Adsorption behaviour of Cs^+ and Sr^{2+} onto natural clays towards a predictive modelling

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This study is part of the DEMETERRES project which aims to develop new methods and technologies in the field of decontamination and remediation of contaminated agricultural soils and effluents, after a nuclear accident.

The main aim of this work is to build a consistent thermodynamic databasis necessary to describe and predict the adsorption behaviour of Cs^+ and Sr^{2+} onto natural clays and directly operational to predict contaminant migration in the case of a nuclear accident in France. In this database clay minerals are described as multisite ion-exchangers [1] where the different sites of sorption are characterized by their concentration (SC_i) and their relative chemical affinity for major cations (Na, Ca, K and Mg), and Cs or Sr, expressed as the selectivity coefficients relative to protons ($K^{*i}_{H+/M+}$).

First, the three most representative clay minerals from the French agricultural soils – smectite, illite, and kaolinite – have been identified. Second, a wide review of available literature has been performed to obtain raugh sorption data from which retention parameters were fitted according to the ion-exchange formalism. These data are directly used to build the adsorption databasis. From this literature analysis, it comes out that the behaviour of strontium on smectite has been scarcely studied. In addition, adsorption experiments of strontium on a Na-smectite were realized: first at varying pH values, then at varying initial concentration of strontium. The competition between calcium and strontium was also studied.

Therefore using the databasis, it is possible to predict the adsorption of strontium or cesium on natural clay minerals for various chemical conditions, at different ionic strengths taking into account the competitive adsorption of other cations. Now this databasis needs to be tested with more complicated environnements such as real soil samples.

[1] Estela Reinoso-Maset and J. Ly (2014) Study of major ions sorption equilibria to characterize the ion exchange properties of kaolinite. J. Chem. Eng. 4000-4009.