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Magnetic properties of alluvial soils polluted with heavy metals

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Magnetic properties of soils, reflecting mineralogy, concentration and grain-size distribution of Fe-oxides, proved to be useful tool in assessing the soil properties in terms of various environmental conditions. Measurement of soil magnetic properties presents a convenient method to investigate the natural environmental changes in soils as well as the anthropogenic pollution of soils with several risk elements. The effect of fluvial pollution with Cd, Cu, Pb and Zn on magnetic soil properties was studied on highly contaminated alluvial soils from the mining/smelting district (Příbram; CZ) using a combination of magnetic and geochemical methods. The basic soil characteristics, the content of heavy metals, oxalate, and dithionite extractable iron were determined in selected soil samples. Soil profiles were sampled using HUMAX soil corer and the magnetic susceptibility was measured in situ, further detailed magnetic analyses of selected distinct layers were carried out. Two types of variations of magnetic properties in soil profiles were observed corresponding to indentified soil types (Fluvisols, and Gleyic Fluvisols). Significantly higher values of topsoil magnetic susceptibility compared to underlying soil are accompanied with high concentration of heavy metals. Sequential extraction analysis proved the binding of Pb, Zn and Cd in Fe and Mn oxides. Concentration and size-dependent parameters (anhysteretic and isothermal magnetization) were measured on bulk samples in terms of assessing the origin of magnetic components. The results enabled to distinguish clearly topsoil layers enhanced with heavy metals from subsoil samples. The dominance of particles with pseudo-single domain behavior in topsoil and paramagnetic/antiferromagnetic contribution in subsoil were observed. These measurements were verified with room temperature hysteresis measurement carried out on bulk samples and magnetic extracts. Thermomagnetic analysis of magnetic susceptibility measured on magnetic extracts indicated the presence of magnetite/maghemite in the uppermost layers, and strong mineralogical transformation of iron oxyhydroxides during heating. Magnetic techniques give valuable information about the soil Fe oxides, which are useful for investigation of the environmental effects in soil. Key words: magnetic methods, Fe oxides, pollution, alluvial soils.