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Variable diffusion rates during exsolution coarsening in the presence of fluids.

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The scale of exsolution textures in mineral solid solutions has long been used as an indicator of thermal history during cooling. The theory of spinodal decomposition in an anisotropic solid and subsequent coarsening of exsolution textures as a function of temperature and cooling rate is well developed (see Petrishcheva et al., 2009 and Abart et al., 2009 for a review of the Cahn-Hilliard theory). For the case of exsolution in the alkali feldspar solid solution [(Na,K)AlSi3O8] the characteristic texture shows compositional fluctuations in Na,K with a wavelength that depends on the cooling rate. The cooling rate is determined from knowledge of the Na-K interdiffusion coefficient, assuming that the unmixing is simply due to the interdiffusion of Na and K in an otherwise fixed tetrahedral Al,Si framework. Cryptoperthites and mesoperthites with a periodic lamellar microstructure are considered to be the end-result of such a solid-state exsolution process.
Later-stage fluid infiltration results in patch perthites that are formed at a sharp replacement front by a dissolution-precipitation mechanism (Parsons et al., 2015). Patch perthites have an easily recognizable texture and are clear indicators of a reaction with an aqueous solution. The distinction is thus drawn between crypto- and meso-perthite showing periodic lamellae, associated with a solid-state exsolution process, and the patch perthite showing irregular domains of Na-rich and K-rich feldspars associated with a fluid mediated reprecipitation process.
However, the presence of fluids can also enhance the coarsening of lamellar exsolution textures, retaining an apparently solid-state microstructure but with a length scale that is dependent on local recrystallization driven by fluid infiltration. Examples will be given from alkali feldspars in granitic rocks where it is clearly demonstrable that cooling rates cannot be inferred from such exsolution textures. The variability in Na,K diffusion rates and thus different length scales of exsolution are likely to be due to the efficiency of diffusional transport through a fluid phase, which is influenced by differences in fluid-induced micro- and nano-porosity.

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