

Assessment of modern radioecological situation in Aghdam, Lachin and Kalbajar districts

^{1*} Aliyev Chingiz Said, ² Humbatov Famil Yusif, ¹ Mahmudova Farah Fuad,
¹ Aliyeva Aziza Rafik, ¹ Karimli Khayal Mardan

¹ Institute of Geology and Geophysics, Ministry of Science and Education of the Republic of Azerbaijan, 119 Huseyn Javid Ave., Baku AZ1143, Azerbaijan

² Institute of Radiation Problems, Ministry of Science and Education of the Republic of Azerbaijan, 9 BakhtiyarVahabzadeh Str., Baku AZ1143, Azerbaijan

*For correspondence: aliyev.chingiz47@gmail.com

Received: October 1, 2022; Received in revised form: October 17, 2022; Accepted: November 6, 2022

The article presents the typical results of investigations carried out for assessment of the modern radioecological situation in liberated territories of the Aghdam, Lachin and Kalbajar districts. Earlier studies have shown that the radioactivity of rocks in Karabakh varies depending on the composition and age of lithological-stratigraphic intervals. In general, the gamma activity of rocks in this area does not exceed the background significance characteristic of structural complexes of different ages of the Lesser Caucasus. During radioecological monitoring in the studied area, the measurement of the strength of the exposure dose of gamma radiation was carried out by the IndetiFINDER-2 dosimeter-spectrometer, and the strength of the ambient equivalent dose was carried out by the portable dosimeter-radiometer of MKC-AT1125. As a result of the conducted studies, it was found that the radiation background in Aghdam and Lachin regions is within the norm, and only in soil samples taken from Istisu settlement of the Kalbajar region, the average value of the dose absorbed in the air (D), external hazard index (Hex) and the annual effective dose equivalent (AEDE) were higher than the limit values.

Keywords: Karabakh, natural radioactivity, gamma radiation, liberated territories, radioecological pollution, strength of exposure dose of radiation

INTRODUCTION

Maintaining a balanced ecosystem is one of the most important and urgent problems of the XXI century, which includes the problems of reducing the anthropogenic impact on ecosystems as much as possible and protecting the environment against global environmental disasters. Studying radioactive areas in the Earth's crust has particular importance in solving these problems.

As it is known, as a result of the occupation of Azerbaijani lands by Armenia for 30 years, various man-made activities and combat operations in these territories have caused serious damage to the environment. Also during those years, in the investigations devoted to the study of

the radiation background in the territory of the republic, the occupied territories were left out for obvious reasons, and old data were used on the compiled maps, which creates the need for new radiometric studies in these territories.

Earlier studies have shown that the radioactivity of rocks in Karabakh varies depending on the composition and age of lithological-stratigraphic intervals. In general, the gamma activity of rocks in this area does not exceed the background significance characteristic of structural complexes of different ages of the Lesser Caucasus (Алиев и др., 2004; Алиев, 2005). The Jurassic structural complex, which forms the main part of the geological section in the Lakh-Karabakh zone, is represented by

terrigenous-tufogenic sections in the lower part of the section, volcanogenic - sedimentary sections in the middle part, and volcanogenic-sedimentary and carbonate facies in the upper part.

Various structural and material complexes of chalk are also widely represented in the lower mountainous and north-eastern slopes of the Murovdag and Karabakh ranges (Lok-Karabakh zone, Gazakh-Agburun and Khachinchay-Khojavand structure), as well as in the basins of Hakari and other left tributaries of the Araz River (Gafan zone). In general, for Cretaceous rocks, indicators of natural radioactivity vary within the limits of 4,5-7,5 $\mu\text{R/h}$. In the Eocene-Miocene-Golocene volcanogenic complex of the Kalbajar zone, natural radioactivity varies within 5-7 $\mu\text{R/h}$, and in some areas of Eocene rocks, it reaches 8-9 $\mu\text{R/h}$ or more.

The main purpose of the research work was the assessment of the modern radioecological situation in the liberated Karabakh territories, the identification of sources of danger and the determination of radionuclide content of samples taken from the areas with high levels of radioactivity.

METHODS AND DEVICES

During radioecological monitoring in the studied area, the measurement of the strength of the exposure dose of gamma radiation was carried out by the IndetiFINDER-2 dosimeter-spectrometer, and the strength of the ambient equivalent dose was carried out by the portable dosimeter-radiometer of MKC-AT1125 (Fig. 1).

The measurement works were carried out taking into account the requirements of the standard operating theory. Gamma spectrometric analysis of the taken soil samples was carried out in the laboratory. Gamma spectrometer complex with sensitive semiconductor detector based on high - purity Ge-crystal manufactured by "CANBERRA" company and scintillation spectrometer CEG-001 "AKII-C"-150 were used during the research works in the laboratory. Samples were prepared for measurement using standard operating procedures based on the ASTM c1402-04 (2009) method and the determination of radionuclides in soil samples was carried out. During preparation, after removing stone and plant residues, soil samples were dried at room temperature, ground and passed through a 1 mm sieve and homogenized.



Fig. 1. Measurement devices

Samples were placed in 100 cm³ plastic containers, sealed with silicone glue and stored for four weeks to achieve radioactive equilibrium.

Before the analysis of the samples, quality assurance and quality control procedures were carried out. For this, the spectrum of the standard source (Na22, Eu155mix) and the background spectrum of the measuring camera were used.

The spectra were analyzed by using the GENIE 2000 program. The specific activity of ²²⁶Ra and ²³²Th was determined from their decomposition products on the basis of ²¹⁴Bi (609 keV) and ²²⁸Ac

(911 keV), respectively. The measurement time of samples was 86400 seconds (24 hours) (Humbatov et al, 2016; Humbatov et al, 2017).

RESULTS AND DISCUSSION

During the studies in Aghdam Region, in 18 points measurements were made, samples were selected and taken from 10 points (Table 1). Samples were taken mainly from arable land and near water sources.

Table 1. Preliminary results of radioecological research conducted in the Aghdam region

Region	R (nSv/h)	A _{eff} (Bq/kg)	U (Bq/kg)	Th (Bq/kg)	K (Bq/kg)
Sarjali	53	68.6	14.2	19.8	335
Giyasli	66	82.5	20	24.3	362
Temoyut	60	98.8	22.3	28.9	455
Kengerli	44	85.4	16.7	25.6	414
Papravend	36	79.6	17.7	18.7	441
Boyehvendli	70	93.8	20.8	29.4	406
Magsudlu	63	84.5	18.3	25.3	390
Gervend	60	64.4	12.3	19.8	309
Eyvazchanbeyli	70	95.6	23.9	28.2	410
Khidirli	61	81.2	14.1	20	481

Table 2. Preliminary results of radioecological research conducted in the Lachin region

Region	R (nSv/h)	A _{eff} (Bq/kg)	U (Bq/kg)	Th (Bq/kg)	K (Bq/kg)
Dashlı №5	50	87.8	19.4	23.3	446
Lachin №3	40	39.7	6.3	11	224
Lachin №6	54	64.2	12.3	19.3	313
Lachin №7	60	70.2	14.7	17.5	383
Lachin №2	40	32.2	4.6	6.51	224
Lachin №8	56	58.9	9.18	17.2	320
Lachin Erdeshevi	30	25.3	6.97	6.46	116
Lolabaghırlı	50	10.7	3.44	2.63	45.5
Lachin №9	60	65.6	10.8	16.2	395

Table 3. Preliminary results of radioecological research conducted in the Kalbajar region

Region	R (nSv/h)	A _{eff} (Bq/kg)	U (Bq/kg)	Th (Bq/kg)	K (Bq/kg)
Istisu	500-530	927	845	38	376
Istisu 2	115	176	77.22	33.3	651
Zallar	55	35.9	9.41	9.48	165
Chopurlu	42	34.2	8.41	8.54	171
Kalbajar	65	121	26.1	35.1	581
Zulfugarlı	27	24.4	5.62	6.89	114
Kalbajar №3	38	80	19.4	24.6	335
Kalbajar №4	114	58.8	12.6	12.1	357
Kalbajar №5	79	106	26.6	26.5	527

Table 4. Parameters for assessment of radiological risk in Istisu

	C_{Ra}, Bq/kg	C_{Th}, Bq/kg	C_K, Bq/kg	R_{aeq}, Bq/kg	D, nGy/h	Hex	AEDE, Sv	AGDE, μSv/year
Istisu 1	511	44	398	601.78	279.374	1.63371	342624.3	1887.882
Istisu 2	64.8	27.5	546	142.345	69.4796	0.394826	85209.78	486.626
Average value				370	55	<1	70	

According to the results of the conducted research, in this region the integral radioactivity (R) indicators vary within 30-70 nSv/h, effective specific activity (A_{eff}) 64-99 Bq/kg, the specific activity of uranium-238 isotope (U) 12-24 Bq/kg, the specific activity of Thorium-232 isotope (Th) 19-29 Bq/kg, the specific activity of potassium-40 isotope (K) 309-481 Bq/kg, which can be considered as normal values.

During the studies in Lachin district, measurements were made at 22 points, samples were selected and taken from 12 points (Table 2). Samples were taken mainly from arable land and near water sources.

According to the results of the conducted studies, in this region the integral radioactivity (R) indicators vary within 30-60 nSv/h, effective specific activity (A_{eff}) 11-88 Bq/kg, the specific activity of uranium-238 isotope (U) 5-19 Bq/kg, the specific activity of Thorium-232 isotope (Th) 3-23 Bq/kg, the specific activity of potassium-40 isotope (K) 46-446 Bq/kg, which also can be considered as normal values.

Measurements in Kalbajar were carried out at 35 points, samples were selected and taken from 15 points (Table 3). Samples were taken mainly from arable land and near water sources.

During radioecological monitoring in the territory of Kalbajar region, measurement of the exposure dose of gamma radiation was carried out using IndetiFINDER-2 dosimeter-spectrometer. Measurements were carried out taking into account the requirements of the standard operating procedure, and for 80 stations where measurements were made based on observed radiation background values.

It should be noted that during radioecological monitoring, a relatively high radiation background (50.4 μR/h) was observed in Istisu settlement of Kalbajar region, in the area of Istisu.

According to the recommendations of the "International Atomic Energy Agency", the following parameters should be calculated to assess radiation risks and hazards in the

territories, and the prices obtained should be compared with the recommended limits [UNSCEAR, 2000].

- The average value of the dose absorbed in the air (D),

$$D \text{ (nGy/h)} = 0.462C_{Ra} + 0.0604C_{Th} + 0.042C_K$$

- Equivalent activity to radium (R_{aeq}),

$$R_{aeq} \text{ (Bq/kg)} = C_{Ra} + 1.43C_{Th} + 0.07C_K$$

- External hazard index (Hex),

$$Hex = C_{Ra}/370 + C_{Th}/259 + C_K/4810$$

- Annual dose equivalent of internal organs (AGDE)

$$AGDE \text{ (}\mu\text{Sv/year)} = 3.09 C_{Ra} + 4.18C_{Th} + 0.314 C_K$$

- Annual effective dose equivalent (AEDE)

$$AEDE \text{ (Sv)} = D \times 24 \times 365 \times 0.7 \times 0.2$$

The parameters calculated on the basis of the established prices are presented in Table 4.

CONCLUSION

As a result of the conducted studies, it was found that the radiation background in Aghdam and Lachin regions is within the norm, and only in soil samples taken from Istisu settlement of Kalbajar region, the average value of the dose absorbed in the air (D), external hazard index (Hex) and the annual effective dose equivalent (AEDE) were higher than the limit values. It should be noted that for a sample taken from Istisu settlement, near a hot water source, radium equivalent activity also exceeds the limit value. For this reason, there is a need for continuous implementation and control of radioecological monitoring in the mentioned areas. It should be noted that the results obtained are preliminary and currently it is planned to carry out large-scale studies in accordance with the mine action plan.

REFERENCES

Aliyev Ch.S., Zolotovitskaya T.A., Ismail-zade T.A. (2004) Anomalies of natural radioactive

fields in seismically active zones. *Scientific and technical journal of the Ministry of Natural Resources of the Russian Federation and the Euro-Asian Geophysical Society "Geophysics" No. 1*: 54-57 (in Russian).

Aliyev Ch.S. (2005) On the history of the development of radiometric research in Azerbaijan. *News of ANAS, Earth Sciences ser., No. 145-149* (in Russian).

Humbatov F.Y., Suleymanov B.A., Ahmedov M.M., Balayev V.S. (2016) Radium isotopes in an oil-field produced lake near Baku, Azerbaijan. *Journal of Environmental*

Protection, USA, 7: 1149-1156.

Humbatov F.Y., Ahmadov M.M., Balayev V.S., Aslanova G.F. (2017) Determination of radioactivity levels and hazards of soil samples, taken from oil field area near Baku. *Proc. of 8th Eurasian Scientific-Practical Conference «Nuclear Science and its Application»*, Almaty, p. 286.

UNSCEAR (2000) United Nations Scientific Committee on the Effects of Atomic Radiation. Report of UNSCEAR to the General Assembly, United Nations. USA: New York, p. 111–125.

Ağdam, Laçın və Kəlbəcər rayonlarında müasir radioekoloji vəziyyətin qiymətləndirilməsi

¹ Əliyev Çingiz Səid oğlu, ² Hübətov Famil Yusif oğlu, ¹ Mahmudova Fərəh Fuad qızı, ¹ Əliyeva Əzizə Rafiq qızı, ¹ Kərimli Xəyal Mərdan oğlu

¹ Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Geologiya və Geofizika İnstitutu, Bakı, Azərbaycan

² Azərbaycan Respublikası Elm və Təhsil Nazirliyinin Radiasiya Problemləri İnstitutu, Bakı, Azərbaycan

Məqalədə Azərbaycanın işğaldan azad edilmiş ərazilərində ətraf mühitdə radioekoloji vəziyyətin ilkin qiymətləndirilməsi, təhlükə mənbələrinin müəyyənləşdirilməsi və anomaliya aşkar olunmuş ərazilərdən götürülmüş nümunələrin laborator şəraitdə radionuklid tərkibinin müəyyən edilməsindən bəhs edilir. Əvvəllər aparılan tədqiqatlar göstərmişdir ki, Qarabağ ərazisində süxurların radioaktivliyi litoloji-stratigrafiya intervallarının tərkibindən və yaşından asılı olaraq dəyişir. Ümumiyyətlə, bu ərazidə süxurların qamma fəallığı Kiçik Qafqazın müxtəlif yaşlı struktur kompleksləri üçün xarakterik olan fon əhəmiyyətini aşır. Aparılmış tədqiqatlar nəticəsində Ağdam və Laçın rayonlarında radiasiya fonunun norma daxilində olduğu, yalnız Kəlbəcər rayonu İstisu qəsəbəsindən götürülmüş torpaq nümunələrində havada udulan dozanın orta qiymətinin (D), Xarici təhlükəlilik indeksi (Hex) və illik effektiv doza ekvivalentinin (AEDE) limit qiymətindən yüksək olduğu müəyyən olunmuşdur. Radiuma ekvivalent aktivlik də limit qiymətini keçir. Bu səbəbdən qeyd olunan ərazilərdə radioekoloji monitorinqin davamlı şəkildə həyata keçirilməsinə və nəzarətdə saxlanmasına ehtiyac vardır. Qeyd etmək lazımdır ki, alınan nəticələr ilkindir və hal-hazırda ərazilərin minadan təmizləmə planına uyğun olaraq genişmiqyaslı tədqiqatların aparılması planlaşdırılır.

Açar sözlər: Qarabağ, təbii radioaktivlik, qamma şüalanma, işğaldan azad edilmiş ərazilər, radioekoloji vəziyyət, şüalanmanın ekspozisiya dozasının gücü

**Современное радиоэкологическое состояние в Агдамском, Лачинском
и Кельбаджарском районах**

¹Алиев Чингиз Саид оглу, ²Гумбатов Фамиль Юсиф оглу, ¹Махмудова Фарах Фуад гызы,
¹Алиева Азиза Рафик гызы, ¹Керимли Хаял Мардан оглу

¹ *Институт геологии и геофизики Министерства науки и образования
Азербайджанской Республики, Баку, Азербайджан*

² *Институт радиационных проблем Министерства науки и образования
Азербайджанской Республики, Баку, Азербайджан*

В статье проведена оценка радиоэкологического состояния окружающей среды на освобожденной от оккупации территории Карабаха. Исследования, проведенные ранее, показали, что на территории Карабаха радиоактивность пород меняется в зависимости от состава и возраста литолого-стратиграфических интервалов. В целом гамма-активность пород не превышает фоновые значения для разновозрастных структурно-вещественных комплексов Малого Кавказа. В результате проведенных исследований было установлено, что радиационный фон в Агдамском и Лачинском районах находится в пределах нормы, только в образцах почвы, взятых из поселка Истису Кельбаджарского района, средняя величины поглощенной дозы в воздухе и годовой эффективной дозы были выше предельной нормы. По этой причине существует необходимость в постоянном контроле и проведении радиоэкологического мониторинга на указанных территориях. Следует отметить, что полученные результаты являются предварительными и в настоящее время планируется проведение масштабных исследований в соответствии с планом разминирования территорий.

Ключевые слова: *Карабах, естественная радиоактивность, гамма-излучение, освобожденные территории, радиоэкологическое загрязнение, мощность экспозиционной дозы радиации*