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Exploring an active hydrothermal system – An analogue study from the Swiss Alps

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Understanding the detailed flow paths in hydrothermal reservoirs is crucial for successful exploration of naturally porous and permeable rock masses for energy production. However, due to the common inaccessibility of active hydrothermal systems of suitable depth, e.g. in the northern Alpine foreland of the European Alps, direct observations are normally impossible and the knowledge about such systems is still insufficient. For that reason, a known fault-bound hydrothermal system in the crystalline basement of the Aar Massif serves as an analogue for potential geothermal reservoirs in the deep crystalline subsurface of the northern Alpine foreland. During summer 2015, a 125 m hole has been drilled across this active hydrothermal zone on the Grimsel Pass for in-situ characterization of its structural, petrophysical, mechanical as well as geophysical parameters. With this information, this project aims at improving the knowledge of natural hydrothermal systems as a potentially exploitable energy source. The investigated system is characterized by a central breccia zone surrounded by different types of cataclasites and localized high strain zones. The surrounding includes different altered and deformed granitoid host rocks. In this study, we focus on the ductile and brittle deformation (shear zones, fractures, joints) that provides the main fluid pathways. Their spatial distribution around a central water-bearing breccia zone as well as their continuity and permeability provide constraints on the water flow paths in such structurally controlled hydrothermal systems. The aim will be the connection of detailed structural data with petrophysical parameters such as porosities and permeabilities. The drillcore shows the high variability of deformation structures and related fluid pathways at different scales (millimeter-decameter) demonstrating the urgent need for an improved understanding of the link between mechanical evolution, associated deformation structures as well as the time- and space-integrated evolution of fluid pathways.