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Poroelastic response of geothermal reservoirs during hydraulic stimulation treatment

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Enhanced geothermal systems (EGS) are engineered reservoirs developed to extract heat from low permeability and low porosity geological formations. Cyclic hydraulic stimulation treatments are used in such a context to create hydraulic fractures, minimizing the fluid injected volume (recently proposed as a mitigation strategy for induced seismicity) to gain access to the target formation fluids, drain the geothermal fluid and therefore increase the overall productivity of the geothermal reservoir. During these operations, successive cycles of injection of high flow rates are conducted to decrease the effective minimum principal stress, and therefore the tensile strength of the material, developing a hydraulic fracture. Opening of these newly developed fractures induces an additional deformation of the reservoir rocks. In this study, the poroelastic response resulting from induced deformation during cyclic hydraulic stimulation treatment of a well is investigated using hydromechanical coupling between pore pressure variations and solid rock deformation. The effects of this poroelastic response on the hydromechanical state of a reservoir is illustrated by means of field measurements of a cyclic hydraulic stimulation treatment conducted at the Groß Schönebeck geothermal research site in August 2007. This study points out that a nonlinear pore pressure response arises within the reservoir rocks due to the deformation generated by the stimulation treatment. It is shown here that the 3D poroelastic response of the reservoir leads to an unexpected quasi-instantaneous pore pressure increase in a neighbor monitoring well located approximatively 475 m away from the stimulated well at reservoir depth.