Rare earth and minor elements behavior in red soil from principle component analysis

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The geological disposal of high level nuclear waste from atomic power plant has been a problem at present. The plan of disposal of the waste at 300~1000m depth below sea level is underway. However, there is a possibility that the disposal site becomes shallower by upheaval or erosion during a long term period.

The natural analogue study on red soil that is distributed widely throughout southwest Japan might be important for elucidation of radioactive elements behavior in shallow geologic environment. The main objectives on this study are: (1) to clarify the REE and minor elements behavior in the weathering process of red soil: and (2) to determine which soil is suitable for radioactive waste disposal.

The sampling has been performed at Ishigaki Island and the main island of Okinawa. All the samples are normalized with PAAS(Post Archean Australian Shale) to study a weathering process on mineral dissolution and on nature of mineral elements behavior.

From the results of this research, it was revealed that the minerals which compose acidic soil and alkaline soil are almost same. Weathering behavior of many elements consisting of red soil are controlled by chemical conditions (pH, solubility etc). However, some elements like Zr do not receive those influence because it does not dissolve by the weathering. There seems to be other factor of chemical conditions on controlling the weathering of REE. To clarify the weathering behavior for REE, PCA (Principle Component Analysis) is used. We have found that REE in alkali soil are contained in apatite although it is not detected by XRD. Apatite is not found in acidic soil and REE in the soil are contained in feldspar and adsorbed onto clay minerals. The high REE concentration in alkaline soil is due to the presence of apatite which contains appreciable amounts of REE.

In situ stabilization of ^{90}Sr by microbially facilitated calcite precipitation

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Radionuclide and metal contaminants such as ^{90}Sr are present beneath U.S. Department of Energy (DOE) lands in both the groundwater (e.g., 100-N area at Hanford, WA) and vadose zone (e.g., Idaho Nuclear Technology and Engineering Center at the Idaho National Laboratory [INL]). *In situ* containment and stabilization of these contaminants is a cost-effective treatment strategy. We are investigating the *in situ* immobilization of radionuclides and contaminant metals (e.g., ^{90}Sr) by their microbially facilitated co-precipitation with calcium carbonate in groundwater and vadose zone systems. The facilitated approach relies upon the microbial hydrolysis of introduced urea to cause the acceleration of calcium carbonate precipitation (and trace metal co-precipitation) by increasing pH and alkalinity and liberating cations from the aquifer matrix by exchange reactions.

$$H_2NCONH_2 + 3H_2O = 2NH_4^+ + HCO_3^- + OH^-$$
$$>X:_2Ca + 2NH_4^+ = 2>X:NH_4 + Ca^{2+}$$
$$Ca^{2+} + HCO_3^- + OH^- = CaCO_{3(s)} + H_2O$$

where >X: is a cation exchange site on the aquifer matrix.

We have developed and experimentally parameterized a coupled kinetic/equilibrium biogeochemical model of the stabilization processes that explicitly includes ion exchange and solid solution reactions. This model has been used to simulate remediation scenarios and shows that although the initial groundwater is supersaturated with respect to calcite and that urea hydrolysis increase the degree of supersaturation, the system may exhibit a transient period during which calcite and co-precipitated $SrCO_3$ may redissolve at the conclusion of urea treatment. The result is a strongly influenced by both the advective flux of groundwater and the hydrolysis rate of urea and illustrates the importance of using fully coupled reactive transport models and considering both treatment and post treatment time periods in the design and evaluation of *in situ* remediation treatments for hazardous and radioactive waste.