

NMR investigation of boron adsorbed on illite

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Boron Species on Minerals

Boron is one of the important elements in geological environments and also essential plant nutrients in soils. The concentration range in which plants exhibit neither boron deficiency nor boron toxicity symptoms is narrow. Illite is the most abundant clay minerals in geological environments and boron adsorption on illite is an important reaction controlling migration and distribution of boron in soils and water. NMR has been used to investigate the mineral surface reactions successfully for many nuclei, but boron on mineral surface has not been tried yet. ¹¹B is a quadrupole nucleus ($I = 2/3$, 81.17% natural abundance) and a good candidate for NMR (Nuclear Magnetic Resonance) study.

Discussion of Results

Illite was used for the main set of experiments, and boehmite and silica gel were also used for our data interpretation. Those mineral phases were reacted at room temperature in boric acid solutions at pH 3 to pH 11 with 1 M and lower concentrations. Our results suggest that there are two local environments of boron on mineral surfaces, trigonal boron ($B(OH)_3$, 18-20 ppm) and tetrahedral one ($B(OH)_4^-$, 0-2 ppm). The relative intensities of those two peaks for boron on boehmite do not change much at different pH's, but those on silica gel change gradually, almost one trigonal boron peak at pH 3 to tetrahedral boron at pH 11, well correlated with the relative abundances of those two species in solution. Those results indicate that most of the boron on boehmite is adsorbed as inner-sphere complexes, whereas that on silica gel adsorbed as outer-sphere complexes, partly due to the PZC of two mineral phases. The ¹¹B NMR spectra for boron on illite usually contain four different peaks; two pH-dependent trigonal and tetrahedral peaks and two pH-independent trigonal and tetrahedral ones, respectively. The behaviors of pH-dependent peaks are similar to those from silica gel, but the general trends of pH-independent peaks are well correlated with those from boehmite. These observations indicate that, on illite, boron is adsorbed on aluminol sites as well as silanol ones by inner-sphere and outer-sphere complexes.

References

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Behavior of Eu in fractured aquifers with different lithology: An application to behavior of the actinide elements in geological conditions

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Introduction

In order to investigate the behavior of Eu in various geological environments, the abundance of rare earth elements were determined in three gneisses and tuff cores originated from different geological environments.

Results and Discussion

In experiments, we observed that Eu was the most variable element of REEs in the hydrogeological environment condition such as changes of oxidation-reduction and lithology. Especially, a positive Eu anomaly was recognized at specific depth and lithology (Fig. 1). The leaching experiment showed that the positive Eu anomalies of core samples obtained from granite and granodiorite protolith were occurred due to calcite fraction. In the samples of TTG origin, however, no change of Eu anomaly was shown despite the presence of calcite, suggesting that the lithology is an important factor in controlling the sorption process of REE in geological environments.

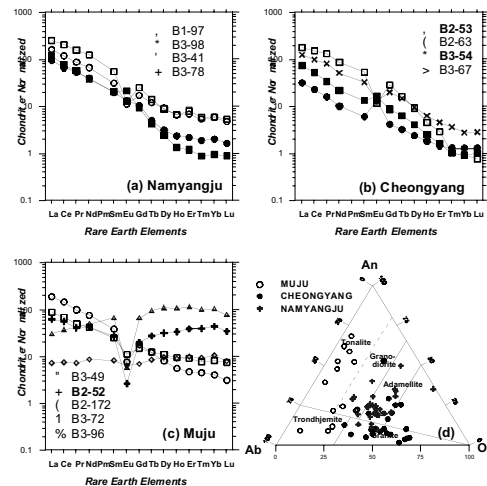


Fig. 1. Chondrite-normalized REE patterns of gneiss core originated from different source material

Conclusions

REE abundances of fracture-filling calcites with lithology may provide an important key for understanding the behaviour of actinide elements in geological environments. Results showed that the fracture-filling calcite and REE is a good tool in understanding the changes of geochemical environments in paleo-groundwater as well as an analogue for actinide elements.