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Using amorphous manganese oxide for remediation of smelter-polluted soils: a pH-dependent long-term stability study

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In soil systems, manganese (Mn) oxides are commonly found to be powerful sorbents of metals and metalloids and are thus potentially useful in soil remediation. A novel amorphous manganese oxide (AMO) and a Pb smelter-polluted agricultural soil amended with the AMO and incubated for 2 and 6 months were subjected to a pH-static leaching procedure (pH = 3 - 8) to verify the chemical stabilization effect on metals and metalloids. The AMO stability in pure water was pH-dependent with the highest Mn release at pH 3 (47% dissolved) and the lowest at pH 8 (0.14% dissolved). Secondary rhodochrosite ($MnCO_3$) was formed at the AMO surfaces at pH > 5. The AMO dissolved significantly less after 6 months of incubation. Sequential extraction analysis indicated that "labile" fraction of As, Pb and Sb in soil significantly decreased after AMO amendment. The pH-static experiments indicated that no effect on leaching was observed for Cd and Zn after AMO treatments, whereas the leaching of As, Cu, Pb and Sb decreased down to 20%, 35%, 7% and 11% of the control, respectively. The remediation efficiency was more pronounced under acidic conditions and the time of incubation generally led to increased retention of the targeted contaminants. The AMO was found to be a promising agent for the chemical stabilization of polluted soils and other in situ applications need to be evaluated. This study was supported by the Czech Science Foundation (GAČR 15-07117S).