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Magnetic methods in assessing natural and anthropogenic soil degradation in Ukraine

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Soil is a non-renewable resource at human time scale and vulnerable to degradation (Lal, 2015). Magnetic susceptibility (MS) measurement are a cost-effective tool to quantify soil properties (Liu et al., 2015). The aim of this work is to apply MS measurements to assess soil degradation processes in Ukrainan areas: Lviv region (Truskavets, peri-urban area), Kyiv city (peri-urban area) and Kharkiv region (Pechenigi, perennial plantations).
Methods. The studies included the field MS (bulk) measurements and soil sampling. Under the laboratory condition we measured mass-specific MS, its frequency dependence (χfd). The thermomagnetic curves were obtained when heating up to the 700 [U+2103], and cooling to the near 4 K. Additionally the magnetic hysteresis, isothermal remanent magnetization (IRM), and anhysteretic remanent magnetization (ARM) were measured to identify magnetic phases, particle size, and domain state of the ferrimagnetics.
Results. The anthropogenic factor of soil degradation and its links to the magnetic parameters of soil were considered on cases of peri-urban area of Truskavets (Lviv region), and urban area of Kyiv. In Truskavets soil samples were collected near the roadway and railway and are characterized by a high MS comparing to natural areas at the mentioned area. Soil pollution was correlated with MS. The magnetic mineralogical analyzes identified that the magnetite-like phase as the main responsible for the magnetic enrichment in the polluted soil. Simultaneously, non-polluted soils have a small amount of the single domain (SD) particles and high coercivity minerals such as haematite and goethite. In Kyiv region, the correlation between heavy metals content and MS were: Cu 0.81; Pb 0.9; Fe -0.74, Zn 0.81. The given Pearson correlation is significant for the 21 samples with the probability of error p=0.05, limit $r \geq 0.3352$ (Fisher and Frank, 1961). The increase of the MS for surface soil comparing with non-polluted ones was up to 4-6 times higher. χfd values were up to 3-4, which shows the predominance of the multidomain (MD) grains of anthropogenic origin (Evans and Heller, 2003).
In Kharkiv region the results of MS distributions in the genetic horizons demonstrated the relation between genetic horizons, geomorphologic position, and MS values. The deeper horizons of the bog area located profiles are characterized with the decrease of MS. The surface organic rich topsoil has MS 2-3 times higher.
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