Geophysical Research Abstracts
Vol. 16, EGU2014-11929-1, 2014
EGU General Assembly 2014

COTHERM: Numerical modeling of the deep roots of volcanic geothermal systems

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We report numerical simulations of the transient evolution of fluid flow and heat transport in high-enthalpy geothermal systems around cooling intrusions, including the deep, 'supercritical' roots. We employ the CSMP++ fluid flow and heat transport code, and analyze the temperature, pressure, phase state distribution etc. during the whole lifetime of a geothermal system. Such simulations are of high relevance to projects like the Iceland Deep Drilling Project, which aim to dramatically improve the economics of geothermal power production by tapping such 'supercritical' reservoirs. We study the effects of the depth of the intrusion, the system-scale permeability and the permeability change across the brittle-ductile transition. While previous studies have commonly adopted a temperature-dependent parameterization, with permeability decreasing in a log-linear fashion at temperatures above 360°C, this study explores a variety of different potential temperature dependencies of permeability and their effects on model results. These effects are large and namely affect the thickness of the conductive boundary layer, which impacts the overall rate of cooling of the intrusion.