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Seismic response and fracture growth due to fluid injection

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Seismicity from the northwestern part of the Geysers (TG) geothermal field is used in SHale gas Exploration and Exploitation Risks (SHEER, www.sheerproject.eu) project as a proxy of seismicity accompanying shale gas operations. The seismicity occurs there as a results of thermoelastic and poroelastic effects that change the local stress filed in a reservoir. The seismic activity in TG highly correlates with the injection operations. Moreover, some authors revealed the temporal variations of seismic focal mechanisms in accordance with the changes in flow rate in TG. Our analysis shows that the positive gradient of injection rate highly positively correlates with the interevent time. The increase in injection rate gradient causes the pore pressure excess influencing the stress symmetry by moving the intermediate stress closer to the principal stress. For such stress conditions there are many equivalent orientations of the macroscopic failure plane once the failure criterion is fulfilled, and the failure plane takes the orientation for which the rock fails most easily, across pre-existing local discontinuities of rocks. This suggest also that during these periods pore pressure diffusion likely dominates over thermoelastic effects decreasing the total observed seismicity rate. We propose an approach to model fracture growth, with the use of the transformation to equivalent dimensions. The transformation converts a set of seismic parameters in a set of their equivalent dimensions, which are strictly comparable. Based on above results and seismic parameters we define the criteria for possible linking of fractures with the potential for gas migration. We use these criteria to identify the fracture networks and the impact of flow rate to the structure of this network.
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