MULTI-SCALE HYDRAULIC CHARACTERIZATION OF STIMULATED FRACTURED CRYSTALLINE ROCK AT GRIMSEL TEST SITE

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Natural and induced fractures make flow in oil and gas reservoirs, nuclear waste repositories and enhanced geothermal systems strongly heterogeneous and anisotropic. In such environments, characterization of the fractured medium through a combined multi-scale and multi-component approach could result into an improved understanding of the physical setting and behavior of the medium of interest.
As part of the In-situ Stimulation and Circulation (ISC) experiment at the Grimsel Test Site (GTS), which is located in the central Swiss Alps, a comprehensive hydraulic characterization campaign has been conducted in order to evaluate the efficiency of hydraulic fracturing and hydraulic shearing on the permeability enhancement and heat exchange capacity of the granitic host rock. The hydraulic characterization consists of tests of varying scale, ranging from single-hole (e.g. pulse injection and oscillatory injection tests) to cross-hole (e.g. constant rate injection and oscillatory interference tests) and reservoir scale (e.g. ling-term constant rate injection test). Moreover, various components in addition to hydraulic tests have been added to these measurements such as thermal and conservative tracer tests, single-hole and cross-hole geophysical measurements and strain/deformation measurements.
The results obtained indicate enhancement of permeability as well as non-integer flow dimension, and thereby natural heat exchange efficiency of the fractured zones. In addition to that, the characteristic of the thermo-hydro-mechanical (THM) behavior on the influenced fractures during the hydraulic/thermal characterization tests has been affected as more flow paths now contribute to the hydraulic system after the hydraulic stimulation. Finally, combinations of all above mentioned methods provide new insights on the heat exchange efficiency of the stimulated rock mass.