

Biotite dissolution process and mechanism: Early stage weathering environment

Takashi Murakami[1], Tadashi Yokoyama[2], Satoshi Utsunomiya[3], Takeshi Kasama[4]

[1] Dept. of Earth Planet. Sci., Univ. of Tokyo, [2] Dept of Earth and Planetary Science, Univ. Tokyo, [3] Mineralogical Inst., Univ. of Tokyo, [4] Dept. of Earth and Planetary science, Univ. of Tokyo

Biotite dissolution in the laboratory and field was examined and compared to elucidate the weathering processes and mechanisms. Batch dissolution experiments of fresh biotite in granite were carried out at 150 C for 1 to 56 days. Scanning electron microscopy (SEM) equipped with energy dispersive X-ray spectrometer (EDS) revealed that dissolution proceeds from the edges inward and secondary minerals such as Fe oxide are precipitated mostly at the edges but few at the basal surfaces in the early stage. One-dimensional transport model of Fe based on the dissolution data indicated that the Fe concentration at the edge is higher by two orders of magnitude than that at the basal surface, which results in a much higher nucleation rate at the edge after supersaturation with respect to Fe (hydr)oxide is achieved. A dissolution experiment for a mixture of biotite and muscovite was done at 150 C for 7 days, which indicated that hematite crystals are formed mostly at the edges of biotite but not on muscovite. This suggests that released Fe is precipitated before it diffuses to solution. The higher nucleation rate and precipitation before diffuse of dissolved elements to bulk solution well explain the preferential secondary-mineralization at the edges in the laboratory. SEM-EDS of fresh to slightly weathered biotites revealed that early stage weathering proceeds in the same way as that of the laboratory dissolution: the edges are preferentially weathered and secondary minerals are precipitated mostly at the edges. Because of the similarity of the occurrence of secondary minerals between the laboratory and field, the laboratory results elucidate the early stage-weathering environment. Namely, (1) supersaturation with respect to secondary minerals in a solution around biotite occurs, i.e., the solution is poorly connected to a main flow pathway of water, and (2) once supersaturation is achieved, secondary minerals are precipitated mainly at the edge before diffuse of released elements into the solution. The immobility of water around primary minerals partly explains the large difference in dissolution rate between the laboratory and field.