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Effect of Aluminium Competition on Lead and Cadmium Binding to Humic Acids

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The competitive interactions of H^+, inorganic Al species, and major cations (Ca^{2+}, Mg^{2+}, ...) with Natural Organic Matter will affect the pH, Al speciation, and the Natural Organic Matter solubility (as well as its cation exchange capacity). These interactions can influence chemical weathering, Al transport and toxicity, and the buffering of acidity. Hence, it is important to obtain reliable Al binding data for both inorganic and organic ligands and to develop sound models which can be used to predict Al speciation in natural, multicomponent systems (i.e. soils, rivers). The models should not only give information about the speciation of Al but also should predict the net charge of the natural organic particles since this is controlled by the extent of proton and metal ion binding.
In this paper we present new Al competition data on Pb and Cd binding to humic substances. This competitive data is used to derive Al binding parameters within the NICCA-Donnan unifying approach. Effect of pH, salt and Al competition on the binding of Pb and Cd are shown. The presence of Al in the experiments induce a strong reduction of both metal ion binding to the humic molecules. The effect of Al on the binding of both Cd and Pb is similar in strength although Cd and Pb binding to humic molecules is different. The results interpreted in the NICCA framework clearly show that both specific and non specific Cd and Pb binding are affected by the Al in the competitive experiments. To explain non specific binding changes, the proposed mechanism is both a direct competition between Al and Cd and Pb in the Donnan gel phase as well as the effect of Al on the overall charge of the humic molecule. Specific binding of Cd and Pb is affected via direct competition with Al to COOH binding type groups of the humic molecule. The NICCA-Donnan approach clearly show that models should take into account both non specific and specific binding if they are meant to be used with field based data. The will be shone by applying the present approach to describe the Pb binding in a field system where Al is a major competitor.