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Abstract

The Southern Andes Volcanic Zone (SVZ) represents one of the largest undeveloped geothermal provinces in the world. Development of the geothermal potential requires a detailed understanding of the fluid transport properties of its main lithologies. The permeability of SVZ rocks is altered by the presence of fracture damage zones produced by the Liquiñe-Ofqui Fault System (LOFS) and the Andean Transverse Faults (ATF). We have therefore measured the permeability of four representative lithologies from the volcanic basement in this area: crystalline tuff, andesitic dike, altered andesite and granodiorite. For comparative purposes, we have also measured the permeability of samples of Seljadalur basalt, an Icelandic rock with widely studied and reported hydraulic properties. Specifically, we present the results of a systematic study of the effect of fractures and fracture offsets on permeability as a function of increasing effective pressure. Baseline measurements on intact samples of SVZ rocks show that the granodiorite has a permeability (10^{-18} m^2), two orders of magnitude higher than that of the volcanic rocks (10^{-20} m^2). The presence of throughgoing mated macro-fractures increases permeability by between four and six orders of magnitude, with the highest permeability recorded for the crystalline tuff. Increasing fracture offset to produce unmated fractures results in large increases in permeability up to some characteristic value of offset, beyond which permeability changes only marginally. The increase in permeability with offset appears to depend on fracture roughness and aperture, and these are different for each lithology. Overall, fractured SVZ rocks with finite offsets record permeability values consistent with those commonly found in geothermal reservoirs (>10^{-16} m^2), which potentially allow convective/advective flow to develop. Hence, our results demonstrate that the fracture damage zones developed within the SVZ produce permeable regions, especially within the NE-striking fault zones that have an extensional component, that have major importance for geothermal energy resource potential.