Geophysical Research Abstracts
Vol. 20, EGU2018-5195-1, 2018
EGU General Assembly 2018

Potential for permeability enhancement by hydroshearing: numerical modeling of a pressure experiment at Fenton Hill

Antonio Pio Rinaldi (1,2) and Jonny Rutqvist (2)

(1) Swiss Seismological Service, ETH Zürich, Zürich, Switzerland (antoniopio.rinaldi@sed.ethz.ch), (2) Energy Geosciences Division, Lawrence Berkeley National Laboratory, Berkeley, CA, USA (jrutqvist@lbl.gov)

In this study, we analyze a deep hydraulic stimulation of a fracture zone that was conducted as part of the classical Fenton Hill Hot Dry Rock Program in the 1970s. At the time, it was suggested that a pre-existing fracture or multiple fractures within the fracture zone were jacked open aseismically by injection-induced increase in pressure. In this study, we analyze the same stimulation experiment, but investigate the possibility of an alternative mechanism of aseismic shear reactivation of pre-existing fractures. We conduct modeling that accounts for both jacking (or elastic-fracture opening) and shear-slip dilation and demonstrate that injection-induced shear reactivation (or hydroshearing) could have occurred simultaneously with seismic events of magnitudes lower than what can be felt by humans. In fact, simulations considering shear reactivation seem to better match observed fluid recovery after multiple injection cycles. Shear reactivation and shear dilation results in locked-open fractures, especially near the injection well that provides permeability enabling higher flow recovery. We then investigate the sensitivity of the proposed model by varying some of the critical parameters such as maximum aperture, dilation angle, as well as fracture density. Interestingly, none of the simulated cases resulted in a large event that could have been felt by humans, but did result in a cumulative seismic magnitude of less than 1 for each given stimulation step. These results suggest that a permanent irreversible permeability increase of several orders of magnitude can be obtained by hydroshearing in a “seismically” safe manner.