

Empirical and Numerical Investigation of the Effects of Hydraulic Fracturing Operational Factors on Triggering Induced Seismicity in Northeastern British Columbia

Afshin Amini¹, Steve Rogers², Erik Eberhardt¹

¹Geological Engineering, Department of Earth, Ocean and Atmospheric Sciences, University of British Columbia

²Golder Associates Ltd.

Summary

Hydraulic fracturing operations to enable production from unconventional oil and gas reservoirs have been subject to public, industry, and regulator concerns regarding induced seismicity around the world. Specific to Montney shale play in north eastern British Columbia (NEBC), a sharp increase in seismic activity began in response to hydraulic fracturing activities. Amongst the different factors influencing induced seismicity, operational factors such as injection volume and rate are of interest because they can be controlled in contrast to other factors such as the effect of geology. In this project, we investigate the association of hydraulic fracturing injection parameters with induced seismicity in Montney in NEBC and explore where each parameter plays a more important role in generating seismicity. Our results from empirical data analysis (Figure 1) suggest that injection volume is the dominant factor in generating seismicity for the wells that target both upper and middle Montney formations whereas injection rate is associated with seismicity only within upper Montney. Three-dimensional numerical modelling was also performed to further investigate and better understand the mechanistic behavior that leads to these empirical observations. For the modelled geological scenario, the results indicate that injection rate is associated with induced seismicity in cases where natural fractures are absent, and a pathway needs to be created for fluid to reach the fault. In contrast when pathways to the fault are present (natural fractures) then injection volume becomes important since it influences the volume of reservoir that is affected by the hydraulic fracturing operation.

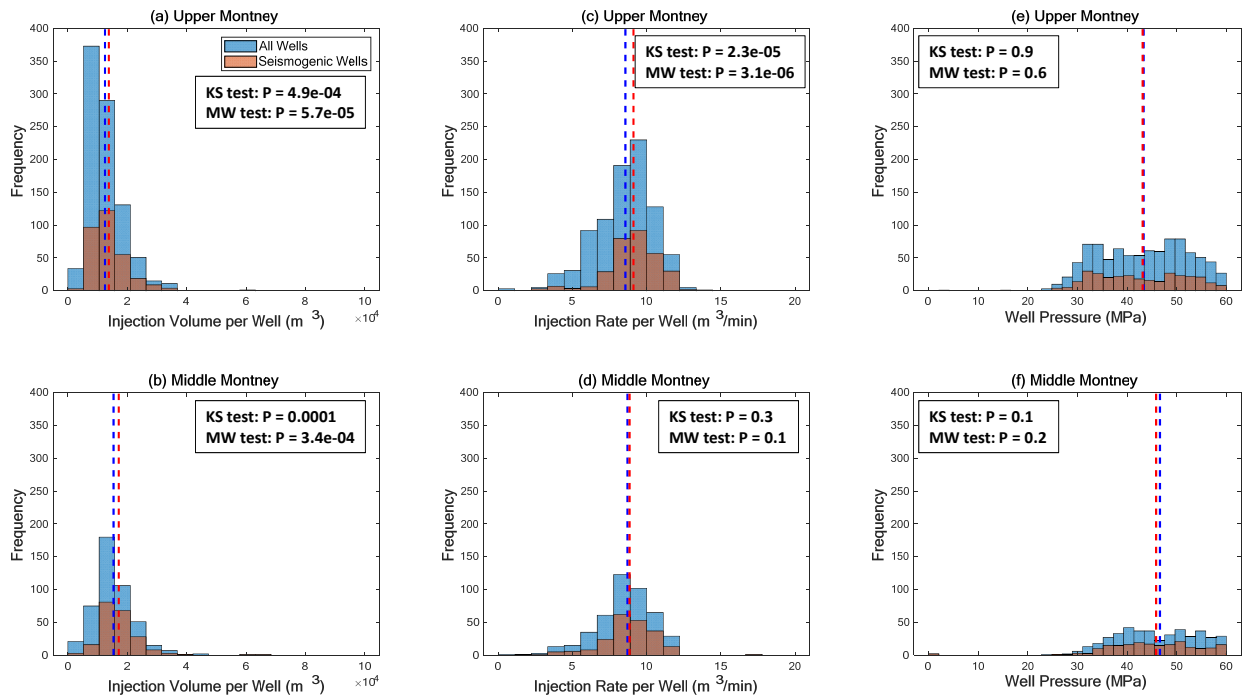


Figure 1- Histogram of operational parameters per well for seismogenic (red) and parent wells (blue). P values from comparisons of complete parameter distributions with seismogenic subsets are shown [KS, Kolmogorov-Smirnov; MW, Mann Whitney]. Dashed lines are average values of each parameter.