Contribution ID: **539** Type: **Oral 20 Minutes**

Quartz fracturing by in-pore water (negative) pressure

Monday, 14 May 2018 14:25 (15 minutes)

Crystallization pressure is the best-known player in the damage of natural and manufactured porous rocks at the Earth surface conditions. In the underground, the combination of pore pressure and confining pressure controls the stress arising in the solid matrix of porous reservoirs, which can lead to different types of damages. We turned our interest towards the role of capillary tension, possibly reaching the negative pressure domain, to deform and even fracture a rigid skeleton limiting the water-hosting pores. The main peculiarity is here to focus on rigid matrix and not only granular stacks with which the compaction effects of capillary bridging are largely referenced.

Isochoric cooling of liquids trapped in closed cavities put them under tensile strength up to the stability limits (e.g., Shmulovich et al., 2009; Qiu et al., 2016). In situ Raman spectroscopy can be used to record the frequency shift of two quartz peaks as a direct function of the growing negative pressure in water occluded inside the same quartz. The procedure uses a classic coupling between thermal cycles (microthermometry) and Raman micro-spectroscopy, of large use in fluid inclusions studies. We demonstrated how the solid rapidly react to in-pore water negative pressure, and may lead to local fracturing, with possible feedbacks towards permeability. Further modelling in terms of elastic solid mechanics, confirms the trends and enlarges the genericity of the measurements, giving also some insights into the role of different parameters (size of pore, values of tension, shape ration of the water-hosting cavity, etc.). One dataset gave contradictory values with respect to the models outputs, which demonstrate that certain parameters are still missing or wrongly parameterized.

These findings illustrate the potentially complex strain-stress relationships in a single pore submitted to tensile forces, like the ones developing during drying processes. The best example of such situation in nature is the aquifers in which supercritical (drying) CO_2 is injected to mitigate atmospheric CO_2 burden. We demonstrated that capillary tension arisen in crystalline or cemented materials can strongly modify their strength, and even may provoke their fracturing. The mechanical balance all around an injection well, and therefore the integrity and injectivity properties through time, should include full consideration of the capillary forces reigning there.

References

Qiu C., Krüger Y., Wilke M., Marti D., Rička J., and Frenz M. (2016) "Exploration of the phase diagram of liquid water in the low temperature metastable region using synthetic fluid inclusion."Phys. Chem. Chem. Phys., 18, 28227-28241.

Shmulovich, K. Mercury L., Thiéry R., Ramboz C., and El Mekki M. (2009) "Experimental superheating of water and aqueous solutions."Geochim. Cosmochim. Acta, 73(9), 2457–2470.

Acceptance of Terms and Conditions

Click here to agree

Primary authors: MERCURY, Lionel; DE BILBAO, Emmanuel (University of Orléans); SIMON, Patrick (CNRS); HULIN, Claudie (University of Orléans)

Presenter: MERCURY, Lionel

Session Classification: Parallel 2-D

Track Classification: GS 3: Experimental achievements