Modeling phosphate adsorption on a Brazilian Oxisol

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Adsorption controls the mobility of nutrients and contaminants in soil and aquatic environments. The prediction of the solubility and transport of these compounds in soils is not simple due to the large complexity of soil systems, with the presence of a variety of different adsorbing materials and competing ions.

Phosphate is an essential compound in natural systems and a major nutrient for terrestrial plant growth. Phosphate ions are strongly adsorbed onto mineral (hydr)oxides, preferentially onto iron and aluminium oxides. Changes in soil surface charge and phosphorus sorption capacity of soils may affect the availability of phosphate in soils.

In the present study, batch adsorption experiments combined with modeling calculations were carried out in order to analyze soil surface properties and phosphate availability in two horizons of a Brazilian Oxisol. Initially, phosphate adsorption isotherms and adsorption edges were obtained at different pH values, ionic strength and phosphate loadings. Even though the mineralogical composition of both horizons is quite similar, phosphate adsorption on the Bw1 horizon is significantly higher than on the Ap1 horizon. These differences are in good agreement with the different charging behaviour for both soil horizons. The pH effect on the adsorption is analogous to the effect observed for typical iron oxides as goethite or ferrihydrite, that is, a decrease in the amount of adsorbed phosphate is observed as the pH increases.

A novel bicarbonate extraction method (Hiemstra et al., 2010) was carried out in order to measure the reactive oxide surface area and the total amount of reversible phosphate in the soil samples. The results of these extractions have been considered in the modelling of the adsorption data. For this purpose, the Charge Distribution Multisite Complexation (CD-MUSIC) model was used. This model was initially developed to describe surface charging behaviour and adsorption properties of mineral oxides (Hiemstra and Van Riemsdijk, 1996), but few attempts have been made with it to describe the adsorption behaviour of field samples.
