Analcime alteration of montmorillonite: Growth rates

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Analcime is very common zeolite as a low-temperature secondary mineral of alkaline alteration. Growth of analcime was previously studied on precursor Na-clinoptilolite[1] and leucite[2]. Such an alkaline alteration is predicted in the bentonite barrier of radioactive waste repository by cement-leachates in groundwater[3]. Chemical similarity between analcime ($NaAlSi_2O_6{\cdot}H_2O$) and montmorillonite ($Na_{0.4}Al_{1.6}Mg_{0.4}Si_4O_{10}(OH)_2{\cdot}nH_2O$) may enhance reaction:

$$\text{Na-mont} + 1.2NaOH = 1.6\text{Analcime} + 0.8SiO_2 + nH_2O.$$

We investigated growth kinetics of analcime to evaluate the behavior of bentonite barrier under hyperalkaline condition.

Direct measurements of analcime growth rate on substrate, analcime at 90-120 °C were conducted using in-situ phase-shift interferometer (PSI)[4]. Supersaturation with respect to analcime was controlled by dissolution of coexisting montmorillonite in the cell with flow of 0.3 M NaOH solution.

The dissolution and growth rates of analcime near equilibrium were observed to be -3.6×10^{-3} and 2.7×10^{-3} nm/s, at ΔG of -11.29 and 8.80 kJ/mol respectively (Fig. 1). Our results agree with previous data[1], which roughly draws a growth rate curve. We conclude that the key of analcime growth is porewater chemistry in montmorillonite. The dissolution of montmorillonite can be affected by porosity (density)[5]. Our results can extend the observed alteration towards a mechanistic model involving porosity change.

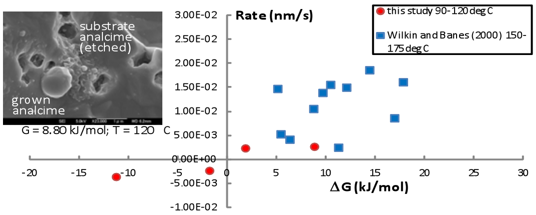

Figure 1: Growth rate curve of analcime and a surface after run showing etch pits and grown grains (FESEM).

[1] Wilkin & Barnes (2000) *Am. Min.* **85**, 1329-1341. [2] Putnis *et al*. (2007) *Am. Min.* **92**, 19-26. [3] Nakayama *et al.* (2004) *Appl. Clay. Sci.* **27**, 53-65. [4] Satoh *et al.* (2007) *Am. Min.* **92**, 503-509. [5] Satoh *et al*. (2013) *Clay Min.* (in press).

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Heterogeneity of the uppermost mantle in back-arc settings: Insights from trace-element compositions and water contents in Japanese peridotite xenoliths

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The uppermost mantle in the back-arc region of a subduction zone is the site of complex interactions between partial melting and fluid migration. To constrain these interactions and reveal the heterogeneity of the uppermost mantle in back-arc setting, we measured geochemical compositions and water contents of spinel peridotite xenoliths obtained from two back-arc volcanoes; Ichinomegata (NE Japan) and Oki-Dogo (SW Japan). The mineral chemistry of Ichinomegata peridotites shows a typical residual peridotite trend, depleted in light rare earth elements (LREE). Some samples of Oki-Dogo peridotites have lower Mg# in olivine (down to 0.88) and are enriched in LREE, indicating that these are affected by melt-rock interactions. Olivine has low water contents in samples from both Ichinomegata and Oki-Dogo. However, the water contents in pyroxenes in Ichinomegata peridotites are significantly higher than in Oki-Dogo. These differences might be due to the different mobility of water during fluid metasomatism versus melt-rock interaction. The water contents of the pyroxenes suggest interactions with water-rich fluids. Hydration incorporation in Ichinomegata peridotite is proposed to be associated with a water-rich metasomatism, which lead to depleted REE patterns in clinopyroxene, and the REE patterns of orthopyroxene are more depleted than for Oki-Dogo samples. However, the chemical composition of Oki-Dogo peridotites shows that they have experienced melt-rock interactions that have lead to the characteristic flat REE pattern of the clinopyroxene. Furthermore, these variations in chemical characteristics between Ichinomegata and Oki-Dogo might be induced by the changes in the subduction system in the Japan Island arc, such as the age and angle of the subducting slab.

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