Interpretation of Speciation and Reactivity of Lead and Zinc in Soil by Combining Multi-element Stable Isotopic Dilution, Chemical Extraction and Multi-surface Modelling

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Abstract

Correct characterization of metal speciation and reactivity is a prerequisite for the risk assessment and remedial activity management of contaminated soil. To better understand the intrinsic lability of Pb and Zn, nine non-contaminated and contaminated soils were investigated using the combined approaches of chemical extractions, multi-element stable isotopic dilution (ID) method, and multi-surface modelling. The ID results show that 0.1-38% of total Pb and 3-45% of total Zn are isotopically exchangeable after a 3-day equilibration. The intercomparison between experimental and modelling results evidences that single extraction with 0.43 M HNO_3 solubilizes part of non-isotopically exchangeable fraction of Pb and Zn in the studied soils, and cannot be used as a surrogate for ID to assess labile Pb and Zn pools in soil. Both selective sequential extraction (SSE) and modelling reveal that Mn oxides are the predominant sorption surface for Pb in the studied soils; while Zn is predicted to be mainly associated with soil organic matter. Multi-surface modelling can provide a reasonable prediction of Pb and Zn adsorption onto different soil constituents for the most of the studied soils. The modelling could be a promising tool to decipher the underlying mechanism that controls metal reactivity in soil, but the submodel for Mn oxides should be incorporated and the model parameters, especially for the 2-pK diffuse layer model for Mn oxides, should be updated in the further studies.

Keywords: lead, zinc, speciation, reactivity, stable isotopic dilution, multi-surface modelling