Transfer Rate of Radionuclides between Chemical Species in Brackish Water

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Abstract

Radionuclides deposited on the surface of water expanses such as lakes and oceans are considered to be initially in ionic forms. They are then removed from the water system as particulates after various chemical and biological reactions. This study aims at clarifying the transformation rate of ionic radionuclides to various chemical forms and the effects of environmental parameters, such as salinity and microorganism activities, etc., on this rate, by adding stable elements, Th, and U to water samples. We have already reported results for a fresh water sample. Results for a brackish water sample are reported here.

A brackish water sample was collected from Lake Obuchi in Rokkasho where a spent nuclear fuel reprocessing plant is located. We added a mixture of lanthanoids, Th and U or just inorganic iodine as ionic forms to aliquots of the sample. After standing for a predetermined period from 10 min up to 2 weeks, the particulate fraction in each aliquot was collected on a filter (pore size, 0.22 μm). The molecular size of organic materials binding the elements in the filtrate was analyzed with an ultra-filter with a cut-off size of 10 kDa. The target element concentrations in the particulate and filtrate fractions were analyzed by ICP-MS.

Iodine was added to the sample as I^- or IO_3^- to examine the effect of chemical form on I behavior. Several percent of the I^- changed to a particulate form (> 0.22 μm) 10 min after its addition, and remained as that form during the experiment. Initially, 3% of the added I^- was in the >10 kDa fraction, and then the percentage varied from 7 to 16% after 15 min without dependency on elapsed time. Almost all added IO_3^- was retained in the <10 kDa fraction throughout the experimental period. Most of the added lanthanoids were in the <10 kDa fraction. The percentage of the lanthanoid particulate fraction varied from 0 to 15% at 10 min, and decreased with elapsed time. The fraction of >10kDa retained 5-10% of the original amount of lanthanoids throughout the experimental period. The relative distributions of Th in particulate and >10 kDa fractions were larger than those of the lanthanoids, and they did not change over time. Initial percentages of particulate and >10 kDa fractions were 10% and 20%, respectively. However, the relative amount of natural lanthanoids and Th in particulate form was much larger than that in our experiment; the cause of this is unknown.

The behavior of the target elements in the brackish water sample was similar to that in the fresh water sample. However, the percentages of particulate and >10 kDa fractions of lanthanoids and I in the brackish water sample were smaller than those in fresh water for the same fractions. From this we inferred that dissolved salts suppressed transformation between the fractions.

Since microorganism activity is considered as one of the parameters affecting transformation of chemical form, we have begun to investigate the effect of phytoplankton on the transformation. Species composition of phytoplanktons in the fresh water lakes, Lake Ichiyanagi and Takahoko, was surveyed. Dominant species were separated and their cultivation methods were established.

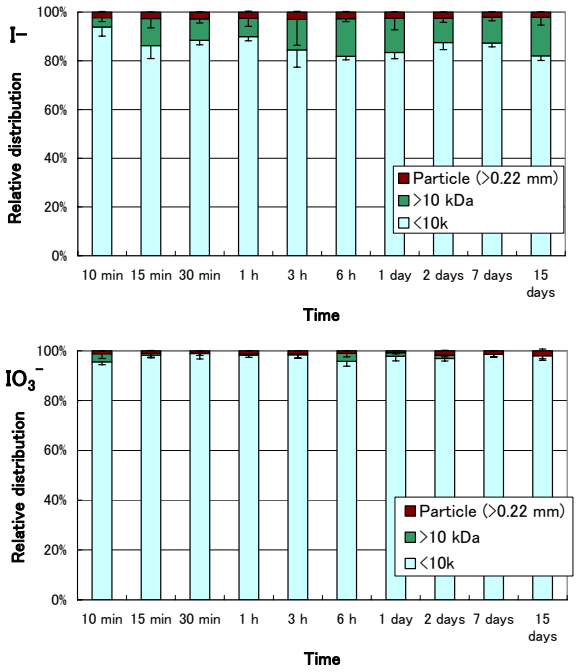

Fig. 1 Relative speciation of iodine added as I^- and IO_3^- to the brackish water sample collected from Lake Obuchi.

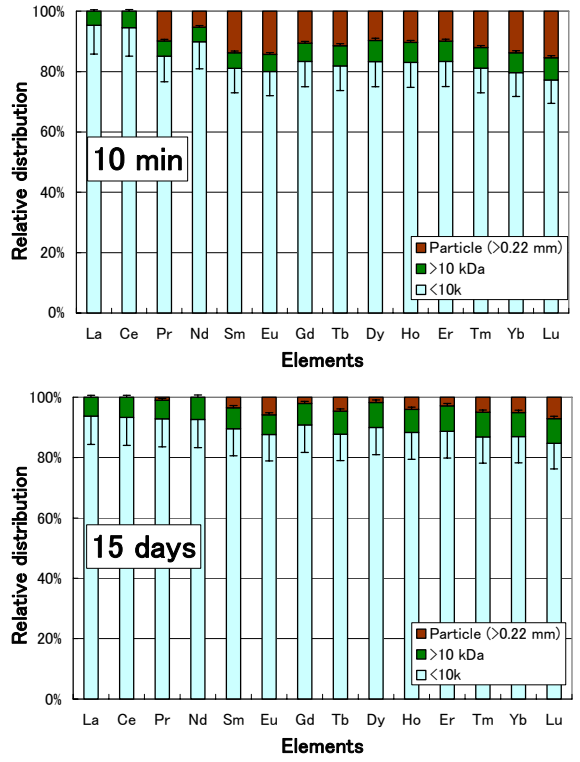

Fig. 2 Relative speciation of lanthanoids added to the brackish water sample collected from Lake Obuchi.

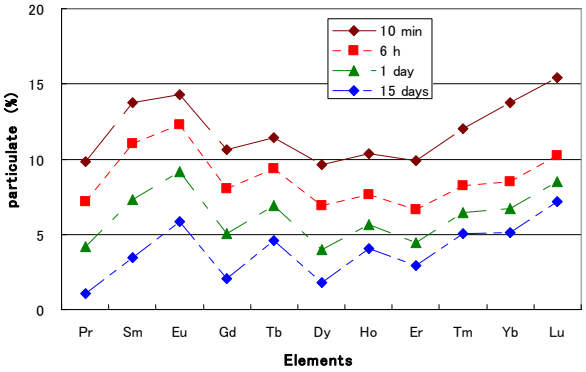

Fig. 3 Ratio of particulate lanthanoids from Pr to Lu to total concentration after addition to the brackish water sample collected from Lake Obuchi.