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# Radionuclide Composition of Soil

[1]Rashid Eshboriyev, [2]Akhmedova Guljahon, [3]Fayzullayeva Mukarram, [3]Khudaykulova Mohigul, [4]Yunusova Umorobegim.
[1]Head of the Department of Nuclear Physics, Samarkand State University
[2]Samarkand State University, Associate Professor of "Nuclear Physics".
[3]SamDu 1st year master's degree.
[4] Student of Samarkand State University
mukarramfatzullayeva@gmail.com

***Abstract:*** *In this study, the radionuclide composition of the soil of cultivated areas was studied using a NaI (Tl) -crystalline scintillation gamma spectrometer. The specific activities of natural* $Th^{232}, Ra^{226}, K^{40}$ *and technogenic* $Cs^{137}$ *radionuclides as well as* $Th^{232}/Ra^{226}$ *ratios in the tested soils were determined.*

**Keywords:** uranium, radium, thorium, potassium cesium, natural radionuclides, man-made radionuclides, radioactivity.

## 1 INTRODUCTION

The bulk of natural radioactive elements is found in rocks, especially in igneous rocks, which make up 95% of the Earth's crust. Under the influence of winds, temperature changes, water currents and other natural reagents, rocks are naturally eroded, resulting in the formation of soil layers on the surface of rocks.

Therefore, the source of radioactive elements in the soil is the rocks that make up the soil. Accordingly, the amount of radioactive elements in soils formed from different rocks also varies

Natural radionuclides, are found in soils, uranium, thorium, radionuclides formed from their decomposition, such as $Ra^{226}, Ac^{227}, Bi^{214}, Pb^{212}, Tl^{208}$ and radionuclides such as radioactive isotopes of rare earth elements $K^{40}, Rb^{87}, Lu^{176}, In^{115}$.

In addition, radioactive isotopes are formed for peaceful and military purposes, $Cs^{137}, Sr^{90}, Ce^{144}$ and others. Technogenic radionuclides also contribute to soil radioactivity to a certain extent, albeit in small amounts.

Soil is the primary link in the transition of radionuclides to the human body, because radionuclides pass through the biological chain of human soil-water-plant-air-consumption products. Plants are the basis for the preparation of a large number of food products.

Plants are grown in soils, radionuclides in the soil in the form of their solutions are absorbed and accumulated in all parts of the plant, as well as through the plant roots.

In this way, radionuclides are transferred to food and the human body. Excessive accumulation of radionuclides in living organisms above the permissible limit of safety leads to over-radiation of humans

Scientists have found that excessive radiation can lead to the development of various life-threatening pathological processes (cancer, infertility, hereditary diseases, etc.) in a healthy body.

Therefore, one of the most pressing issues facing the natural sciences is to determine the amount of radionuclides that can be found in the soil, especially in arable lands, its changes, migration, to improve existing methods, to find new methods.

Such information is important in ensuring radiation safety of people.

In this study, the radionuclide content of the soils of cultivated areas, the specific activities of natural $Ra^{226}, Th^{232}, K^{40}$ and technogenic $Cs^{137}$ radionuclides, and the $Th^{232}/Ra^{226}$ ratio / in the soils are determined.

Soil samples were taken from Jambay and Pastdargom districts in April 2019. The gamma spectra of the samples were measured on a NaI (Tl) crystal gamma spectrometer in Marinelli vessel geometry for two hours.

The detector's energy resolution is 10% in 661 keV energy gamma line of $Cs^{137}$. The peaks observed in the measured spectra were identified by energy.

Gamma spectra revealed 295, 351, 1120, 1764 keV energy peaks belonging to the uranium-238 family, 911, 968, 2614 keV energy peaks belonging to the decay chain of the thorium-232 family.

In the spectra, the photo-peak with the energy of 1460 keV is clearly formed, and the photo-peak with the energy of 661 keV is weak.

Analytical photovoltaics were selected to determine the specific activity of radionuclides detected in the gamma spectra of soils, taking into account the quantum emissions of photovoltaics, half-lives, and relative determination using $Ra^{226}, Th^{232}, K^{40}$ in OMACN sets and $Cs^{137}$ reference radionuclides.

The results are as follows, Bk / kg in units: $A_{Ra^{226}} = 42, A_{Th^{232}} = 35, A_{K^{40}} = 796, A_{Cs^{137}} = 15$ in the soil of Jambay district; $A_{Ra^{226}} = 35, A_{Th^{232}} = 40, A_{K^{40}} = 708, A_{Cs^{137}} = 16$ on the soil of Pastdargom district:. These results show that the radioactivity of soils obtained from both crop areas is determined by natural $Ra^{226}, Th^{232}, K^{40}$ and technogenic $Cs^{137}$ radionuclides.

The highest activity is $K^{40}$, due to the relatively large distribution of the element potassium in the Earth's crust, which can be attributed to the treatment of soils with potassium fertilizers.

The difference between the relative activity of $Ra^{226}$ and $Th^{232}$ radionuclides detected in soils is not significant. This indicates that natural radionuclides are distributed naturally in the same type of soil, almost uniformly, within the limits of measurement errors. The specific activity detected in soils is also almost the same

Due to the proximity of the areas where the soils were extracted, they may have been uniformly applied to technogenic $Cs^{137}$ areas that appear in nuclear weapons tests. The half-life of $Cs^{137}$ is determined $T_{1/2} = 30$ years in soils to date.

The literature states that different amounts of uranium and thorium are detected in different soils, but the amount of thorium in all types of soils is higher than that of uranium $[1,3]$

**2 RESULTS**

The ratio of thorium / uranium in different soils varies, ranging from (5.7 to 50), which indicates that the ratio of thorium to uranium in soils is small. The amount of thorium in different soils varies between $(2{,}6 - 6{,}0) \cdot 10^{-4}\%,$ amount of thorium $(0{,}12 - 0{,}93) \cdot 10^{-4}\%$.

Due to the fact that thorium is soluble in water and migration is weaker than that of uranium, the amount of thorium in soils can be high.

Uranium dissolves much better in water, forming solutions and leaching out of soils.

Therefore, its content in the soil is small compared to thorium. The amount of radium formed from the decay of uranium in different soils is $(0{,}28 - 0{,}9) \cdot 10^{-10}\%$

The leaching of radium from soils is weaker than that of uranium. In this study, the Th / Ra ratio in the studied soils was considered. But this ratio, found in the soils of both fields, is almost the same value.

This result can be explained by the difference in the half-lives of Ra and Th. $T_{1/2}(Ra) = 1620$ yil, $T_{1/2}(Th) = 1{,}4 \cdot 10^{10}$ year. The smaller $T_{1/2}$ of the radionuclide, the higher the rate of decomposition, the higher the activity, and vice versa (according to the formula A = $\lambda N; \lambda = \dfrac{0{,}693}{T_{1/2}}$).

**3 CONCLUSION**

Accordingly, the specific activity of a small amount of radium in the soil can be almost equal to the specific activity of a large amount of thorium in the soil.

The results of the study provide information on the level of distribution of radionuclides in the soils of different regions.

The amount of radionuclides detected in soils does not exceed their limit values, which are defined as safe.

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