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Adsorption edge study about cadmium, copper, nickel and zinc adsorption by variable charge soils

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The improper discharge of industrial and urban residues and the inadvertent use of fertilizers and pesticides can result in soil and water pollution and improve the potential of trace metals to enter in the human food chain. Adsorption reactions occur at the solid/liquid interface and are the most important mechanisms for controlling the activity of metal ions in soil solution. In a complex system with amphoteric behavior, the comprehension of the mobility, availability and fate of pollutants in the soil system is crucial for the prediction of the environmental consequences and for development of prevention/remediation strategies. A comparative study of cadmium (Cd), copper (Cu), nickel (Ni) and zinc (Zn) adsorption by highly weathered soils was carried out. Surface (0-0.2m) and subsoil (B horizon) samples were taken from a Rhodic Kandiudalf (RH), an Anionic "Xanthic" Acrudox (XA) and an Anionic "Rhodic" Acrudox (RA), located in brazilian humid tropical area. As the pH and the ionic strength are important environmental factors influencing the solution chemistry of heavy metals in variable charge systems, adsorption envelopes, in a batch adsorption experiment, were elaborated by reacting, for 24 h, soil samples with individual 0.01, 0.1 and 1.0 mol L−1 Ca(NO3)2 aqueous solutions containing nitrate salts of the adsorptive heavy metal (Cd, Cu, Ni and Zn) at the initial concentration of 5 mg L−1, with an increasing pH value from 3.0 to 8.0. [U+F044]pH50-100%, the difference between the pH of 100 and 50 percent metal adsorption was determined. A sharp increase of adsorption density (adsorption edge) was observed within a very narrow pH range, usually less than two pH units. Commonly, the relative affinity of a soil for a metal cation increases with the tendency of the cation to form inner-sphere surface complexes. This may be caused by differences in extent of hydrolysis of Cu ions and in affinity of adsorption sites for Cu. In general, subsurface samples showed low [U+F044]pH50-100% when compared with surface ones, independently on metal ion type. [U+F044]pH50-100% indicated that Cu was preferentially adsorbed. pH50 values for Cd, Ni and Zn increased as the ionic strength increased, but not for Cu. This behavior indicated the weak electrostatic bonding mechanisms involved in the formation of outer-sphere complex between these metal ions and the soil adsorbents