



HAL
open science

Competitive sorption processes at clay surfaces: Experimental and modeling approaches

Esra Orucoglu, Sylvain Grangeon, Alexandre Gloter, Jean-Charles Robinet,
Benoît Madé, Christophe Tournassat

► To cite this version:

Esra Orucoglu, Sylvain Grangeon, Alexandre Gloter, Jean-Charles Robinet, Benoît Madé, et al.. Competitive sorption processes at clay surfaces: Experimental and modeling approaches. 8th International Conference on Clays in Natural and Engineered Barriers for Radioactive Waste Confinement, Jun 2022, Nancy, France. hal-03667914

HAL Id: hal-03667914

<https://hal-brgm.archives-ouvertes.fr/hal-03667914>

Submitted on 13 May 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Competitive sorption processes at clay surfaces: Experimental and modeling approaches

Esra Orucoglu^{1,2*}, Sylvain Grangeon², Alexandre Gloter³, Jean-Charles Robinet⁴, Benoît Madé⁴, Christophe Tournassat^{1,2,5}

¹ *Institut des Sciences de la Terre d'Orléans, UMR 7327 Université d'Orléans–CNRS/INSU–BRGM, 45071 Orléans, France*

² *BRGM, 3 avenue Claude Guillemin, 45060 Orléans, France*

³ *Laboratoire de Physique des Solides Université Paris Sud, Bât 510 91405 Orsay France*

⁴ *Andra, R&D Division, 1 – 7 rue Jean Monnet, 92298 Châtenay-Malabry, France*

⁵ *Earth and Environmental Sciences Area, Lawrence Berkeley National Laboratory, Berkeley, CA 94720, USA*

*Corresponding author: e.orucoglu@brgm.fr

Abstract

Quantification of adsorption processes on clay mineral surfaces is often necessary to predict the extent and the evolution of contaminants migration in surficial and underground environments. Many studies have been dedicated to retention measurement as a function of pH and ionic strength in relation with the two main identified adsorption processes for clay minerals, i.e. cation exchange on their basal surfaces and surface complexation on their edge surfaces. The latest process has been repeatedly assessed as an effective retention mechanism at circumneutral pH conditions, which often prevail in natural environments. This assessment must however be tempered by the lack of information about competitive processes that can take place with the numerous chemical species present in natural settings, compared to simplified systems investigated in laboratory experiments. In this study, we quantified experimentally the competition between Pb^{2+} , Co^{2+} , Zn^{2+} and Mg^{2+} for specific adsorption on montmorillonite edge surfaces. Zn^{2+} was an effective competitor with Pb^{2+} and Co^{2+} , and our

results showed also unambiguously the influence of Mg^{2+} concentration levels on the specific adsorption of Pb^{2+} and Co^{2+} . Because of the high ionic strength used in the experiments, cation exchange with Mg^{2+} was dismissed as a possible reason for such competition process, leaving specific competitive adsorption on edge surfaces as a unique explanation for our observations. Modeling of Pb^{2+} adsorption data with a state-of-art electrostatic complexation model for montmorillonite edge surfaces, supported by state-of-the-art, made it possible to distinguish two types of possible competition driving forces: Zn^{2+} competition for adsorption site occupancy, but also detrimental changes in surface electrostatic potential following Mg^{2+} adsorption on sites neighboring those of Pb^{2+} adsorption. Mg^{2+} competition observed in our experiment should apply in most of clayey environments. Consequently, adsorption data obtained on pure clay mineral phases, and the associated models that have been built based on these data without considering the geochemical background in competitive species, may overestimate the retention properties of clay minerals when applied to natural settings.

Keywords: Adsorption; Competition; Surface complexation modeling; Clay; Montmorillonite.