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RADIOLOGICAL RISK ASSESSMENT OF THE ISSYK-KUL REGION

In this article we propose the results of experimental studies in the Issyk-Kul region. Graphs of radiation levels on the southern shore of Lake Issyk-Kul at different times of the year. Radiation maps in populated areas. The article has important practical significance.

Key words*: radionuclides, radiation in air and water, radiation level, thorium, potassium, uranium.*

Бул иште Ысык-Көл облусунун эксперименталдык изилдөөлөрүнүн жыйынтыктарын тартуулайт. Ысык-Көлдүн түштүк жээгиндеги радиациянын ар кандай мезгилиндеги графикалык деңгээли, кыштактардын радиациялык картасы берилет. Макала маанилүү практикалык мааниге ээ.

Негизги сөздөр*: радионуклиддер, абадагы жана суудагы радиация, торий, калий, уран.*

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ОЦЕНКА РАДИОЛОГИЧЕСКОГО РИСКА ИССЫК-КУЛЬСКОЙ ОБЛАСТИ

В данной работе предложены результаты экспериментальных исследований в Иссык-Кульском регионе. Графики уровней радиаций на южном побережье озера Иссык-Куль в различные времена года. Радиационные карты в населенных пунктах. Статья имеет важное практическое значение.

Ключевые слова*: радионуклиды, радиация в воздухе и воде, уровень радиации, торий, калий, уран.*

Introduction

In the northeastern corner of Kyrgyzstan emerald-blue Issyk-Kul lake is an alpine lake competing in its beauty with the lakes of Switzerland. The waters of 134 rivers flow from the mountains which surround Issyk-Kul, many of them originating in eternal glaciers, and feeding into the lake. The Issyk-Kul basin is surrounded by 834 glaciers; in warm weather more than 60% of the river water comes from glacial melt.

Systematic operating observations over underground waters outlet in Djilu-Bulak valley were conducted first under an international Project APELIK from November 2000 to February 2003 monthly, and then under the ISTC Project #*KR* 330.3 from March 2003 to February 2005 seasonally. The observations were aimed at estimating uranium carrying out from coal and ashes dumps, radioactive burial ground and from a plant area, where uranium ore was concentrated.

The observation network is situated in the Djilu-Bulak valley and consists of *3* points with the following coordinates (fig. 2):

1. 42^n 09,307 ' N, 77 °13,065 ' E - group spring at the bottom of concrete breaslwall draining the plan! area from the east;
2. 42° 09,262 ' N, 77^U 12,944 ' E- spring from the western gully cut feeding from flow of the northern part of the plant area;
3. 42^n 09,572 'N, 77° 13,101 'E-watercourse in the junction of the right and left springs.

During the spring and autumn period, the spring 3 weakens as it strains to mudflow sediment trains of the Djilu-Bulak valley. It flows to highway only in winter, when penetration of bottom sediments decreases sharply due to water freezing. In 2003 it flowed even up to the Issyk-Kul coastline.

Water and air temperature, and water discharge were estimated during the operating observations. The discharges of springs and stream were determined using pump-out method and measurements with the use of spill way with triangular plunge cutting respectively.

Within the framework of the APELIK Project, water samples {with the total volume 100 ml approximately) taken from the observation point were strained through a filter of $35 \cdot 10^2$ mm and acidified by 2 ml of nitric acid 6N. Then the samples were sent for analysis to 2 independent addresses: Joint Institute of geology, geophysics and mineralogy (JIGG&M) of RAS Siberian department (Novosibirsk) and Geochemistry Institute laboratory of Rome University La Sapienza (Italy).

In JIGG&M people analyzed the samples for total uranium concentration in water using ICP-MS and laser-fluorescence methods, and in La Sapienza they used only ICP-MS.

Since March 2003 water samples analysis have been carried out by specialists of RPNC VNIITF from Snezhinsk (Project KR33O.3), who used spectrometric method. Results of the measurements conducted right at the place and laboratory analysis data are listed in the tables 1-3.

The table 1 shows that water temperature of spring 1 slightly changes during the season from 13° in winter to 20° in summer. Spring flow quantity is unstable, it significantly increases in winter. In the first part of 2005 fieldworks were carried out not far from the spring. They resulted in channel changes of the main water flows and changes in the total discharge (see table 1).

Fig. 1. Satellite photo.

Chart of annual water and air temperature fluctuations is represented on the fig. 2, and chart of spring flow quantity for the whole period - on the fig. 3.

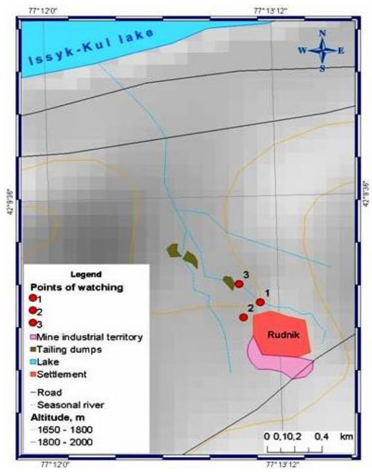

Fig. 2. Scheme map of operating observations of outlet in the Djilu-Bulak valley.

Water temperature in the spring 2 (table 2, fig. 4) varied during the year from 7,2° in winter to $14,8^0$ in summer. Spring run-off was small and sometimes it almost disappeared, and it totally ran dry in January 2003. Uranium content in water is stable, it does not depend on the season and it is 100 *ppb* approximately. From the beginning of 2002 operating observations at this spring were stopped due to the small water run-off.

Table 3 shows that seasonal water temperature fluctuations in the stream 3 correlate well enough with temperature of the springs 1, 2. Water temperature of all three points is connected with air temperature (table 1-3). Operating observations held 25.02.05 revealed increase in the flow quantity up to 10 l/s in the stream 3. It exceeds almost twice the quantity estimated earlier. Earthworks on "Kadji-Sai burial ground" led to changes in stream channel; it was directed to the left valley side and now it flows to precipitation lank No. 2. After the works conducted 15,05.05, the stream flow quantity became 3,8 l/s; it is 2,5 times smaller than the figure estimated 25.02.05. Diagram of water temperature in stream 3 is represented on fig. 5.

Water discharge of these sources almost does not depend on the season. Discharge increase can be registered both in winter, and during spring and summer floods. There was a common trend of falling discharge in all sources before the measurements carried out 25.02.05. Their result 10 l/s, however, was not in line with the forming trend.

Results of operating observations for spring 1

Table 1

Sampling date	Discharge, l/s	Temperature,		Uranium content in water, *ppb*		
		air	water	Alpha-spectrometry method	ICP-MS method	Laser and fluorescence method
08.2000	-	-		-	221,0	227,0
23.11.01	0,20		14,9	-	191+6	180
29.11.01	0,20	-9,8	14,2	-	200±8	180
26.01.02	0,31	-9,4	13,2	-	185±7	170
23.02.02	0,26	4,2	14,6		190±7	140
23.03.02	0,31	10,2	15,8	-	170±4	160
12.04.02	0,20	8,8	15,4	-		140
26.04.02	0,20	11,8	15,8	-	-	140
16.05.02	0,07	9,2	15,9	-	-	130
18.06.02	0,07	12,8	17,3	-	-	130
27.07.02	0,088	17,3	12,8			110
27.08.02	0,11	18,6	17,2	-	-	110
16.09.02	0,14	20,4	17,7	-	-	120
17.10.02	0,16	14,2	17,3	-	-	100
25.11.02	0,16	8,7	15,9	-	-	100
28.12.02	0,10	-7,2	15,8		-	110
26.01.03	0,10	-4.8	15,6	-		110
21.02.03	0,11	-2,6	15,6	-	-	100
11.05.03	0,04	-	20,0	141,6±7,1	-	-
17.08.03	0,05	-	-	122-23	-	-
20.02.04	0,16	-	14,9	-	-	-
17.05.04	0,21	-	18,3	-	-	-
03.11.04	0,11	-	15,1	142±7	-	-
25.02.05	0,6	-	15,1		-	-
15.05.05	0,42		16,9			

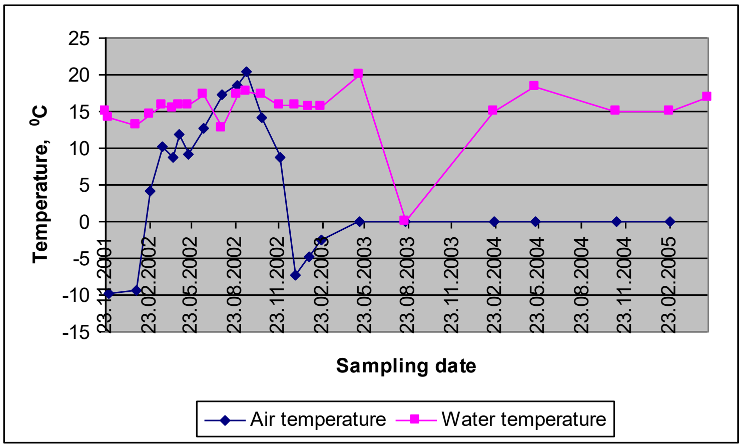

Fig. 3. Air and water temperature waving of spring 1

Results of operating observations for spring 2

Table 2

Sampling date	Discharge, l/s	Temperature, ^{0}C		Uranium content in water, *ppb*	
		air	water	TCP-MS method	Laser and fluorescence
08.2000	..	-	-	281.3	-
23.11.01	0.07	16.6	10.5	133±5	110
19.12.01	0.11	-7.8	8.8	110+5	100
26.01.02	0.11	-9.8	7.4	128+4	120
23.02.02	0.13	-0.8	8.2	134±4	110
23.03.02	0.09	10.4	10.1	125±5	110
12.04.02	0.07	9.2	8.2	-	100
26.04.02	0.03	12.2	10.8	-	110
16.05.02	0.03	9.8	7.2	-	110
18.06.02.	0.03	13.6	13.2	-	100
27.07.02	0.03	21.2	14.8	-	100
25.08.02	0.035	22.0	12.5	-	100
16.09.02	0.04	17.3	14.3	-	100
17.10.02	0.05	19.6	10.8		110
25.11.02	0.07	7.6	7.8	-	100
28.12.02	0.08	-6.4	7.2	-	100
26.01.03	0.00	-	-	-	-

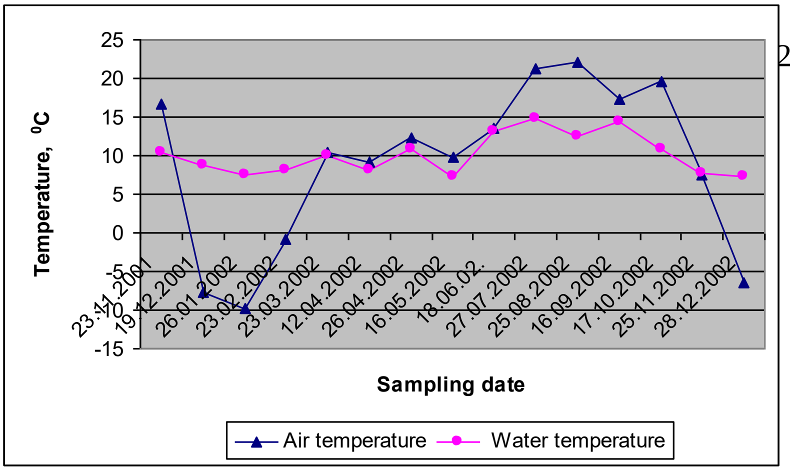

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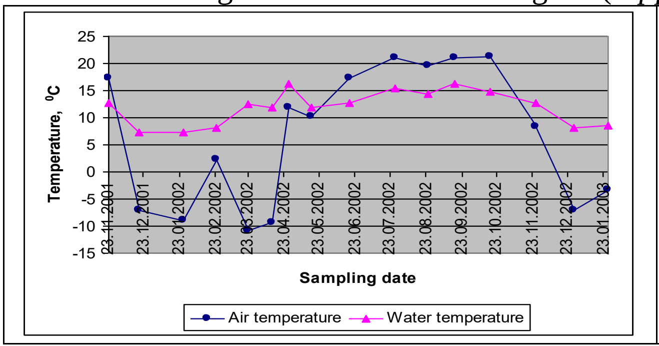
Table 3

Sampling date	Discharge, l/s	Temperature, ^{0}C				
		air		Uranium content, ppb		
		Air	water	Alpha-spectrometry method	ICP-MS method	Laser and fluorescence method
08.2000		17,3	-	-	-	-
23.11.01	5,5	-7,0	12,8	-	-	-
19.12.01	3,5	-9,0	7,2	-	-	120
26.01.02	5,6	2,2	7,2	-	121 ±6	100
23.02.02	6,2	-10,8	8,2	-	122±4	120
23.03.02	5,6	-9,3	12,6	-	121±5	110
12.04.02	6,3	11,9	11,8	-	-	100
26.04.02	6,3	10,2	16,2	-	-	110
16.05.02	4,4	17,2	11,8	-	-	110
18.06.02	4,8	21,0	12,8	-	-	110
27.07.02	6,7	19,6	15,5	-	-	100
25.08.02	4,3	21,1	14,3	-	-	100
16.09.02	4,0	21,2	16,3	-	-	110
17.10.02	3,6	8,4	14,8	-	-	100
25.11.02	3,7	-7,0	12,8	-	-	110
28.12.02	4,2	-3.4	8,2	-	-	100
26.01.03	3,8		8,6		-	100
21.02.03	I,8	-	8,2			100
22.11.03	1,2	-	12,6	120,3±6	-	-
20.02.04	4,4	-	9,8	117±6	-	-
03.11.04	6,5	-	11,5	120±6	-	-
25.02.05	10,0					

Uranium content in water samples from the investigated points is represented in tables 1-3 and fig.6, 7. The tables show that uranium content in the samples taken by different people using different methods varies. According to laser and fluorescence method uranium content in the samples is 100-110 *ppb* and according to ICP-MS method, it is 120-122 *ppb*. Thus, the discrepancy is 20% approximately, which is quite possible; it can occur due to different types of analysis.

As tables and fig. 7 show, the highest uranium concentrations are found in waters of the spring I. During the research period (3 years) they reduced twice and even more (from 227 *ppb* to 100 *ppb)* according to the laser and fluorescence method. From the middle of 2002 uranium content in waters of the investigated points became equal and 100 times more than background content in underground waters of the region (1 *ppb* approximately).



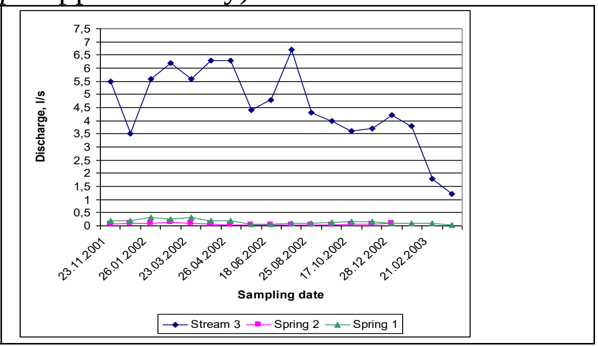


Fig.5. Air and water temperature waving of strea

Fig.6. Spring water waving quantity of 1,2,3.

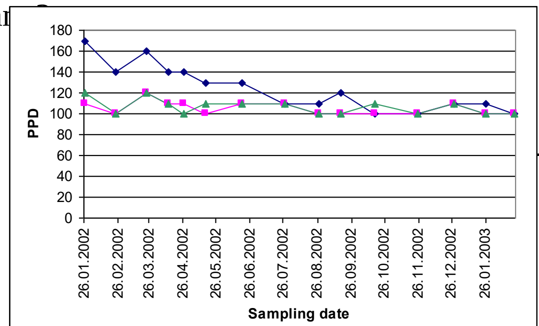


Fig.7. Uranium consistent in water probe (laser-fluorescent method)

Uranium concentration in waters of the Issyk-Kul Lake in 1963-1990 was close to 30 *ppb* according to numerous studies conducted in Central Monitoring Department of the Kyrgyz SSR (later Department of State Agency on geology and mineral resources under the Kyrgyz Parliament) and by Kovalski P.P., a hydrochemist (1968). The works within the frames of APELIK Project and KR 330.3 revealed that uranium content in waters of the Issyk-Kul Lake is higher, it reaches 50 *ppb,* i.e. uranium concentration is 2-3 times higher in the investigated sources. According to our data, it is all-time high for coastal of Issyk-Kul waters and natural waters of Kyrgyzstan [1-3].

Seismic operations on two lateral sections were carried out in the August- September 2002 in Djylu-Bulak valley. They were aimed at estimating underground water flow from the valley to the Issyk-Kul Lake. A seismic station "TALGAR-6" was used in the working process.

The investigations revealed that capacity of modern grave and sand mudflow sediment train at the valley bottom on Neogene sediments, which are relatively waterproof, is 8-12 m. There is almost no underflow in the valley. Its possible capacity does not exceed 1 m with the valley 65-110 m wide. This means that underground inflow from the Djylu-Bulak valley to Issyk-Kul Lake is limited by the flow quantity that we registered at the observation point 3. Its average value for 9 months is 4.5 1/s (390 m^3 /day) with fluctuations from 3,5 1/s (November) to 6,7 I/s (July). Total uranium run-off is 40 g/day or 14,6 kg/year on average. With high size of Issyk-Kul Lake 1738 km^3 [3] and uranium concentration in its water 50 *ppb,* total concentration of the element is 86 900 tons. Thus, annual uranium inflow from the Djylu-Bulak valley to Issyk-Kul Lake increases uranium mass $l,68*10^{-7}$ Limes more, and it can not significantly influence uranium balance in the lake.

Researching of radon in the in the Issyk-Kul region

The Ecological risk for majority researchers define as probability of the origin in natural ambience such, breaches under anthropogenic interference which can be disadvantage for the further operation and existence of the ecological systems. Natural and natural radiation accompanies us during the whole our life. Only comparatively recently became known that one of important for health of the person is a radon. The Studies called on in miscellaneous country, have shown that its impact forms beside half of the dose, got person from all sources of radiation. The Methods of the measurements presents itself simultaneous removing of importance of the coordinates of the site by means of satellite instrument GPSR and measurement radiation background exposure meter-detector “Eberline”. The Results analysis has shown existence of the certain difference level to radiation inwardly and outside of premises.

Problem of radon In Kyrgyz Republic pertains to lack of conducted researching. In given article we represent the radon value situation on seaside Lake Issyk-Kul on base of our derived outcomes. Several expeditions were organized for period of the research work on south coastal Lake Issyk-Kul, in the course of which was executed measurements radiation background and is displayed sample of ground and water. The derived results of the measurements of different terrain were analyzed with coordinate feature and were created maps, graphically demonstrating general radio-ecological situation in explored region and area near mouth of the rivers, were created falling into lake on south coast (Fig. 8-14).

The selective measurements gamma-background were organized in the course of performing the studies inwardly premises in different populated points, were herewith installed significant differences in powers exposition dose gamma radiations inwardly premises of the under study settlements. Averaged factors internal and external radiations are presented on Fig.4 graphically. The method of the choice of the surveyed houses was carried the casual nature though they were chosen old and new buildings. It was installed that factors level to radiation in some premises exceed the natural background in several times [4-5].

The cartographical maps of radiation level indications and other thematically maps in south coastal zone of Issyk-Kul Lake were made using geographical information system (GIS) tools, special software ArcGIS product of ESRI company as well.

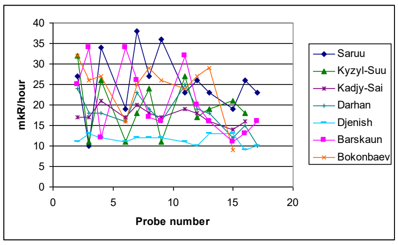


Fig.8. Power level of gamma-radiation exposure dose of **soil** probe are sampled in villages of south coast of Issyk-Kul Lake

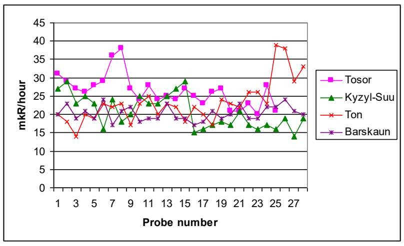


Fig.9. Power level of gamma-radiation exposure dose of **water** probe are sampled in villages of south coast of Issyk-Kul Lake

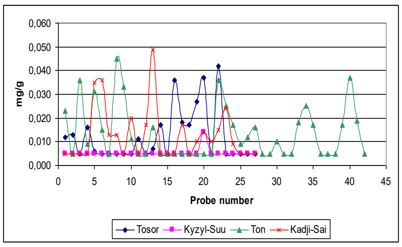
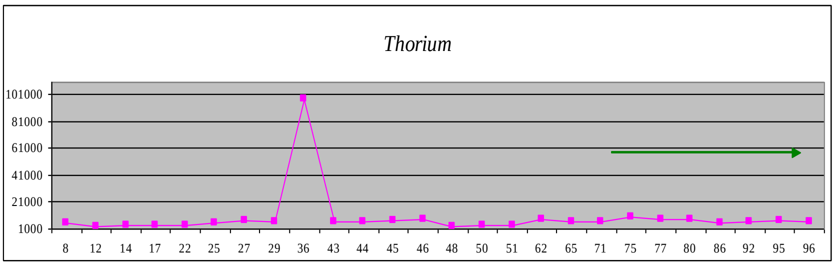
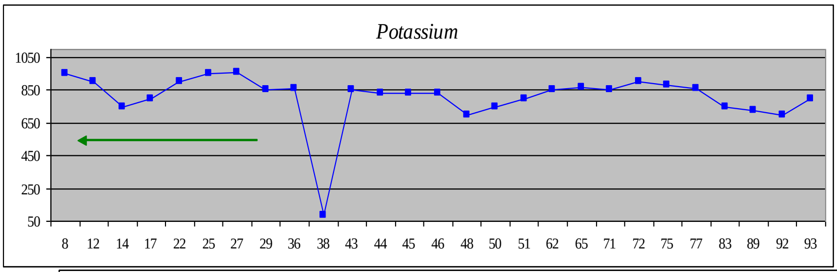


Fig.10. Thorium content in water of south coast of Issyk-Kul Lake (mg/g)





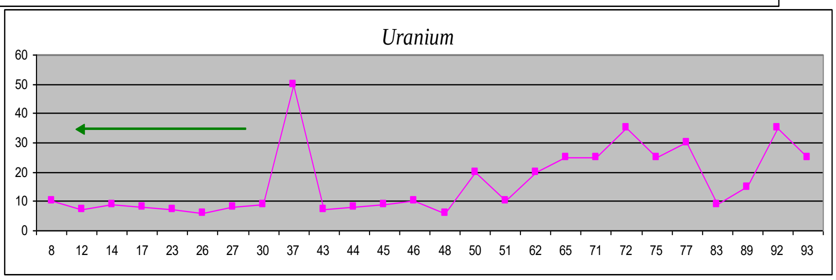


Fig.11. Thorium, potassium and uranium (%) consistent in south coast of Issyk-Kul Lake

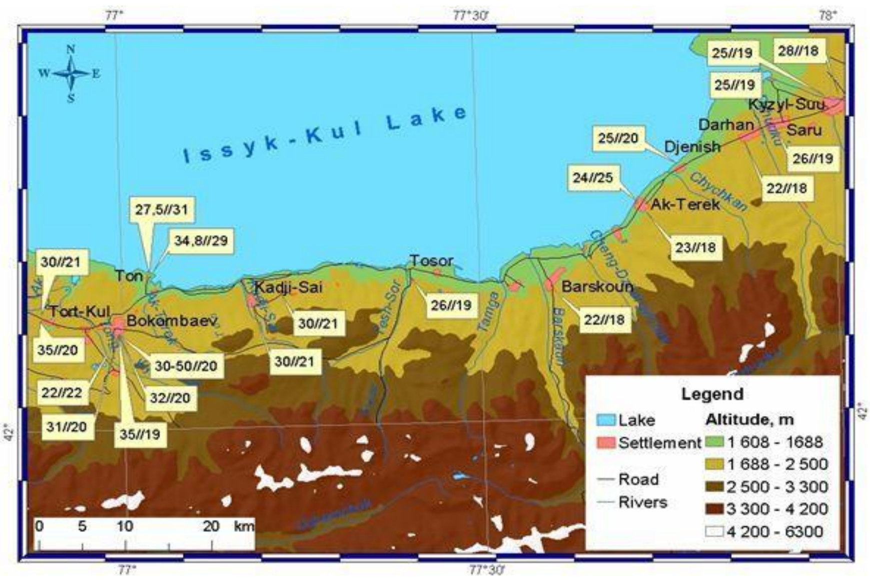


Fig.12. Indication of internal radiations in settlements of south coastal zone of Issyk-Kul Lake.

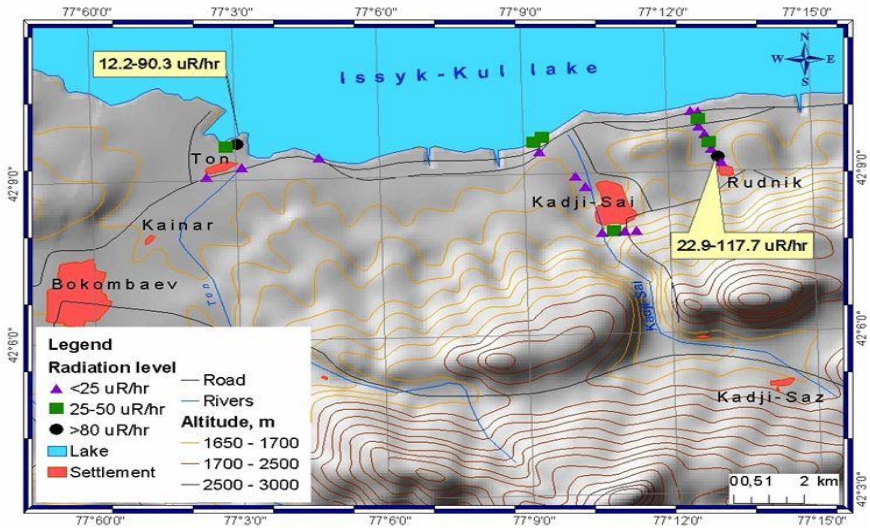


Fig.13. Indication of radiation level near the shop No.7 and tailing dumps

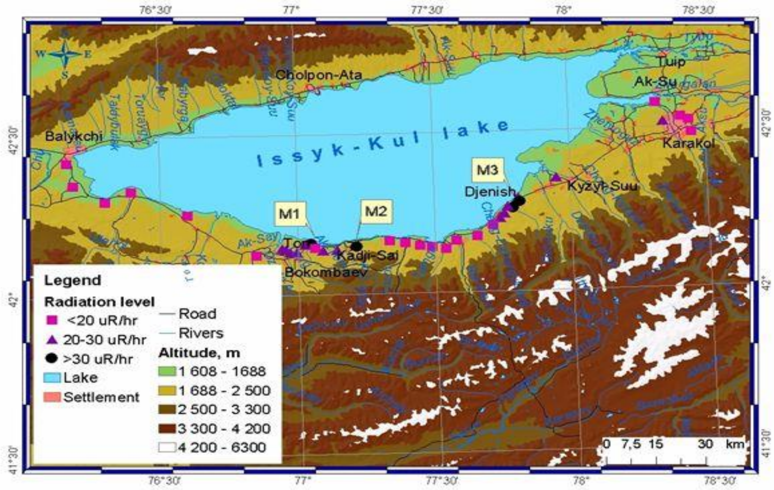


Fig.14. Radiation level in different parcels of south coastal zone of Issyk-Kul Lake

Parcel M 1- 94 uR/hr (11,8 uR/hr) an altitude - 1 meter

Parcel M 2- 118 uR/hr (12,3 uR/hr) an altitude - 1 meter; 150 uR/hr an altitude - 1 m

Parcel M 3- 108 uR/hr (13,0 uR/hr) an altitude - 1 meter; 140 uR/hr an altitude - 1 m

The Results of given research work are:

1. Removal radiation background to terrain with provision for coordination features on longitude and width is executed in south-east part of Lake Issyk-Kul using the latest satellite instrument.

2. Coordinates of the selection places of the ground tests and contents of radioactive element: thorium and radium were defined.

3. Maps of the distributing radiation background of the explored territory are drawn on the result of conducted measurements and analysis.

4. Place with raised importance of radioactivity was defined, which was a coastal near the Djenish village and territory of the former production area (No.7) near Ton village. The High level of radioactivity in determined places is explained by raised content of radioactive element - thorium in ground.

The Results of done work show that general level of external radiation in the investigation territory is found within rate, but factors level of internal radiation exceeds the natural rate several times. It is necessary to undertake the detailed further studies for clarification of the high content reasons of the radon midair vein of the premises.

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