Radioactive cesium binding to dissolved organic matter extracted from litter collected at forest in Fukushima prefecture

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Introduction

To understand migration of radioactive cesium (RCs) in soils is an important issue after the accident of Fukushima Dai-ichi nuclear power plant, Japan. Dissolved organic matters (DOM) possibility bind with RCs and alters the migration of RCs in soils. DOM is negatively charged at pH 3-11 owing to the dissociation of hydrogen ion from the functional group, enable to adsorb metal cations. Most of the DOM is composed of humic substances. Humic substances are classified into humic acid (HA), which is acid-insoluble and alkaline-soluble, and Fulvic acid (FA), which is soluble in both acid and alkaline solution. Previous studies showed soil organic samples adsorbed with Cs by using stable Cs solution with high concentration. However, it is not clear whether RCs binds to DOM in the condition with low RCs concentration typically observed in Fukushima. In this study, we evaluated effects of co-existing cations and difference in types of organic matter on RCs binding to organic matters based on adsorption batch experiment.

Materials and Methods

DOM and humic substance (e.g. HA and FA) were extracted from a litter which was collected at an abandoned forest in Iitate, Fukushima, Japan. DOM solution was filtrate solution made by filtering the litter and pure water mixture through 0.45 μm membrane filter. HA and FA were extracted according to the method of the International Humic Substance Society (IHSS). The RCs solution was made by diluting ^{137}Cs stock solution.

The mixture of each organic matter and RCs solution was shaken for 72 hours. DOC concentration in the mixture was adjusted to 20 mg-C L^{-1}, while Cs concentration in the mixture was adjusted to 2.27 $\times 10^{-11}$ mol L^{-1}. Furthermore, in order to evaluate the effect of Na ion on Cs binding to DOM, the concentration of Na ion in the mixture was adjusted to 0, 1×10^{-13}, 1×10^{-11}, 1×10^{-10}, 1×10^{-7}, 1×10^{-4}, 1×10^{-1} by adding NaBr solution to the mixture. After mixing, water-soluble RCs and RCs bound to DOM (hereinafter called RCs-organic form) were separated by ultrafiltration. RCs concentration in the sample was measured by NaI scintillation counter (2480 WIZARD2, Perkin Elmer).

Results and Discussions

As a preliminary experiment, adsorption experiment of RCs and DOM was conducted using DOM solution extracted from litter collected from the forest floor at university forest of the University of Tokyo in Chichibu city, Saitama prefecture, Japan. In the mixture without adding Na ion, 30% of RCs in the mixture bound to DOM. However, as the concentration of Na ion in the mixture increased, the RCs-organic form in the mixture decreased. When Na concentration was more than 1×10^{-3} mol L^{-1}, there was no RCs-organic form in the mixture. These results indicated that Na ion depressed RCs binding to DOM.

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