Chemical fractionation of heavy metals in urban soils (the Eastern District of Moscow)

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A study was undertaken to investigate fractionation of heavy metals (HMs) in urban soils of the Eastern District of Moscow where multisource pollution problems occur. 21 samples of the urban soils were collected using a regular grid with 1 km spacing and a reference sample representing background uncontaminated soils (podzoluvisols) located at the distance of 200 km to the east from the city. Each sample was digested with HF+HClO4+aqua regia for the analysis of total HMs content and also partitioned into 5 fractions using sequential extraction procedure (Tessier et al., 1979): F1 – exchangeable (MgCl2); F2 – bound to carbonates (CH3COONa); F3 – bound to Fe/Mn oxides (NH4OH•HCl+CH3COOH); F4 – bound to organic matter (HNO3+H2O2); F5 – non-silicate residual (aqua regia). The concentrations of HMs were determined using ICP-MS. The concentrations of HMs in the fraction bound to silicates (F6) were calculated as the difference between the total and F1+F2+F3+F4+F5 concentrations. The results show that in the urban soils the significant proportions of Cd, Mn, Zn are associated with Fe/Mn oxides; while lower percentage of these metals are held in other fractions. Co, Ni, As, Pb, Cr, Mo, Be, Bi, Sb are mostly bound to non-silicate residual and silicate fractions (> 60%), but the amounts of the metals associated with organic matter and Mn/Fe oxides are also high (~10-20% each). About 90% of V, Ti, Fe, Sn are found in F5 and F6. The significant proportions of W and Cu are bound to organic matter. The potential mobility factor (PMF) for each element was calculated: PMF=(F1+F2+F3+F4)•100%/C, where C is the total content of a HM in a sample. The results show that PMF in urban soils increases in order: Cd > Mn, Zn, W > Cu, Pb, Mo, Sr, Cr, Co, Ni, As > Be, Bi, Ag, Sb, V, Fe > Ti, Sn.