Fluoride sorption to a granitic soil: Interaction mechanism and factors influencing sorption

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Fate of fluoride in soil is considered to be important because of the possible effects on the surface water and groundwater contamination by leaching of fluoride from soil (Wang et al., 2002), and enhancement of fluoride uptake by plants (Amalraj and Pius, 2013). In this study, a granitic soil from Tsukuba, Japan, was chosen as an example sample, and the adsorption processes of fluoride as a function of varying pH and fluoride concentrations were evaluated by equilibrium and kinetic experiments. Then, a surface complexation model (SCM) was developed to explain the pH dependent fluoride adsorption. Four possible surface complexation reactions were postulated with and without including dissolved aluminum.

Fluoride sorption closely followed the pseudo-second-order kinetic model, suggesting chemisorption. Adsorption was high, decreased with increasing pH, with a change in the sorption pattern from pH 6 to 7, in the studied fluoride concentrations of 2.5 to 10 mg/l and pH range of 4 to 9. Aluminum release was also observed, which decreased with the increase in pH. The adsorption process was strongly influenced by the changes in pH, solid concentration and ionic strength. The mechanism for fluoride adsorption was proposed to be ion exchange between fluoride ion in solution, and the surface –OH group of soil in addition to surface adsorption, as inferred from the isotherm models. The SCM including Al-F complexation can simulate the experimental results quite successfully. From laboratory experimental results and model calculations, it is clear that including dissolved Al and Al-F complex in model calculations is inevitable for soil (or Al-oxide)-fluoride system. These findings provide meaningful information on the mechanism of fluoride sorption in soil and also on the possible contamination mechanisms of groundwater by fluoride migration from soil under favorable environmental conditions such as higher pH.

References: **[1].** Amalraj and Pius (2013). *Food. Sci. Human. Wellness*. 2, 75- 86; **[2].** Wang et al., (2002). *Fluoride*. 35(2), 122-129