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Radioactivity of Molluscs, Aqueous Sediments and Water in the Jambay Canal of Uzbekistan.

Shakhboz Khasanov*, Temur Mavlonov

Department of Nuclear Physics, Faculty of Physics, Samarkand State University, Samarkand, Uzbekistan
*E-mail address: shakhboz.khasanov@list.ru

Abstract: *The research findings summarized in the paper include data on the radioecological conditions of the canal located in Jambay region of Uzbekistan. The focus of the study was on the determination of accumulation of radionuclides in molluscs depending on the content of radionuclides in aqueous sediments and water by the help of the scintillation gamma spectrometry method.*

Keywords— Reservoir; cumulation; technogenic; migration; igneous.

1. INTRODUCTION

In natural waters the main contribution is caused by the decay of natural radionuclides (NRN) of uranium-238, thorium-232, Radium-226, Radon-222, polonium-210, radium-228, radium-224, uranium-234 and natural radioactive isotopes potassium-40, rubidium -87. The concentration of NRN in water varies over a very wide range and mainly depends on the species composition of the radionuclide and soil which water comes in contact with [1].

In addition, nuclear and underwater tests carried out by different countries, radioactive waste disposal in rivers, accidents at the nuclear power plants have led to environmental pollution, including reservoirs with technogenic radionuclides of ^{137}Cs, ^{90}Sr, ^{144}Ce and others. Technogenic radionuclides ^{137}Cs and ^{90}Sr in water are in a highly dispersed and soluble form, which contributes to their intensive participation in the metabolic processes of biotic systems.

Radioactive substances in aqueous media, algae, aqueous sediments can be perceived by aquatic ecosystems, as well as other mineral elements, through the food chain and by way of absorption on boundary tissues.

Some algae serve as food for molluscs. Algae can accumulate natural radionuclides from both water and aqueous sediments. Radioactive elements in the body of aquatic ecosystems accumulate in different magnitudes and this depends on the content of radionuclides in the water, in the bottom and in algae, on the properties and the external structure of the ecosystems themselves. [2]

For example, the concentration of radium-226 and uranium in marine plankton reaches 100 pCi / kg, and the thorium content does not exceed 25 pCi / kg of fresh tissue. Intensive accumulation of radionuclides in molluscs was noted [3].

In the present work, the specific radioactivity of natural radionuclides ^{226}Ra, ^{232}Th and ^{40}K by the help of the scintillation gamma spectrometry in aqueous sediments, water, and molluscs of the Jambay canal was determined. Samples of molluscs and sediments were dried and crushed. The weight of the prepared samples of molluscs and aqueous sediments was 1200 grams.

The measurements of the gamma spectra of the samples were performed in Marinelli beaker geometry on γ- spectrometer with NaI(Tl) scintillation detector, Ø63 × 63 mm, an energy resolution of 10% on a gamma line ^{60}Co with an energy of E = 1332 keV.

Registration and processing of the spectra were done on IBM PC with automatic writing of the spectra into the computer memory every hour which allowed to control the stability of spectrometer and correct the spectra when necessary. The duration of the measurement was t=2 h. The results of the measurement of the spectra are shown in Figure 1 - 2. The identification detected in the photopeak spectra was carried out by energy, taking into account quantum yields, half-lives, and the position of photopeaks in the spectra. In all measured gamma spectra of the samples, a photopeak with an energy of 1460 keV of the natural radionuclide ^{40}K, as well as photopeaks belonging to the radionuclides of the uranium-thorium families is clearly manifested. For decomposition of experimental spectra into parts and determination of activities, we used volumetric standard sources OMACH - ^{226}Ra, ^{232}Th, and ^{40}K packed in Marinelli beakers (identical with samples) with accuracy of 0.95.

Table 1. Specific activities of ^{226}Ra, ^{232}Th, and ^{40}K in samples, Bq / kg.

Samples	**^{226}Ra**	**^{232}Th**	**^{40}K**
Aqueous sediment	26.7 ± 3.0	35.2 ± 4.4	28.7 ± 2.0
Water	1.4 ± 0.2	4.8 ± 0.5	36.0 ± 3.5
Mollusc	5.2 ± 0.5	5.0 ± 0.5	32.0 ± 3.2

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Fig 1. The gamma spectrum of aqueous sediments.

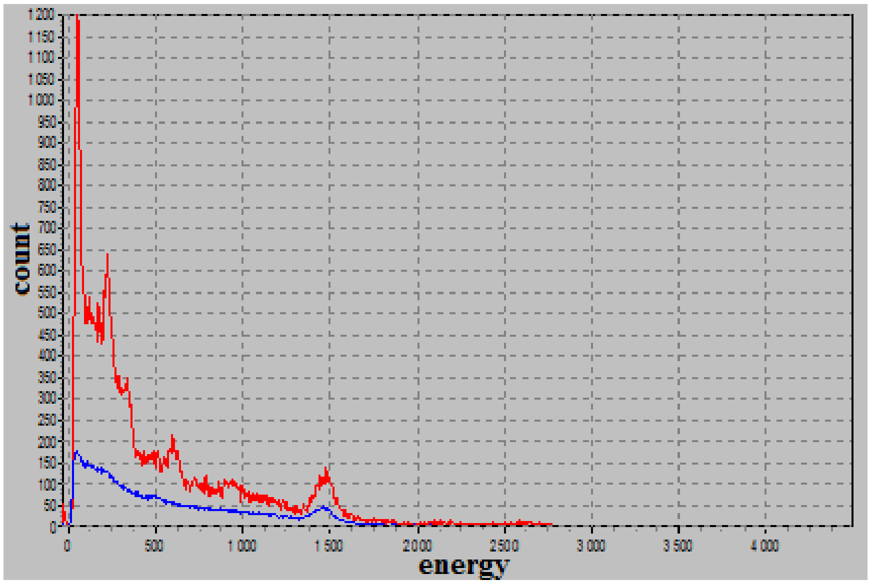
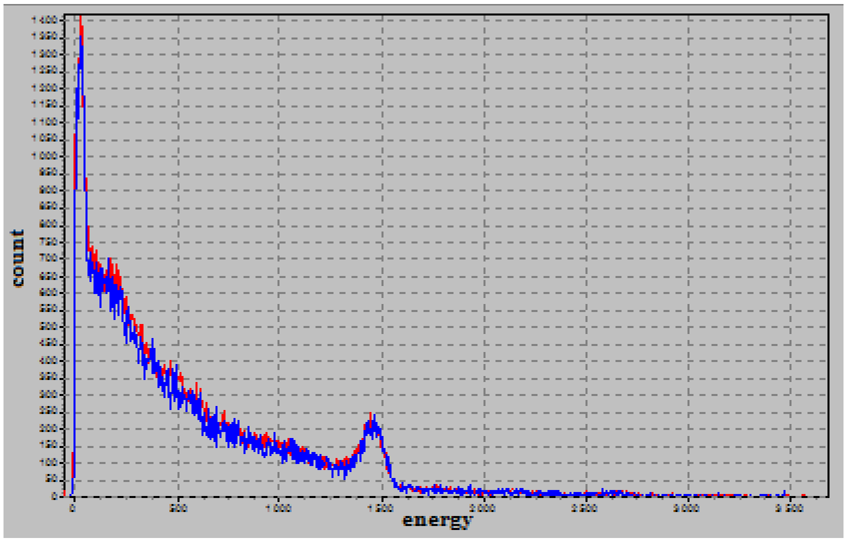


Fig 2. The gamma spectrum of mollusc.



2. RESULTS AND DISCUSSION

From the data presented in the Table 1 it can be seen that, in the content of the investigated water, molluscs and aqueous sediments ^{226}Ra, ^{232}Th, and ^{40}K radionuclides were determined. The content of radionuclides in water depends both on the chemical composition washed by these waters and on climatic and metrological factors. In the investigated water, the specific gamma activity of the natural potassium-40 radionuclide is on average ~ 7 times higher than the specific gamma activity of radium-226 and thorium-226. This circumstance can be explained as follows: the bulk of potassium, like other elements, is found in igneous rocks, for which its average frequency equals to 2.4%. In the leaching rocks potassium relatively easily washed away, it passes into the state of solution and goes partly into the reservoirs. Its average content in seawater is 0.0038%, that is, in these sediments it is 0.7–3.5% [3], which significantly exceeds the content of uranium, thorium and radium. It was established that the radioactivity of river-water is mainly caused by potassium-40 [3, 4].

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The specific gamma activity of radium-226 in water is 4.4 Bq / kg. Like other radioactive elements, radium, found in igneous rocks, when eroded in a significant amount, pass into natural solutions and is transferred to the lake, seas, rivers, and oceans, where it partially remains dissolved in water, partly together with silt and other sediments are precipitated on the bottom of reservoirs [5].

However, thorium compounds are practically insoluble. Thorium migrates mainly in water flows in a suspended and colloidal state [5]. Thorium is characterized by weak migration with the formation of chemical compounds. In addition, the radionuclide content in river-waters is significantly influenced by the characteristics of the channel, the flow rate, temperature, chemical composition and degree of water salinity. For different rivers, these features are not identical. There is a high content of radionuclides ^{226}Ra, ^{232}Th, and ^{40}K in aqueous sediments in relation to their content in reservoirs. Apparently, this phenomenon is explained by the fact that in an aqueous medium, potassium due to adsorption, is predominantly retained on particles of sediments. The minerals of thorium in natural waters dissolve much less than the minerals of uranium. Therefore, thorium is contained in waters hundreds of times less than uranium. Consequently, the thorium content in the aqueous sediments should be just over. Thorium goes into aqueous sediments not from solutions, but through the weathering of the igneous rocks in which it was originally present. In aqueous sediments enclosed the bulk of thorium [5]. ^{226}Ra is relatively easier to leach out of rocks, due to its location outside the crystal latitude of minerals. ^{226}Ra from minerals pass into aqueous solutions and goes into the reservoirs. The corresponding part of the ^{226}Ra, which has got into the aquatic medium, gradually settles to the bottom of reservoirs, and participates in the formation of sedimentary rocks. ^{226}Ra is poorly washed out of the soil, as well as from sediment compared to uranium, which leads to the enrichment of sediment with ^{226}Ra. At the numerous measurements of the specific activity of sedimentary rocks, it was found that deep- aqueous sediments have the highest activity [4]. This result also requires a high content of certain radionuclides in sediments in relation to their content in the reservoirs. In the studied gamma spectra of molluscs of this reservoir also detected radionuclides ^{226}Ra, ^{232}Th, and ^{40}K. This indicates that radioactive substances contained in the aquatic medium can be perceived by aquatic ecosystems, including molluscs, like other mineral elements, along food chains and absorbed by their border tissues.

3. Conclusion

In the molluscs the accumulation of radionuclides ^{226}Ra, ^{232}Th, and ^{40}K depending on their content in reservoirs were observed. It was revealed that the accumulation of radionuclides in molluscs is proportional to their content in the reservoir. By determining the specific activity of radionuclides in molluscs, one can obtain information on the radioactivity of reservoir.

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