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Stabilization of Pb and Cu in contaminated soils using (nano)oxides - a preliminary study

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Chemical stabilization techniques (the application of various stabilizing amendments, which by chemical means reduces contaminant mobility, bioavailability and bioaccessibility) have shown to be possible less destructive alternatives to conventional remediation options. Most stabilization techniques aim at rendering less available the metal(loid) fractions that can pose significant environmental and/or toxicological risks and protecting the functionality of the soil environment. Nano-particulate oxides (particle size of 1-100 nm) are important scavengers of contaminants in soils and due to their reactive and relatively large specific surface area, engineered oxide nanoparticles are promising materials for the remediation of soils contaminated with inorganic pollutants. However, studies assessing the efficiency of these amendments in contaminated soils are still rather scarce. Therefore, the aim of this work is to evaluate the stabilization efficiency of four (nano)oxides (maghemite, magnetite, gibbsite and amorphous Mn oxide (AMO)) in two soils contaminated with Cu (400 mg/kg; pH 3.6) and Pb (1500 mg/kg; pH 5.5), respectively, using chemical extraction methods (CaCl2, EDTA and the BCR sequential extraction) and direct sampling of soil solution using rhizons. The results suggest that the application of the oxides did not influence the pH of the soils, with the only exception of the AMO, which increased the pH and resulted into the formation of $MnCO_3$ on the oxide surface (data from SEM and XRD). Additionally, the high reactivity of the oxides led to increased DOC concentrations originating from the dissolved soil organic matter, especially in the case of the AMO. The AMO was also the most efficient stabilizing amendment for Cu (most significant decrease in Cu in soil solution, in the exchangeable fraction and CaCl2/EDTA extracts), promoted by the pH increase. Despite their lower particle size, maghemite, magnetite and gibbsite were less efficient; although partial immobilization of Cu and Pb occurred as well. The stabilization of Pb was less pronounced due to its already low mobility/availability in the soil. This preliminary study highlighted the need for various extraction and soil solution tests to evaluate the efficiency of novel amendments. More contrasting soil types will also need to be studied in order to assess the interactions between the reactive (nano)oxides and soil components (e.g., SOM).