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Understanding Hydraulic Fracture Growth by Mapping Source Failure Mechanisms

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SUMMARY

Developing a model of hydraulic fracture development to characterize the effective fracture volume and identify potential means for re-stimulation of previously treated wells by utilizing seismic moment tensor inversion techniques.

Microseismicity recorded utilizing two optimally placed mutli-level downhole triaxial geophone arrays was analyzed to characterize fracture growth related to a hydraulic fracture stimulation in North-Eastern British Columbia. A total of 81 microseismic events with clear P, Sv, Sh first motion arrivals and a signal to noise ration greater than 3:1 were detected. Of these, Seismic Moment Tensor Inversion (SMTI) was carried out for a subset of 29 events with good focal sphere coverage. Our analysis suggests that the majority of the events consisted of significant volumetric components of failure although a shear component of failure was generally present. Additionally, spatial analysis of the failure mechanisms showed that as the hydraulic fracture propagated from the perforation zone the mechanism of failure also changed. In regions close to the treatment zone the event failures were predominantly volumetric whereas as distance increased the failures were more shear. The distribution of failure planes suggested that a complex mesh-like pattern of cross-faults in the direction of the maximum horizontal stress was responsible for the observed fracture growth. Based on these analyses, further consideration is given to developing a model of hydraulic fracture development that can be used to characterize the effective fracture volume and identify potential means for re-stimulation of previously treated wells.