



Immobilisation of potentially toxic elements by natural sorbents: case study of spolic technosol from São Domingos Cu-ore deposit (Portugal)

Pavol Midula^{1,4}, Oliver Wiche², Peter Andráš¹, Janka Ševčíková¹, Marek Drimal¹, João X. Matos³, and Pavel Kuráň⁴

¹Matej Bel University in Banská Bystrica, Department of environmental management, Banská Bystrica, Slovakia

²TU-Bergakademie Freiberg, Germany

³Laboratório Nacional de Energia e Geologia Unidade de Recursos Minerais e Geofísica, Portugal

⁴University of Jan Evangelista Purkyně, Centre of Advanced Separation Techniques, Ústí and Labem, Czech Republic

Ore-mining industry produces a waste, which belongs to the main sources of potentially toxic elements (PTEs). One of the initial steps necessary for remediation project of contaminated sites is the research of PTEs mobile forms that are very capable to enter trophic chain mainly through plants. Great abandoned copper deposit São Domingos (Portugal) was selected as a representative area since the presence of high PTEs contents was proved there in previous research activities.

The presented work is focused on efficiency of natural sorbents on the immobilisation of PTEs in copper-polluted soil developed on tailings taken from the mine district, and to compare the treated soils as habitats of vascular plants. Several natural sorbents were selected for the adequate realization of experimental part: bentonite, charcoal, calcium carbonate, phosphate, chicken manure, and organo-zeolitic substrate (mixture of perlite, chicken manure, and calcium carbonate; 5:1:3).

From the whole area of the mine-dump, 10 sites were chosen as the representatives of not-so-heterogenic soil conditions, where the sampling itself was realized. As the representative PTEs; Cr, Mn, Co, Ni, Cu, Zn, As, Cd, and Sb were chosen. The sorbents were added to composite soil sample. Ex situ experiments were realized from 1st of June to 30th of September 2020. At the end of experiments, a soil sample from each pot were taken, dried and grained into the fine powder. For assessment of total concentration of elements, microwave digestion was performed, with 100 mg of grained powder dissolution in aqua regia. For the purpose to assess the forms of PTEs with the ability to be assimilated by plant roots, the extraction from 1 g of sample was executed in the sequence: I. deionized water; II. 1M ammonium acetate solution by pH 7 (both mixed for 12 hours); 0.01M citric acid solution (mixed for 2 hours). First two fractions can be referred as mobile / exchangeable. The processed soil solutions were measured by Inductively Coupled Plasma Mass Spectrometry (ICP-MS).

The technosol was contaminated mainly by As, Cu, and Zn. Obtained results show that neither As nor Sb are present in investigated fractions, whereas the concentrations of Cr is also very low. The other PTEs are contained in significant concentrations, mostly in mobile fraction, especially Co (36 %); Mn (27 %); Cu (25 %); and Cd (15 %). Among the natural sorbents, the only ones efficient in reducing the mobile forms were charcoal and organo-zeolitic substrate. These pots were also the only suitable habitats for mixture of grass species. In both cases, the mobile contents of Ni, Cu, and Zn were practically reduced to zero since the mobile contents of Co, Mn and Cd decreased to minimum. For better understanding of habitat-suitability after application of those sorbents, the plant-nutrient characterisation should be included in further research. Based on those results, both natural sorbents could be considered for application in remediation techniques aimed on those PTEs.