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Anions adsorption onto nanoparticles: effects on colloid stability and mobility in the environment

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Nanoparticles and colloids can enhance the contaminant transport in groundwater, if the contaminant is irreversibly adsorbed onto their surface; additionally colloids must be stable and mobile under the chemical conditions of the environment of interest.

Colloid stability and mobility are factors directly related to the chemistry of the water, which determines the charge and size of the particles, but these colloidal properties can also be affected by the contaminant adsorption. This last point, which is potentially very relevant on the overall colloid-driven transport, is scarcely investigated.

The evaluation of the stability of a colloidal system is generally carried out by measuring the aggregation kinetic after the change of a specific chemical condition, mainly pH or ionic strength of the aqueous solution. The effect of anion adsorption onto the stability of colloidal systems is mostly neglected. Parameters of the nanoparticles,as the point of zero charge (pH PCZ) or the isoelectric point (pH IEP) are determined with “inert” electrolytes and this might not be representative of their real behavior in natural systems.

In this work, the effects of the Se(IV) (selenite) adsorption on alumina (Al_2O_3) nanoparticles have been analyzed. Selenite adsorption was studied in a wide range of pH (2-12) and ionic strengths (0.0005 - 0.1 M in $NaClO_4$) and the effect of the adsorption on the main properties of the colloids (size and charge) were analyzed.

Se adsorption on Al_2O_3 is almost independent of the ionic strength and decreases with increasing pH; sorption data were successfully fit by surface complexation modeling. Selenite adsorption (at medium-high surface occupancies) clearly affected the stability of Al_2O_3 colloids, with a clear shift of the isoelectric point towards more acid pH and enhancing colloid aggregation when the ionic strength increases.

Considering the obtained results, the effect of anions in the chemical composition of natural water, frequently not accounted for in stability studies, will be discussed, as well as their implications on possible colloid-driven selenite transport in the environment.