Fluid pressure drops during stimulation of segmented faults in deep geothermal reservoirs

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ABSTRACT

Hydraulic stimulation treatments required to produce deep geothermal reservoirs present the risk of generating induced seismicity. Understanding the processes that operate during the stimulation phase is critical for minimizing and preventing the uncertainties associated with the exploitation of these reservoirs. It is especially important to understand how the phenomena of induced seismicity is related to the pressurisation of networks of discrete fractures. In this study we use the numerical simulator CFRAC to analyse pressure drops commonly observed during stimulation of deep geothermal wells. We develop a conceptual model of a fractured geothermal reservoir to analyse the conditions required to produce pressure drops and their consequences on the evolution of seismicity, fluid pressure, and fracture permeability throughout the system. For this, we combine two fracture sets, one able to be stimulated by shear mode fracturing and another one able to be stimulated by opening mode fracturing. With this combination, the pressure drop can be triggered by a seismic event in the shear-stimulated fracture that is hydraulically connected with an opening-mode fracture. Our results indicate that pressure drops are not produced by the new volume created by shear-dilatancy, but rather by the opening of the conjugated tensile fractures. Finally, our results show that natural fracture/splay fracture interaction can potentially explain the observed pressure drops at the Rittershoffen geothermal site.