DISCRIMINANT ANALYSIS OF HEAVY METAL CONTAMINATION IN THE DEPTH SOIL

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Introduction

Understanding the mechanism and speciation change of lead and copper is the important procedure for tracing the contamination pathway at the contaminated site. Before the pathway analysis, researchers need to discriminant the contamination source by analyzing the contaminants' characterization. Heavy metals contamination from the polluted site is generally caused by several mechanisms such as particle movement, a water extraction, transformation, and other reaction process. Leaching column tests are fundamental tools for predicting the contamination of soil profiles, resulting in groundwater contamination (Beesley, Moreno-Jiménez, Clemente, Lepp, & Dickinson, 2010; Shafiquzzaman, Azam, Nakajima, & Bari, 2010; Tabelin, Hashimoto, Igarashi, & Yoneda, 2014).

Methods

The present study investigated the leaching characteristics of Pb and Cu through the soil profile using an intermittent column leaching with acid solution (adjusted pH in rain water, pH 3) and fresh rain water (pH 6.85), which are representing the metal leaching under mimic conditions of acid mine drainage (AMD) and surface run off by rain water (RW). Polycarbonate columns (90 cm long with a 1.6 cm internal diameter) were used, in which 30 g of Pb and Cu co-contaminated soil (surface layer soil) and 120g non-contaminated urban soil (underlying soil) were packed. Underlying soil was divided into four layers and each layer contained 30 g of soil. About 1 cm of ceramic wool was placed at the bottom and middle of the each soil layers in the columns. Heavy metal contaminated soil was collected from the shooting range located in Yeo-su, Korea. The initial concentration of Pb and Cu in contaminated soil was 21,500 and 762 mg/kg, respectively. The properties of soil samples are shown in Table 1. The leaching solution was injected using the metering pump (BT100-1L) to the column down-flow mode (150 μL/min) for 15 min per times, and four times in a day, corresponding the flow rate was 9 mL/day and the mean precipitation of 1.9 mm/hr.

Table 1. The properties of heavy metal contaminated soil and fresh soil.

Soil	Pb conc. (mg/kg)	Cu conc. (mg/kg)	pH	EC	Water content (wt %)	Organic matter (wt %)	Soil taxonomy	CEC ($cmol_c/kg$)
Shooting range	21,500	762	6.8	191	3.24	12.4	Sandy loam	17.0
Fresh soil (urban site)	41	32	5.9	68	3.02	6.41	Sandy loam	3.03

Results

After 4 month, the leaching efficiency based on Pb and Cu concentration in the surface soil was measured to be about 2% and 8%, respectively, and this may be retained in underlying soil. The heavy metal concentrations in the underlying soil layers at two and four month columns were shown on Figure 1.

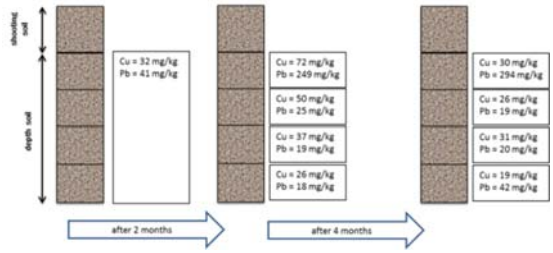

Figure 1. Cu and Pb concentrations in the depth soil (15, 30, 45 and 60 cm) (leaching condition, pH 3)

The fractionation of heavy metals in the surface and depth soils at every leaching event was analyzed by using the sequential extraction procedure (Tessier, Campbell, & Bisson, 1979). We observed that the all fractions of Pb and Cu were increased in top layer of depth soil with the leaching duration, and the change of metals speciation is shown in Figure 2. Specially, carbonate/specifically adsorbed (phase-2) and Fe-Mn (hydro)oxides (phase-3) fractions of Pb and Cu were dramatically increased with increasing the leaching duration.

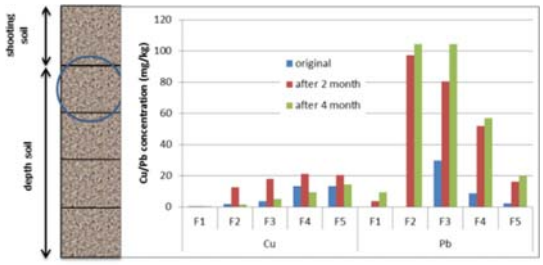

Figure 2. The concentration of Cu and Pb fractions in top layer of depth soil (leaching with pH 3)

Conclusion

In summary, it can be concluded that leaching with simulated acid and real rain water can be changed the significant portion of the Pb and Cu in contaminated soil (source) and metals can be leached out a significant portion which indicating a potential risk for underlying soil and groundwater contamination.. After 4 month of down-flow leaching, the leaching efficiency based on Pb and Cu concentration in the surface soil was measured to be about 2% and 8%, and this may be retained in top layer of underlying soil. And the pH of leaching solution (pH 3.0 and 6.85) had a very small effect on the Pb and Cu leaching.

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References

Beesley, Luke, Moreno-Jiménez, Eduardo, Clemente, Rafael, Lepp, Nicholas, & Dickinson, Nicholas. (2010). Mobility of arsenic, cadmium and zinc in a multi-element contaminated soil profile assessed by in-situ soil pore water sampling, column leaching and sequential extraction. *Environmental Pollution, 158*(1), 155-160.

Shafiquzzaman, Md, Azam, Md Shafiul, Nakajima, Jun, & Bari, Quazi Hamidul. (2010). Arsenic leaching characteristics of the sludges from iron based removal process. *Desalination, 261*(1–2), 41-45.

Tabelin, Carlito Baltazar, Hashimoto, Ayaka, Igarashi, Toshifumi, & Yoneda, Tetsuro. (2014). Leaching of boron, arsenic and selenium from sedimentary rocks: II. pH dependence, speciation and mechanisms of release. *Science of The Total Environment, 473–474*, 244-253.

Tessier, A., Campbell, P. G. C., & Bisson, M. (1979). Sequential extraction procedure for the speciation of particulate trace metals. *Analytical Chemistry, 51*(7), 844-851.