Supplementary Material Information for

[Flexible parallel implicit modelling of coupled Thermal-Hydraulic-Mechanical processes in fractured rocks]

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Figure S1.1 and S1.2 (a, b)

Table S1.1

Additional Supporting Information (Files uploaded separately)

We have uploaded 2 animations in addition. The first is an animation of the results presented in the manuscript (paragraph 4.4, Cacace_Jacquey_4-4.avi). The second is an animation of the benchmark test case presented as Supplementary Information material (Cacace_Jacquey_SI1.avi).

Section S1

An example of a synthetic benchmark for 3D flow in a fractured medium: Thermo-Hydraulic modelling in a two layered system in the presence of two intersecting fractures

This paragraph describes a synthetic 3D "benchmark" for flow and heat transport in a fractured medium. The set up has been intentionally inspired by the results published by one of the two co-authors, (Blöcher et al., 2010). The latter serves as an additional comparison for the current formulation. We consider a box model for a two-layered porous medium in the presence of two intersecting planar fractures. Table S1.1 lists the geometrical attributes of the model as well as all material properties adopted for the simulation, while the basic geometry of the model formulation is additionally presented in Fig. S1.1.

A regional flow from the southern boundary into the model is enforced by imposing a pressure gradient equals to Δp = 0.5 MPa across the whole model. Across the inlet boundary, we fixed the temperature which we vary linearly from east to west from a minimum of 40°C up to a maximum of 80°C. This was done in order to have water infiltrating in the model domain and advecting the boundary temperature, thus helping to best visualize the hydrodynamics within the model domain as disturbed locally by the presence of the two fractures. The simulation is run under transient conditions, for approximately a total of 150 years. In the following we only illustrate and discuss the results as obtained at the end of the simulation, while an animation of the system dynamics is uploaded separately as additional material.

Fig. S1.1a illustrates the pressure filed at the end of the simulation as extracted along a plane cutting the model domain approximately in the middle (see Fig. S1.1b for the location of the plane).

The impact of the two fractures on the pressure field is evident, with the highest gradients pressure occurring at the fractures' tips.

Fig. S1.1b depicts the 3D thermal field at the end of the simulation. Because of focussed flow within the fracture planes, the isotherms follow the plane of the fractures leading to a mixing at the intersection line located approximately in the middle of the domain.

Table S1.1: geometry and material properties

Property	SI units	Layer 1	Layer 2
Averaged thickness	(m)	55	45
Porosity	(-)	0.15	0.08
Storage	(Pa^{-1})	7×10^{-10}	7×10^{-10}
Permeability	(m^2)	2×10^{-14}	1×10^{-14}
		Fault 1	Fault 2
Dip direction	(°)	316.7	225
Dip	(°)	80.6	63.2
Length	(m)	233.5	183.8
Aperture	(m)	0.05	0.05
Porosity	(-)	1	1
Storage	(Pa^{-1})	4.6×10^{-10}	4.6×10^{-10}
Permeability	(m^2)	1×10^{-8}	5×10^{-9}

Fig. S1.1: Geometry of the model consisting of two layers cut by a system of two intersecting fractures

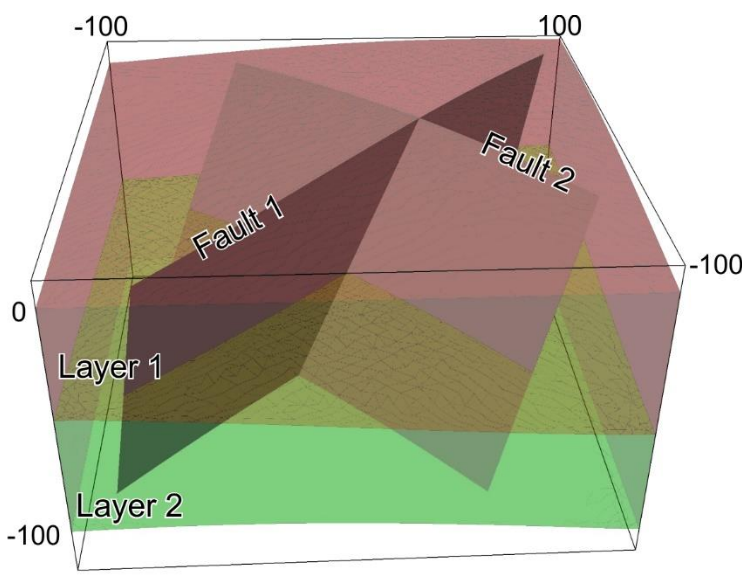

Fig. S.1.2 (a) pressure distribution after 150 years of simulation time along a horizontal plane cutting the model in its middle part. (b) 3D temperature distribution at the end of the simulation run. The location of the plane used to show panel (a) is also shown.