Completion Optimization through Geomechanical Modeling of Interacting Hydraulic and Natural Fractures - Application to the Montney Shale

Nick Umholtz

FracGeo

Abstract

This study describes the application of a workflow that uses Geophysics, Geology, and Geomechanics (3G) for completion optimization. The 3G workflow relies on the modeling of the interaction between hydraulic and natural fractures to estimate key reservoir properties that can be used to better understand data such as microseismicity or to engineer optimal completion designs. The 3G workflow uses geomechanical simulation that combines the meshless Material Point Method (MPM) with Continuous Fracture Modeling (CFM). The distribution of the natural fracture density is estimated from G&G data and in this study it uses a time lapse 3C seismic that was processed for Shear Wave Velocity Anisotropy (SWVA). The Geomechanical workflow uses this as an input to quickly predict the Normalized Differential Horizontal Stress (NDHS) and the Maximum Horizontal Stress Direction (MHSD) over a large area. Both of these properties are used to improve the interpretation of microseismicity and to provide valuable information for the completion engineer to optimize their frack design. When using this approach on a Montney two-well pad, it appears that high values of NDHS are directly correlated to the fracture density estimated from the shear wave splitting parameter. While the local direction of maximum horizontal stress generally follows the direction of the imposed regional stress, large stress rotations of up to 90 degrees could occur in areas where the NDHS is very high. This observation is validated with microseismic data that confirms the local development of axial fracas instead of the desired transverse hydraulic fractures. Combining the NDHS and MHSD maps will be a very valuable completion optimization tool that would assist the completion engineer in adapting their frack design and treatment to the local geomechanical environment. The same 3G workflow will also provide the completion engineer with quantitative tools such as the strain distribution and the *J integral* to predict or evaluate the efficiency of different multi-well fracing sequences. Three fracing sequences (sequential, parallel and zipper) were tested with the geomechanical simulation to investigate the best fracing sequence that achieves the optimal drainage between the two wells.