Permeability of high-temperature fractured granite under confining stress

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A new and economically attractive type of geothermal resource was recently discovered in the Krafla volcanic system, Iceland, consisting of supercritical water at 450 °C immediately above a 2-km deep magma body. Similar resources may be widespread below conventional geothermal systems. However, in case of such geothermal resources, it is expected that the reservoir rocks are ductile and have low permeabilities. One of possible ways to enhance permeabilities of ductile rocks is hydraulic and/or thermal fracturing. Although creating fractures may be possible, there is concern about the permeability of the fractured rock after recovery of temperature and/or effective confining stress to the initial state, at which plastic deformation of fracture surface may occur. The present study has experimentally explored permeability of thermally fractured granite at temperatures of 350-500 °C under confining stress up to approximately 100 MPa. It has been found that, at each temperature, a change in stress decency of permeability occurs at a specific stress level, beyond which permeability reduction with increasing effective confining stress is much larger, and the permeability reduction is irreversible, due to transition from elastic to plastic deformation of fracture surface.

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