

Phosphate and arsenate adsorption on iron mineral surfaces

Juan Antelo¹, Sarah Fiol², Claudio Pérez², Dora Gondar², Rocío López², Florencio Arce²

¹ *Departamento de Edafología y Química Agrícola, Universidad de Santiago de Compostela, Santiago de Compostela, A Coruña, Spain;* ² *Departamento de Química Física, Universidad de Santiago de Compostela, Santiago de Compostela, A Coruña, Spain*
juan.antelo@usc.es

Phosphate and arsenate are of major concern in environmental chemistry. Phosphate is essential for plant growth in natural systems and is a nutrient that usually limits algal growth and eutrophication in surface water bodies. Arsenate, on the other hand, is a contaminant that may be present at high concentrations in groundwater. Even though both species are analogous, there may be very important differences between phosphate and arsenate since their biogeochemical behaviour is completely different. In fact, whereas phosphate is a macronutrient constituent of most biological tissues, arsenate is a toxic substance even at very low concentrations.

It is well known that both phosphate and arsenate have relatively strong affinity for mineral surfaces. They are strongly adsorbed at the surface of metal (hydr)oxides, especially iron and aluminium oxides, which are important constituents of soils and sediments and key solids for the control of the transport and bioavailability of many nutrients and contaminants in the environment (Gao and Mucci, 2003; Li et al., 2010).

In the present study, extensive adsorption experiments for phosphate and arsenate on different iron oxide (goethite, ferrihydrite) were conducted. Effects of pH, ionic strength, surface coverage and the presence of competing ions, Ca^{2+} or Mg^{2+} , on the phosphate and arsenate adsorption were analyzed. The experimental results for the anion retention were explained by means of the CD-MUSIC model (Hiemstra and van Riemsdijk, 1996; Hiemstra and van Riemsdijk, 2006). This surface complexation model has been developed to macroscopically quantify ion adsorption onto mineral oxides under various conditions and has become one of the most popular models to describe the surface reactivity of iron mineral surfaces. For the modelling calculations, the available spectroscopic and molecular information were used to select adequate surface species for both phosphate and arsenate. The combination of the experimental results and the modelling calculations showed that the dominant surface species in the whole pH and ionic strength range studied are the bidentate species.

Gao, Y., and A. Mucci. 2003. Individual and competitive adsorption of phosphate and arsenate on goethite in artificial seawater. *Chem. Geol.* 199:91–109.

Hiemstra, T., and W.H. van Riemsdijk. 1996. A surface structural approach to ion adsorption: The charge distribution (CD) model. *J. Colloid Interface Sci.* 179:488–508.

Hiemstra, T., and W.H. van Riemsdijk. 2006. On the relationship between charge distribution, surface hydration, and the structure of the interface of metal hydroxides. *J. Colloid Interface Sci.* 301:1–18.

Li, W., J., Feng, K.D. Kwon, J.D. Kubicki, B.L. Phillips. 2010. Surface speciation of phosphate on boehmite ($\gamma\text{-AlOOH}$) determined by NMR spectroscopy. *Langmuir* 26:4753–4761.