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Removal of mineral salts (including bicarbonate calcium and magnesium) from Ulken Almaty and Kishi Almaty rivers

Abstract: For evaluated some components of hydrochemical balance watercourses necessary to carry out the calculation flow of chemicals, which is very important not only for biological productivity, but also studied intensity of erosion and accumulation processes occurring in the basin. It was learned of long-term dynamics of this process can also deeper understanding the nature of the influence of those or other lithological and anthropogenic factors in the basin on the formation of chemical composition and quality of the river water. The article presents data on the flow of dissolved mineral substances, including calcium and magnesium carbonates, rivers Ulken Almaty, Kishi Almaty in comparison to other rivers of northern slope of Ili Alatau (Shilik, Turgen, Esik, Esentai) over many years. It was established that during the period from 2009 to 2010 years water of Ulken Almaty upstream 5,486 tons of mineral salts, and in the downstream – 7,135 tons, and the share of calcium bicarbonate (calculated of calcium carbonate) have an average of 68% of all salts. Kishi Almaty river in the upstream 4,776 tons (including calcium bicarbonate – 4,080 tonnes) and downstream – 29,520 tons (including 18,745 tons of calcium bicarbonate).
Key words: calcium carbonate equilibrium, removal mineral salts, ion flow, water flow, water consumption

Introduction

Removal of calcium and magnesium carbonate salts is part of the remove of mineral salts. To calculate the removal of carbonate salts necessary to investigate the carbonate calcium equilibrium in the river waters. The results of systematic hydrological observation and monitoring of water quality of the rivers of northern slope of the Ile Alatau possible to calculate flow minerals from the territory of the river basins in Kapshagai reservoir. Calculation chemical substances of flow is great importance not only for the assessment of a number of components of the chemical balance and biological productivity of basins, but also for the knowledge intensity of erosion and accumulation processes occurring in the basin. In this regard, the study of long-term dynamics of this process makes it possible to deeper understanding the nature of the influence of those or other lithological and anthropogenic factors in the basin on the formation of the chemical composition and quality of the river water.

L.V. Brazhnikova, B.A. Beremzhanov and M.A. Ibragimova to investigate the data on the ion flow for rivers all Balkash basin for 1936-1949 y. [1, 2] and 1961-1968 years. [3]. A.N. Nevskaya calculated ion flow of 17 rivers arid areas of Kazakhstan and it is established that during the peak of the flood goes up to 80% of the ion flow [4].

Ion flow of rivers of northern slope of the Ili Alatau after 1968 was not calculated. In this regard, we have calculated the flow of mineral salts, nutrients and organic matter, microelements for rivers Shilik, Turgen, Ulken Almaty, Kishi Almaty and Esentai for 2000 – 2003 years [5] and compared with the data for the period 2009-2010.

Experimental part

To calculate the ion flow of these rivers used results of the chemical analysis of monthly water samples authors and Kazhydromet data on the chemical composition and water flow of the rivers from 1997 to 2002. (Table 1). The ion flow is calculated by the standard technique [6, 7].

Methods of determining the components of carbonate and calcium balance is detailed in the manual [8]. The calculation of the components of the calcium carbonate equilibrium produced by the method and recommendations O.A. Alekin and N.P. Morichev [9], S.M. Romanova [10] without the formation of ion pairs and complexes.

According to the recommendations of L.V. Brazhnikov, A.S. Demchenko [11] and O.A. Alekin [12] definition of unstable components of water (pH, permanganate oxidation performed immediately after sampling, and such as P, Fe, Si in laboratory after canning appropriate reagents. Identification of all the

components of the chemical composition of water was carried out by conventional methods in hydrological practice [11-15] (Table 1). Verification of these methods have shown that the error rate does not exceed the values of their accuracy.

Water flow in the river was measured by a surface float. To measure water flow above and below the main hydrometric alignment equidistant break two additional alignment so as to move the length of the floats between the upper and lower alignment was at least 20 seconds. This duration is due to the fact that the timing with a stopwatch in determining the duration of the course of the floats can be mistakes due to rounding to whole seconds and due to some inaccuracies determine when passing through the float line alignment. Floats throw only stem of the river, where there is the highest rate of the river. Of all running floats (5-10) selected three float with the least duration of the course.

Table 1 – Methods for determination of the components of the chemical composition of water

Component	Method	The sensitivity of the method	Accuracy of the method
pH	Colorimetric	0,05 unit pH	±0.5-0.8%
Ca^{2+}, Mg^{2+}	Complexometric indicators murexide with chrome and black GS-ET	0,5 mg/l	±0.5%
$Na^{+}+K^{+}$	Calculated from the difference between the sum of cations and anions in the 1 / z (C) mol / l		
HCO_3^-, CO_3^{2-}	Volumetric, direct titration	10 mg/l	±1-5%
SO_4^{2-}	Gravimetric	10 mg/l	±0.5%
Cl^-	Volumetric, argentometric	10 mg/l	±0.5-0.8%
NH_4^+	Photometric reagent Nessler	0.002 mg/l	±4-5%
NO_2^-	Photometric with Griess reagent	0.5 μg/l	±3-5%
NO_3^-	Photometric, the revolt-leniem metal cadmium nitrate to nitrite	0,010 mg/l	±5%
The mineral phosphorus	Photometric with ammonium molybdate and ascorbic acid	0.005 mg/l	±1.5-5.5%
Silicon	Photometric with ammonium molybdate	0.5 mg/l	±2%
Iron	Photometric with sulfosalicylic acid	0.02 mg/l	±8%
Oxidation permanganate	By Kubel	0.5 mg/l	±4-5%
Manganese	Photometric with formaldoxime	5 μg/l	±2%
Oxygen	Iodometric according to Winkler	0.05 mg/l	±0.3-0.5%

Results and their discussion

It is known that the absolute values of ion flow depends from water availability on the year. In 2000, river Shilik had the highest ionic flow among the rivers of northern slope of the Ile Alatau, which amounted to 161,540 tons (water flow is 440.8 km^3), and in 2001, 109,591 tons (water flow is 375 km^3). In 2002, the annual value of the ion flow increased to 196,726 tons, and water flow to 645 km^3, i.e. 1.8 times more than in 2001.

The same can be noted for river Turgen. In 2000, the flow of mineral salts there was 31, 379 tons (water flow 113 km^3), and in 2002, 56, 561 tons. The rivers Ulken Almaty, Kishi Almaty, Esentai examined data on upstream and downstream. The calculation showed that the ion flow of Ulken Almaty in 2000, on upstream was 3, 395 tons, and on downstream was 21, 118 tons, and with the flow increased by 6.2 times. In the following 2001 and 2002 the increase ion flow is reduced by half.

Ion flow of solutes river Ulken Almaty for the period from 1997 to 2002, ranges 920.3-17 959.9 tons, the minimum values correspond to the lowest values of the water flow.

Ion flow river Kishi Almaty for 2001 is 1.5-2 times greater than r.Ulken Almaty, although the water flow is less (Table 2).

Ion flow r.Esentai with the flow increases. For example, in 2002, at a point al-Farabi avenue ion flow is 5631 tons, and at a point Ryskulov avenue, i.e. downstream with the flow increases to 2230 and 7861 tons, correspondingly.

Table 2 – Changes in the annual ion flow (R_i), depending on the water flow (R_w) for some of the rivers Ili Alatau

r. Kishi Almaty – Almaty (2.0 km above the city)			r. Kishi Almaty – Almaty (0.5 km below the reset fur factory)			r. Kishi Almaty – Almaty (4.0 km below the city)			r. Kishi Almaty – Almaty (0.5 km below the reset radio center)		
Year	R_w, km^3	R_i, t	Year	R_w, km^3	R_i, t	Year	R_w, km^3	R_i, t	Year	R_w, km^3	R_i, t
2000	16.7	3378.0	1998	1.98	524,7	1998	11.7	4,5440	1998	22.7	10,3717
2001	14.8	6124.5	2000	23.26	9207,1	2000	39.3	17,1460	2001	41.9	25,8630
						2001	33.7	13,9540			
r. Ulken Almaty – Almaty 9.1km above the city			r. Ulken Almaty – Almaty (0.5 km below the city)			r. Ulken Almaty – Almaty 0.5 km below the reset water flow			r. Ulken Almaty -Ustya 12 km above the estuary		
Year	R_w, km^3	R_i, t	Year	R_w, km^3	R_i, t	Year	R_w, km^3	R_i, t	Year	R_w, km^3	R_i, t
1997	8,5	1839,1	1997	20.3	3503,0	1997	17.9	3525,5	1997	28.0	14238,1
1998	4,8	920,3	1998	5.2	2207,5	1998	5.8	1979,2	1998	7.9	3807,8
2000	11,4	3395,5	2000	45.9	14555,1	2000	102.1	31027,5	2000	55.3	21718,7
2001	16,2	3537,8	2001	38.9	9514,9	2001	49.5	12222,8	2001	2.6	1336,3
2002	26,0	6107,7	2002	43.3	10609,6	2002	71.6	17959,9			
r. Esentai – Almaty al-Farabi avenue						r. Esentai – Almaty – Ryskulov avenue					
Year		R_w, km^3		R_i, t		Year		R_w, km^3		R_i, t	
2000		10.9		2463		2000		11.0		2617,0	
2001		17		4360		2001		18.7		5144,0	
2002		21.6		5631		2002		29.0		7861	

The authors calculated flow of mineral salts rivers Ulken Almaty, Turgen and Kaskelen for 2003 and 2009-2010 (Table 3). As you can see, the flow of mineral salts of r.Turgen only for June and July 2003 is 13, 900 tons. Ion flow of river Kaskelen over the same period more than (17,531 tons.) river Turgen (13 900 tons), although water flow less (Table 3). If, in June 2003, the most submitted HCO_3^- (1435 tons) and Ca^{2+} (383 tons), in July predominant ions become SO_4^{2-} (5800 tons), and Na^+ (3105 tons). Flow of river Kaskelen formed by flowing tributaries, in particular river Ulken Almaty. Removal of mineral salts river Ulken Almaty in June and July 2003 is 2 300 tons. with the prevalence of HCO_3^- and Ca^{2+} ions. For this study the rivers with increasing annual water or season an increase the ion flow (eg, r.Ulken Almaty correlation coefficient is – 0,89-0,95).

During the period from March 2009 to July 2010 (16 months) the water of river Ulken Almaty river upstream 5,486 tons of mineral salts, and in the downstream – 7135 tons, share of calcium bicarbonate (calculated of calcium carbonate) have an average of 68% of all salts. Kishi Almaty river in the upstream (Medeu) for the period from March to November 2009 removed 3,039 tons of substances, including calcium bicarbonate – 2,833 tons, and from January to May 2010, 1,737 and 1,247 tons respectively, with an average of during this period 82% of all minerals.

In the downstream of the river Kishi Almaty for 10 months of 2009, 18,952 tons of salt removes, and the share of calcium bicarbonate accounting for 63%, and for 6 months of 2010, 10,568 tonnes and 64%, respectively. The data in Table 2 that the Kishi Almaty river flowing through the city Almaty, enriched in minerals by 24.7 thousand tons, in other words, removal of salts increases by more than 6 times in the downstream than compared with upstream. It should be noted that the columbine area of river Kishi Almaty more (1,240 km^2) 2.7 times compared to the river Ulken Almaty (461 km^2), but the average of the 2009-2010 consumption of water at the outlet of the mountain river Ulken Almaty (1.26 m^3/s), river Kishi Almaty (1.38 m^3/s) and in the mouth portions are little differ 1.75 m^3/s to 1.86 m^3/s, respectively. This explains the higher salt removal river Kishi Almaty compared with river Ulken Almaty.

Table 3 – Removal of mineral salts some rivers of Ili Alatau

No. point (station)		Date of sampling	Consumption, m^3/s	R_w, $l*10^9$	Mineralization, mg/l	R_i, ton
r. Turgen	13	10.06.03	14.4	37.3	122.0	4551
	27	17.07.03	23.4	62.7	134.0	8402
	39	27.07.03	21.5	57.6	178.0	10253
r. Kaskelen	18	10.06.03	6.72	17.4	149.0	2593
	32	18.07.03	18.4	49.3	303.0	14938
r. Ulken Almaty	5	10.06.03	0.57	1.47	174.0	256
	36	17.07.03	4.89	13.1	156.0	2044
r. Ulken Almaty, the upstream (3.5 km above the district Orbita)	48	31.03.09	0.973	2.31	155.8	360,52
	140	05.07.09	2.258	5.37	169.8	911,83
	166	02.08.09	1.723	4.10	150.8	617,98
	196	13.09.09	1.413	3.66	141.4	517,81
	248	22.11.09	0.421	1.09	178.9	195,18
	272	07.01.10	0.546	1.30	162.1	210,57
	309	28.02.10	0.390	0.94	204.2	192,76
	336	27.03.10	0.445	1.06	193.3	204,51
	380	24.05.10	0.303	0.72	208.1	150,04
	399	14.07.10	4.150	9.87	159.5	1574,27
r. Ulken Almaty (downstream, Boraldai)	144	05.07.09	3.710	8.82	159.7	1409,19
	160	01.08.09	2.339	5.56	156.9	872,83
	200	13.09.09	1.239	3.21	170.4	547,15
	223	25.10.09	0.859	2.04	207.7	424,33
	278	08.01.10	0.443	1.05	241.2	254,22
	316	28.02.10	0.468	1.13	329.4	372,89
	342	28.03.10	1.950	4.64	245.3	1137,70
	371	22.05.10	0.578	1.37	402.4	553,30
	406	14.07.10	4.170	9.92	157.7	1564,07
r. Kishi Almaty (downstream, Medeu)	49	31.03.09	0.347	0.83	193.3	159,47
	128	13.06.09	0.109	0.28	283.9	80,34
	138	05.07.09	2.303	5.48	123.3	675,31
	165	02.08.09	5.850	13.9	117.1	1629,33
	195	13.09.09	1.381	3.58	138.1	494,40
	247	22.11.09	1.170	3.03	159.1	482,55
	271	07.01.10	0.439	1.04	160.5	167,56
	321	08.03.10	0.228	0.54	259.1	140,43
	335	02.04.10	1.092	2.83	198.9	562,89
	379	24.05.10	0.908	2.16	177.8	384,04

Continuation of table 3

No. point (station)		Date of sampling	Consumption, m^3/s	R_w, $l*10^9$	Mineralization, mg/l	R_i, ton
r. Kishi Almaty (downstream, Pokrovka, source Almerek)	18	22.02.09	1.354	3.28	736.8	2413,76
	61	12.04.09	3.044	7.89	634.9	5009,36
	111	27.05.09	2.874	6.83	494.3	3378,54
	121	13.06.09	1.404	3.64	504.0	1834,06
	152	05.07.09	1.737	4.13	503.8	2081,20
	167	02.08.09	1.030	2.45	550.6	1348,97
	203	13.09.09	1.423	3.69	438.8	1618,29
	230	25.10.09	0.960	2.28	555.2	1267,52
	296	30.01.10	0.985	2.34	685.3	1605,66
	345	28.03.10	2.942	7.00	499.5	3495,00
	372	22.05.10	3.303	7.86	501.0	3935,86
	387	27.06.10	1.300	3.37	454.4	531,33

Conclusion

1. A study of water flow of the rivers Ulken Almaty and Kishi Almaty showed that the greatest flow of water masses in the summer. So, for the river Ulken Almaty summer in the upper portion of the water flow reaches $5.37*10^9$ – $9.87*10^9$ l, while the lower alignment – $8.82*10^9$ -$9.92*10^9$ l at respective maximum water flow, 2.26-4.15 m^3 / s and 3.71-4.17 m^3 / s. The lowest water flow in the autumn – winter period. So, for the river Ulken Almaty in the upper portion of flow decreases to $1.09*10^9$ -$1.30*10^9$ l, while the lower alignment – $1.05*10^9$ – $1.13*10^9$ l at the appropriate minimum water flow 0.42-0.45 m^3 / s and 0.44-0.47 m^3 / s.

2. For river Kishi Almaty a similar pattern in the distribution of water flow. Thus, in the upper portion of the maximum water flow in summer reaches $13.9*10^9$ l, while the lower alignment – $7.89*10^9$ l at respective maximum water flow rate of 5.85 m^3/s and 3.04 m^3/s. The lowest water flow of the river in the autumn and winter period. So, for the river Kishi Almaty in the upper portion of stock is reduced to $1.04*10^9$ l (and in early spring before $0.54*10^9$ l), while the lower alignment – $2.28*10^9$ l at the appropriate minimum water flow of 0.44 m^3/s and 0.96 m^3/s.

3. The calculation of the removal of mineral salts North Slope rivers Ili Alatau allowed to establish the following. During this period the water river Ulken Almaty in the upstream 5,486 tons of mineral salts, and downstream – 7,135 tons, and the share of calcium bicarbonate (calculated calcium carbonate) have an average of 68% of all salts. River Kishi Almaty in the upstream removed 4,776 tons substances (including calcium bicarbonate – 4,080 tons) and downstream – 29,520 tons (including 18,745 tons of bicarbonate).

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