

Competitive effect of potassium and proton on cesium desorption from vermiculite

JULIEN DUBUS¹, NATHALIE LEONHARDT¹ AND
CHRISTELLE LATRILLE²

¹Aix-Marseille Univ, CEA, CNRS, BIAM, Equipe Signalisation pour l'Adaptation des Végétaux à leur Environnement

²Université Paris-Saclay, CEA, Service d'Etude du Comportement des Radionucléides

Presenting Author: julien.dubus@cea.fr

Soil contamination by radiocesium following nuclear disaster as in Fukushima, is a major concern for human health. Cesium could be absorbed by plant and enter in the trophic chain. To reduce environmental risks of contaminated soils, the use of phytoremediation technique may avoid the plant transfer. The aim of this study is to evaluate the key physicochemical parameters that could be modified in the rhizosphere during phytoremediation techniques and impact cesium environmental availability.

Vermiculite was chosen as study material because vermiculite shows a strong affinity for cesium and is found in soil surrounding the Fukushima prefecture. Competitive effect of potassium and proton on cesium desorption is investigated to mimic the potassium amendment on soil usually applied to reduce Cs uptake by plant and the induced plants feedback on the soil by exuding protons. Batch experiments were performed on vermiculite equilibrated with background solutions containing calcium, magnesium and potassium. Cesium sorption isotherms were acquired by using mixtures of stable ¹³³Cs and radioactive ¹³⁷Cs as tracer at initial cesium concentrations in solution ranging from 10⁻⁸ to 10⁻² mol/L. Effects of potassium and proton addition on cesium desorption from vermiculite doped at a trace concentration of 6 10⁻⁶ mol/kg were estimated with the excess of released cesium and the cation mass balance. Cations concentrations were measured in solutions by ionic chromatography, ¹³⁷Cs activity was measured by gamma counter and structural change in vermiculite was determined by X ray diffractometry.

Sorption isotherms revealed a reversible high cesium adsorption at cesium concentration in solution until 10⁻⁵ mol/L. Cesium desorption was increased with potassium adding from 0 to 5 mmol/L or with proton adding from pH 7 to 3.5. The occurring reaction is a cation exchange according to the mass balance. Unexpectedly, high potassium excess in solution (above 10 mmol/L) leads to deplete the cesium desorption. This observation underlays the implication of another reactive mechanism. Vermiculite collapse occurring in potassium excess in solution may explain the inhibited cesium desorption. This study provides a better understanding of complex interactions occurring in the rhizosphere and could be used for improving phytomanagement techniques.