Abstract

Six soil samples corresponding to selected horizons (both topsoil and subsurface layers) from the forested and unforested soil profiles located in the vicinity of Mufulira Cu-Co smelter in the Copperbelt Province (Zambia) were investigated, in order to describe binding of main metal contaminants (Cu, Co, Pb, Zn) to soil constituents with a special emphasis on solid phase speciation. Sequential extraction procedure (SEP), X-ray diffraction (XRD) and scanning electron microscopy coupled to energy dispersion spectrometry (SEM/EDS) were used in this study. The highest bulk concentrations were found in soil samples from grassland areas located 3.6 and 8 kilometers from the smelter (Cu: 12 600 mg/kg, Co: 42.4 mg/kg, Pb: 40.6 mg/kg, Zn: 65.2 mg/kg). Copper was found to be the most mobile contaminant, also present in elevated concentrations in the subsurface soil layers of highly contaminated profiles, with substantial amount bound in the exchangable chemical fraction (19.3-25 mg/kg, 21-30 % of bulk Cu concentration). Besides the presence of lithogenic minerals, anthropogenic phases originating from mining and smelting activities were also observed in the heavy mineral soil fraction. These anthropogenic particles enriched in Cu or Co were identified by SEM/EDS as Cu-(Fe) oxides or sulphides of variable composition, sulphates or metallic Cu. Anthropogenic spherical particles were smelter-derived and were mainly composed of Cu sulphides (e.g. chalcocite (Cu_2S), covellite (CuS) or spionkopite ($Cu_{2-x}S$)), while angular grains of mining-derived particles were composed mainly of Cu-Fe sulphides (chalcopyrite, $CuFeS_2$). Copper also formed oxides with predominant occurence of tenorite (CuO), delafossite ($CuFeO_2$) or hydrated secondary Fe oxides.