

Effects of pH, temperature and sodium ion concentration on cation exchange and alteration of biotite

Hirokazu Sugimori[1]; Takashi Murakami[2]

[1] EPS, Univ. Tokyo; [2] Dept. of Earth Planet. Sci., Univ. of Tokyo

Dissolution of silicates is often affected by ions in solution. Silicates react with rainwater, interstitial water and groundwater containing many kinds of cations and anions in nature. On the other hand, we usually use buffer solutions for dissolution experiments to maintain the solution pH constant in the laboratory. Therefore, it is very important to understand the effects of ions in solution on dissolution rates and mechanisms of silicates. Because preferential release of interlayer K and vermiculite formation initiated in the interlayers are characteristics of biotite dissolution, the effects of alkali or alkaline earth ions in solution on kinetics and mechanisms are especially important for a better understanding of biotite dissolution. This study was performed to investigate the effects of sodium ions in solution on cation exchange and alteration of biotite at different pH values and temperatures.

15 mg samples of biotite were reacted with 12 ml NaCl solutions in teflon vessels for 3 days. 0.1 M, 0.5 M, 0.8 M and 1.0 M NaCl aqueous solutions adjusted to pH 3 by hydrochloric acid were used to examine the effect of sodium ion concentration in solution. pH dependence was investigated by treatments with 1.0 M sodium chloride solutions at pH values 1-4.5 and cation-free solutions at pH 1, 2 and 3 at 40 degrees C. 1.0 M NaCl experiments at pH 1, 2 and 3 were also performed at 60 degrees C and 80 degrees C to examine the temperature effect. Materials after the experiments were analyzed by XRD using preferred orientation method to estimate the amount of potassium exchange for sodium dissolved species. Concentrations of silicon and potassium dissolved species in the reacted solutions were measured by ICP-AES for each experiment at pH 1, 2 and 3. The measured concentrations were used to calculate the release rates of elements.

Potassium ions in the interlayer of biotite were exchanged for hydrated sodium ions by the treatment with NaCl solutions, indicated by the appearance of 1.2 nm peaks in the XRD patterns. The amounts of sodium-exchanged interlayers, which were represented by the intensities of the 1.2 nm peaks, were larger at higher sodium ion concentrations in solution and at higher temperatures in the experiments at pH 3. Large pH dependence was observed for the amounts of sodium-exchanged interlayers. The amount of sodium-exchanged interlayers increased from pH 4.5 to pH 3. In contrast, the amount of sodium-exchanged interlayers in biotite decreased at pH less than 3, which is probably caused by proton adsorption to the biotite surface and by exfoliation of biotite flakes.