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Lanthanides in humic acids of soils, paleosols and cultural horizons (Southern Urals, Russia)

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In recent years, commercial interest in this element group increases. As consequence, their content may increase in environment, including soil and soil components. This requires quantitative estimations of rare metal accumulation by soils and their humic acids. The latter began to be actively used as fertilizers and it is alarming, because information about rare element participation (including lanthanides) in metabolism of live organisms is inconsistent.

There was investigated lanthanide content in humic acids extracted from humus horizons of different objects of archaeological site Steppe 7 (Southern Urals, Russia). Humic acids were extracted from modern background soils and paleosols and cultural horizons of the Bronze Age as well. According to archaeological data burial of paleosols under a barrow and formation of the cultural layer (CL) took place 3600 and 3300–3200 years BP, respectively. The area of the site is located in the forest-steppe landscape, far from industrial plants. Lanthanides in soils are immobile elements, and such number of objects will allow to receive information about their content changing over time and to have more detailed basis for the future monitoring of this territory as well.

Humic acids were precipitated from 0,1 n NaOH extraction after preliminary decalcification. Cleaning of humic acid preparations by 6N HCl or HF+HCl was not carried out. Determination of La, Ce, Sm, Eu, Tb, Yb and Lu was performed by multi-element neutron-activation analysis.

According to carried out diagnostics and reconstruction of natural conditions of all object formation, all objects correspond to steppe type landscape with a different level of humidity.

Analysis of received data has shown that cerium is presented in humic acid preparations in the largest quantities among lanthanides (on average 4,0–6,6 mg/kg of preparation mass). The average content of samarium, europium, ytterbium and lutetium in the humic acids in the order of magnitude ranges from 0.13 to 0.49 mg/kg, terbium and lutetium – two orders of magnitude. The quantities determined by us for lanthanum is also high at 1,9–3,3 mg/kg. In this case all lanthanides in modern soils have the degree of accumulation in humic acids distinguished from other objects: Ce>La>Sm>Yb>Eu>Tb>Lu. In the paleosols and cultural layer these series are identical: Ce>La>Yb>Sm>Eu>Lu>Tb.

There is suggested the approach to direct estimation of share of the lanthanides connected by humic acids in the their total soil pool which includes recalculation of the content of separate elements in humic acid preparations on carbon of soil humic acids (in mg/kg) and the subsequent correlation of their quantities. The content of the total organic carbon in soil, a share of humic acids as a humus part, the lanthanide content and weight carbon percentage in humic acid preparations were considered during recalculations.

The results have shown that the highest shares of all elements are found in modern background soils, the lowest - in the soils buried under barrows. The total percentage of all lanthanides in humic acids is 4.63% in relation to their content in modern soil, 1.56% – in CL and 1.36% – in buried paleosols.