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Fractionation and mobility of heavy metals in soils of urban area of Moscow's Eastern District

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For assessment of urban soils contamination with heavy metals (HMs) their forms and mobility should be investigated. The main objective of this study is to determine 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 ($MgCl_2$); F2 – bound to carbonates (CH_3COONa); F3 – bound to Fe/Mn oxides ($NH_4OH \cdot HCl+CH_3COOH$); F4 – bound to organic matter ($HNO_3+H_2O_2$); 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 significant proportions of Cd, Mn, Zn are associated with Fe/Mn oxides; while lower percentage of these metals is 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: $PMF=(F1+F2+F3+F4)\cdot 100\% / C$, 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. Thus, very high environmental risk is associated with Cd, high risk is caused by Mn, Zn, W, and medium is formed by Cu, Pb, Mo, Sr, Cr, Co, Ni, As.

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