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URANIUM AND THORIUM ISOTOPES IN SOILS OF ALMATY REGION (KAZAKHSTAN)

Intensive development of various industries leads to environmental degradation, including soil pollution. The natural radioactivity of soils is caused by the content of natural radionuclides of the uranium and thorium series in the soil [1]. Soil contamination with radionuclides provokes many negative consequences, including negative effects on vegetation, animals, and humans, entering the body through the food chain [2-3]. The aim of this work to evaluate content of uranium and thorium isotopes, as well as determine mobile and potentially mobile species of radionuclides, which can easily migrate and accumulate in environment.

A sampling of soil was done from the territory of Almaty region in a village Avat which is located 40 km from Almaty one of the biggest cities of Kazakhstan. Soil sample was digested with application of lithium borates with usage of Claisse LeNeo furnace. Extraction chromatography TEVA resin was used for separation of Th isotopes, and UTEVA resin was used for U isotopes. The micro-co-precipitation technique was used for counting source preparation [4]. To analyse the fractionation and bioavailability of uranium, a sequential extraction protocol was applied. For the measurement of alpha particles of uranium, thorium isotopes, an alpha spectrometry system (Alpha Analyst, Canberra, USA) with PIPS semiconductor detectors was used. A standard reference material IAEA-375 (Radionuclides and Trace Elements in Soil) were used as quality control samples.

Content of thorium isotopes was almost two times higher in comparison to uranium isotopes. Uranium isotopes mostly distributed in strongly bond fraction, where radionuclides can be fixed in crystal lattice of the clay minerals and mostly be immobile. In first three fractions, which belongs to the mobile and potentially phytoavailable, are distributed 9% of U-234 and 5% of U-238. In potentially mobile fractions such as bound to Fe/Mn oxides and bound to organic matter are distributed 39% of U-234 and 40% of U-238. Formation of anionic carbonate forms of uranium - $[UO_2(CO_3)_2]^{2-}$, $[UO_2(CO_3)_3]^{4}$ is possible in bound to carbonate fraction, these complexes belong to the highly mobile due to their low adsorption onto soil colloids [5]. Uranium isotopes distributed in bound to organic matter fraction could bond with hardly decomposable organic matter which led to immobilisation of uranium. Thorium isotopes (Th-230, Th-232) was mostly distributed in strongly bond fraction (69% of Th-230, 91% of Th-232) which belongs to immobile fraction, where thorium isotopes possible are fixed in crystal lattice of different minerals, such as quartz, aluminosilicates due to high affinity of thorium to adsorption onto mineral surfaces [6]. Nine percent of Th-232 was distributed in bound to carbonates, bound to Fe/Mn oxides, bound to organic matter fractions while thirty one percent of Th-230 was distributed in first five fractions, which belongs to the mobile and potentially mobile. Such differences in distribution of thorium isotopes in mobile and potentially mobile fractions could indicate that Th-230 is more mobile compared to Th-232.

Despite that content of thorium isotopes in soil sample were higher than uranium isotopes, thorium isotopes were less mobile and phytoavailable. Mostly uranium isotopes could be presented in mobile and phytoavailable fractions as carbonate complexes.

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Section

Radiation ecology and methods of analysis (Section 3)

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