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Impact of fracture sealing on their hydraulic and mechanical properties

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In deep tight reservoirs like Enhanced Geothermal Systems (EGS), the fracture flow often plays a dominant role. The hydraulic and mechanical behaviors of the fracture are affected by a couple of factors such as the sealing deposits owing to mineral cementation. Here we aimed to investigate the impact of the sealing material on the hydro-mechanical properties of a rough fracture using a well-established self-affine rough fracture model. We developed finite element model based on the MOOSE/GOLEM framework dedicated to modeling coupled Hydraulic-Mechanical (HM) process of the rock-fracture system. We conducted numerical flow through a granite reservoir hosting one single large and partly sealed fracture of size 512x512 m^2. Navier-Stokes flow and Darcy flow are solved in the 3-dimensional rough aperture and in the embedding poro-elastic matrix, respectively. In order to mimic the impact of the fracture sealing material on the physical properties of the rock-fracture system, we sequentially increased the amount of the fracture-filling material in the rough fracture by changing the thickness of the sealing deposits. The evolution of the contact area, fracture permeability, fracture diffusivity and normal fracture stiffness, is monitored up to the percolation threshold of the fluid flow. We show that sealing induces strong permeability anisotropy, significant decrease of hydraulic diffusivity and increase of fracture stiffness. The results have strong implications for optimizing the stimulation strategy like chemical stimulation of fractured reservoirs, as well as understanding the fluid-induced seismicity.