ELEMENTAL COMPOSITION OF THE RIVER BOTTOM SEDIMENTS IN THE TOP OF THE ZERAVSHAN RIVER BASIN

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Abstract: The carried out of the work was devoted to the processing and interpretation of new data bases (2020 years) for the study of toxic metals in bottom sediments of the Zeravshan river basin. Particular attention was paid to the Fondarya River, the left tributary of the Zeravshan River. The Fondarya River is subject of a large anthropogenic impact. The most heavily polluted lower reaches of the Jijikrut, below the Anzob mining and processing plant (AGOK). In the 90s of the last century, due to an accident on the slurry pipeline, AGOC dumped flotation tailings directly into the Jijikrut River, which caused severe pollution of the bottom sediments of this river with metals such as Cr, Ni, Sb, Zn.

Key words: Zeravshan River, Fondarya River, toxic metals, pollution of river bed, arsenic, antimony, mercury.

Zeravshan river has an annual average runoff of 5.3 km3, of which 97% (5.1 km3) are generated in Tajikistan. Currently Tajikistan is only using approximately 6% (0.3 km3) of the Zeravshan waters. The main proportion of the Zeravshan runoff is utilised for irrigation water, about 550,000 ha in Samarkand, Navoi, Jizzak and Kashkadarya Provinces of Uzbekistan. The annual water consumption for irrigation of this region is 6.6 km3 (12,000 m3/ha per year) and therefore 1.3 km3 above the available mean runoff. For balancing the higher irrigation demand drainage water is reused [1].

Zeravshan Valley can be divided into three sub-basins, distinguished by their geological structure, relief and climate: Old Matcha, Fondarya and Zeravshan, fig. 1. The sub-basin borders near Ayni village at the confluence with the Fondarya.

The Fondaria sub-basin begins from the Yagnob River, originating from the same glaciers. After merging with Iskandarya, it takes the name Fondarya. In the sub-basin are several large lakes: Iskanderkul, three Aloutdin lakes.

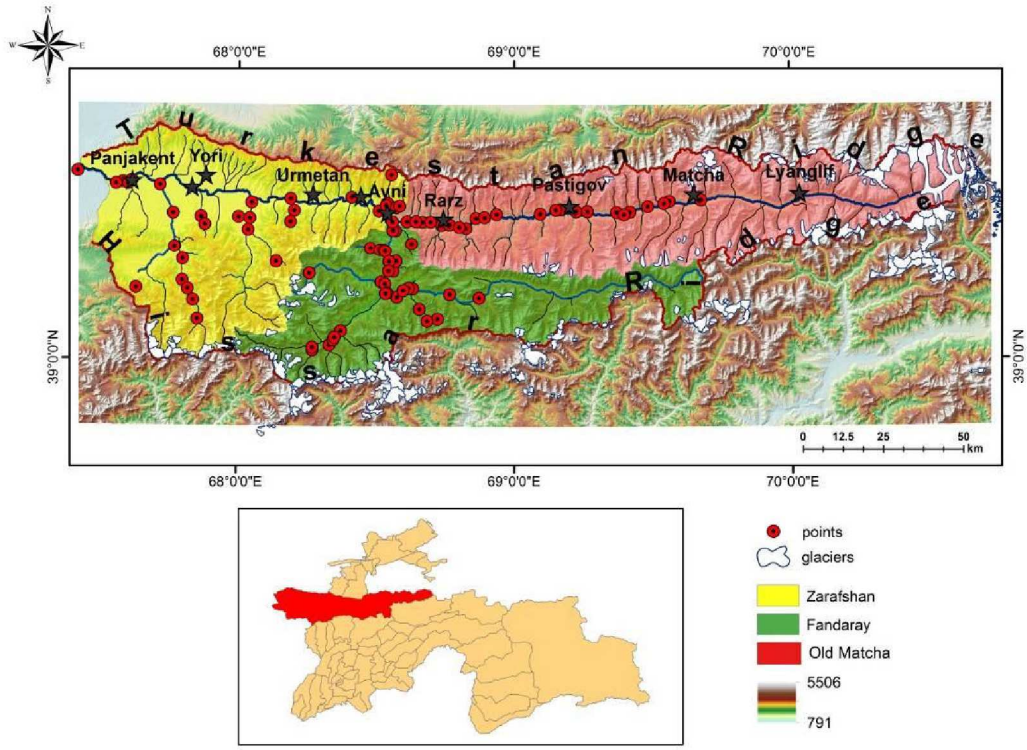

Fig. 1. Zeravshon river basin

The Zeravshan sub-basin is formed at the confluence of the Fondarya and Zeravshan and extends to the border of Tajikistan with Uzbekistan. The sub-basin contains several large lakes, primarily 7 Marguzor lakes.

Relief: the territory of Zeravshan basin can be divided into two types; valley and mountain. The extreme western part of the basin is occupied by relatively low mountains. On the north side, the valley is surrounded by Turkestan, on the south side, Zeravshan ranges. On the extreme southwestern part of the valley, the northern slope of the Hissar Range is located. The territory of the basin is on average 1,600-1,800 meters above sea level.

Geologically, entire of Zeravshan basin in his main part extremely monotonous. This is geochemically "neutral" graptolite shales (sometimes containing an increased amount of scattered syngenetic pyrite in black shales) by Silurian period and overlying carbonate (dolomite and limestone) column Devon Carboniferous age, mainly in the southern side of the valley throughout Zeravshan district. Against this background, significant anomalies of major- and trace elements create local ore sites with factories for processing of ore, gypsum-salt accumulations of Mesozoic deposits along the river and places with specific composition of intrusive rocks outputs: alkaline and nepheline-syenite, sometimes with small displays of carbonates, Figure 2 [2, 3].

In Figure 2, the square with the icons inside them (red circles) shows the position of the factories for processing of ores: T - Taror Mining and Metallurgical Enterprises (MME), A - Anzob Mining and Processing Plant (MPP). Natural sources of the anomalous zones (areas of specific clusters with rock composition) are shown by ovals with designations of leading elements, giving halos with high content: Na – salt of Jurassic- Cretaceous (with gypsum) thickness in the region of Ayni village; REE - area output of alkaline intrusive rocks (sometimes with carbonates) with high contents of Rare Earth Elements (REE) in the Mountain region (upper valley of Old Matcha).

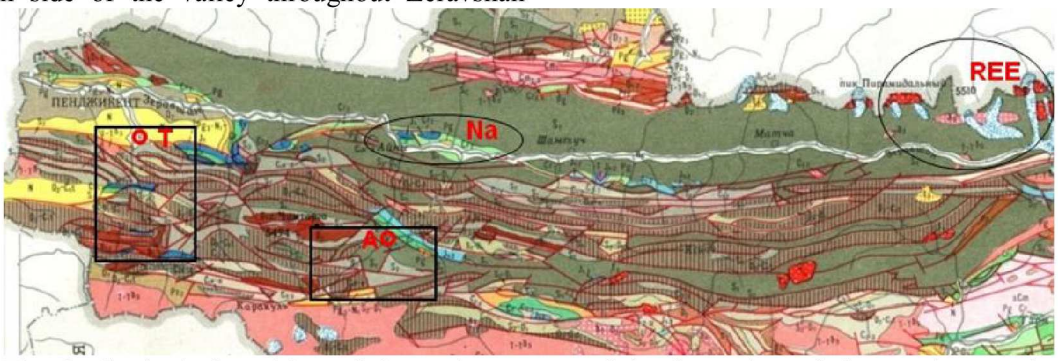

Fig. 2. Geological position of the main sources of the formation of abnormal zones by trace element concentrations in the Zeravshan River Basin [2]

The cleanliness of the river bed and its bottom sediments often compared with the quality of water pipes. If the pipes are old and rusty, they will actively pollute the water. The riverbeds, and especially their bottom sediments, affect to the quality of water in the rivers. In river aquasystems, the processes of sorption of heavy metals from water to bottom sediments and the reverse process of desorption from bottom sediments to water are constant and occur everywhere. The processes of migration of heavy metals from bottom sediments into water depend on many parameters, both chemical and physical.

To the chemical composition of bottom sediments is actively influenced the geological and geochemical features of localities (geogenic), as well as anthropogenic impacts on the environment. During analyzing the bottom sediments, many geochemists often use soil average abundance of elements, and this is true for Valley Rivers, the bottom sediments of which are mainly formed by flushing soil particles. Another picture develops for Mountain Rivers. Bottom sediments, are formed mainly due to weathering of rocks. The sediments of Mountain Rivers are mainly composed of quartz sand and feldspars. Feldspars do not have sufficient hardness, are destroyed, and are carried downstream, forming loams in a calmer course.

In the summer of 2020, expeditionary work was carried out in the basin of the river Zeravshon, where samples of bottom sediments were taken. In the fall of 2020, at the Institute of Nuclear Physics of the National Nuclear Center of the Republic of Kazakhstan, elemental analyzes of samples were carried out at the reactor, in the group of neutron

activation analysis, as well as X-ray florescence analyzes of samples.

The data from these analyzes significantly enriched the available data on the geochemistry of the Zeravshon River [4-6]. Since in the early studies, only the hydro and geochemistry of the Zeravshon River were studied, and for Fondare River, which is experiencing a large anthropogenic load, was not paid attention.

The paper is devoted to the processing and interpretation of new databases for the study of the content of toxic metals in the bottom sediments of the Zeravshon river basin, especially its left tributary Fondarya.

Objects and methods of analysis

During the expedition conducted in 2020, 20 samples of bottom sediments of the Yagnob, Fondarya, Jijikrut, Iskanderdarya, Upper Kumarg and Kumarg Zeravshon, Shahristan, Mogiyan and others were taken.

Table

Sampling points and their GPS coordinates

№	Data & Time		Sampling points	N	E	Above sea level m.
1	15.07.2020, 12:26	Fbot 1	Jijikrut-1	39º06,592	068º41,252	2658
2	15.07.2020, 12:40	Fbot 2	Jijikrut tunnel	39º06,590	068º41,242	2659
3	15.07.2020, 12:55	Fbot 3	Jijikrut -2	39º09,067	068º39,087	2355
4	15.07.2020, 13:22	Fbot 4	Jijikrut-3	39º11,972	068º37,992	1772
5	15.07.2020, 13:35	Fbot 5	Yagnob-1	39º11,986	068º38,428	1772
6	15.07.2020, 13:50	Fbot 6	Yagnob-2	39º12,057	068º37,095	1759
7	15.07.2020, 16:10	Fbot 7	Up. Kumarg	39º16,595	068º32,743	1561
8	20.07.2020, 16:32	Fbot 8	Chore	39º18,339	068º32,015	1459
9	20.07.2020, 16:10	Fbot 9	Kumarg	39º21,837	068º33,668	1398
10	16.07.2020, 07:31	Zbot 1	Zeravshan -2	39º22,841	068º46,412	1520
11	16.07.2020, 12:24	Zbot 2	Obburdon	39º24,657	068º05,641	1885
12	16.07.2020,13:53	Zbot 3	Kalahona	39º25,080	068º15,894	1923
13	17.07.2020,08:30	Zbot 4	Shahristan -2	39º31,234	068º33,347	2677
14	17.07.2020,08:52	Zbot 5	Shahristan-1	39º31,243	068º33,204	2665
15	17.07.2020,09:30	Zbot 6	Shahristan-3	39º26,439	068º32,481	1749
16	17.07.2020,09:51	Zbot 7	Zeravshan-3	39º25110	068º30,625	1365
17	19.07.2020, 11:48	Zbot 8	Shing-2	39º18,969	067º46,337	1253
18	19.07.2020, 09:16	Zbot 9	Mogien-1	39º18,944	067º46,207	1244
19	19.07.2020, 07:56	Zbot 10	Mogien-3	39º29,338	067º42,979	984
20	18.07.2020,07:57	Zbot 11	Zeravshan-4	39º31,535	067º26,215	888

The objects of research are the study of the content of toxic metals in the bottom sediments of the Zeravshon River and its tributaries, as well as the assessment of the general ecological state of the river basin.

As mentioned above, bottom sediments of Mountain Rivers are mainly formed in the process of weathering of rocks, and their elemental composition is influenced by the geological and geochemical characteristics of river basins [7–9].

During the analyzes, the following 42 elements were analyzed (in alphabetical order), major elements (rock forming): Ca, Fe, K, Mn, Na, Ti and trace elements: As, Ba, Br, Cd, Ce, Co, Cr, Cs, Cu, Eu, Ga, Hf, Hg, La, Lu, Mo, Nb, Nd, Ni, Pb, Pr, Rb, Sb, Sc, Sm, Sn, Sr, Ta, Tb, Th, U, V, Y, Yb, Zn, Zr.

The results of NAA analyzes on the content of toxic elements in bottom samples are given in the figure 3. The Igeo coefficient was calculated for the analyzed samples.

The average As concentration in the Zarafshon basin is 50 mg / kg, which is more than 10 times higher than its Clarke. The maximum concentration was noted directly at the point Jijikrut3 (217 mg / kg) and in fact they are deposits (Figure 4) [9]. The concentration is especially high in the zones of antimony-mercury deposits. The lowest concentration is at the Zarafshon point 2.

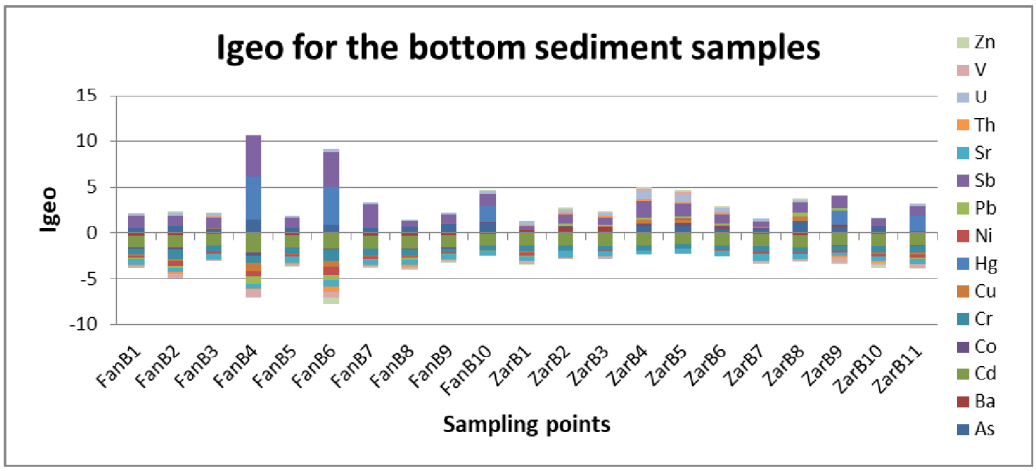

Figure 3. - Distribution of the Igeo coefficient for samples bottom sediments

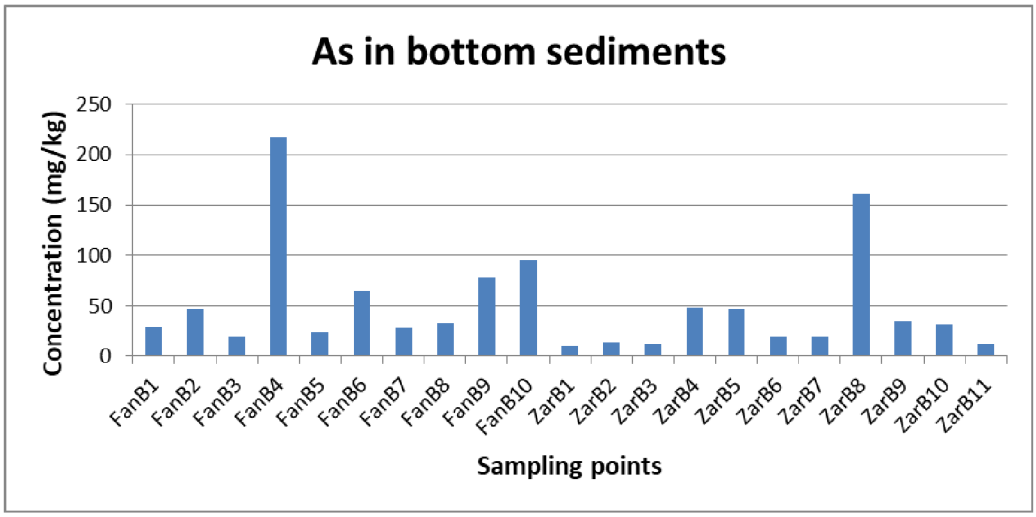

Figure 4. - Distribution of arsenic in bottom sediments

The average Sb concentration in the Zarafshon basin is 23 mg / kg. The spatial distribution of Sb forms two anomalous points with high concentrations: downstream of the AGOK at the Jijikrut 3 point, and in the tailings dump in Gabirud. The anomaly at point Jijikrut 3 was formed due to the fact that in the late 90s and early 2000s a man-made accident occurred at the plant, and AGOK for a number of years dumped flotation waste into the Jijikrut River. The lowest concentration at the Zarafshon3 point is 2.5 mg / kg, fig. 5.

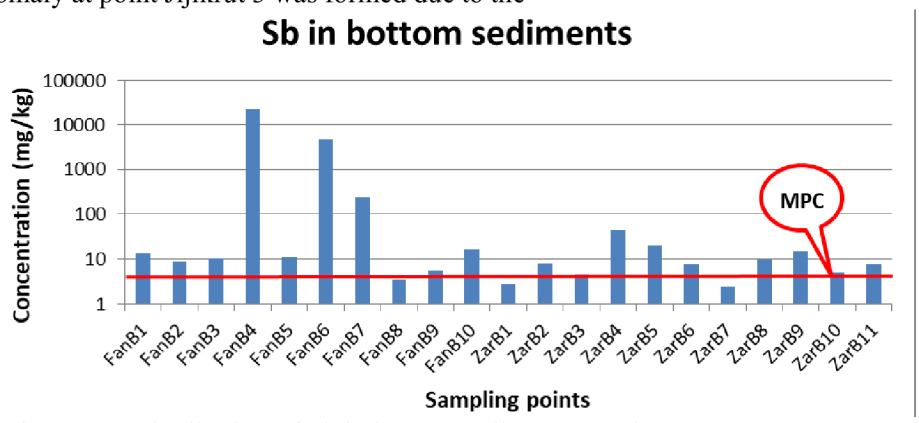

Figure 5. - Distribution of Sb in bottom sediment samples

The distribution of mercury in bottom sediments is quite interesting. The highest concentration is recorded below AGOK, at the Dzhijikrut 3 point and is equal to 650 mg / kg, which is 65000 Clarkes for soils. There is also a lot of mercury in the Gabirud tailing dump, 166 mg / kg, which is 16600 Clarkes.

Almost all elements have anomalous accumulation zones; these zones are mainly confined to non-ferrous metal deposits. These are antimony-mercury deposits Kanchoch, Jijikrut, lead-zinc deposits in Chore. At the same time, there are clean zones, mainly in the upper reaches of the Fan Mountains.

The lower reaches of the Jijikrut-3 river are most heavily polluted, below the AGOK. In the 90s of the last century, due to an accident on the slurry pipeline, the GOK dumped flotation tailings directly into the Jijikrut River, which caused severe pollution of the bottom sediments of this river with metals such as Cr, Ni, Sb, Zn. Unfortunately, there are no data on the content of As at this point, but it is expected that its concentration is very high.

Concentrations of Co, V, and Zn are high in the Chore geological exploration tunnels. A high concentration of Zn may be associated with lead-zinc ore occurrence, which is accompanied by an increased content of Ag.

Despite the excessively high concentration of toxic metals in the Jijikrut River, their concentration in bottom sediments after the AGOK (Yagnob 3 and Fondarya) does not differ much from the overlying points on the Yagnob river (Yagnob 1 and Yagnob 2). This can be explained by the fact that during floods and especially mudflows, bottom sediments of rivers are washed away to downstream and accumulate in reservoirs and in the lower reaches of rivers.

During the study, the concentrations of 10 toxic elements of hazard class 1 and 2 were analyzed, and these are: As, Ba, Co, Cr, Mn, Ni, Sb, Sr, V and Zn. As is belongs to class 1 of the hazard, and the rest to class 2.

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ЭЛЕМЕНТНЫЙ СОСТАВ РЕЧНЫХ ОТЛОЖЕНИЙ В ВЕРХНЕЙ ЧАСТИ БАССЕЙНА РЕКИ ЗЕРАВШАН

Д.А. Абдушукуров

Работа посвящена обработке и интерпретации новых баз данных (2020 г.) по изучению содержания токсичных металлов в донных отложениях бассейна реки Зеравшан. Особое внимание было уделено реке Фондаре, левому притоку реки Зеравшан. Река Фондаре подвержена сильному антропогенному воздействию. Наиболее загрязненное низовье Джиджикрута, ниже Анзобского горно-обогатительного комбината (АГОК). В 90-х годах прошлого века из-за аварии на пульпопроводе АГОК сбрасывал хвосты флотации в реку Джиджикрут, что вызвало сильное загрязнение донных отложений этой реки такими металлами, как Cr, Ni, Sb, Zn.

Ключевые слова: река Зеравшан, река Фондарья, токсичные металлы, загрязнение русла реки, мышьяк, сурьма, ртуть.

ТАРКИБИ УНСУРИИ ТАҲШИНҲОИ ДАРЁҲО ДАР ҚИСМИ БОЛОИИ ҲАВЗАИ ДАРЁИ ЗАРАФШОН

Ҷ.А. Абдушукуров

Аннотатсия:

Дар мақола коркард ва тафсири махзани маълумотҳои нав (соли 2020) оид ба омӯзиши таркиби металлҳои заҳрнок дар таҳшинҳои болои ҳавзаи дарёи Зарафшон бахшида шудааст. Таваҷҷуҳи асосӣ ба шохоби чапи дарёи Зарафшон, дарёи Фондарё равона карда шудааст. Дарёи Фондарё ба таъсири шадиди антропогенӣ дучор мешавад. Поёноби Ҷиҷикуруд, поёнтар аз Комбинати кӯҳию маъдантозакунии Анзоб (ККМА) аз ҳама олудатар мебошад. Солҳои 90-уми асри гузашта, бар асари садама дар лӯлаи обкаши Корхонаи кӯҳӣ-маъдантозакунии Анзоб партовҳои флотатсияро ба дарёи Ҷиҷикуруд партофтанд, ки боиси ифлосшавии шадиди таҳшинҳои поёнии ин дарё бо металлҳое, ба монанди Cr, Ni, Sb, Zn гардид.

Калидвожаҳо: дарёи Зарафшон, дарёи Фондарё, металлҳои заҳрнок, ифлосшавии маҷрои дарёҳо, маргимуш, сурма, симоб.

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