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Comparative analysis of the radiation situation in the Stepnogorsk district in the Akmola region

Abstract. The territory of the Akmola region is characterized by the presence of a number of radiation factors caused by natural and man-made manifestations of increased radioactivity, the main of which are numerous areas of anomalous increases in natural radioactivity, uranium deposits and ore occurrences, as well as long-term large-scale activities of uranium mines and enterprises for the extraction of other minerals, with associated uranium mineralization.

In this article, we will show the results of a study of pollution in the Stepnogorsk district in recent years and demonstrate the analysis of the data. The article will analyze the research data of 2016 and 2020. Comparison of the results showed that the concentration of pollution is present in high doses, in particular, special attention is paid to the village of Aksu.

Keywords: radioactivity, air pollution, EEVA, radon, soil pollution.

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Introduction

In 2015-2016, a scientific project was carried out, the study of which was «Study of the role of microRNA in the regulation of cellular processes induced by radiation for the development of molecular diagnostics and typing of lung tumors». In the course of the study, work was done to conduct assessments of radiation risks for the population in the Republic of Kazakhstan living in areas with a high radon content. Based on the results of this work, on the territory of the Republic of Kazakhstan, zones with an increased level of radon and its daughter decay products (DDP) of natural and technogenic origin were established: East Kazakhstan and Akmola regions [1].

The main criteria for identifying radon-hazardous zones are:

- Lack of development of loose sediment cover.
- The presence of magmatic formations of a predominantly acidic series.
- The presence of a manifestation of long-lived renewed and young tectonics.
- The presence of uranium deposits, manifestations and radioactive anomalies.
- Availability of water sources with radon manifestations.
- Presence of manifestations of high concentration of radon in the premises of settlements and cities [2].

In the Akmola region there is a large part of one of the world's largest North Kazakhstan uranium ore province, which includes more than 30 uranium deposits and ore occurrences of uranium, combined into 7 ore clusters, and several hundred radiation natural anomalies, which forms the uranium geochemical specialization of the region. The deposits were worked out by mining or opened by exploratory mine workings, which led to the formation of a large amount of radioactive waste. All these factors contribute to the manifestations of high radon activity in the region [3].

Stepnogorsk is a city in the Akmola region, with about 50 thousand inhabitants, which is located 185 km northeast of Astana (Fig. 1).

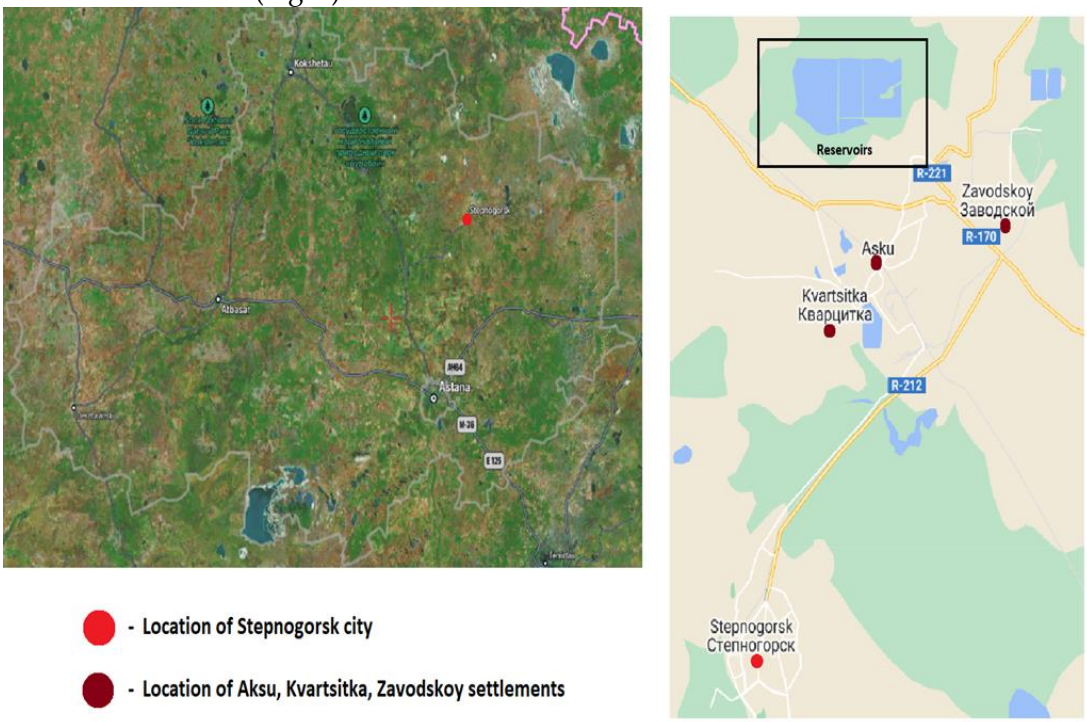

Figure 1. Map of Akmola region and locations of Stepnogorsk city and Aksu, Kvartsitka, Zavodskoy settlements [4]

The city of Stepnogorsk previously housed the Tselinny Mining and Chemical Combine, which was engaged in the extraction of uranium and other chemical elements for the nuclear industry, as well as the Stepnogorsk Scientific Experimental Industrial Base, where bacteriological weapons were developed and produced. Now Stepnogorsk is a city in which there are large enterprises, a chemical industry, gold is mined outside the city, in which cyanide breakthrough periodically occurs, there are burials of uranium waste and tailings.

The purpose of the work is to compare the data obtained from the studies of 2016 and 2020 and show an analysis of the changes.

In 2016, at the Astana Medical University, a report was made on the topic "Problems of radon safety in the Northern regions of Kazakhstan" from Berdimbaeva D.Sh. To conduct this study, settlements were selected in the Akmola region - Aksu, Zavodskoy, Kvartsytka, adjacent to the operating Stepnogorsk Mining and Chemical Plant (SMCP) and in the North Kazakhstan region, the Saumalkol settlement, located 5 km from the mothballed mining department No. 5 of Tselinnoye Mining - chemical plant. In this work, we measured the exposure dose rate of gamma radiation, the flux density of α- and β-particles, and the equivalent equilibrium volumetric activity (EEVA) of the daughter products of 222Rn and 220Rn radon isotopes in residential areas of settlements [5].

In 2020, the work of D. Ibrayeva was published on the topic “Radiation Situation in the Territories Affected by Mining Activities in Stepnogorsk Areas, Republic of Kazakhstan: Pilot Study”. The purpose of this investigation was to study the radiation situation of the technogenically modified natural environment in the settlements of the Stepnogorsk region in order to understand the sources of pollution and the potential source of radiation hazard. For this, work was carried out to measure the equivalent equilibrium volumetric activity (EEVA) of radon in indoor air and to study the vertical distribution of the activity of the concentration of natural radionuclides (226Ra, 232Th and 40K) in the soil [6].

Research methods

In the work of Berdimbaeva D.Sh. radiometric measurements were carried out with «RKS-01-Solo» dosimeter and with Ramon-02 radon monitor. Pedestrian gamma survey on the territory of settlements was carried out using a network of 500 x 500 m with detailing in areas of radioactive contamination. At each of the identified sites, a detailed gamma survey was carried out using a 1x1m network with the measurement of gamma background, alpha and beta radiation.

In a 2020 study, the equivalent equilibrium volume activity of radon in indoor air was measured with Ramon-02 and Ramon-02A automatic small-sized radon and thoron radiometers [7]. The measurements were carried out in residential and administrative underground premises. And the concentration of radionuclide activity 232Th, 226Ra and 40K in the soil was measured on the «Progress-BG» beta-gamma spectrometer with a NaI detector with a relative efficiency of no more than 30% [8].

Results and discussion

According to the results of a study in 2016, it turned out that in the Aksu village, the concentration of radon in administrative buildings exceeds 4 times, and in the private sector 5 times, compared with radiation safety standards (Fig. 2).

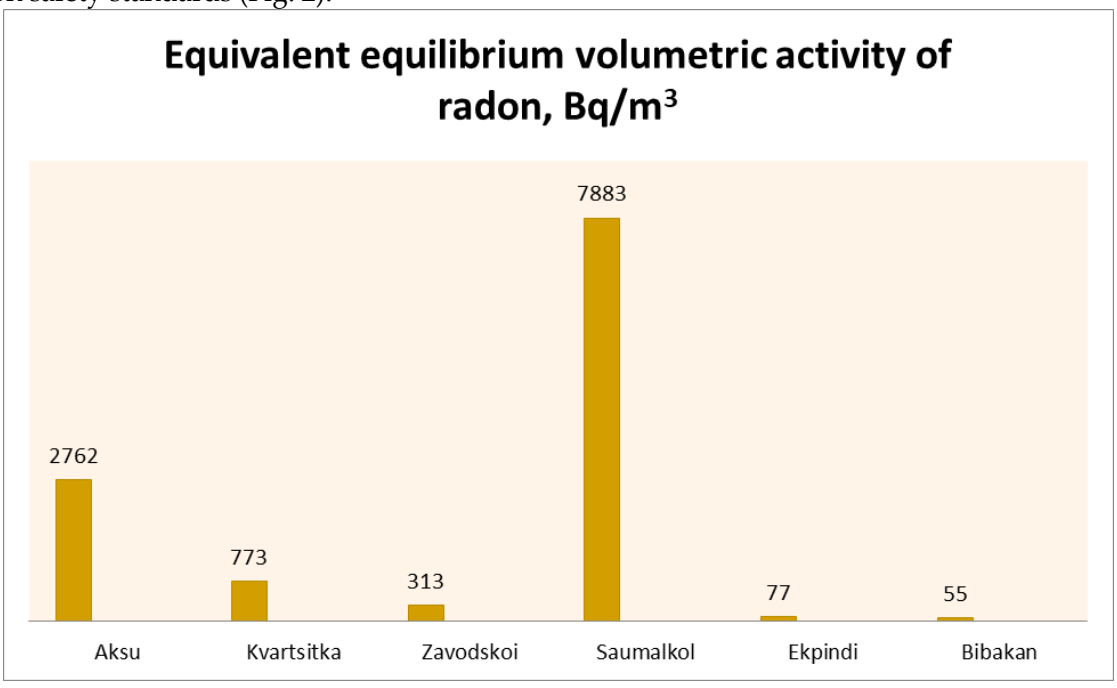

Figure 2. Equivalent equilibrium volume activity of radon, Bq m−3 [5]

In the private sector, in the area of the abandoned quarry in the Saumalkol settlement, a high level of radon concentration was detected, which exceeds the norm by 21 times.

Also, abnormally high radon activity was detected in a number of surveyed residential premises (Saumalkol, Aksu), probably associated with the use of local building materials containing elevated concentrations of natural radionuclides.

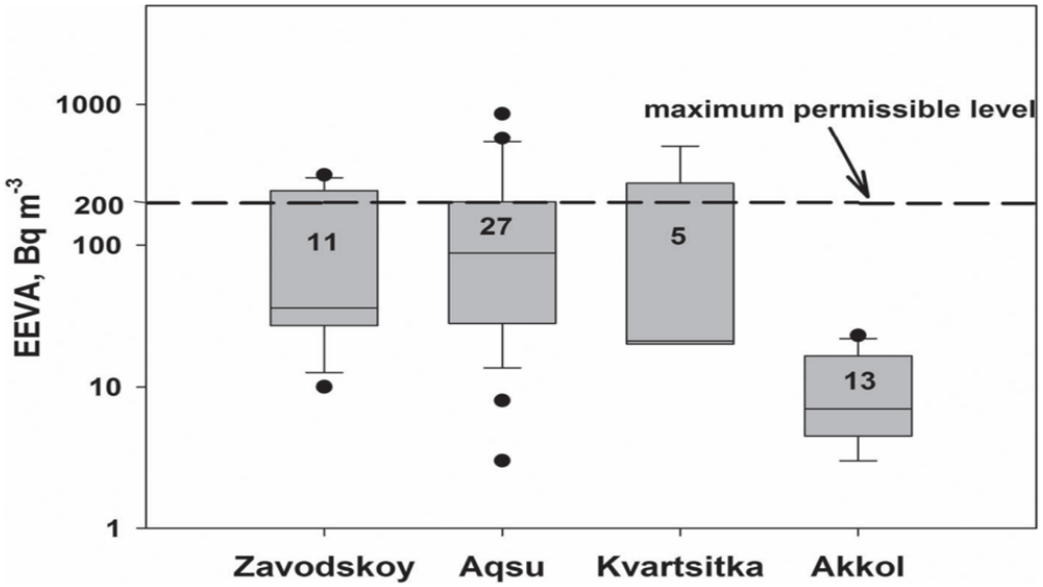

Figure 3. Measurement results equivalent equilibrium volumetric activity of radon in residential premises of Aksu, Zavodskoy, Kvartsytka and Akkol settlements, Bq m−3 [6]

The results of the study conducted in 2020 (Fig.3) showed that the main factor of the increased natural radiation background of the environment was not the impact of the removal of radionuclides from the territory of the tailings dump in the territory of the Akmola region. However, the high values of radon and soil pollution in abnormal areas in the studied territories could be explained by the fact that in the 1930s there was a gold mining site.

The equivalent equilibrium volume activity of radon (indoors) reaches values of 313-858 Bq m−3 (which exceeds the permissible level) in buildings located near former gold mining enterprises. High concentrations of the activity of natural radionuclides in the soil up to 226Ra-4060, 232Th-1170 and 40K-4080 Bq/kg, respectively, were established on the territory of the former gold mining complex in Stepnogorsk district.

Conclusion

The results of 2016 showed that abnormally high radon activity was detected in a number of surveyed residential premises (Saumalkol, Aksu), probably associated with the use of local building materials containing elevated concentrations of natural radionuclides. And the results obtained in 2020 also revealed high concentrations of air and soil pollution near the location of gold mining. Ultra-high values of the equivalent equilibrium volume activity of radon were detected in the school premises of the village of Aksu.

Referring to the results of data from studies that were conducted in 2016 and 2020, it is possible to see buildings and territories with high local pollution. However, in 2016, the reason for such anomalies was the use of local building materials that contain elevated concentrations of natural radionuclides, and in 2020, these contaminants are explained by the location of the place where gold ore has been mined and processed since 1932.

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Ақмола облысы Степногорск ауданындағы радиациялық жағдайды талдау

Аңдатпа. Ақмола облысының аумағы жоғары радиоактивтіліктің табиғи және техногендік көріністеріне байланысты бірқатар радиациялық факторлардың болуымен сипатталады. Олардың негізгілері: табиғи радиоактивтіліктің қалыптан тыс жоғарылауының көптеген аймақтары, уран кен орындары мен кен көріністері, сондай-ақ уран кеніштері мен уран минералдануы бар басқа да пайдалы қазбаларды өндіру жөніндегі кәсіпорындардың көпжылдық ауқымды қызметі. Бұл мақалада соңғы жылдардағы Степногорск ауданының ластануын зерттеу нәтижелері және алынған деректерді талдау көрсетіледі. Мақалада 2016 және 2020 жылдардағы зерттеу деректері талданады. Нәтижелерді салыстыру деректері арқылы ластану концентрациясы жоғары дозаларда екендігі көрінеді, әсіресе Ақсу ауылына ерекше назар аударылады.

Түйін сөздер: радиоактивтілік, ауаның ластануы, эквивалентті тепе-тең көлемдік белсенділік, радон, топырақтың ластануы.

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Сравнительный анализ радиационной обстановки Степногорского района в Акмолинской области

Аннотация. Территория Акмолинской области характеризуется наличием целого ряда радиационных факторов, обусловленных естественными и техногенными проявлениями

повышенной радиоактивности, главными из которых являются многочисленные участки аномальных повышений природной радиоактивности, урановые месторождения и рудопроявления, а также многолетняя масштабная деятельность урановых рудников и предприятий по добыче других полезных ископаемых, с сопутствующей урановой минерализацией. В данной статье мы покажем результаты исследования загрязнения Степногорского района за последние годы и продемонстрируем анализ данных. В статье будут анализированы данные исследований 2016 и 2020 годов. Сравнения результатов показал, что концентрация загрязнения присутствует в повышенных дозах, в особенности особое внимание уделяется поселку Аксу.

Ключевые слова: радиоактивность, загрязнение воздуха, ЭРОА, радон, загрязнения почвы.

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