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RADIATION MONITORING OF SOIL COVER OF NATURAL URANIUM IN THE ISSYK-KUL PROVINCE

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Abstract: This article presents the current state in the radioecological soil Issyk-Kul province of natural uranium. Found that the background radiation - exposure dose and artificial radionuclides in the soil of the coastal zone of the lake as a whole at the level of the background and the acceptance of lower standards except for natural-technogenic and some natural areas. Radioecological this province is mild natural and industrial uranium province.

Key words: Issyk-Kul, province, tailing, dump, biogeochemistry, exposure dose, radionuclides.

1. Actuality

Today in our country there is a large amount of radioactive sources (about 1200). After the Soviet Union collapse in the Kyrgyzstan, orphan status was 55 at the tailings of 770 hectares, of which more than 132 made million m^3 of tailings and 85 dumps. 700 m^3 – waste volume, cover an area of over 1,500 hectares, of which 31 and 25 tailing dumps - uranium waste, the volume of 51.83 million m^3. As period of 2008, their total radioactivity over than 90 thousand curies (Djenbaev, 2009; Djenbaev, Shamshiev, Jolboldiev, 2008).

According to scientists and geochemists Issyk-Kul biogeochemists Basin is a natural uranium biogeochemical provinces. There functioned Kaji-Sai mining plant for processing uranium ore from 1948 to 1969. Scrap and industrial equipment were buried to form the tailings, with a total uranium waste 400 thousand m^3, an area of 10.8 thousand m^2. Tailings from uranium waste is located 2.5 km east of the residential village, but due to natural factors (rainfall, groundwater, landslides and mudflows) an environmental threat to the Issyk-Kul Lake (1.5 km from the lake) and the nearest villages , located on the slopes with a slope between the mountains to 30-45 ° (Kaldibaev, Djenbaev, 2009; Kowalski, Vorotnitsky, Lekarev, 1968).

Many of the tailings in the country are located in populated areas, seismic and landslide prone areas. Not yet fully known radiological impact on the environment and the population - low standard of living, social and migration issues, etc. contribute to the overall poor socio-psychological situation in these areas, including threats and risks from radiation and other potential is physical risks.

Because of the large number of active recreation on the shores of Issyk-Kul Lake, both nationally and internationally, with particular concern of the public and the Government of the Kyrgyz Republic is a former uranium production on the southern shore of the lake and at the same time the Issyk-Kul lake is in the country one of the main fishery waters.

1. Research methods

Conducted a comprehensive survey of the study area, according to the methodology and radiological study of different taxa radiobiogeochemical biosphere. Sampling was conducted in accordance with the standards that take into account the structure of the soil and soil heterogeneity. Equipment used in the research, consists of a set - Dosimeter-radiometer DKS-96,

λ-spectrometer (CAMBERRA), radiometer UMF-2000 PC with integrated data recording, etc. (Djenbaev, 2009; Kuzin, 1991).

To perform gamma dosimeter used surveying PSA-68-01 with model of gamma ray sources number ACA - 4066-87 with dosimeter-radiometer DKS-96 Biogeochemistry Laboratory of Biology and Soil Science National Sciences Academy. Measurements were carried out in accordance with the "Regulations on the ground survey of the radiation situation in the contaminated area" at a height of 0.1 and 1 meter above the ground. Determine the radionuclide composition was used gamma-spectrometric method, based on measuring the gamma radiation of the samples of soil and plants. The measurements were made using semiconductor detectors, gamma spectrometer GX4019 software Genie-2000 S 502, S501 RUS.

2. Results and discussion

We have previously established 10 experimental plots around Issyk-Kul and the measurement showed that the power of natural background radiation in the gamma radiation of the coastal lake zone is an average of 17 to 25 mR/h in some areas up to 40 mR/h. As the distance from the lake to the side slopes of its level in some places rises to 40 mR/h, especially in some mountainous areas, canyons, which are based on the rocks, granites and their fragments are small, red sand, with a slightly increased radioactivity.

For small areas with high natural background radiation can be attributed to the beaches of the coastal zone v. Jenish, v. Ak-Terek, located on the southern shore of Issyk-Kul Lake. The radioactivity of 30 - 60 mR/h, and in areas with a high content of iron in the sand inclusions level exposure dose increases up to 400 mR/h (Fig. 1). Small areas of the coastal zone of Issyk-Kul Lake, mostly mud deposits with characteristic brilliance giving high radiation background. These areas include: the beach v.Tosor - 40-50 mR/h, 10 km west of the coast v.Kaji-Sai - 32-40 mR/h, the shore around with. Toru-Aigyr - 30 mR/h, the coast around v.Tamchi - 40-50 mR/h. In general, cities in the Issyk-Kul basin Kara-Kol, Cholpon-Ata and Balykchy radiation situation quite well, the average exposure dose of gamma radiation does not exceed 20 - 22 mR/h, but in some places the use of crushed granite, as filler and construction material, the level of background radiation increases to 40-50 mR/h This indicates that these natural resources, without first checking the radiation is not recommended for use as building materials.

Fig.1. In the course of field work

There are also slight variations in the natural radiation background in different soil types of Issyk-Kul region, probably due to the inhomogeneous distribution of natural radio-nuclides,

scattered in soil, terrestrial rocks, surface, ground water and other objects of the environment (Table 1). As can be seen from the data for the gray-brown soils of its value varies between 20-28 mR/h, with an average - 22 mR/h, light-brown soils - 16-26 mR/h, with an average - 22 mR/h for the mountain-valley chestnut - 21-24 mR/h, with an average of 22 mR/h, for the mountain-valley chestnut - 18-21 mR/h, with an average - 20 mR/hr, for the mountain-valley dark chestnut 17-21 mR/h, with an average - 18 mR/h

Table 1. The results of measurements of the exposure of gamma radiation on soil types of Issyk-Kul coastal

Soil type	Place of measurement	Height 0.1 (m) (mR/h)	Height 1 (m) (mR/h)
gray-brown	c.Balykchi	23±2	18±1
	v.Sari-Kamish	22±2	20±2
	v.Tamchi	20±1	18±1
light brown	c.Cholpon-Ata	19±3	15±2
	v.Tort-Kul	23±3	18±3
	v.Ton	26±4	22±4
	v.Kaji-Sai	26±3	24±2
mountain-valley light brown	v.Ortho-Oruktu	23±2	22±2
	r.Jeti-Oguz	22±1	18±2
	v.Ak-Terek	29±4	21±1
	v.Jenish	34±6	24±2
	v.Mikhaylovka	19±2	16±2
mountain-valley dark brown	c.Karakol	19±3	18±2
	v.Maman	21±3	20±2
	r.Jyrgalan	22±2	20±1

The results of measurements of natural background radiation we compiled conditional schematic map of the exposure dose of external gamma radiation in the Issyk-Kul region (Fig. 2).

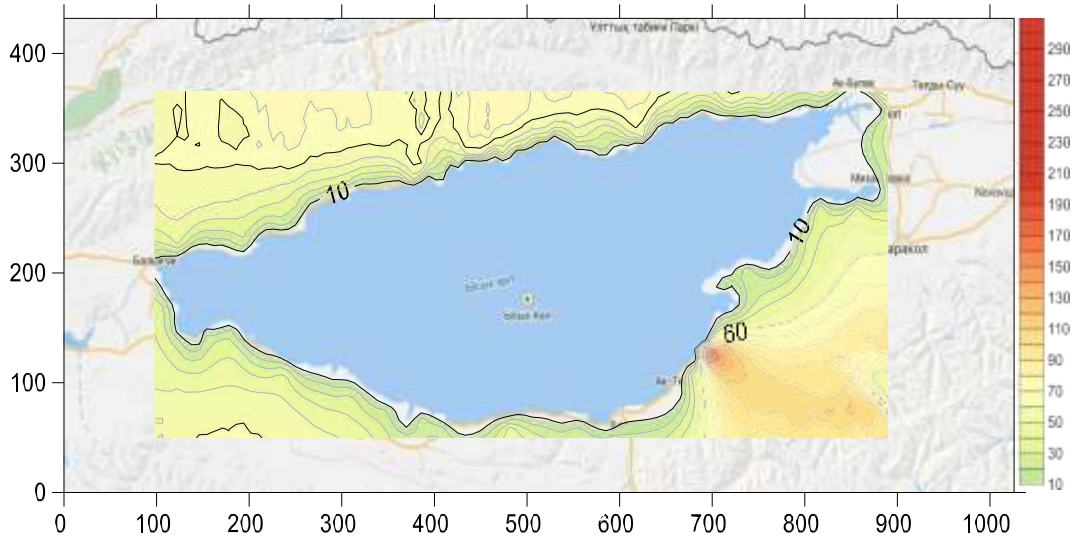

Fig. 2. Schematic map of the exposure of external gamma radiation in coastal of Issyk-Kul lake

4. Radon in soil cover

Radon (Rn) is recognized and regarded as a serious threat to the environment and human health, in the West, based on the results of numerous studies have identified Rn-222 as a known carcinogen (ICRP. 21, 1991; IAEA, 2003, 2009, etc.). In developed mills much work done on the dangers of radon. However, the Kyrgyz Republic has not yet begun to similar information company. The danger of radon in uranium provinces increased and intensified the lack of information among the population.

However, in Kyrgyzstan, research on natural radio-nuclides of radon (Rn) - 222 and its by-products with a short half-lives in the environment, including indoor air and building materials are not prepared or were occasionally (not available for a number of reasons, due to a lack of modern equipment, institutional capacity, etc.). According to statistics from Kyrgyzstan showed a growing number of cancers among the population, as well as blood diseases and endocrine diseases.

We have studied the -222 radon in the soil cover in the coastal areas of the Issyk-Kul Lake (Table 2, Fig. 3).

Table 2. Rn^{222} level in the soil cover in the coastal areas of Issyk-Kul Lake

№	Sampling site number	mBq/(m^{2}-s)
1	Balykchy (north-east 20 m from the shore)	17,60
2	Cholpon Ata (Biological Station)	30,61
3	v.Oruktu (200 m from the shore)	15,80
4	v.Oruktu (Brick, hot spring)	24,24
5	Tyup Bay	11,50
6	v.Mikhaylovka near the bridge	14,35
7	v.Ak-Terek	19,20
8	v.Jenish (from the road 60 meters)	18,37
9	Kaji-Sai (100 meters from the shore of beach below tailings).	19,86
10	v.Bar-Bulak (hot spring)	28,48

According to the research from the table 2 shows that in the upper layer of soil radon levels below the exposure of coastal areas and the concentrations at the background level, but in some areas there is a small increase in the hot springs - v. Oruktu - 24.24 mBq/(m^2-s), r. Bar-Bulak-28.48 mBq/(m^2-s) and the Biological Station - 30.61 mBq/(m^2-s). In the villages of Kaji-Sai, Jenish and Ak-Terek in the average the same level. Thoroughly studied the situation in developed countries. For example, in the U.S., where the typical content of the soil radon per liter is7,4-74 mBq/(m^2-s).

Fig. 3. The process of radon Rn^{222} measuring in soil cover

5. Soil radioisotope composition

The analysis of the top of the soil (0-20 cm) was carried out, as shown in Table 3.

Table 3. Average isotopic composition of Issyk-Kul soil region

№	Number of sampling points	Bq/kg			
		226 Ra	228Th	228 Ra	
1	v.Jenish	30	67	74	80
2	v.Oruktu	15,2	22,9	42,5	45,2
3	v.Bar Bulak	41,5	39,9	63,8	68,6
4	c.Balykchy	26,9	27,4	35,4	35,4
5	v.Kaji-Sai	33,6	27,9	39,1	38,6
6	v.Jeti-Oguz	30,2	49,5	59,6	59,9
7	Tyup Bay	31,8	31,1	44,1	53,9
8	Jyrgalan Bay	30,1	40,9	51,7	50,1
9	v.Kurmontu	32,5	38,9	40,1	50,6

Table 3 shows that the 226 Ra in an area Oruktu compared to other sites on average below 2 times; 228Th at the site v. Jenish 2-3 times increased in relation to the other sites, 228 Ra ranges from 35.4 to 80 Bq/kg on a site v. Jenish and hot spring v.Bar-Bulak increased by 2 - 2.5 times. The overall level of the studied radionuclides in the soil cover at the background level (Mamytov, 1996; 8, 10).

6. Thorium sands

On the southern shore of the lake are two parts sand and thorium conducted survey of radio-nuclides and gross alpha and beta activity. The results of the gamma-spectrometric analysis revealed the presence in the samples of sand. Jenish following radio-nuclides, the specific activity of which was: radium-228 - 4173,3 ± 72,1 Bq/kg, thorium-228 - 4087 ± 87,9 Bq/kg of uranium-238 - 425 ± 34 Bq/kg, radium- 226 - 296 ± 16,0 Bq/kg. The level of gross alpha activity was 88,700 ± 9200 Bq/kg, beta - 14700 ± 1500 Bq/kg. In samples of sand. Ak-Terek had traces of natural radio-nuclides: thorium-228 - 915 ± 57 Bq/kg, radium-228 - 846 ± 70 Bq/kg, 238 - 260 ± 30 Bq/kg, radium-226 - 103 ± 8 Bq/kg, lead-210 - 169 ± 30 Bq/kg.

In accordance with the rules of the committee on radiation protection as a valid natural radiation exposure dose of external gamma radiation does not exceed 0.33 mSv/h, which ensures that radiation dose to 1 mSv/year (NRB, 1999; IAEA, 2009; OSPORB, 99) . Given that the level of natural background radiation in the Issyk-Kul region average is 23 mR/h is possible to calculate the average annual exposure dose: Te = 23 mR/h × 24 hours/day × 31 days × 12 months = 205 344 mR/year or Te = 205,3 mR/year. In the calculation of the absorbed dose of gamma radiation relative biological effectiveness factor is unity. Then, in this case, An = 205.3 mBer/year, equivalent dose Au = 205.3 mBer/year or 0.2 Ber/year, which is 2.5 times lower than the IAEA standards (0.5 Ber/year).

We have also studied artificial of radio-nuclides that the strontium content in the arable soil horizon Issyk-Kul region ranges from 162 to 226 mg/kg of calcium - 0,9-2,8%. The specific activity of ^{90}Sr was 1,8-5,2 Bq/kg, with an average of 3.2 Bq/kg (RC - 9 Bq/kg) (Table 4). The maximum value of the specific activity of ^{90}Sr were observed in mountain-valley chestnut soils Tyup area 3,0-5,2 Bq/kg, with an average 4.1 Bq/kg. The ratio was Ca/^{90}Sr wide range 3,4-11, with average of 5.6, indicating that the prevailing concentrations of calcium in the soil. There is a positive correlation between the specific activity of ^{90}Sr and content Sr ($r = 0,61$; $P < 0.05$) and negatively with Ca ($r = -0,04$; $P > 0.05$), ie with increasing Sr and a decrease in soil Ca specific activity of ^{90}Sr increases slightly.

Consists of tsezium in the arable soil horizon of Issyk-Kul region of 67-94 mg/kg of potassium - 1.2-2.4%. The specific activity of 137Cs varies between 3,5-9,5 Bq/kg, with an average 6.1 Bq/kg (RC - 15 Bq/kg). The maximum value of the specific activity of the radionuclide were found on the mountain-valley chestnut soils Tyup area 5,8-9,5 Bq/kg, with the average of 7.9 Bq/kg (see Table 4).

Table 4. The specific activity of strontium-90 and cesium-137 in soil Issyk-Kul region

Soil type	^{90}Sr Bq/kg	Sr mg/kg	Ca %	^{137}Cs Bq/kg	Cs mg/kg	K %
Gray-brown	1,8–2,5 2,1	185–203 195	1,1–1,4 1,2	3,5–4,1 3,8	76–88 82	1,2–1,8 1,5
Light brown	2,2–3,8 2,9	165–175 170	1,8–1,9 1,87	4,0–7,4 5,5	88–92 89	1,6–2,2 1,8
Mining valley light brown.	3,0–3,6 3,3	198–212 204	2,4–2,8 2,6	4,8–7,4 6,1	78–94 86	1,9–2,1 2,0
Mountain-valley. brown.	3,0–5,2 4,1	214–226 220	0,9–1,2 1,0	5,8–9,5 7,9	76–84 79,3	1,5–2,2 1,8
Mountain-valley. dark brown.	3,2–4,6 3,8	162–171 167	1,9–2,1 2,0	5,5–9,0 7,2	67–82 76	2,0–2,4 2,2

Note - In the numerator - the limit fluctuations in the denominator - the average

K/^{137}Cs attitude was 6.8 - 11.8, with an average 8.7, indicating that sufficient concentrations of potassium in the soil. There is a positive correlation between the specific activity of ^{137}Cs and content of Cs ($r = 0,57$; $P < 0.05$) and negatively with K ($r = -0,68$; $P > 0.05$), ie with increasing and decreasing K Cs specific activity of ^{137}Cs increases slightly. Attitude ^{137}Cs/^{90}Sr in soils varied from 1,73-1,86, with an average 1.82. The maximum rate of this ratio is typical for light-brown soil Ton District 1.86, indicating that the prevailing concentrations of ^{137}Cs in the arable soil horizon relative to 90Sr.

7. Conclusion

We found that the main background radiation in this natural origin province, but in some coastal areas there is technogenic (Kaji-Say technological province). In the elevated parts exposure dose (MED) in coastal areas reached (at the trials) -230 to 120 mR/h, sometimes very high levels - 200-400 mR/h (compared to background levels 17-27 mR/h), but only two of these areas - Jenish and Ak-Terek.

The results of measurements of the exposure dose of gamma radiation coastal Issyk-Kul on soil types have shown that in general, the level of the background (from 19 ± 3 to 34 ± 6 mR/h) and a lower acceptance of the norm. And in some areas of the natural and technogenic (tailings of Kaji-Sai, thorium sands Jenish and Ak-Terek) DER, the total alpha activity and isotopic composition increased from 2 to 10 times the background regions.

The results showed that the content of artificial radio-nuclides in soil Issyk-Kul region is several times lower than the maximum permissible levels. Thus, radiologically this province is mild natural and industrial uranium province.

In spite of the Issyk-Kul Basin is biosphere territory (since 2001), uranium tailings of Kaji-Sai on the southern shore of the lake are poorly protected and poorly understood especially biodiversity and other adverse radiation situation in these areas is largely due to mismanagement of the former uranium production and is mainly due to lack of financial resources and lack of adequate radiation protection standards in the country.

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РАДИАЦИОННЫЙ МОНИТОРИНГ ПОЧВЕННОГО ПОКРОВА ПРИРОДНОГО УРАНА В ИССЫК-КУЛЬСКОЙ ОБЛАСТИ

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Резюме: В данной статье представлено современное радиоэкологическое состояние почвенного покрова Иссык-Кульской природной урановой провинции. Установлено, что радиационной фон - мощности экспозиционной дозы и искусственные радионуклиды в почвенном покрове прибрежной зоны озера в целом на уровне фона и ниже приятой нормы за исключением техногенных и отдельных природных участков. В радиологическом отношении данная провинция является слабо выраженной природно-техногенной урановой провинцией.

Ключевые слова: Иссык-Куль, провинции, хвостохранилища, отвал, биогеохимия, экспозиционной дозы, радионуклиды.

İSSIK-KUL VİLAYƏTİNDƏ TƏBİİ URAN TORPAQ ÖRTÜYÜNÜN RADİASİYA MONİTORİNQİ

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Xülasə: Məqalədə İssık-Kul təbii uran vilayətində torpaq örtüyünün cari radioekoloji vəziyyəti tədqiq olunmuşdur. Aşkar olunmuşdur ki, göl sahilinin torpaq örtüyündə radiasiya fonu – şüalanma dozası və süni radionuklidlər texnogen və bəzi təbii ərazilər istisna olmaqla, fon səviyyələrində tam və qəbul olunmuş normalardan aşağıdır. Radioloji cəhətdən bu ərazi bir qədər zəif təbii - texnogen uran əzrazisidir.

Açar sözlər: İssık-Kul, vilayət, tullantı gölməçələri, tullantı, biogeokimya, şüalanma dozası, radionuklidlər.