2–5 Investigation of the Sorption of Radioactive Iodine onto Rocks
— Experimental Determination of the Sorption Distribution Coefficient —

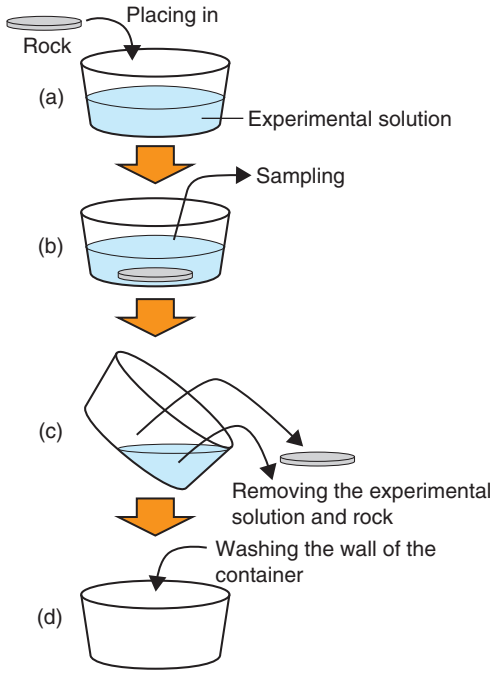

Fig.2-13 Flow of the sorption experiment
(a) The sorption experiment was commenced by immersing a rock specimen into solution in the container. (b) Sampling and concentration measurement were performed until the concentration stopped changing. (c) The experimental solution and the rock were removed from the container. (d) The amount of iodine adsorbed onto the wall was evaluated by analyzing the washing solution.

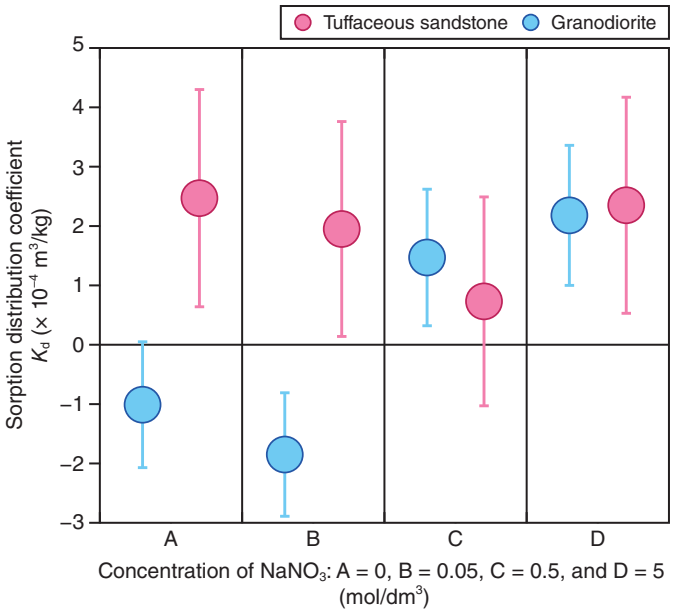

Fig.2-14 Sorption distribution coefficients of iodine on granodiorite and tuffaceous sandstone vs. concentration of $NaNO_3$
Error ranges included zero in the cases of a $NaNO_3$ concentration of 0 mol/dm^3 for granodiorite and a $NaNO_3$ concentration of 0.5 mol/dm^3 for tuffaceous sandstone, indicating that the sorption distribution coefficients (K_d) may have been zero in these cases. K_d values in other cases were found to be small but non-zero. This study showed how to judge the significance of K_d values that were close to zero.

Radioactive wastes generated from reprocessing spent fuel contain long-lived radionuclides such as iodine-129 (half-life: 1.6×10^7 year). If such wastes are disposed of into geological formations, nuclides may be eluted by groundwater and may migrate into the bedrock over a long period of time. The migration of nuclides will be delayed by the sorption of nuclides onto the bedrock. The sorption distribution coefficient, K_d, is used to evaluate this sorption.

K_d is the ratio of the element concentration in rocks to that in solution, and it never has negative values. It is difficult to directly and precisely measure the element concentration in the rock when K_d is obtained in experiments. The amount of the element sorbed onto the rock is thus determined as the difference between the element concentrations in the solution before and after contact with the rock, as shown in Fig.2-13. Either values with large errors or negative values should be obtained for the amount of the element in the rock because the measured elemental concentrations include errors due to the analysis and the handling. Such a problem is realized for low-sorptive elements (e.g., iodine) because the K_d is very small or close to zero. For such low-sorptive elements, it is essential to know whether even slight retardation of the migration in the bedrock due to sorption can be expected. It is thus necessary to clarify whether the obtained K_d values are significant by appropriately evaluating the errors.

In this study, sorption experiments of radioactive iodine onto tuffaceous sandstone and granodiorite were conducted for various sodium nitrate ($NaNO_3$) concentration conditions by considering the effect of $NaNO_3$ eluted from waste. The K_d was evaluated by subtracting the amount of iodine adsorbed onto the wall from the difference between the element concentrations in the solution before and after contact with the rock. Because the sorption of iodine onto rock was very small, various error propagations arising in the processes for the experimental solution were considered for the K_d evaluation. The experimental results showed significant values, which were non-zero under certain solution conditions, although the K_d of iodine was very small, as shown in Fig.2-14. The results showed the appropriate experimental and evaluation methods for the case where very small K_d values were expected for important nuclides involved in a safety assessment of waste disposal.

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Reference

Hemmi, K. et al., Distribution Coefficients of Iodine and Tin on Granodiorite and Tuffaceous Sandstone Specimens, Genshiryoku Bakkuendo Kenkyu (Journal of Nuclear Fuel Cycle and Environment), vol.22, no.1, 2015, p.3-10 (in Japanese).