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RADIOECOLOGICAL ASSESSMENT OF URANIUM TAILS DEPOSITS (SUMSAR, SHEKAFTAR, TEREK-SAI)

©Zhakypbekova A., *SPIN-code: 4148-6525, Osh State University, Osh, Kyrgyzstan, atyrgul67@mail.ru*
©Kulchinova G., *SPIN-code: 6705-9771, Osh State University, Osh, Kyrgyzstan, kgulya1975@gmail.com*
©Abdymomunova B., *SPIN-code: 7337-8029, Osh State University, Osh, Kyrgyzstan, Bunisa-08@mail.ru*

РАДИОЭКОЛОГИЧЕСКАЯ ОЦЕНКА ОТЛОЖЕНИЙ УРАНОВЫХ ХВОСТОВ (СУМСАР, ШЕКАФТАР, ТЕРЕК-САЙ)

©Жакыпбекова А. Т., *SPIN-код: 4148-6525, Ошский государственный университет, г. Ош, Кыргызстан, atyrgul67@mail.ru*
©Кулчинова Г. А., *SPIN-код: 6705-9771, Ошский государственный университет, г. Ош, Кыргызстан, kgulya1975@gmail.com*
©Абдымомунова Б. А., *SPIN-код: 7337-8029, Ошский государственный университет, г. Ош, Кыргызстан, Bunisa-08@mail.ru*

Abstract. The article presents the results of radio ecological studies of the territories of uranium tailings in Kyrgyzstan (Sumsar, Shekaftar and Terek-Sai), as well as their current state and assessment of the radioactive contamination's potential risks. The ore field of this region is characterized as an extremely complex structure and covers about 30 ore occurrences of lead and rare metals. Starting from the Precambrian period both applicative and disjunctive disturbances within its boundaries have been widely developing and being manifested many times throughout the history of geological development. Oxidized and sulfide ores have been developed within the deposit. Unfortunately, serious miscalculations were made. As result of natural disasters; such as earthquakes, landslides, mudflows, etc., several uranium tailing dumbs have been damaged. Day by day, the risk of destruction and the threat of radioactive contamination of the Kyrgyz Republic territory are increasing. There are eight tailing dumps on the territory of Shekaftar uranium natural-technogenic province, the total volume of which is 1194 thousand m^3 of radioactive waste. There are 15 mountain dumps of substandard ore with an ore volume of 4585.6 thousand m^3 hour, in local areas it exceeds 500 μR/h.

Аннотация. В статье представлены результаты радиоэкологических исследований территорий урановых хвостохранилищ Кыргызстана (Сумсар, Шекафтар и Терек-Сай), их текущее состояние и оценка потенциальных рисков радиоактивного загрязнения. Рудное поле этого региона отличается чрезвычайно сложной структурой и охватывает около 30 рудопроявлений свинца и редких металлов. В его границах широко развиты как пликативные, так и дизъюнктивные нарушения, многократно проявляющиеся на протяжении истории геологического развития, начиная с докембрия. В пределах месторождений развиты окисленные и сульфидные руды. К сожалению, были допущены серьезные просчеты. В

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результате стихийных бедствий, например, землетрясения, оползни, сели и т. д., несколько урановых хвостохранилищ были повреждены. Увеличивается риск разрушения и угроза радиоактивного заражения территории Кыргызстана. На территории урановой природно-техногенной провинции Шекафтар расположены 8 хвостохранилищ с общим объемом радиоактивных отходов 1194 тыс м^3 и 15 горных отвалов некондиционной руды с объемом руды 4585,6 тыс м^3 час, местами превышает 500 мкР/час.

Keywords: uranium, tailings, radioecology, radioactivity, technology-related province, mountain, biogeochemical processes.

Ключевые слова: уран, хвостохранилища, радиоэкология, радиоактивность, технологическая провинция, гора, биогеохимические процессы.

Introduction

Mountains are the large ecosystems of our planet, where natural landscapes have been preserved and used in a traditional way. Recently the mining industry has been rapidly developing in many mountainous countries. However, biogeochemical processes, preservation of biodiversity, the extraction and the transportation of minerals in the mountains are the most important factors in the destruction of natural mountain ecosystems. Kyrgyz Mountains are rich with different types of minerals. According to the updated information more than 300 large and medium-sized deposits of sold minerals have been explored and evaluated, including gold, silver, antimony, mercury, molybdenum, tin, rare earth (U, Th, Ra) and nonferrous metals, coal, nonmetallic raw materials [1]. In the recent past the country has produced uranium oxide, rare earth metals, semi-finished products for non-ferrous metallurgy (lead, zinc, molybdenum, etc.)

From the mid-1950s to the present 20 mining and processing enterprises have been shut for the extraction and processing of uranium raw materials [2–4]. Long term and man-made impacts on the subsoil associated with the exploration, production, processing of mineral resources have led to significant changes in some mining areas, in the geological environment and in some cases even to the emergence of a wide range of potentially hazardous natural-man-made geological processes that caused and still causing significant economic and environmental damage.

In the complex of geo-ecological problems, both inherited from the Soviet mining and metallurgical industry, and acquired after the collapse of the USSR, the problem of the safe keeping of a large amount of mining waste is put forward in the first place. As a result of ineffective and irrational processing of minerals

1) Large scale dumps of waste rocks, substandard ores, and metallurgical slags were formed.
2) Tailing dumps and sludge ponds were created, which not only pollute the environment, but are also potentially dangerous sources of natural and man-made emergencies [5].

Tailings dumps are in a particularly unfavorable position because of special hydraulic structures which were created from man-made soils — the so-called “tailings”. In fact, they were obtained as a result of complex and diverse ore processing processes. Tailings dumps are concentrated massifs of finely dispersed production wastes, which depending on the processed ores contain radionuclides (Shecaftar, Sumsar and Terek-Sai). Currently on the territory of Kyrgyzstan there are 55 tailing dumps with a volume of more than 132 million m3 on an area of 770 hectares, 85 mountain dumps with a volume of 700 m^3 occupying over 1500 hectares, including 31 tailing dumps and 25 dumps.

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Waste of uranium production with a volume of 51.8 million m^3 (as of 2014–15 their total radioactivity exceeds 87 thousand curies) with the development of new deposits it will increase even more (Figure 1).

Occupying significant areas, the tailings of the storage have a negative impact on the environment; both at the stage of operation and for long periods of time after the storage facilities and mothballed [4]. Close location of objects with radioactive waste to the borders of the adjacent states of central Asia, as well as their location on the catchments of rivers of a trans-boundary nature, water flow, which in case of emergencies can contribute to the expansion of the boundaries of radioactive contamination.

So, the necessity for regular monitoring of tailings and dumps of a trans-boundary nature is very topical nowadays (Shecaftar, Sumsar, and Terek-Sai). According to experts currently there are risks of emergencies and there is a zone of possible radioactive contamination of which falls not only on the territory of Kyrgyzstan, but also on neighboring states (Kazakhstan, Tajikistan, and Uzbekistan) where about 5 million people live [1].

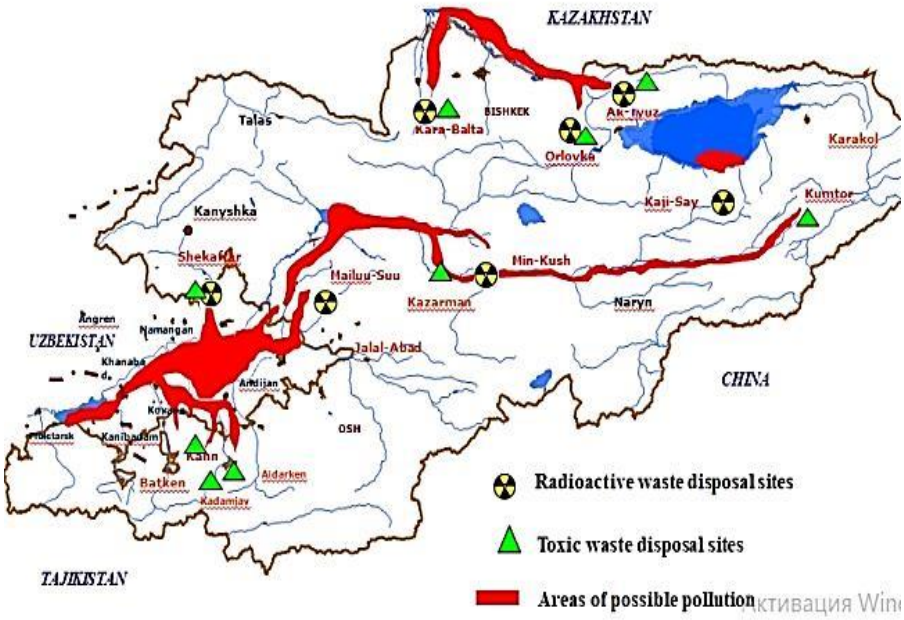

Figure 1. Map of the location of tailing dumps and the area of possible pollution of the territory of Kyrgyzstan and trans-boundary states

Material and research methods

Of radio ecological studies were carried out on the territories of tailing dumps: Shecaftar, Sumsar, and Terek-Sai. A dosimeter-radiometer DKS-96 of the laboratory of biochemistry of the Institute of Biology of the National Academy of Sciences of the Kyrgyz Republic was used to carry out gamma survey of the territories. It provides an operational measurement of the main quantities characterizing the radiation situation and the search for sources of ionizing radiation (Figure 2). Measurements of the exposure dose of γ-radiation were carried out in accordance with the IAEA instructions for ground-based survey of the radiation at a height of 0.1 and 1 meter from the earth's surface. According to the technical instructions of the dosimeters, measurements at one point were carried out at least three times, and then the arithmetic mean values were determined [5].

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In selecting coil samples when compiling a soil map of Kyrgyzstan, we used the classification of adopted soils [3]. Soil sampling was carried out in accordance with the requirements of GOST 53123-2008 (ISO 10381-5:2005) [4].

Figure 2. DKS-96 dosimeter

Figure 3. Satellite device (GPS)

A satellite device (GPS) regularly and automatically recorded the longitude and latitude of the location (Figure 3) On the territory of the village. There are 8 mountain dumps in Shekaftar. The dumps have accumulated about 700 thousand m^3 of low-active rocks and substandard ores. Residential buildings with private plots are located in the immediate vicinity. All dumps have not been reclaimed. The average exposure dose rate (DER) of gamma radiation on the surface of the dumps is 60–150 μR/h (0.6–1.5 μSv/h).

Dumps located on the bank of the river. Sumsar, are intensively eroded by the waters of the river with the removal of radionuclides into its channel and floodplain. This is evidenced by the results of testing bottom sediments of the river near the border with Uzbekistan, where high concentrations of uranium (215 g/t) and an increased content of heavy metals: lead, iron, copper, chromium, cadmium were recorded. These heavy metals and toxic elements owe their origin to the activities of the Sumsar lead-zinc mine, located three kilometers up the river valley.

As a result of 25 years of operation of this mine, 4.5 million tons of toxic waste were generated, which are deposited in three tailing dumps on the slopes of the Sumsar River valley. In the spring of 1994, as a result of heavy rainfall, tailing dump no. 1, located in the immediate vicinity of the river's edge, was destroyed, and the facility turned into a source of permanent pollution of the Sumsar River.

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Table 1.

SPECIFIC ACTIVITY OF RADIONUCLIDES
IN THE SOILS OF TAILING DUMPS AND DUMPS SHEKAFTAR

№	*Sampling location*	^{238}U	^{232}Th	^{226}Ra	^{210}Pb	^{40}K
		Specific activity, Bq/kg (M±m)				
1.	Dam (control)	9.38±1.51	71.00±8.00	63.78±7.64	76.56±10.85	705.00±12.00
2.	Tailings pond no. 1	2044.15±296.51	80.90±9.40	10662.10±592	7065.13±841.19	396.20±22.00
3.	Tailings pond no. 2	51.40±11.31	44.15±5.65	137.03±16.09	850.11±107.26	800.00±57.00
4.	Tailings pond no. 3	29.60±5.10	26.30±1.35	35.71±1.80	150.00±70.32	450.70±25.00

Waste dumps in the area of Shekaftar village: The absence of vegetation on the surface of unremediated dumps contributes to the development of wind erosion and surface washout of the dump material and their spreading to the territory of Shekaftar settlement, as well as the adjacent territory of the Fergana Valley. There are no data from regular monitoring of the environment in the zone of influence of the considered objects.

Thus, the population living in the valley of the lower reaches of the Sumsar River, including the chile on the territory of the Namangan region of Uzbekistan, experiences a synergistic effect of radionuclides and heavy metals. In this regard, it is advisable to conduct biomedical research in this area.

Earlier in 1992, the design institute “UkrNIPIpromtechnologii” (Ukraine) developed a project for reclamation of dumps, but the project was never implemented. The cost of rehabilitation works is estimated at up to USD 1.5 million.

Table 2.

THE AVERAGE MAINTENANCE OF SEPARATE COMPONENTS
IN ORES AND TAILINGS OF SHEKAFTAR

Components, %	*Original ore*	*Tailings*
Ca	10–20	30
Si	20	6–10
Fe	2–3	0.4–1.0
Rb	1.5–3.0	2.0–3.2
Cr	4.5–6.0	2–3
Mn	3.0	50–200
V	1.5	0.4–0.6
Ni	3–5	2

Conclusion

In the complex environmental problems in the country first place put forward the problem of safely storing large quantities of waste mining. The accumulation of significant amounts of radioactive waste resulted from the activities of mining and processing enterprises of the uranium industry 40-70s. Storage in open dumps, tailings and not enough trained squares leads to an intense weathering of toxic substances into the atmosphere, their penetration into the groundwater, soil, surface water and adverse impact on the environment and human health. Many of the tailings and dumps, radioactive waste disposal in the border areas are in critical condition and cause a risk of

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contamination and radiation exposure in the territory of Kyrgyzstan, as well as possibly other Central Asian republics.

The main causes of environmental stress in the region due to bad choice of storage sites and storage facilities, short-term considerations of economic gain, a low level of geological engineering survey and design lack of foresight and taking into account the effects of technological impacts on the stability of fragile mountain ecosystems.

Many of the tailings were formed within settlements. With the recent surge in industrial and natural catastrophic events, landslides, mudflows, erosion, the threat of radioactive pollution of the environment increases significantly. There is a threat to the health of people living near areas with high levels of radiation and radioactivity in the environment. On many dangerous areas, lack of basic information on the radioactivity content of tailings is not being monitored due to lack of funding and related equipment on the ground.

The main radiological concern in the country is the restoration of plant-soil (gardening) and the bare heaps tailing, protection from the intense erosion of the protective layer of tailings. Thus, the uranium tailings are poorly protected and poorly understood features of life in different organisms (biological response to the increased content of radionuclide, the state of microbial complex and human).

References:

1. Elyutin, D. N., Ryazantseva, V. D., Knauf, V. I. & Pomazkov, K. D. (1972). Kirgizskaya SSR. Geologicheskoe opisanie. In *Geologiya SSSR*, 25. Moscow. (in Russian).

2. Aleshin, Yu. G., Torgoev, I. A., & Losev, V. A. (2000). Radiatsionnaya ekologiya Mailuu-Suu. Bishkek.

3. Dzhenbaev, B., Kaldybaev, B., Toktoeva, T., Kendzhebaeva, A. (2016). Radiobiogeokhimicheskaya otsenka pochvy v raione Issyk-Kul'skoi oblasti. *Geologicheskie resursy i inzheneriya*, *4*(1), 39-44.

4. Torgoev, I. A., & Aleshin, Yu. G. (2009). Geoekologiya i musorodobyvayushchii kompleks v Kyrgyzstane. Bishkek.

5. Aitmatov, I. T., Torgoev, I. A., & Aleshin, Yu. G. (1997). Geoekologicheskie problemy v gornodobyvayushchem komplekse Kyrgyzstana. *Nauka i novye tekhnologii*, (1), 81-95.

Список литературы:

1. Елютин Д. Н., Рязанцева В. Д., Кнауф В. И. Помазков К. Д. Киргизская ССР. Геологическое описание // Геология СССР. Т. 25. М.: Недра, 1972.

2. Алешин Ю. Г., Торгоев И. А., Лосев В. А. Радиационная экология Майлуу-Суу. Бишкек: Илим, 2000. 96 с.

3. Дженбаев Б., Калдыбаев Б., Токтоева Т., Кенджебаева А. Радиобиогеохимическая оценка почвы в районе Иссык-Кульской области // Геологические ресурсы и инженерия. 2016. Т. 4. №1. С. 39-44.

4. Торгоев И. А., Алешин Ю. Г. Геоэкология и мусородобывающий комплекс в Кыргызстане. Бишкек: Илим, 2009. 240 с.

5. Айтматов И. Т., Торгоев И. А., Алешин Ю. Г. Геоэкологические проблемы в горнодобывающем комплексе Кыргызстана // Наука и новые технологии. 1997. №1. С. 81-95.

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