土壌中のRCs移動におけるRCs濃度と溶存有機物の影響
Effects of RCs concentration and dissolved organic matter on RCs migration in soil under flowing condition

*辰野 宇大 [1]、濱本 昌一郎[1]、二瓶 直登[1]、西村 拓[1]
*Takahiro Tatsuno[1], Shoichiro Hamamoto[1], Naoto Nihei[1], Taku Nishimura[1]

1. 東京大学　大学院農学生命科学研究科　生物・環境工学専攻
1. Deptartment of Biological and Environmental Engineering, Graduate School of Agricultural and Life Sciences, University of Tokyo

INTRODUCTION
To understand migration of radiocesium (RCs) in soils is an important issue after the accident of Fukushima Dai-ichi nuclear power plant, Japan. In general, RCs strongly adsorb to soils, especially clay minerals in the soil. Frayed Edge Site (FES), siloxane ditrigonal cavity (SDC), and clay plane are known as RCs adsorption sites of clay minerals. The clay planes have much more adsorption sites than FES and SDC, while RCs adsorbed on the clay plane is relatively easy exchanged with other cations. On the other hand, RCs fixed on high affinity site such as SDC and FES cannot be readily exchanged with other cations. RCs concentration of the applied solution may affect effective sites for RCs adsorption. The lower RCs concentration in the soil solution, the greater the contribution of high affinity sites such as SDC and FES is expected.
Dissolved organic matters (DOMs) alter sorption and transport of RCs in soils. There are three possible processes in regard to DOM-induced RCs transport. First, DOMs in soil solution can complex with RCs and the RCs-DOM complexes enhance RCs transport to deeper layer or prevent it due to their adsorption to the soil. Second, DOMs in the soil solution may remove RCs adsorbed on the soils and promote RCs migration. Third, DOMs adsorbed on the soil can prevent RCs to access to high affinity sites (i e., FES and SDC).
There are many previous studies on the effects of RCs concentration and soil organic matters on RCs adsorption based on batch experiments with high DOM concentration. However, these studies are not enough for fully understanding RCs migration in a real soil system where water flow should occur and DOM concentration is low. In this study, we investigated the effect of DOM on the migration of RCs using two different concentrations of RCs solution by laboratory column experiments.

MATERIALS and METHODS
Soil sample was a weathered granite called as Masa-soil in local dialect. It was collected at an abandoned forest in Iitate, Fukushima, Japan. DOM solution was extracted from a litter which was collected from forest floor of university forest of the University of Tokyo in Chichibu city, Saitama prefecture, Japan in 2008. Dissolved organic carbon (DOC) in the DOM solution was adjusted to 20mg-C/L.
The Cs solutions with two different concentrations, 1.5×10^{-4} mol/L prepared by using stable CsCl (^{133}Cs) as the high one and 4.5×10^{-17} mol/L made by diluting the ^{137} Cs solution as low concentration solution. The Cs-DOM mixture was also used as a percolation solution.
An acrylic plastic column was used for the transport experiments. The soil column was prepared by packing air dried soil sample. Then, different solutions were applied with a constant ponding depth. Four different sequences of flowing solution were as follows ; (i) NaCl solution (pH6, ionic strength of 1mM) followed by Cs solution, (ii) NaCl solution followed by Cs-DOM mixed solution, (iii) DOM solution followed by Cs solution, and (iv) NaCl solution followed by Cs solution in soil which was adsorbed DOM in advance.

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Cs concentration of the effluent was measured. Some effluent solution was divided into water-soluble Cs and Cs-DOM complexes by ultrafiltration.

RESULTS and DISCUSSION

During the experiment using the high concentration Cs solution, there was no significant difference in the effluent Cs concentration among all conditions ((i) - (iv)). On the other hand, when using the low Cs concentration solution, effluent Cs concentrations of the column (ii) and (iv) were higher than that of (i). The ultrafiltration for some selected effluent samples of the column experiment with Cs-DOM mixture as supplied solution, and effluents of (ii) and (iv) showed all the Cs in the effluents were water-soluble form. These findings suggest DOM did not work as a carrier for Cs, but rather promoted Cs migration by inhibiting Cs adsorption to high selective sites.

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