Synthesis of fluid inclusions: experimental tests on achieving equilibrium

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In recent years, synthesis of fluid inclusions and subsequent LA-ICP-MS analysis have become the method of choice in collecting thermodynamic data constraining the transport of metals in aqueous fluids. One of the main challenges in such studies is to guarantee that the fluid had reached equilibrium with respect to the investigated phases prior to its entrapment as fluid inclusion in the host mineral. Various methods have been suggested to delay healing of the host mineral or to (re-)open previously healed or new cracks after a defined length of time [1-3]. In experiments conducted at 800°C and 200 MPa we tested the effects of quartz pretreatment, pressure cycling and intermediate quenching on the formation of equilibrated fluid inclusions. Except for the pressure cycling, which resulted in fluid inclusion with a larger range of analyzed concentrations, all methods resulted in the formation of predominantly equilibrated fluid inclusions.

We further tested the efficiency of the intermediate quench at 600°C (200 MPa) by forming fluid inclusion at 400°C after the quench. Both generations could be distinguished easily via microthermometry and show two distinct homogenization temperatures (T_{hom}) that match the calculated T_{hom} within the error of the method. Nevertheless, it was not possible to distinguish the two generations optically, in contrast to [1]. This would be crucial to limit the LA-ICP-MS analysis to fluid inclusions that formed after the intermediate quench.

In addition to the time after which the fluid is trapped in annealing fractures, the kinetics of the dissolution of metals is crucial to ensure equilibration with the fluid before entrapment. We investigated the kinetics of dissolution of molybdenite, scheelite and gold in experiments at 800°C and 200 MPa with runtimes ranging from 1.8h to 100h and found that Mo and Au concentrations achieve constant values after 1.8h and W after 10h. As a consequence experimental durations can be designed much shorter than previously done, which is a great advantage when using solid mineral buffers.

[1] Li & Audetat (2009), *Am Mineral* **94**, 367-371 [2] Sterner *et al* (1988), *Geochim Cosmochim Ac* **52**, 989-1005 [3] Zajacz *et al* (2010), *Earth Planet Sc Lett* **297**, 50-56