In-situ Measurement of Thermo-Mechanical Transport Properties of Fractured Reservoirs

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ABSTRACT

Deformations from cold water that flow into a hydraulically isolated fracture are investigated by numerical simulations. These results indicate that there are two modalities of deformation: 1) immediate (<10 seconds) pressure-driven dilation of the fault/fracture; and 2) a second delayed thermally induced response of opening and slip. Observed deformations are analyzed with the theory for a soft inclusion (Eshelby, 1957) and indicate that thermally induced unloading and consequent deformations are strongly dependent on the hydro-thermal-mechanical properties of the reservoir and fracture. Stress evolution and its magnitude is determined by the morphology of the cooled volume. A flat cooling ellipsoid centered on the fracture results in thermal cracking (opening in the direction normal to the fracture) while the fracture opening enlarges as cooling proceeds. The analysis of cold water injection for one month (fracture zone of 4 mm thickness and 10 Darcy permeability) resulted in ~3 mm of opening and ~6mm of slip. Further, we assess the recoverable signals from a HPP (Hydraulic Pulse Protocol, Guglielmi et. al., 2005) tool. Expected HPP signals (deformations at ~30cm above the isolated fracture) are significantly larger than tool resolution confirming the utility of the tool to precisely measure the hydro-thermal-mechanical properties of the reservoir and to describe reservoir deformation behavior. Abstract text should not exceed 500 words.

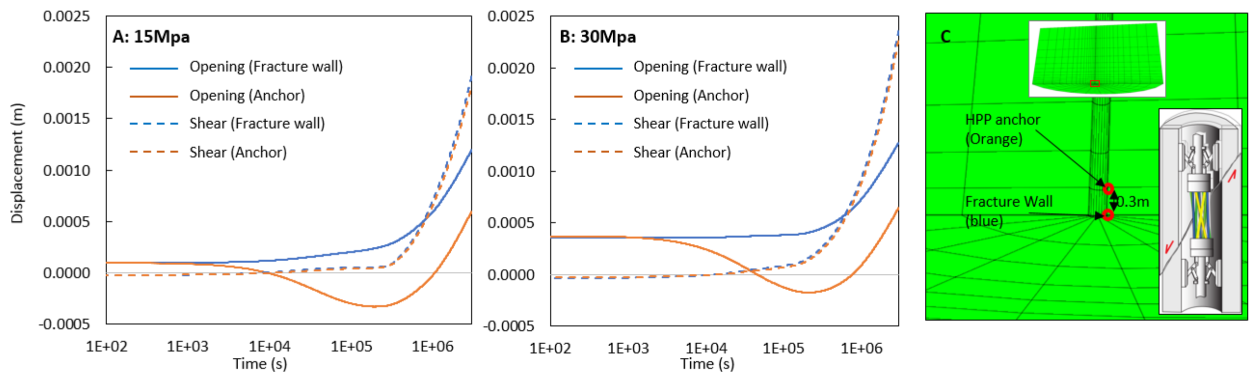

Figure 1. Wellbore response of fracture wall and HPP anchor. Blue denotes fracture wall, orange denotes HPP tool response, solid line denotes fault opening displacement and dashed line denotes fault shear displacement.

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