



Geochemical Behavior of Heavy Metals During Treatment by Phosphoric Fertilizer at a Dumping Site in Kabwe, Zambia

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Abstract. Kabwe area in Zambia has been affected by heavy metal contaminations which derived from past mining activities. Particularly, Pb is one of the most concerned elements for human health in Kabwe. In this context, treatment by phosphoric fertilizer was conducted to reduce Pb solubility in soil and slag, limiting their bioavailability. Because leach plant residue in Kabwe contains metal sulfate minerals with high solubility, concentration of heavy metals in groundwater is high. We clarified the geochemical behavior of heavy metals (Pb, Cd, Zn and Cu) after the addition of phosphoric fertilizer (Triple Super Phosphate: TSP) in column experiment. Immobilization of Pb and Cd lowers concentration of the metals in ground below WHO environmental standard.

Keywords: Insolubilization · Soil amendments · Heavy metal contamination · Phosphate mineral · Mine waste

1 Introduction

Kabwe town is the worst polluted place in Africa due to mining and smelting of Pb and Zn ores. Orthophosphate has been receiving a lot of attention as stabilization agent for heavy metals. In order to reduce dispersion and mobility of Pb metal from the slag, we suggest treatment by adding phosphoric fertilizer (Triple super phosphate: TSP) which is effective and locally available.

2 Methods and Approaches

We conducted a series of column experiments in 50 ml of syringe tubes, simulating treatment for stacked slags at a dumping site in Kabwe. The syringes were filled with slags obtained from Kabwe site with 10 g of TSP on the top of slag sample. 6 mL of rain water obtained from the site was added every day, which is consistent with average daily precipitation rate. Infiltrated water was collected at the bottom of syringe and analyzed by ICP-AES and ICP-MS. After the column experiments, the slag samples in the column also investigated to understand geochemical processes occurred during the experiments by SEM/EDS.

3 Results and Discussion

We confirm the reduction in Pb and Cd concentrations in the eluents. Remarkably, the reduction for Pb concentration is 96%. In the infiltrated slags simultaneously, we observe the alteration from PbSO_4 to $(\text{Pb, Ca})_5(\text{PO}_4)_3\text{Cl}$ (Fig. 1), which effects to reduce the mobility of Pb. In contrast, elution of Zn and Cu from the slags are promoted by the presence of TSP. This is due to lowering pH by TSP, desorbed Zn and Cu from amorphous and crystalline iron hydroxides. It suggests to supply orthophosphate at neutral pH range is effective for immobilization of heavy metals in slags.

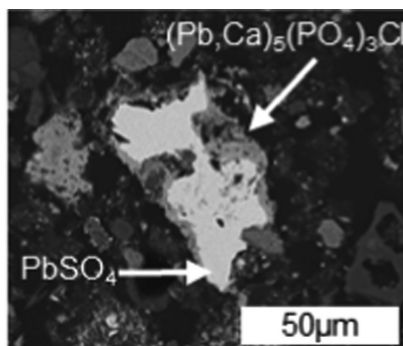


Fig. 1. The alteration from anglesite to pyromorphite

4 Conclusions

We confirmed the behavior of some heavy metals applied TSP in column scale. From the results, TSP could immobilize Pb and Cd, however, it promoted elution of Zn and Cu due to soil acidification. This suggests applying TSP with dolomite to the slag could be a better remediation method.

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