Advanced estimation of Pb isotope ratio in geogenic source for analyzing relative contribution of multiple Zn sources to soil contamination

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Analyzing the relative contributions of multiple sources to soil contamination is essential to determining the remedial responsibility and developing the most efficient countermeasure. For the soil contaminations by Zn and Pb, previous studies have proposed an equation to calculate the relative contirbutions of geogenic and anthropogenic sources using their Pb isotope ratios. In this calculation, soil samples collected at the depth of 0.5 ~ 1.5 m from the surface where the influence of anthropogenic source might be presumably minimal was employed for obtaining the geogenic Pb isotope ratios. However, the metal contaminants released onto the top soil could be penetrated into the deep by precipitation, and transported to different distances depending on the soil properties like cation exchange capacity, organic matter contents and vertical hydraulic conductivity etc. In practice, an intact sample for the geogenic Pb isotope ratio is hard to be ensured, which challenge the reliability of the calculation. In this study, we proposed a method to precisely estimate the geogenic Pb isotope ratio, and estimated its applicability. As preliminary experiments, soils were artificially contaminated with Zn containing minerals, the possible trasnfers of metals (Zn and Pb as a co-existing element) present in a certain binding fraction to the others were estimated by sequential extraction analysis, and the most stable binding fraction was confirmed. Based on the results, a method for estimating the geogenic Pb isotope ratio was suggested, in which the mobile and transferrable fractions in a soil sample was priorly leached out, and the residual fraction was subjected to the isotope analysis. For estimating the feasibility of the method, soil samples contaminated with ZnS (containing Pb as impurities) around a Zn smelting facility in South Korea were analyzed by previous and proposed methods, and compared.