ABSTRACT

The constant energy demand, together with the raise of greenhouse gasses emissions, has enhanced the development of new green energy resources, such as geothermal energy. The exploration and exploitation of deep geothermal reservoirs has significantly increased during the last years. These reservoirs use heat exchange to produce heat or electricity. Amongst these, we can distinguish between hydrothermal reservoirs (i.e., those using a pre-existing aquifer) and petrothermal reservoirs (i.e., those requiring a phase of hydraulic stimulation). The so called Enhanced Geothermal Sistems (EGS) are characterized by a stimulation phase that aims to increase fluid flow and heat transfer between wells. This stimulation tries to increase the reservoir permeability and transitivity by injecting high-pressure fluids (normally water) with the aim of increasing the apertures of existing fractures, their sliding and/or the generation of new ones. Regrettably, this technique might produces low-magnitude induced seismicity that sometimes can result in damage at the Earth's surface. Numerical simulations able to reproduce the hydro-thermo-mechanical behaviour of geological reservoirs are an essential tool for the evaluation and forecasting of induced seismicity in such systems. In this study, the numerical code CFRAC is used to systematically evaluate how the orientation of faults with respect to the stress field influences seismicity, the injection rate and the fracture sliding behaviour. This orientation dependence has also been evaluated at different scales and for different systems: (i) in an isolated fault, (ii) in a sigmoidal fault with different orientations combinations and (iii) in a multifractured network with differently orientated fracture sets. The results show how fault orientation has an important effect in pressurization, sliding behaviour, fault propagation, the seismicity produced and their magnitude, as well as in the fracture stimulation potential. Furthermore, these results can be extrapolated to different work scales and are in agreement with analytic solutions and with field observations.

Predicting induced seismicity during hydraulic stimulation in enhanced geothermal systems (EGS): a numerical approach.

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