Finite Element Modelling of Fault Stress Triggering Due to Hydraulic Fracturing

Arsalan Sattari[1] and David Eaton[1]

[1]Geoscience Department, University of Calgary, Calgary, Alberta, Canada

Abstract

In this study, we aim to model fault slip due to stress perturbation by hydraulic fracturing. For this purpose, the finite-element modelling package ABAQUS is used with two distinct models. Prior to computing fault slip, ABAQUS first adjusts and equilibrates the stresses. In the presence of faults, ABAQUS attempts to achieve an equilibrium state in several distinct ways: stress adjustment and reaction forces. Here, the reaction-force approach is used. The initial vertical stress is computed based on the overlying rock mass, and the initial horizontal stress is computed subject to the condition that the critical fault stability (CFS) is set to 5 MPa. The stress perturbation by a tensile crack is calculated based on theory by a simple model for crack-tip stress. The combination of both background and crack stress is used as an initial condition for the model to investigate slip. The result is 2.8m of maximum slip along the fault in presence of perturbation due to hydraulic fracturing. This amount of slip along the fault is equivalent to a magnitude 5.6 earthquake, based on fundamental physics of earthquake. Further work is required to better characterize the fault slip. For example, use of a finer computational mesh may result in less distortion of elements and a more accurate result.

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