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MEASUREMENTS OF RADIATION CONTAMINATION AT FORMER URANIUM MINING FACILITY AT THE SAUMALKOL SETTLEMENT

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Introduction

The nuclear industry is one of the most promising and dynamically developing sectors of the world economy. Kazakhstan is also a follower of the development of this industry, as the country has one of the world's largest raw materials base of natural uranium. However unfortunately, the extraction of raw materials and the testing of atomic weapons at the Semipalatinsk nuclear test site, as part of the USSR's nuclear program, entailed negative changes in the environment.

The former North Kazakhstan uranium ore province is located on the territory of the Akmola and North Kazakhstan regions of Kazakhstan. There are 34 deposits and 19 uranium mines concentrated here. The total volume of accumulated radioactive waste is over 54.5 million m^3. The main sources of radon include:

• ore raw materials (uranium, rare earth ores and some others);
• tectonic faults;
• water from radon-bearing water sources;
• building materials from highly radioactive rocks;
• soils and grounds formed from highly radioactive mountain
rocks, or overlying fault radon-bearing systems.1

Radon is the source of half of the entire dose of ionizing radiation received by humans. It is also the second leading cause of lung cancer after smoking.

In Kazakhstan, lung cancer ranks second in the structure of oncological diseases and first in mortality. About 3,500 cases of malignant neoplasm are detected annually in the Republic of Kazakhstan, while six to seven Kazakhstanis dies every day due to lung cancer. Mortality from lung cancer within one year is 50%, and in the absence of adequate therapy, 80% of patients die within two years. And only 23.46% of patients with lung cancer, according to statistics, will be able to live for five years or more. The highest rates of morbidity and mortality from lung cancer are noted in East Kazakhstan, Pavlodar, North Kazakhstan, Akmola and Karaganda regions.2

The investigated Saumalkol settlement is located on the northwestern shore of Lake Saumalkol. A spent uranium mine is located 5 kilometers to the northwest.1

The aim of the work is to provide isotopic analysis of construction materials at territory of uranium mining facility for finding amount of radioisotopes which are able to decay into radon gas causing radioisotope contamination of air.

Materials and Methods

For isotopic analysis of the samples, the Saumalkol settlement in the North Kazakhstan region was chosen, located 5 km from the mothballed mining department No. 5 of the Tselinny mining and chemical plant.

To determine the flux density of alpha and beta particles, as well as to determine the value of the specific activity of gamma radiation, an MKS AT1315 gamma spectrometer was used, which included a scintillation NaI detector of gamma radiation. Two-channel scintillation gamma spectrometer MKS-AT1315 is designed for simultaneous and selective determination of:

- specific activity of 137Cs, 40K and 90Sr in samples of environmental objects;
- specific effective activity of natural radionuclides 40K, 226Ra, 232Th in building materials.

The principle of operation of the MKS-AT1315 gamma-beta spectrometer: based on the measurement and conversion of gamma and beta radiation recorded by autonomous detecting units into amplitude distributions, which are subsequently converted into a digital code and stored in the detecting unit.5

Samples were collected using the envelope method.

The work was carried out in accordance with the standard methods for measuring radiation parameters and laboratory analyzes.

Results and discussion

The specific activity values were obtained from the radiometric method of processing samples, which were collected from two non-residential points of the Saumalkol settlement itself.

Figure 1- Location of the Saumalkol settlement and uranium mining facility №5 on the map of Kazakhstan

Figure 2 -The places where the samples were collected

Building materials from the area were collected as samples and combined for general analysis.

According to the hygienic standard "Sanitary and Epidemiological Requirements for Ensuring Radiation Safety", the effective specific activity (Aeff) of natural radionuclides in building materials mined at their deposits or being a by-product of the industry, as well as industrial waste used for the manufacture of building materials, and finished products should not exceed:

$$A_{eff} = A_{Ra} + 1.3A_{Th} + 0.09A_K \leq 370 \text{ Bq/kg} \qquad (1)$$

Where:

A_{Ra} and A_{Th} - specific activities of ^{226}Ra and ^{232}Th, which are in radioactive equilibrium with other members of the uranium and thorium series,

A_K - specific activity of ^{40}K (Bq / kg).3

In our analysis, we received the final results of the collected samples:

Table 1 - Results of isotope analysis of collected samples

	Radionuclide	Activity, Bq/kg	Uncertainty,%
#1	Ra-226 Th-232 K-40 A_{eff}	49.3 37.7 413 135 Bq/kg,+/-13.7 Bq/kg	6.88 5.58 105
#2	Ra-226 Th-232 K-40 A_{eff}	48.0 40.7 525 148 Bq/kg,+/-14.4 Bq/kg	6.78 5.79 114
#3	Ra-226 Th-232 K-40 A_{eff}	44.7 41.3 509 144 Bq/kg,+/-14.2 Bq/kg	6.55 5.82 112
#4	Ra-226 Th-232 K-40 A_{eff}	46.5 37.5 402 131 Bq/kg,+/-13.6 Bq/kg	6.69 5.57 105
#5	Ra-226 Th-232 K-40 A_{eff}	49.7 40.0 437 141 Bq/kg,+/-13.9 Bq/kg	6.93 5.35 106
Total result	Ra-226 Th-232 K-40 A_{eff}	47.7 ,+/-10.2 Bq/kg 39.4 ,+/-8.62 Bq/kg 457 ,+/-204 Bq/kg 138 +/-23 Bq/kg	

The results of isotope analysis of building materials showed a specific activity of 138 +/- 23Bq / kg.

According to evidences taken from isotopic analyses, construction materials at uranium mining facility contains approximately natural amount of radioisotopes and they are not the source of radiation contamination of air. Nevertheless, different contraction materials were taken as a samples. Different molecular consistence of these samples cannot give us full view of radioisotope distribution in material. This error must be corrected in next researches.

Conclusion

Results of this research shows that construction materials at buildings of uranium mining facility No 5 cannot cause radiation hazard for population of v. Saumalkol. However, there are evidences provided by KAZNU university and Institute of molecular and cell biology SB RAS 4 that background radiation in houses and other premises at this region are much higher than it is supposed to be. Considering that samples were taken from decontamination point we can expect that other buildings of facility was the uranium processing buildings, and isotopic consistence at this buildings

must show different radiation level. Therefore, additional researches must be done. In this research. it is important to acquire samples of soil and water.

The article presents the results of studies of isotope analysis of samples from the Saumalkol settlement in the North-Kazakhstan region in connection with the radon hazard of the area. A pilot study was carried out to identify the radon activity of the area. On the territory of the Saumalkol settlement, the collected samples of building materials showed the permissible value of the specific activity, showing the result A = 138 +/- 23 Bq / kg. Building materials did not reveal abnormal indicators of radon activity that could threaten the lives of the local population.

Key words: radon, gamma radiation, dosimetry, radionuclides, isotope analysis

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