

Stage M2

Title: « *Effects of environmental parameters on phosphate adsorption by kaolinite: experimental and modeling* »

Laboratory: UMR Eco&Sols, Montpellier

Supervisor: Frédéric Gérard, Senior Researcher at INRA (gerard@supagro.inra.fr; Tel: 04 99 61 30 24)

Collaboration planned: Laurent Caner (UMR HydrAsa, Poitiers) et Camille Rivard (ESRF Grenoble)

Context

It is important for several environmental issues (eutrophication, plant nutrition, pollutions) to get a comprehensive knowledge of the nature of the PO₄-containing minerals in soils and sediments, and thus to know their relative importance of the control of PO₄ dynamics in these geomedia.

Major uncertainties still exist in the literature concerning the relative importance of clay minerals and Fe/Al oxides. It is commonly considered that clay minerals have a negligible effect on PO₄ adsorption in soils and sediments as their adsorption capacity would be 100 smaller than that of Fe/Al oxides. However, much smaller differences were sometimes reported in the literature, and the adsorption capacity of clay minerals increases with the content of structural iron (Fe³⁺). Therefore, it is very likely that the adsorption capacities of clay minerals and Fe/Al oxides are in turn very similar. Moreover, published experimental results suggest that the effect of pH on PO₄ adsorption depends on the level of the adsorbed concentration, which would be consistent with a control of PO₄ adsorption by two types of binding sites, which could correspond to high and low affinity Al-O and Fe-O sites respectively.

Objectifs

This project has two main objectives. The first one is to study experimentally the adsorption properties of clay minerals according to environmental parameters (i.e. pH, PO₄ concentration, ionic strength, Fe content). The second objective is to simulate these experimental results using mechanistic modeling (surface complexation).

Material and Methods

Two kaolinites showing differences in their structural Fe content will be studied. The experiments will be performed over a large pH range, at two background electrolyte concentrations and at two levels of PO₄ concentrations. The equilibration time will be determined from the literature.

Some samples will be analyzed using X-ray absorption spectroscopy from a Synchrotron (C. Rivard, Grenoble) in order to investigate the nature of the PO₄-binding sites of clay minerals according to the concentration of adsorbed PO₄.

Mechanistic modeling (surface complexation) will be tentatively used to reproduce experimental results and by this to furnish a comprehensive formalism to simulate PO₄ adsorption on clay minerals as a function of environmental conditions.

Miscellaneous

Traineeship grant: 480 Eur/month

Access to INRA restaurant at a preferential rate (lunches)