Parameters of Iodine Migration in Soil

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Abstract

Iodine-129 (half-life, 1.6×10^7 y) is one of the important radionuclides discharged from the first commercial nuclear fuel reprocessing plant in Rokkasho, Japan for the assessment of radiation dose to the public. A part of the ^{129}I discharged to the atmosphere from the plant is deposited on the land surface and retained in surface soil. Downward migration of ^{129}I in soil is important for the prediction of its concentration in both ground water and surface soil during and after long-term operation of the reprocessing plant. The aims of this study are to evaluate the rate of downward migration of ^{129}I in soil around the reprocessing plant and to clarify physico-chemical and biological factors affecting the migration rate. In FY 2015, we studied: 1) the downward migration rate of radioiodine in core soil samples (3–20 m), and 2) factors controlling the downward migration rate of radioiodine in surface soil.

A core sample of 3–20 m was collected from a pasture field in Rokkasho to study the downward migration rate of I. The distribution coefficient (Kd) values of ^{125}I, as well as ^{85}Sr and ^{137}Cs, in the soil samples fractionated from different depths of the soil core sample were measured by the batch sorption method. Downward migration rate of the nuclides was estimated up to the depth of 11.7 m at which a water table was found. The downward migration rate was estimated by using a retardation factor, which was obtained by the measured Kd value, under the assumption that half of the precipitation in Rokkasho permeates in the soil. The downward migration rate of the ^{125}I from the 3 m depth and deeper was higher than that in the upper 3 m and almost constant up to the water table, while the rates of ^{137}Cs and ^{85}Sr gradually decreased with depth in the soil profile.

To study the controlling factor of the migration rate of radioiodine, surface soil samples were collected at four points around the nuclear fuel reprocessing plant from different depths up to 50 cm. Soil samples before and after the pot cultivation of pasture grasses were also collected. The Kd of ^{125}I and soil chemical properties were determined for those samples and the relationships between the Kd and soil properties were examined. The Kd value of ^{125}I in the soil samples was positively correlated with Kd value of organic carbon, which was calculated from the concentrations of soil total carbon and dissolved organic carbon. The results suggest that radioiodine is transformed from inorganic to organic form in surface soil rapidly after deposition, and migration in soil is controlled by the partitioning of dissolved organic substances.

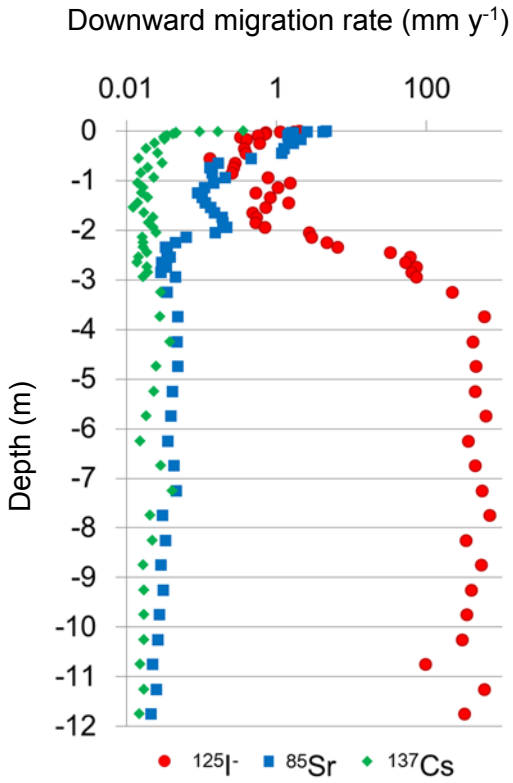

Fig. 1 Downward migration rate $^{125}I^-$, ^{85}Sr and ^{137}Cs in soil samples from different depths in a pasture field. Results were obtained in FY2012, FY2014 and FY2015.

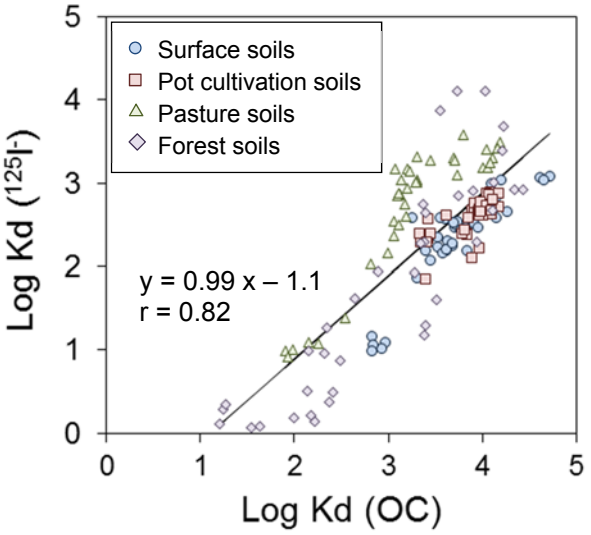

Fig. 2 Kd of $^{125}I^-$ and organic carbon in soils.
Kd ($^{125}I^-$), Kd of $^{125}I^-$ evaluated from batch sorption experiment of $^{125}I^-$. Kd (OC), Kd of organic carbon evaluated from concentration of soil total carbon and dissolved organic carbon. Surface soils represents soil samples from different depths (0-50 cm) collected from four different sites around the nuclear fuel reprocessing plant.
Pot cultivation soils represents soil samples before and after the pot cultivation experiments. Pasture soils represents soil samples from different depths (0-3 m) in a pasture field. Forest soils represents soil samples from different depths (0-3 m) in a forest area.