Digital Rock Approach to Model the Permeability in an Artificially Heated and Fractured Granodiorite from the Liquine Geothermal System (39 degrees S)

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Abstract

The Southern Volcanic Zone of the Andes has a high potential in terms of geothermal resources and is an exceptional and poorly explored natural laboratory to study the interplay between tectonic stresses, thermal damage, low-permeable crystalline rocks, and fluid flow. Permeability is mostly related to the damage zones associated with the faults controlling regional tectonics, namely, the Liquine-Ofqui Fault System and Andean Transverse Faults. This research presents a laboratory approach comprising a characterization of the analogue host rock from a shallow, low-to-medium temperature geothermal system surrounding the Liquine area in Southern Chile (39 degrees S) to better constrain intrinsic and extrinsic factors which allow permeable pathways to exist. We analyse the effect of thermal stress at 25, 150, and 210 degrees C in a granodiorite, measuring some petrophysical properties before and after applying thermal damage, and then loaded the samples until failure. We also compared petrophysical properties with the fracture network characterization using X-ray microcomputed tomography imaging, segmentation, and fluid flow computational simulations. The results show that thermal stress produces intercrystalline microcracks, which result in: (1) an increase in capillary absorption; (2) a decrease in ultrasonic wave velocities; (3) a decrease in compressive strength; (4) a decrease in fracture aperture, and (5) fluid flow simulations indicate that permeability is similar at different temperatures. We conclude that for the granodiorite host rock of the Liquine geothermal system, the combined effect of thermal stress, even at low temperature, may constitute an effective mechanism for sustaining permeability at shallowest depths.

Palabras clave

Palabras clave de autor: Primary low-permeability granitoids; Thermal decay; Artificial fractures; Image analysis; Geothermal system

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