Evaluation of Struvite as a Phosphate Amendment to Immobilize Lead in Contaminated Urban Soils

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Urban soils have a legacy of contamination, being continuously subject to anthropogenic stresses and emissions from infrastructural development, industrial and vehicular sources. Urban soils are the sink for various organic and inorganic contaminants, especially heavy metals. Amongst inorganic contaminants, lead (Pb) is a pervasive metallic contaminant in urban areas arising from burning leaded gasoline, paints and industrial emissions, and is known to be present in elevated concentrations. A popular approach in soil remediation is chemical treatment, which is achieved by immobilizing the metal as an insoluble compound on addition of an amendment. The objective of this study is to investigate the interaction of struvite ($MgNH_4PO_4 \cdot 6H_2O$, MAP) with Pb, and subsequently evaluate its potential as an amendment to remediate Pb in soils. Struvite is a wastewater recovered phosphate product, and has demonstrated a tendency to interact with metal ions. Batch sorption experiments were conducted to study the sorption of six divalent metals copper (Cu), nickel (Ni), cobalt (Co), zinc (Zn), cadmium (Cd), and Pb, on struvite at pH 7-10, at 1-5 μM initial metal concentration. The extent of sorption of Pb on struvite was considerably more than that of the other metals at all pH values; the recovered product with sorbed Pb in the range 223-492 ppm exceeded the EU struvite fertilizer limit value of 150 ppm. Divalent metal sorption at the higher pH values followed the selectivity sequence Pb >> Co > Zn > Cu > Ni > Cd. To test the effectiveness of MAP as a soil amendment, laboratory scale experiments were set up using contaminated soil samples from urban community gardens in Newark, New Jersey. Soil samples were subject to treatment with MAP, and Pb concentration in various soil fractions were monitored by analyzing soil samples intermittently. The effective removal of Pb from mobile fractions suggests that struvite has the potential to immobilize Pb in-situ in contaminated soils. The use of a wastewater recovered product makes this a sustainable soil remediation strategy.