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State and migratory ability of uranium and radium in the soils of Belarus

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Alpha-emitting uranium and radium are present practically in all ecosystems and together with their decay products play an important role in formation of internal radiation dose of population from natural radionuclides. This dose depends essentially not only on the content of radionuclides in environmental components, but also on the radionuclides'state and migratory ability in a soil medium.
The aim of this work is the determination of uranium and radium species in soils and natural soil waters and evaluation of radionuclide migratory ability in different soils.
The objects of investigation were samples of 0-10 cm layers of soils from different regions of Belarus.
The natural system "solid phase –pore water of soil"have been used for determination of uranium and radium migratory active forms in the soil samples. The potentially mobile forms and potentially biologically available forms were determined using accordingly the model systems "soil –1 mol/L solution of ammonium acetate" and "soil –1 mol/L solution of HCl".
Radionuclide species in soil waters were investigated by passing of the water samples through the filters of different pore size with subsequent separation of complex radionuclide forms of different electrostatic charge using the method of ion exchange chromatography. Radionuclide activity in the samples was determined by radiochemical analysis with radionuclide identification by alpha; spectrometer SOLOIST U0450 with low-background detectors 576 A 600 RV.
The specific activities of the soil samples are 4.8–22 Bq/kg for ²³⁸U and 4.5–29 Bq/kg for ²²⁶Ra. It was found that both ²²⁸U (84–94%) and ²²⁶Ra (77–91%) are mostly in the fixed forms (insoluble in 1 mol/L HCl). The radionuclide rate in migratory active forms for ²³⁸U was 0.06–0.7 % and for ²²⁶Ra 0.01–1.0 % of the total radionuclide content in soil samples. The rates of potentially mobile radionuclide forms are 3.1–9.3 % for ²²⁸U and 1.8–4.5 % for ²²⁶Ra but the radionuclide rates of potentially biologically available forms are respectively 6–16 % and 9–23 % of the corresponding radionuclide content in the soil samples.
The main part of ²²⁸U and ²²⁶Ra of natural soil water samples (65–91 %) is in dissolved state or in composition of fine colloidal (less than 0.45 μm) particles. The radionuclides in this state are the most mobile in environment. In composition of this portion of natural water samples ²²⁶Ra is mainly in the cationic form, but ²²⁸U coexist in anionic, cationic and neutral complexes. In organic soil waters, the anionic uranium complexes prevail, but in mineral soil waters, the cationic and neutral complexes are the main portion of radionuclide.
The received information allows estimating the uranium and radium rates in forms participating actively in radionuclide distribution in the soil medium as well as evaluating the radionuclide reserves in forms that can enter the soil solutions and participate in processes of biogeochemical radionuclide migration in ecosystems. The results of investigation are the basis for differentiation of soils according to migration ability of uranium and radium and for modeling of radionuclide transferring in the environment.

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