

Modeling Eu(III) sorption on granite

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There have been very few researches for the trace elements sorption on complex mineral assemblages such as rocks, sediments and soils. In order to make predictions for the trace elements migration on geologic media, it is crucial to understand the nano-scale interaction of trace elements with complex mineral assemblages, and to construct the thermodynamic sorption models based on the molecular-scale information. In the present study, the batch sorption experiments of Eu(III) on granite were conducted as function of pH and ionic strength. The sorption behavior was modeled based on our microscopic observation (Hasegawa et al. this volume).

The granite sample was collected from a borehole at a depth of 400 m from the Mizunami Underground Research Laboratory constructed by Japan Atomic Energy Agency in central Japan. The granite was visually fresh. However, the microscope observation and the X-ray diffraction analysis of clay fraction show the occurrences of smectite, chlorite, vermiculate, calcite and hydrous iron oxides. Eu(III) sorption experiments on granite in the Teflon vessels were conducted as function of pH (2 to 8), ionic strength ($I=0.01$ and 0.1) and Eu concentration (1 and 10 μM) under ultra-pure N_2 atmosphere in room temperature.

The experiments and modeling results are shown in the Figure. Sorption ratio of Eu(III) was almost zero at pH 2. They abruptly increase with pH up to 3.5. Above pH 3.5, the sorption ratio indicates almost constant. The sorption strongly depends on ionic strength at the pH more than 3.5. Our microscopic observations show that Eu(III) is selectively scavenged by biotite and that sorption mode of Eu(III) is identified to be exchange reaction with inter-layer K in biotite and Eu(III). The sorption behaviors at pH more than 3.5 are consistent with the cation exchange reaction. At low pH conditions, less than pH 3.5, the release of the Al and/or Fe must occur with dissolution of minerals. The Al and/or Fe should be competed with Eu(III) on the exchange site of biotite. The sorption modeling is simply considering ion exchange reaction and solubility of hydrous iron oxide. The model reasonably reproduces the overall sorption behavior.

