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New Approach for Fractioning Metal Compounds Studies in Soils

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A combined approach for fractioning metal compounds in soils on the basis of sequential (Tessier, 1979) and parallel extractions (1 N NH4Ac, pH 8; 1% EDTA in NH4Ac; and 1N HCl) is proposed. Metal compounds in sequential and parallel extracts are grouped according to the strength of their bonds with soil components. A given group includes metal compounds with similar strengths of bonds and, hence, with similar migration capacities. The groups of firmly and loosely bound metal compounds can be distinguished. This approach has been used to assess the group composition of Zn, Cu, and Pb compounds in an ordinary chernozem and its changes upon the soil contamination with metals.

Contamination of an ordinary chernozem from Rostov oblast with heavy metals caused a disturbance of the natural ratios between the metal compounds. In the natural soil, firmly bound metals predominate (88–95%of the total content), which is mainly caused by the fixation of metals in lattices of silicate minerals (56–83%of the total content). The mobility of the metals in the natural soil is low (5–12%) and is mainly related to metal compounds loosely bound with the soil carbonates. Upon the soil contamination with metals (application rates of 100–300 mg/kg), the content of all the metal compounds increases, but the ratio between them shifts towards a higher portion of the potentially mobile metal compounds (up to 30–40% of the bulk contents of the metals). Organic substances and non-silicate Fe, Al, and Mn minerals become the main carriers of the firmly and loosely bound metals. The strengths of their bonds with Cu, Pb, and Zn differ. Lead in the studied chernozems is mainly fixed in a loosely bound form with organic matter, whereas copper and zinc are fixed both by the organic matter and by the non-silicate Fe, Al, and Mn compounds. Firm fixation of the applied Cu and Pb is mainly ensured by the soil organic matter and non-silicate minerals, whereas firm fixation of Zn is mainly due to non-silicate minerals. The amount of the applied metals fixed in the lattices of the silicate minerals is insignificant. Hence, all the soil components participate in the loose and firm fixation of the metals. The leading role in mobilization–immobilization of natural metal compounds in the ordinary chernozem belongs to carbonates and silicate minerals. For exogenic metal compounds, this role belongs to the soil organic matter and Fe-Mn oxides and hydroxides.

The obtained data are important for ecology because they enable us to predict the transformation of soil components responsible for metal fixation and the possibility of their secondary mobilization. The danger of metal mobilization is more probable for metal compounds with organic substances that are particularly active in the loose binding of the introduced metals.

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