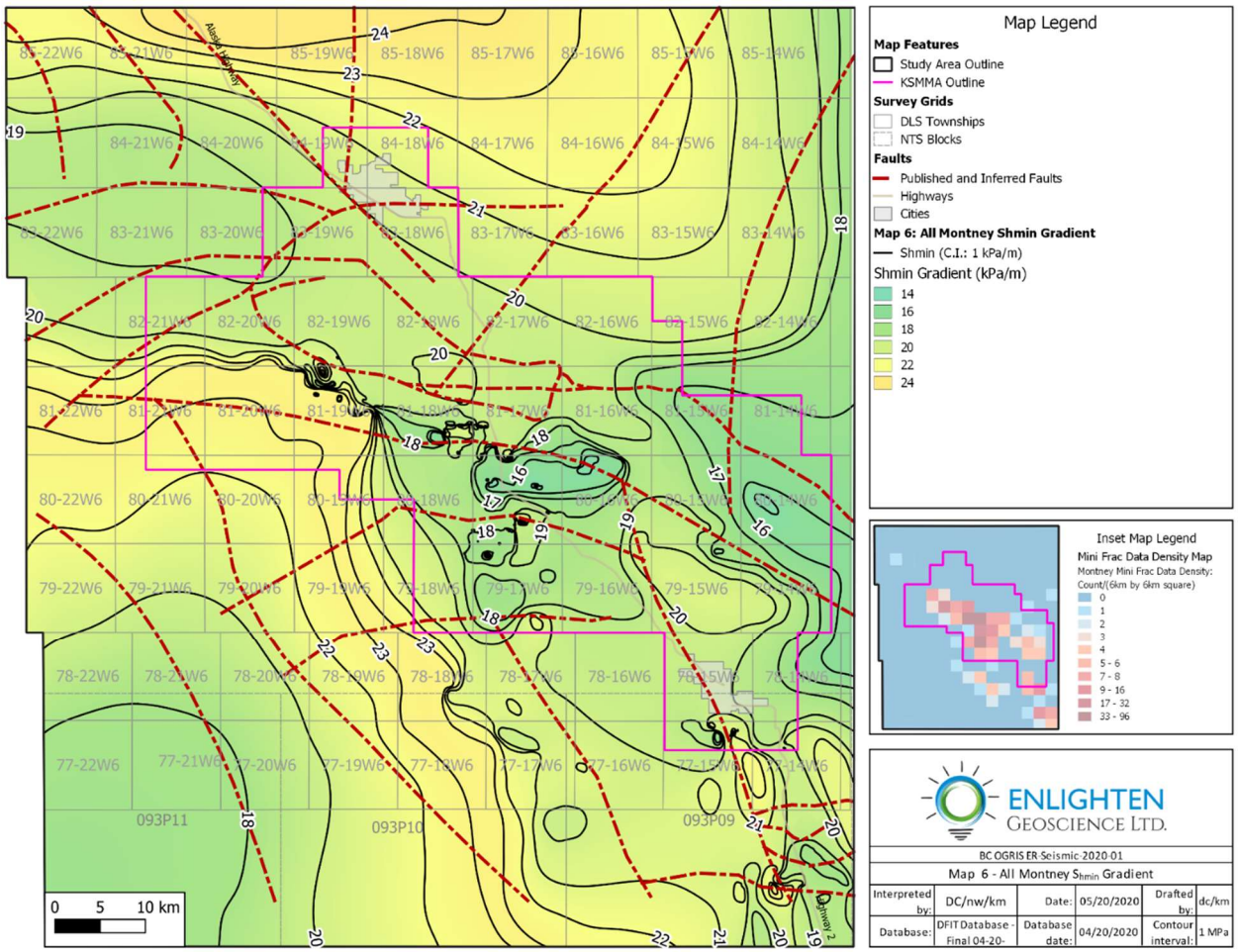

Figure 1. Montney S_{hmin} gradient map for the KSMMA.