In situ observations of the crystallization of beryl and phenakite in aqueous solutions in a hydrothermal diamond-anvil cell

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Beryl and phenakite are important industrial beryllium minerals. In the hydrous melt of the BeO-Al_2O_3-SiO_2-H_2O (BASH) system, the transition between beryl and phenakite can occur in the reaction of beryl + H_2O = chrysoberyl + phenakite + SiO_2, or beryl + H_2O = euclase + phenakite + SiO_2. Beryl and phenakite are stable at different pressure–temperature (*P–T*) conditions, based on the experimental results using quench-type high-*T* and high-*P* equipment [1].

Here, we observed *in situ* crystallization process of phenakite and beryl in an aqueous solution of the beryl ($Be_3Al_2(SiO_3)_6$)-H_2O system in a hydrothermal diamond anvil cell (HDAC). In our experiments, phenakite began to crystallize while the originally loaded beryl was dissolving during heating above ~450 °C (at the corresponding *P*s of ~200 MPa), and phenakite continued to grow during cooling from the upper *T* limits of that particular HDAC (845–870 °C), where beryl was totally dissolved at the corresponding *P*s of 500–1300 MPa. However, in some cases, beryl was not totally dissolved at these *T*s and it began to recrystallize with the dissolution of phenakite during cooling. In the phenakite crystallization experiments during heating and cooling, it crystallized in a columnar shape, and therefore it is easy to calculate its crystallization rates. For example, one phenakite crystal in our experiments was observed to grow at the rates of $0.58–2.90 \times 10^{-5}$ cm/s in length and 3.23–22.39 $\mu m^3/s$ in volume. These rates are higher than those crystallized from a hydrous melt [2], indicating the higher diffusion rates of components in aqueous solution than in melt. In our future studies, more experiments will be performed in HDAC to observe the transition between beryl and phenakite at fixed *P-T* conditions for extended experimental durations.

[1] Franz & Morteani (2002) *Rev. Mineral. Geochem.*, **50**, 551–589. [2] Sirbescu et al. (2017) *J. Petrol.*, **58**, 539–568.