



## **Assessment of soil stabilization by chemical extraction and bioaccumulation using earthworm, *Eisenia fetida***

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Soil stabilization does not remove heavy metals from contaminated soil, but lowers their exposures to ecosystem. Thus, it should be evaluated by measuring the fractions of heavy metals which are mobile and/or bioavailable in soils. The study compared several chemical extractions which intended to quantify the mobile or bioaccessible fractions with uptake and bioaccumulation by earthworm, *Eisenia fetida*. Soil samples were taken from the abandoned mine area contaminated with As, Cd, Cu, Pb and/or Zn. To stabilize heavy metals, the soils were amended with limestone and steel slag at 5% and 2% (w/w), respectively. All chemical extractions and earthworm tests were applied to both the contaminated and the stabilized soils with triplicates. The chemical extractions consisted of six single extractions which were 0.01M CaCl<sub>2</sub> (unbuffered), EDTA or DTPA (chelating), TCLP (acidic), Mehlich 3 (mixture), and aqua regia (pseudo-total). Sequential extractions were also applied to fractionate heavy metals in soils. In earthworm tests, worms were exposed to the soils for uptake of heavy metals. After 28 days of exposure to soils, worms were transferred to clean soils for elimination. During the tests, three worms were randomly collected at proper sampling events. Worms were rinsed with DI water and placed on moist filter paper for 48 h for depuration. Filter paper was renewed at 24 h to prevent coprophagy. The worms were killed with liquid nitrogen, dried in the oven, and digested with aqua regia for ICP-MS analysis. In addition to the bioaccumulation, several toxicity endpoints were observed such as burrowing time, mortality, cocoon production, and body weight changes. Toxicokinetics was applied to determine the uptake and elimination heavy metals by the earthworms. Bioaccumulation factor (BAF) was estimated using total metal concentrations and body burdens. Pearson correlation and simple linear regression were applied to evaluate the relationship between metal fractions by single extractions or sequential extractions with bioaccumulations. Finally, we discussed the advantages or disadvantages of simple chemical extractions which are commonly used to estimate the efficacy of stabilization.