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Stability of amorphous hydrous manganese oxide in contrasting soils and implications for its use in chemical stabilization of metals/metalloids in contaminated soil environments

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Amorphous manganese oxides are known to be efficient sorbents in soils and thus useful in remediation technologies. A novel amorphous hydrous manganese oxide (HMO) was prepared by a modified procedure generally used for birnessite synthesis. Its long-term stability in view of possible applications for chemical stabilization of metals/metalloids in polluted soils was evaluated. HMO was sealed in experimental bags prepared from polyamide fabric (pore size 1 um) and placed in the pots containing 200 g of soil. Three contrasting soils were used (two cambisols with pH values of 4.2 and 5.4, respectively, and a chernozem with a pH of 7.3). Each pot was equipped with a rhizon pore water sampler and the water content was maintained at 80% WHC throughout the experiment. HMO and pore waters were sampled after 1, 7, 15, 30, 45, 60, 75 and 90 days of incubation. Up to 113 mg Mn/L was released into pore water at the beginning of the experiment in more acidic soils indicating a slight dissolution of HMO surfaces. Manganese release into the pore water stabilized after 15 days in agreement with mass loss measurements. Mass loss decreased again after 60 days of the incubation for the neutral soil due to the formation of secondary rhodochrosite ($MnCO_3$) detected on the HMO surfaces by X-ray diffraction analysis (XRD) and transmission electron microscopy (TEM). The efficiency of HMO for trace metal retention in soils (e.g., Zn) slightly decreased after 60 days, probably due to the mineralogical transformation of the sorbent leading to decrease of binding surfaces. Nevertheless, only approximately 10% of HMO dissolved after 90 days of experiment showing that this sorbent can be relatively stable in the studied soils. Its binding capacity for metals/metalloids should be further tested in soils with elevated contaminant concentrations.