ENVIRONMENTAL SPECIATION, CHEMISTRY, STABILITY AND KINETICS OF NICKEL IN SOILS, MINERAL SYSTEMS AND PLANTS

by

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ABSTRACT

Soil chemistry is a branch of research stemming from soil science and was mostly geared towards research for agriculture and farming. However, because of increased awareness about the environment, soil chemistry now largely focuses on the chemical processes in contaminated soils. The chemical processes in soil occur at the interfaces between soil components such as minerals, humic substances, microbes, fungi, plants and water, and they control contaminant mobility. In this dissertation four projects were carried out to study the soil chemical processes of nickel. Nickel is a common contaminant in soils polluted with "heavy metals" and a model element to study because other transition metals undergo similar chemical reactions. We find that nickel can transform rapidly at the mineral-water interface into newly formed Ni-Al LDH precipitates in tens of minutes, and we illustrate for the first time these fast reaction kinetics in a "live" sorption reaction. Additionally, nickel hyperaccumulating plants have no specific mechanism to preferentially remove nickel from minerals for transport into their leaves, which was contrary to our hypothesis that the plants had some preferential mechanism for nickel uptake. Lastly, we find that nickel is heterogeneously distributed in ultramafic soils amongst iron and manganese oxides and in the silicate minerals of primary and secondary ultramafic rocks and serpentinite, which illustrates the importance of climate on weathering processes in soils, and that hyperaccumulating plants can remove nickel from a variety of nickel mineral species.