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Dynamic permeability resulting from fluid-rock interaction: insights from reactive transport experiments of tourmalinisation in a perigranitic environment

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The identification of hydrothermal alteration sequences is one of the key criteria for the classification and prospection of ore deposits. However, their feedbacks on the circulation and focus of the chemical and thermal flows are poorly studied. Hydrothermal alterations are the direct consequence of fluid-rock interaction and contribute to the modification of the petrophysical properties of rocks. By changing the original mineral assemblage, metasomatic reactions cause variations in volume and texture, alter porosity in the host rock and modify its permeability.

The proposed study focuses on tourmalinisation reactions met in medium to high temperature orogenic and / or peribatholitic contexts. Tourmaline ($XY_3Z_6[T_6O_{18}]$ $[BO_3]_3$ V_3W) records the physico-chemical conditions during its crystallisation. As its primary chemical zonings are generally unbalanced, its occurrence as an alteration product has been largely used to decipher the physico-chemical properties of fluids [1]. However, its impact on the hydrothermal processes remains little studied. For instance, it has been observed that pervasive tourmaline alteration in metapelites can changes the rheological behaviour of the rocks [2], but no study has been focused on its effect on permeability.

This communication presents the results of reactive percolation experiments, performed on two different rocks sampled in perigranitic contexts. (1) A spotted micaschist naturally tourmalinised was infiltrated with a H_3BO_3 brine at 300°C during 6 weeks. (2) A fine-grained granite was subjected to the continuous injection of a HCl-H_3BO_3 brine (pH = 2.7) at 400°C. Permeability changes were monitored and the petrographic, textural and chemical evolution of the post-experiment cores, as well as outlet fluids composition were analysed.

For the various starting mineralogical assemblies, the characteristics of the evolution of the alteration sequences will be deciphered in order to explore the interactions between the chemistry of the system, the reaction kinetics and the variation of permeability. Measurements and analyses for each experiment will be interpreted as a function of the Damköhler number and linked to the dynamic equilibrium of the tourmalinisation alteration sequence.

References:

[1] Dutrow & Henry (2011), Elements 7, n°5,301-306

[2] Mahjoubi et al. (2016), Miner. Depos. 51, n°3, 431-451