Cadmium adsorption to mixtures of geosorbents: Testing the component additivity approach

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The component additivity (CA) approach accounts for solute adsorption onto mixtures of sorbents with the assumption that the solute distribution is controlled only by the adsorption affinity of the solute for each sorbent and by the relative concentrations of sorption sites on each sorbent. Success of the CA approach requires that sorbents do not interact with each other, and that all solutes in the system have access to all surfaces. Previous applications of the CA approach have met with varying degrees of success. For example, Davis *et al*. [1] showed that the approach does not adequately predict the adsorption behavior of Zn(II) onto assemblages of minerals. However, Pagnanelli *et al.* [2] and Fowle *et al*. [3] demonstrated that the CA approach can be successful in predicting metal adsorption to mixtures of pure minerals and bacteria, respectively.

The objective of this study was to determine if the CA approach accurately predicts adsorption behavior for systems containing mixtures of mineral phases, bacteria, and dissolved organic acid anions. Specifically, we test if the CA approach can account for the distribution of Cd(II) in mixtures of kaolinite, *Bacillus subtilis* bacterial cells, iron oxyhydroxide, and dissolved acetate. Potentiometric titrations and Cd(II) adsorption experiments were conducted for each sorbent separately in order to obtain stability constants for proton- and Cd-surface complexes for each sorbent. This suite of stability constants was used to independently predict the distribution of Cd(II) in both binary and ternary mixtures of the sorbents at different component ratios as a function of pH. We compare these predictions to results from Cd adsorption measurements in these same systems to test the validity of the CA approach. Our results indicate conditions for which the CA approach may be appropriate in predicting Cd(II) distribution, and those for which more complex models that include interactions between the sorbents are necessary.

[1] Davis *et al.* (1998) *Environ. Sci. Technol.* **33**, 2820-2828.
[2] Pagnanelli *et al.* (2006) *Chemosphere* **63**, 1063-1073.
[3] Fowle & Fein (1999) *GCA* **63**, 3059-3067.

Palaeohydrogeology in coastal site characterisation: A case study at Horonobe, Japan

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Designs for radioactive waste repositories consist of multiple safety barriers which include the waste form, the canister, the engineered barriers and the geosphere. The three most important safety features provided by the geosphere are mechanical stability, favourable geochemical conditions and low groundwater flux. Consequently, any repository site characterisation has to not only define if these features are currently appropriate, but also assess if they will remain adequate up to several hundred thousand years into the future. To this end, palaeohydrogeology has been used as a powerful tool in site characterisation. Here, the temporal changes of various characteristics of a site are studied to build up a conceptual model for the overall site evolution over geological time, up to the present. These characteristics and processes may include tectonics, geology, groundwater flow characteristics, groundwater chemistry and topography including uplift and erosion processes. Multidisciplinary expertise is employed to describe these key aspects.

Traditionally, the data produced are then synthesised into a conceptual model of the site evolution over the last several hundred thousand to a million years and this is used to define the likely future evolution of the site and to assess if the main safety features will continue to function adequately. Here, the concept and approach of this programme are presented, which is focussed on the palaeohydrogeology of the coastal site at Horonobe in northern Hokkaido, Japan, with the integration of input from the ongoing Horonobe Underground Research Laboratory Project. In the first phase, a conceptual model of the site will be developed, which takes into account the geological evolution of the Horonobe area, with focus very much on the impact of glacial/post-glacial related changes in the Japan Sea on the site. This will be tested against data currently being produced at new deep boreholes in the area and amended as necessary. This new conceptual model will then be expanded to cover other sites on Japan's western seaboard, with the final aim of producing a regional understanding of the palaeohydrogeological evolution of all coastal sites on the Japan Sea since the last glacial termination.