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Mechanisms of interaction between heavy metals (Cu, Zn, Cd and Pb) and clay minerals

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Soils from South Piedmont (Italy) contaminated with the heavy metals Cu and Zn as a result of industrial activity during the last century were characterized in detail first by separating them into sand, coarse silt, fine silt and clay-sized fractions (2mm-63μm, 63μm-30μm, 30μm-2μm and $<2\mu$m respectively) and then by studying their chemical and mineralogical composition using ICP-MS, X-ray powder diffraction and thermogravimetric analysis**.**

In each case, the clay fraction, made up primarily of phyllosilicates and clay minerals, proved to contain the highest concentration of the contaminants, indicating that this fraction plays an important role in the retention mechanism for the pollutants concerned. A study of the mechanisms of heavy metal retention by different clay minerals was therefore undertaken. Samples of Ca- and Na- montmorillonites, illite, vermiculite and kaolinite were placed in a solution containing different concentrations (0,5-0,8-1-1,2 M) of $Pb(NO_3)_2$, $CuSO_4 \cdot 5H_2O$, $Cu(NO_3)_2 \cdot 2{,}5H_2O$, $ZnSO_4 \cdot 7H_2O$, $Zn(NO_3)_2 \cdot 6H_2O$, $CdSO_4 \cdot 8H_2O$ and $Cd(NO_3)_2 \cdot 4H_2O$.

After mixing, all the solutions underwent ultrasound treatment for 5 minutes and were then centrifuged for 3 minutes. The precipitate was separated from the solution and the solid sample was then washed with bi-distilled water and examined using:

a) ICP-MS to determine the total amount of heavy metal retained by the samples of clay minerals examined;

b) X-ray powder diffraction to identify shifts in the diffraction of the 001 planes as a result of adsorption of heavy metals within the interlayer region of the clay minerals;

c) thermogravimetric analysis to measure the amount of water molecules bound to the heavy metals sorbed in the interlayer.

It was thus possible to identify the mechanisms of interaction taking place between each of the clay minerals and the different heavy metals analyzed.