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Geophysical characterization of an active hydrothermal shear zone in granitic rocks

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Hydrothermally active faults and shear zones in the crystalline massifs of the central Alps are currently of particular interest because of their potential similarities and analogies with planned deep petrothermal reservoirs in the Alpine foreland. In order to better understand such hydrothermal systems, a near-vertical, hydrothermally active shear zone embedded in low-permeability granitic rocks has been drilled. This borehole is located on the Grimsel Pass in the central Swiss Alps, has an inclination of 24 degrees with regard to the vertical, and crosses the targeted shear zone between about 82 and 86 meters depth.

The borehole has been fully cored and a comprehensive suite of geophysical logging data has been acquired. The latter comprises multi-frequency sonic, ground-penetrating radar, resistivity, self-potential, gamma-gamma, neutron-neutron, optical televiewer, and caliper log data. In addition to this, we have also performed a surface-to-borehole vertical seismic profiling experiment. The televiewer data and the retrieved core samples show a marked increase of the fracture density in the target region, which also finds its expression in rather pronounced and distinct signatures in all other log data.

Preliminary results point towards a close correspondence between the ground-penetrating radar and the neutron-neutron log data, which opens the perspective of constraining the effective fracture porosity at vastly differing scales. There is also remarkably good agreement between the sonic log and the vertical seismic profiling data, which may allow for assessing the permeability of the probed fracture network by interpreting these data in a poroelastic context.