

**The Dynamics of Metal Adsorption and Surface Precipitate  
Formation on Soil Materials as Monitored by Surface Molecular  
Techniques**  
**Dynamique de l'adsorption des métaux et de leur précipitation à la  
surface des constituants des sols, suivie par des techniques  
moléculaires de surface**

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An understanding of the dynamics and mechanisms of metal sorption on soil materials is fundamental in assessing the fate, speciation and bioavailability of metals in natural systems [1,2]. Traditionally, sorption has been studied using macroscopic equilibrium approaches. It is now well recognized that the kinetics of metal sorption/release must be understood if accurate predictions are to be made about metal fate/mobility. With some metals (e.g., Co, Cd, Cu) residence time (the time over which the soil material and metal react) affects the rate of metal desorption while with other metals (e.g., Pb), there is little effect residence time. To definitively understand the dynamics of metal sorption mechanisms, one must employ in-situ molecular approaches. *X-ray adsorption fine structure (XAFS) spectroscopy and scanning force microscopy (SFM)* are two such techniques that can be used to study metal reaction mechanisms at the mineral/water interface. This paper will discuss the dynamics of metal adsorption and surface precipitate formation on soil mineral surfaces using XAFS and SFM. It will be shown that with metals such as Ni, polynuclear surface complexes occur on an array of mineral surfaces that are common in the soil environment.

The surface precipitates often form on rapid time scales, at metal surface loadings far below a theoretical monolayer coverage, and in a pH range well below that at which metal hydroxide precipitates would be expected to form according to the thermodynamic solubility product. XAFS studies indicate that the polynuclear complexes are mixed metal Al/hydroxide phases and form when a metal such as Ni(II), Co(II), Zn(II), or Mn(II) is introduced into an environment in which there is a source of hydrolyzed species of Al(III), Fe(III), and Cr(III)[3]. *With metals such as Pb, little if any, polynuclear complexes form with time.* Scanning force microscopy and batch kinetic studies show that the mixed metal/Al hydroxide phases extensively cover mineral surfaces and they are much more resistant to dissolution than the pure divalent metal hydroxide compounds. The dynamics of surface precipitate and adsorption complex formation should be considered in modelling sorption processes.

References

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Mots clés : XAFS, AFM, cinétique, sorption des métaux, précipitation de surface