THE EFFECT OF CLAY MINERALOGY ON RETENTION OF HEAVY METALS BY SOILS

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Adsorption and desorption studies were carried out on brown forest soils characterised by clay illuviation. The samples were taken from the accumulation horizons of soils developed on clayey aleurolites. The clay mineralogy of the studied samples is strongly varying: one of them is characterised by high clay mineral content (45%) and by low charge montmorillonite, while the other one is by low clay mineral content (15%) and vermiculite, as well as chlorite-vermiculite interstratified mineral phases. The Cu, Zn and Pb adsorption experiments were performed in competitive situation, and in the concentration interval of potentially mobile heavy metal fractions of sewage sludge (Cu 200 mg/l, Zn 1200 mg/l, Pb 250 mg/l). The desorption of adsorbed heavy metals from the soil samples was carried out in the following four step according to the sequential extraction after Li et al. (1995): a) exchangeable fraction by $MgCl_2$ extraction, b) specifically adsorbed fraction by NaOAc extraction, c) fraction bound to Fe-Mn-oxides by $NH_2{\cdot}OH{\cdot}HCl$ extraction, and d) fraction bound to organic matter by H_2O_2–HNO_3 extraction.

The affinity of the studied metals to soils decreases as follows, independently of soil composition: Pb > Cu > Zn. Our studies confirmed that the presence of copper and lead has a significant effect on zinc adsorption, while the inverse is not true. The affinity of lead and zinc to soil samples decreases with the dominant clay mineral species in the sequence of vermiculite > montmorillonite, while samples characterised by montmorillonite adsorb more copper than the vermiculite dominated ones. Desorption is also a selective process similarly to adsorption, and the mobility of adsorbed metals increases as follows: Cu < Pb << Zn. The ion exchange is of importance primarily in the samples of high clay mineral content. This process is significant in the case of copper and zinc, as well as of lead in samples characterised by montmorillonite, and vermiculite, respectively. The ion exchange of zinc is more important than the specific adsorption of this metal, because metals characterised by high affinity to soils (Pb, Cu) are adsorbed mainly on the specific sites in competitive situations.

Clay minerals in soils can play an important role in the immobilisation of an eventual heavy metal contamination. The immobilising effect of a soil decreases with the increasing number of polluting metals, and a very small pH change (one unit) can result in loss of an important part of this capacity. The advantage of complex soil composition is that soil acts as a selective buffer for the change of natural conditions. The loss of the buffering capacity of one of the soil compounds does not result in the loss of effect of the other components.

Reference

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