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Hydro-thermal coupling in a rough fracture

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Heat exchange during laminar flow is studied at the fracture scale on the basis of the Stokes equation. We used a synthetic aperture model (a self-affine model) that has been shown to be a realistic geometrical description of the fracture morphology. We developed a numerical modelling using a finite difference scheme of the hydrodynamic flow and its coupling with an advection/conduction description of the fluid heat. As a first step, temperature within the surrounding rock is supposed to be hot and constant. Influence of the fracture roughness on the heat flux through the wall when a cold fluid is injected, is estimated and a thermalization length is shown to emerge. Our model shows that fracture roughness is responsible for channelling effects. Fluid flow is dominant in a significant subpart of the fracture where heat advection is important. Accordingly, temperature distribution is strongly affected by small fluctuations of the fracture aperture. Implications for the Soultz-sous-Forêts geothermal project are discussed.