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Heavy metals in and on magnetic particles

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This study, funded by the Austrian Science Fund (FWF P16314), aims at determining the link between magnetic signatures and heavy metal pollution of soils. A set of soil samples from the vicinity of steel works was measured with the full range of mineral magnetic methods. These measurements yielded typical features of polluted soils, eg. easy saturation, high SIRM, Curie temperatures between 590˚C and 600˚C and pot-bellied hysteresis.

In addition XRD, SEM, total metal content determination as well as a three-stage extraction procedure were performed. The modified (BCR) three-stage extraction procedure allows to quantify metals in following bonds: 1. Exchangeable metals, water soluble and carbonates; 2. Metals bound to iron and manganese oxides (reductible); 3. Metals bound to organic matter and sulphides (oxidizable). For the extraction procedure all samples and two reference samples (BCR-701, BCR-723) were ground and oven dried. The determination of metals in the extracts was performed by ICP-MS. Magnetic susceptibility was measured before the first and after each extraction step to link the metal extraction with changes of magnetic parameters.

Magnetic extracts, cleaned from organic matter with 30% H_2O_2, were used for scanning electron microscopy. The sample extracts were mainly consisting of spherules with diameters ranging from 6 to $\sim$100 μm, scale was detected in limited amount. The surface morphology of the spheres was variable, but “orange-peel” and surfaces with circular and angular rims were most abundant. Many of the spherules were hollow, with varying wall thickness. Elemental analysis displayed that the spherules were either built of iron oxides, or geometrically formed iron oxides embedded into a silicate matrix. The heavy metals Cr, Mn, Ni, Ti, Cu, Zn were found in elemental analysis. Cr, Cu and Zn could only be found in flakes attached to the surface of the spheres, whereas Mn, Ni and Ti occurred either in flakes or in the internal structure of the sphere.