Intragranular replacement of chlorapatite by hydroxyapatite during scapolitisation

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Intragranular replacement of chlorapatite by hydroxyapatite is studied in the Ødegården metagabbro, Bamble sector of south Norway. The Ødegården metagabbro is pervasively scapolitised in a 1.5 km long zone of 50-100 m thickness, forming a rock composed of Cl-rich scapolite +rutile +apatite ±edenite ±phlogopite ±enstatite ±diopside. The magmatic apatite is non-porous and homogenous in composition with a Cl-content of c. 2 wt%. Scapolitisation transforms apatite during multi-stage replacement reactions: I) The magmatic apatite was transformed to chlorapatite with Cl-content of 6.5 wt%. II) A secondary replacement reaction transforms the chlorapatite to porous hydroxapatite with only minor Cl (Fig. 1), and is correlated with a hydration of enstatite to talc. The observed compositional zoning in apatite is consistent with observations of apatite from pegmatites cutting the Ødegården metagabbro (Harlov *et al.* 2002). The observed changes in Cl-content of apatite is interpreted to reflect the fluid evolution and the propagation of metasomatic fronts through the gabbro. The reaction mechanism of chlorapatite to hydroxyapatite is studied by enery-filtered transmission electron microscopy (TEM). A TEM-specimen across the replacement interface was prepared using a focussed ion beam apparatus (FIB). The diffraction pattern is similar in the chlor- and hydroxyapatite parts of the crystal. The results are consistent with replacement by a coupled dissolution-reprecipitation mechanism during metasomatism.

Figure 1: Chlorapatite (light grey) partly transformed to hydroxyapatite (dark grey).
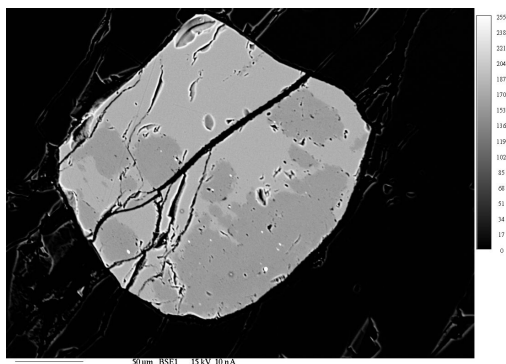
Reference
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Dissolution from a CO$_2$ lake

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If liquid CO$_2$ is stored as a dense "lake" on the deep ocean floor, it is expected to dissolve in seawater. A similar situation may occur if CO$_2$ is dissolved from a saturated benthic boundary layer caused by a potential leak of geological stored CO$_2$. Due to ocean currents and turbulence the net rate of release may increase by several orders of magnitude compared to molecular diffusion. However, density stratification induced by dissolved CO$_2$ will tend to reduce vertical mixing. This scenario has previously been modelled in two dimensional domain (e.g. Fer & Haugan, 2003; Haugan and Alendal, 2005). There has also been a three dimensional study (Enstad *et al.* 2006) using the MIT general circulation model (http://mitgcm.org). Recently the MITgcm model has been coupled with the General Ocean Turbulence Mode (http://gotm.net/), and this model is used to simulate the lake option. The new vertical turbulent mixing scheme takes into account density effects, and should give more realistic results for the CO$_2$ plume than constant eddy diffusivity models. The introduction of a third direction gives qualitatively different results for the spreading of the CO$_2$ plume than previous two dimensional results. Among the results we also show the hit rates of a passive tracer passing through the domain.

References
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