ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ
Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

Х А Б А Р Л А Р Ы

ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК
РЕСПУБЛИКИ КАЗАХСТАН
Казахский национальный исследовательский
технический университет им. К. И. Сатпаева

N E W S

OF THE ACADEMY OF SCIENCES
OF THE REPUBLIC OF KAZAKHSTAN
Kazakh national research technical university
named after K. I. Satpayev

SERIES
OF GEOLOGY AND TECHNICAL SCIENCES

1 (439)

JANUARY – FEBRUARY 2020

THE JOURNAL WAS FO67UNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Webof Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

«ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).
Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген **№10892-Ж** мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.
Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18, http://www.geolog-technical.kz/index.php/en/

Редакцияның мекенжайы: Қазақстан, 050010, Алматы қ., Қабанбай батыр көш., 69а.
Қ. И. Сәтбаев атындағы геология ғылымдар институты, 334 бөлме. Тел.: 291-59-38.

Типографияның мекенжайы: «NurNaz GRACE», Алматы қ., Рысқұлов көш., 103.

«Известия НАН РК. Серия геологии и технических наук».
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан (г. Алматы)
Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан **№10892-Ж,** выданное 30.04.2010 г.

Периодичность: 6 раз в год
Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18,
http://nauka-nanrk.kz /geology-technical.kz

Адрес редакции: Казахстан, 050010, г. Алматы, ул. Кабанбай батыра, 69а.
Институт геологических наук им. К. И. Сатпаева, комната 334. Тел.: 291-59-38.

Адрес типографии: «NurNaz GRACE», г. Алматы, ул. Рыскулова, 103.

News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.
ISSN 2518-170X (Online),
ISSN 2224-5278 (Print)
Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)
The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 10892-Ж, issued 30.04.2010

Periodicity: 6 times a year
Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,
http://nauka-nanrk.kz/geology-technical.kz

Editorial address: Institute of Geological Sciences named after K.I. Satpayev
69a, Kabanbai batyr str., of. 334, Almaty, 050010, Kazakhstan, tel.: 291-59-38.

Address of printing house: «NurNaz GRACE», 103, Ryskulov str, Almaty.

N E W S
OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN
SERIES OF GEOLOGY AND TECHNICAL SCIENCES
ISSN 2224-5278
Volume 1, Number 439 (2020), 6 – 13 **https://doi.org/10.32014/2020.2518-170X.1**

UDC 551.482.214

N. A. Amirgaliev[1], Christian Opp[2], M. Askarova[3], R. A. Kulbekova[1], L. T. Ismukhanova[1]

[1]LLP «Institute of Geography» of the Ministry of Education and Science of the Republic of Kazakhstan, Almaty, Kazakhstan;
[2]University of Marburg, Marburg, Germany;
[3]KazNU al-Farabi, Almaty, Kazakhstan.
E-mail*:* namirgaliev@mail.ru, r.k.85@mail.ru, l--aura@bk.ru,
opp@staff.uni-marburg.dep**,** maulken@mail.ru

ABOUT RATIO AND VALUES OF THE EMPIRICAL COEFFICIENT OF ALKALI METALS (Na^+ and K^+) IN SURFACE WATERS OF KAZAKHSTAN ON THE EXAMPLE OF THE ILE RIVER

Abstract. Issues concerning to insufficient knowledge of such important aspects in the field of regional hydrochemistry, which are the patterns of formation of the regime and the dynamics of alkali metals (sodium and potassium) in surface waters are considered. It is pointed out the need for reliable analytical data on the separate concentration of sodium and potassium in natural waters to solve important practical problems in the field of assessing the suitability of the composition of the water of reservoirs for acclimatization of valuable forage organisms for fish, when choosing water sources for irrigated areas. Special attention is paid to the importance of the empirical coefficient (EC) of sodium and potassium, which is necessary in determining the total mineralization of natural waters, on which the level of their use for various household and drinking needs depends. On the state monitoring data, the nature of changes in the ratio of sodium and potassium along the Ile River was studied and the EC was established to calculate their absolute concentration (in mg/dm^3) and total water mineralization. Based on the analysis of literature data and the results of our own research on the item under consideration, conducted in different years for a number of reservoirs and watercourses in Kazakhstan, it was concluded that: previously adopted for the entire territory of the former USSR, the EC equal to 25 for freshwater reservoirs can be used for waters of some river basins of the Republic of Kazakhstan with their mineralization up to 350-400 mg/dm^3. A decisive role in the formation of the regime and the dynamics of the concentration of sodium and potassium in surface waters has a complex of regional physiographic conditions: climate, nature of the soil, groundwater, anthropogenic influences, etc. The necessity of establishing the EC for reservoirs and watercourses of different climatic zones of the Republic of Kazakhstan, especially for large transboundary basins, is recommended.

Key words: sodium and potassium, values of their ratio in surface waters, empirical coefficients of alkali metals.

Introduction. The sodium and the potassium are one of the main components of the chemical composition of natural waters. However, until now, due to the sufficient laboriousness of their separate chemical analysis and limited distribution of sensitive and relatively simple methods for determining these ions, they are often not determined separately, and the total content of Na^+ and K^+ is calculated from the difference between the sum of anions and cations. The data obtained in this case cannot be considered reliable, since the calculated value of the sum of Na^+ and K^+ contains errors of chemical determination of all major ions.

In terms of assessing the genetic conditions for the formation of the chemical composition of waters of different types of reservoirs, as well as to develop a number of methodological approaches in their study, it is very important to know about the content of water and migration characteristics of alkali metals – Na^+ and K^+. The study of the dynamics of Na^+, K^+ and their ratios is of great importance in determining

the characteristics of their migration in surface waters and other natural objects in different climatic and soil zones, in the characteristics of biological productivity and quality of natural waters, for search purposes, etc.

Literature review. The research of the content and dynamics of sodium and potassium in the lithosphere and natural waters are devoted to the works of a number of geochemistry classics, like F. Clark [1], V.M. Goldschmidt [2], A.P. Vinogradov [3, 4], E.D. Goldberg [5], J.P. Reilly and G. Skirrow [6]. Subsequently, these elements were studied in sufficient detail by A.A. Beus [7], G.S. Konovalov and V.I. Koreneva [8, 9], A.M. Almazov and I.G. Enaki [10].

The scientific data on this issue for surface waters of Kazakhstan have until recently been found in the work of A.I. Mun and A.B. Bekturov [11]. A fairly wide range of issues related to alkali metals (Na^+ and K^+), we studied in some years in the water of a number of important and large brackish-water and fresh water objects in Kazakhstan [12-17].

It is known that a number of aquatic organisms that serve as a fodder basis for fishes can live and reproduce only at certain ratios of potassium and calcium concentrations in water. As the value of the K^+/Ca^{2+} ratio (above 0,2) increases, unfavorable water properties for aquatic organisms increase. The toxic effect of potassium on organisms can neutralize calcium ions at certain ratios and concentrations [18-19].

A clear example that confirms these conclusions is the results of our experimental work on the survival of mysids in the water of in the water bodies in Kazakhstan. According to the results of a number of years of acclimatization works, the introduction of mysids (Paramysis (Mesomysis) intermedia, P (M).kovalevski) and other food items in the large brackish lake Alakol has failed. The reason was precisely in the high concentration of potassium in the water, unbalanced, respectively, by antagonist ions.

In the waters of Lakes Sasykkol and Koshkarkol, which are part of the Alakol lakes system, the concentration of potassium is low, according to average values of 3,9 and 9,4 mg/dm^3, respectively. Mysids were successfully were acclimatized to these lakes, the conditions were optimal for the life of invertebrate organisms, including the ratio of K^+/Ca^{2+} is characterized by values of 0,06-0,16. The ratio of K^+/Ca^{2+} in the water of lake Alakol, taken for experience, was 1,11-0,75. In some areas of the water area, the ratio of K^+/Ca^{2+} in the water of this lake reached 4,1 and 5,6. In our experiments, the survivorship rate of mysids in the water of Lake Alakol was 14-16 %, and in the water of other reservoirs it reached 80 %. According to Yu.V. Epova [20], the mysids have not been found in the Lake Alakol so far.

Separate concentration of sodium is an important indicator in the agro-industrial sphere in assessing the irrigation quality of natural waters. Thus, when calculating the values of the irrigation (alkali) coefficient (Ka) proposed by H. Stabler using an equation $К_a \frac{6620}{Na^+ + 2{,}6\ Cl^-}$, as well as the sodium absorption ratio SAR (used by the Department of Agriculture US farms), which characterizes the danger of soil salinity according to the equation $SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+}+Mg^{2+}}{2}}}$, the value of elemental sodium concentration is quite large.

Sodium and potassium have similar chemical properties, but on the earth's surface, their migration paths diverge. Na^+ leaches from hypergenic formations, while K^+ is trapped by soil colloids and living material.

The geochemical mobility of potassium is many times lower than that of sodium, which is explained by a number of reasons: slower destruction and greater persistence of primary potassium minerals in comparison with sodium; potassium adsorption by sedimentary rocks, soil, potassium absorption by living organisms, especially by plants. The difference in the behavior of sodium and potassium in the weathering crust is reflected in the peculiarities of the ratio of sodium and potassium in natural waters. Sodium prevails in the hydrosphere. About 65% of the total removal of sodium from the weathering zone to the ocean comes mainly in the dissolved state, most of the potassium is in the composition of suspended sediments [8, 21].

The intake of Na^+ and K^+ into natural waters is largely determined by the interaction of water with living organisms, especially with plants. Researches of N.A. Kudryatseva [22] showed that with the loss of aquatic vegetation a significant portion of alkali metals goes into water. From the dry plant mass, according to the results of experiments, on average, 79,2 % of potassium is extracted, and 77,9 % of their

total content is sodium. It turns out that aquatic plants are able to concentrate potassium selectively. For example, in the clasping-leaved pondweed and water persicaria, the potassium content was respectively 41,4 and 54,7 % of the sum of calcium, magnesium, potassium, and sodium.

Baseline data, research results and discussion. In this paper, based on data from the state monitoring of RSE «Kazhydromet», the dynamics of sodium and potassium in the water of the r. Ile, which is one of the main transboundary rivers of Kazakhstan. The features of the change in the ratio of these elements along the river were studied and empirical coefficients (EC) were established for recalculating the amount of Na^+ and K^+ from mg-eq/dm^3 to mg/dm^3.

The laboratory of hydrochemistry of RSE «Kazhydromet» (Almaty), the content of Na^+ and K^+ ions was determined by the ion-selective method. This method is the most accessible, since the determination takes place with the help of the portable ionomer «Anion-7051» and two electrodes for each element; this allows a series of definitions to be taken directly at the object in a short time [23, 24].

Baseline data for the study and calculation of these characteristics are presented in table 1. According to them, the average sodium concentration for 2009-2014 in the water of four hydrological posts located along the river from transboundary hydrological section to the delta (length of 815 km) varied from 22,1 to 27,0 mg/dm^3, and potassium – from 3,0 to 2,5 mg/dm^3 in the delta zone. At the same time, their maximum concentrations reached 31,6 and 4,8 mg/dm^3, respectively. Average values of sodium in the water along the river gradually increase from 22,1 to 27,0 mg/dm^3, while potassium remained at 3,0 mg/dm^3, only at the top of the delta decreased to 2,5 mg/dm^3. In changing the concentration of sodium in the water along the river can be traced dependence on the value of water mineralization. Average mineralization of river water for 2009-2014 varied in the range from 356 mg/dm^3 in the border hydrological section to 386 mg/dm^3 – at the top of the Ile river delta.

Table 1 – Mineralization (Σ_i) and the concentration of sodium, potassium in the water of the river Ile, mg/dm^3

Hydrological post	Ingredient	Years						Average, mg/dm^3
		2009	2010	2011	2012	2013	2014	
Dobyn village (border)	Σ_i	342	340	362	374	358	368	356
	Na^+	20,0	25,7	20,7	24,8	19,0	22,9	22,1
	K^+	4,8	2,2	2,3	2,4	2,5	3,5	3,0
164 km above the dam of the Kapshagay hydroelectric station	Σ_i	348	345	345	370	360	395	361
	Na^+	20,3	23,7	21,8	24,6	20,3	27,9	23,0
	K^+	3,7	1,8	4,1	1,7	2,4	4,3	3,0
37 km below the Kapshagay dam	Σ_i	336	347	372	375	358	380	368
	Na^+	21,7	28,3	29,1	28,8	23,6	31,6	25,5
	K^+	3,0	2,2	3,9	1,4	2,7	4,0	3,1
Ushzharma village (the top of the r.Ile delta)	Σ_i	366	383	384	394	379	410	386
	Na^+	24,2	28,5	30,9	29,2	23,6	25,5	27,0
	K^+	3,3	1,9	2,9	1,3	2,7	3,1	2,5

Analysis of the change in the relative content of sodium and potassium from their sum shows (table 2) the increase in the relative proportion of sodium downstream from 88,2 to 91,3 % and the decrease in the proportion of potassium from 11,8 to 8,7 %. As is known, the relative content of sodium and potassium in waters of different salinities is not the same. In sea waters, the relative content of sodium is on average 96 %, potassium is 4 % of their total. In river waters, the potassium content increases to 12-20 %, and sodium decreases to 88-80 % [10].

According to J.P. Railey and G. Skirrow [6], when the salinity of seawater is 10, sodium concentration is 3,074 g/dm^3, potassium is 0,111 g/dm^3, and at salinity 41 ‰ their content increases to 12,603 and 0,454 g/dm^3, respectively. When the salinity of seawater changes, the relative content of these elements remains constant – sodium 96,5 %, potassium – 3,5 %. In the literature there are data charac-terizing the close proximity of the content of sodium and potassium in the waters of the seas and oceans.

Thus, according to A.P. Vinogradov [4], in oceanic water, sodium is contained in the amount of 10 354 mg/dm^3, potassium – 387 mg/dm^3, and in the sea water by E.D. Goldberg [5], 10 500 mg/dm^3 and 380 mg/dm^3, respectively. At the same time, the relative proportion of these elements also remains unchanged.

Table 2 – The values of ratio and empirical coefficients (equivalents) of sodium and potassium in the water of the River Ile

Hydrological post	Na^+, %	K^+,%	Na^+/K^+, mg/dm^3	$E_{Na^+ + K^+}$
Dobyn village (border)	80,6-92,1 88,2	7,9-19,4 11,8	3,8-12,0 8,3	23,8-25,2 24,2
164 km above the dam of the Kapshagay hydroelectric station	84,2-93,5 88,5	6,5-15,8 11,5	5,3-14,5 8,8	23,6-24,6 24,2
37 km below the Kapshagay dam	87,9-95,4 90,5	4,6-12,1 9,5	7,2-20,6 10,6	23,4-24,2 23,9
Ushzharma village (the top of the r.Ile delta)	88,0-95,7 91,3	4,3-12,0 8,7	7,3-22,5 12,1	23,4-24,2 23,9

According to our data, in the water of brackish reservoirs of Kazakhstan: in the Lake Alakol the relative content of potassium decreased to 1,5-1 %, sodium reached 98,5-99 % [15], in the brackish eastern part of Lake Balkhash the content of potassium decreased to 4 % [13].

Such significant differences in the content of these elements in natural waters are due to their different migration ability, although the Clarke content of these components is very close: according to A.P. Vinogradov [25] sodium – 2,64 %, potassium – 2,60 % , according to S.P. Taylor [29] – 2,36 and 2,09 %, respectively.

In accordance with the changing of the relative content of sodium and potassium, the values of the ratio Na^+/K^+ change. The high mobility of sodium compared to potassium (sodium ionization potential is 5,12, potassium is 4,32) is determined by its best leaching from sedimentary formations, potassium accumulates in weathering products, it is easily adsorbed by rocks, soils and their colloidal part, which greatly limits its migration.

Among natural objects, the highest values of the Na^+/K^+ ratio are characteristic of natural waters. As their mineralization increases, the ratio between these ions increases. In [8] were given the values of the ratio Na^+/K^+ for the main rivers of the Soviet Union. Depending on the physiographic conditions, they varied from 0,75 to 58. At the same time, the greatest significance is characteristic of the rivers of Central and Northern Kazakhstan, which are in arid climate.

The value of the ratio of Na^+/K^+ (mg/dm^3) in the water of the Ertis River near the city of Pavlodar is on average 7,3. It gradually increases along the route of the Ertis-Karaganda canal. The highest values of the Na^+/K^+ ratio (from 34 to 160) are noted in the sections of the canal route, affected by groundwater [12]. In the water of the r. Syrdarya and Shardara water storage reservoir averaged 26,6 and 30,3, respectively [16], water storage reservoirs on the Tobol River from 15 to 51, on average of 27,8, and reservoirs on the Esil River from 3 to 19, on average of 13,8 [14]. In the waters of brackish reservoirs: in the Lake Alakol, it was in the range from 23,2 to 79,2, on average of 54,8 [15], in the Lake Balkhash – from 7,2 to 29,1, on average of 14,0 [13].

Directly the value of ratio Na^+/K^+ is defined by the EC (Na^+ and K^+), that are needed for the calculation of the sum of these ions from mg-eq/dm^3 in mg/dm^3. This indicator for waters of all reservoirs and watercourses studied by us was calculated using the equation $E_{Na^+ + K^+} = \frac{A+B}{\frac{A}{E} + \frac{B}{E}}$, where A is the amount of Na^+ in a sample, mg/dm^3; B is the amount of K^+ in the sample, mg/dm^3; E_{Na^+} is the equivalent of Na^+, equal to 23, E_{K^+} is equivalent of the K^+, equal to 39,1.

The EC of Na^+ and K^+, established by us for a number of reservoirs and watercourses of Kazakhstan are shown in table 3. From the estimates, it follows that from among total surface waters studied on this subject, the EC equal to 25 was registered only for the water resources of the Ertis River and the Vyacheslavsky (Astana) water-storage reservoir, built in the Upper Esil River. The average coefficients equal to 24 and 24,8 are characteristic for the water of the Ile River and the Sergeevsky water-storage reservoirs located in the Middle Esil River. For waters of all other reservoirs and watercourses, the average values of the EC of $Na^+ + K^+$ were in the range of 23,1-23,8, including the brackish reservoirs (Lake Balkhash and Alakol), as well as freshwater reservoirs such as the Syrdarya River, a cascade of water-storage reservoirs on the Tobyl River, on the Ertis-Karaganda canal, Shardarinsky water-storage reservoir.

As is well known by definition of P.A. Kashinsky [26], the EC of $Na^+ + K^+$ for the highly mineralized lake brine is close to 23,5; for the fresh water, as well as for water extraction of basic sediment and soil it is in cases in close to 24,5. In the practice of hydrochemical analysis to date, when calculating the total

content of Na^+ and K^+ from the difference mg-eq. of anions and cations, these values are rounded and are taken equal: for saline water is 24 and for fresh is 25 [27, 28].

These coefficients are also adopted in the system of RSE «Kazhydromet» and are used by those that are to some extent related to the chemical analysis of natural waters.

In this regard, the following should be noted. According to our research, in 1970-1984 the mineralization of water of the cascade of reservoirs on the Tobol River was in the range of 530-833 mg/dm^3, the Sergeevsky reservoir in 1974-1984 from 365 to 489 mg/dm^3 [14], Shardarinsky reservoir – 700-1000 mg/dm^3 in 2003-2005 [16], in the water of the reservoir cascade on the Ertis-Karaganda canal the values of this indicator in 1969-1978 marked within 238-676 mg/dm^3 [12]. The EC values for the waters of these reservoirs are from 23,3 to 24,8 (table 3). Consequently, the use of EC is 25 for these fresh reservoirs in accordance with the generally accepted scheme will be overvalued of the concentration of both the alkali metals themselves and the value of the total water mineralization. The limits of admitted errors will especially increase in the quantitative assessment of reserves of mineral salts in reservoirs, annual and long-term volumes of the flow of chemicals along rivers, salt balance and forecast calculations.

Table 3 – The value of ratio and empirical sodium and potassium coefficients established for waters of various types of water objects in Kazakhstan

Water objects	Na^+/K^+		$E_{Na^+ + K^+}$		Source
	1	2	1	2	
Rivers:					
Ertis	4,2-12,3	7,3	24,2-26,1	25,0	[12]
Syrdarya	24,0-29,3	26,6	23,3-23,4	23,3	[16]
Ile	3,8-22,5	9,9	23,4-25,4	24,0	
Shiderty	89-111	92	23,1-23,2	23,1	[12]
Water-storage reservoir:					
Cascade on the River Tobyl	15-51	27,8	23,5-23,8	23,6	[14]
Vyacheslavsky Sergeevsky	3-18	12,9	24,3-26,1	25,0	[14]
Shardarinsky	6-19	14,6	24,1-25,2	24,8	[14, 12]
Cascade on the Ertis-	24,3-33,9	30,3	23,3-23,4	23,3	[16]
Karaganda canal	5,4-34,9	16,8	23,4-25,7	23,8	[12]
Brackish reservoirs:					
Lake Balkhash	7,2-29,1	14,0	23,3-24,2	23,6	[13]
Lake Alakol	23,2-79,2	54,8	23,2-23,5	23,3	[15]

Note: 1 – limits, 2 – average values.

One of the important conclusions resulting from our research is that the ratio of Na^+/K^+ and the EC value of these elements in surface waters largely depend on the complex natural conditions of the territory where the water object is located. The dependence of the dynamics of these characteristics on the value of the total water mineralization, of course, cannot be excluded, but the influence of this factor has a secondary role, if we consider the peculiarities of these characteristics in the regional aspect. The impact on the dynamics of the characteristics of water mineralization is mainly manifested only through the concentration of sodium ions, which increases with the growth of mineralization, and the potassium content within certain values of the latter does not change significantly.

According to research by A.M. Almazov and I.G. Enaki [10] in water objects of Ukraine, with the water mineralization in the range of 100-500, the EC was 27, and with 500-1000 – this indicator was in the range from 25 to 26,4. At the same time, the authors indicate that this coefficient for some fresh waters can reach higher values – 28-30.

As it was shown above, EC 25 was registered by us for Ertis River water with mineralization of 180-195 mg/dm^3 and Vyacheslavsky reservoir with mineralization of 294-360 mg/dm^3 [12,14]. When water mineralization above these values, even not reaching 1000 mg/dm^3, the EC recorded in the range from 23 to 24. Indicators of the EC 23,5-23,7, according to studies [10], recorded when mixing of river and sea water in the Dniprobuzkiy Lyman with the mineralization of 1000-2000 mg/dm^3.

The results obtained by us on the values of the EC of sodium and potassium for water reservoirs of various territories of Kazakhstan confirm the conclusions made by G.S. Konovalov and V.I. Koreneva [8,9,21], on the basis of detailed studies of the regime and the EC of sodium and potassium in the waters

of the rivers of the Soviet Union. In particular, they indicated the absence of a clear dependence of the EC on the mineralization of river waters. At the same time, it is concluded that this indicator is determined by the complex of physical and geographical conditions in the catchment area of the river basin, the degree of soil and rocks washing, the presence of underground inflow, the amount of precipitation and the balance of radiant energy. Several EC amounts of sodium and potassium have been proposed for rivers of different climatic zones, namely, for rivers in the mountainous region, in the flood – 28,0, in low water – 27,0, for the rivers of the steppe zone and forest-steppe – 25,0 and 24.0, respectively, for rivers of semi-desert and desert zones in the flood – 24, in the low water – 23,5.

From all that has been said in this work, in our opinion, it follows that it is necessary to establish the EC at least for large reservoirs and watercourses of various climatic zones of Kazakhstan, including especially water objects in the basins of the main transboundary rivers. This would allow to eliminate the inaccuracies that occur in the quantitative assessment of the level of water mineralization, especially in the objects of the country's large water basins. It is mineralization that is the determining component of the degree of suitability of natural waters for their use in all economic sectors and for safe drinking.

Conclusion. Sodium and potassium are among the insufficiently studied chemical elements in surface waters, particularly in Kazakhstan. To some extent, this is due to the extremely limited data on their separate concentration in the water of reservoirs and watercourses.

Along with the theoretical significance of knowing their dynamics and migration in nature, information about the separate concentration of sodium and potassium is necessary when solving the number of important practical problems in the use of water resources for various needs. For the water of the Ile River, the values of the empirical coefficient of sodium and potassium are set in the range of 23,9-24,2, on average 24,0. The empirical coefficient, which is 25, generally accepted for freshwater reservoirs, which is applicable to the waters of individual river basins of the Republic of Kazakhstan with mineralization up to 350-400 mg/dm^3. The formation of the regime and the dynamics of the concentration of sodium and potassium are determined by regional physiographic conditions.

The results of the research presented in the manuscript were carried out within the framework of the Grant Financing of the Committee of Sciences of the MES of the RK № AP05133353 «Monitoring concentration and distribution of toxic compounds in the snow cover on the territory of Almaty agglomeration and assessment of their impact on natural sites».

Н. А. Амиргалиев[1], Кристиан Опп[2], М. Аскарова[3], Р. А. Кулбекова[1], Л. Т. Исмуханова[1]

[1]«География институты» ЖШС, Қазақстан Республикасының білім және ғылым министрлігі, Алматы, Қазақстан;
[2]Марбург Университеті, Марбург, Германия;
[3]әл-Фараби атындағы ҚазҰУ, Алматы, Қазақстан

ҚАЗАҚСТАН ЖЕР БЕТІ СУЛАРЫНДАҒЫ СІЛТІЛІК МЕТАЛДАРДЫҢ (Na^+ ЖӘНЕ K^+) ЭМПИРИКАЛЫҚ КОЭФФИЦИЕНТІНІҢ МӘНІ МЕН ҚАТЫНАСЫ ТУРАЛЫ, ІЛЕ ӨЗЕНІ МЫСАЛЫНДА

Аннотация. Аймақтық гидрохимия саласындағы аз зерттелген, маңызды аспектілердің бірі – жер беті суларындағы сілтілік металдар (натрий және калий) режимінің қалыптасу заңдылықтары мен динамикасы бойынша мәселелер қарастырылған. Әдебиетке шолу бөлімінде литосфера мен табиғи сулардағы Na^+и К миграциясына қатысты геохимия саласындағы бірқатар классик ғалымдардың еңбектерінен мәліметтер келтірілген. Табиғи сулардағы натрий мен калийдің жеке концентрациясы бойынша сенімді аналитикалық деректердің осы салада келесідей маңызды практикалық мәселелерді шешудегі қажеттілігі атап өтілді: суармалы массивтерге су көздерін таңдау кезінде; балық үшін құнды ағзаларды бейімдеу үшін суқойманың су құрамының жарамдылығын бағалау. Омыртқасыздарды акклиматизациялау мен су қоймаларының биоөнімділігін арттыру тәжірибесі кезінде судағы негізгі иондардың қатынасы туралы білімнің маңыздылығы тәжірибелік жұмыстардың нәтижелері бойынша нақты мысалда көрсетілген.

Әртүрлі тұрмыстық және ауызсу қажеттіліктеріне пайдалану деңгейін анықтайтын, табиғи сулардың жалпы минералдануын анықтауға қажетті натрий мен калийдің эмпирикалық коэффициентінің (ЭК) маңыздылығына ерекше назар аударылды.

Мемлекеттік мониторинг мәліметтері негізінде Іле өзенінің ағысы бойынша натрий мен калийдің концентрациясы мен қатынасының өзгеру сипаты зерттеліп, олардың абсолюттік концентрациясы (мг/дм^3) мен судың жалпы минералдануын есептеу үшін ЭК анықталды. Өзен ағысы бойымен судағы натрий концентрациясының өзгеруінде судың минералдану мөлшеріне тәуелділігі анықталды. Натрий мен калийдің жалпы сомасындағы олардың салыстырмалы мөлшерінің өзгерісін талдау нәтижесі, өзен ағысы бойымен натрийдің

мөлшері 88,2% -дан 91,3% -ға дейін жоғарылауын және калийдің үлес салмағының 11,8%-дан 8,7%-ға дейін төмендеуін көрсетті.

Дж.П. Рейли, Дж. Скирроу, А.П. Виноградова, Е.Д. Голдберг, С.П. Тейлордың іргелі ғылыми зерттеу жұмыстарынан теңіз бен мұхит суларындағы сілтілік металдардың қатынасы бойынша мәліметтер жинақталған түрде келтірілген. Қазақстанның су қоймалары бойынша өз материалдарымызға салыстырмалы талдаулар келтірілген.

Қазақстанның бірқатар су қоймалары мен су ағындары үшін әртүрлі жылдарда жүргізілген зерттеулер бойынша әдеби мәліметтер мен өзіндік зерттеулердің нәтижелерін талдау негізінде мынадай тұжырымдар жасалды: бұрынғы КСРО-ның барлық аумағы үшін тұщы су қоймаларына бұрын қабылданған ЭК 25-ке тең мәні ҚР кейбір өзен бассейндерінің сулары үшін, яғни олардың 350-400 мг/дм^3 дейін минералдандыру кезінде пайдаланылуы мүмкін. Жер үсті суларындағы натрий мен калий концентрациясының режимі мен динамикасының қалыптастыруда аймақтық кешенді физикалық-географиялық жағдайлардың шешуші рөлі бар: климат, топырақ, жер асты суларының сипаты, антропогендік әсер ету және т.б. ҚР түрлі климаттық аймақтарының су қоймалары мен су ағындары үшін, әсіресе ірі трансшекаралық бассейндер үшін ЭК белгілеу қажеттілігі ұсынылған.

Түйін сөздер: натрий және калий, олардың табиғи сулардағы қатынасының мәні, сілтілік металдардың эмпирикалық коэффициенті.

Н. А. Амиргалиев[1], Кристиан Опп[2], М. Аскарова[3], Р. А. Кулбекова[1], Л. Т. Исмуханова[1]

[1]ТОО «Институт географии» Министерства образования и науки Республики Казахстан, Алматы, Казахстан;
[2]Университет Марбург, Марбург, Германия;
[3]КазНУ им. аль-Фараби, Алматы, Казахстан

О СООТНОШЕНИИ И ВЕЛИЧИНАХ ЭМПИРИЧЕСКОГО КОЭФФИЦИЕНТА ЩЕЛОЧНЫХ МЕТАЛЛОВ (Na^+И K^+) В ПОВЕРХНОСТНЫХ ВОДАХ КАЗАХСТАНА НА ПРИМЕРЕ РЕКИ ИЛЕ

Аннотация. Рассмотрены вопросы, касающиеся недостаточной изученности таких важных аспектов в области региональной гидрохимии, какими являются закономерности формирования режима и динамики щелочных металлов (натрия и калия) в поверхностных водах. В развернутом литературном обзоре приведены некоторые данные из трудов ряда классиков в области геохимии, касающихся миграции натрия и калия в литосфере и природных водах. Указано на необходимость достоверных аналитических данных о раздельной концентрации натрия и калия в природных водах для решения важных практических задач в области: оценки пригодности состава воды водоемов для акклиматизации ценных кормовых для рыб организмов, при выборе источников водоснабжения орошаемых массивов. Важность знания о характере соотношений главных ионов в воде в практике акклиматизации беспозвоночных и повышение биопродуктивности солоноватых водоемов показано на конкретном примере по результатам опытных работ.

Особое внимание уделено важности эмпирического коэффициента (ЭК) натрия и калия, необходимого при определении общей минерализации природных вод, от которой зависит уровень использования их для различных хозяйственных и питьевых нужд.

На данных государственного мониторинга изучен характер изменения по течению р. Иле концентрации и соотношения натрия и калия и установлены ЭК для расчета их абсолютной концентрации (в мг/дм^3) и общей минерализации воды. В изменении концентрации натрия в воде по течению реки прослеживается зависимость от величины минерализации воды. Анализ изменений относительного содержания натрия и калия от их суммы показывает рост относительной доли натрия вниз по течению реки от 88,2 до 91,3 % и снижение доли калия от 11,8 до 8,7 %.

В сконцентрированной форме представлены сведения из фундаментальных трудов Дж. П. Рейли и Г. Скирроу, А.П. Виноградова, Э.Д. Гольдберга, С.П. Тейлора по соотношению щелочных металлов в морских и океанических водах. Дается сопоставительный анализ собственными материалами по водоемам Казахстана.

На основе анализа литературных сведений и результатов собственных исследований по рассматриваемому вопросу, проведенных в разные годы для ряда водоемов и водотоков Казахстана, сделаны выводы о том, что: принятый ранее для всей территории бывшего СССР ЭК для пресноводных водоемов, равный 25, может использоваться для вод некоторых речных бассейнов РК при их минерализации до 350-400 мг/дм^3. Решающую роль в формировании режима и динамике концентрации натрия и калия в поверхностных водах имеет комплекс региональных физико-географических условий: климат, характер почв, подземных вод, антропогенные воздействия и др. Рекомендовано необходимость установления ЭК для водоемов и водотоков различных климатических зон РК особенно для крупных трансграничных бассейнов.

Ключевые слова: натрий и калий, величины их отношения в поверхностных водах, эмпирические коэффициенты щелочных металлов.

Information about authors:

Amirgaliev N., Doctor of geography, Professor, Chief researcher of the laboratory of Hydrochemistry and environmental toxicology, Institute of Geography of the Ministry of Education and Science of the Republic of Kazakhstan, Almaty, Kazakhstan; namirgaliev@mail.ru; https://orcid.org/0000-0002-2664-7473

Christian Opp, Full Professor, Head of Working Group Hydro-Geography and Soil Geography, University of Marburg, Marburg, Germany; opp@staff.uni-marburg.dep; https://orcid.org/0000-0001-7034-6945

Askarova M., Doctor of geographical sciences, Professor KazNU al-Farabi, Almaty, Kazakhstan; maulken@mail.ru; https://orcid.org/0000-0001-5958-3827

Kulbekova R., Master of Ecology, Junior Researcher of the laboratory of Hydrochemistry and environmental toxicology, Institute of Geography of the Ministry of Education and Science of the Republic of Kazakhstan, Almaty, Kazakhstan; r.k.85@mail.ru; https://orcid.org/0000-0003-4622-9823

Ismukhanova L., Master of Natural sciences, Researcher of the laboratory of Hydrochemistry and environmental toxicology, Institute of Geography of the Ministry of Education and Science of the Republic of Kazakhstan, Almaty, Kazakhstan; l--aura@bk.ru; https://orcid.org/0000-0001-6421-8621

REFERENCES

[1] Clarke F.M., Washington H.S. The composition of the Earth's crust. U. S. Dep. Inerior Geol. Survey. Profess. 1924. 127 p.

[2] Goldshmidt V.M. Geochemistry. In the book: Collection of articles on the Geochemistry of rare elements, translated from German. and eng. M., 1938. Pp. 3-10. (in Russ.).

[3] Vinogradov A.P. Average content of chemical elements in the main types of igneous rocks of the earth's crust // Geochemistry. 1962. N 7. Pp. 555-571 (in Russ.).

[4] Vinogradov A.P. Introduction to the Geochemistry of ocean. M.: Nauka, 1967. 215 p. (in Russ.).

[5] Goldberg E.D. Geochemistry of the sea. In the collection Geochemistry of lithogenesis. M.: publishing house of foreign literature, 1963. Pp. 113-124 (in Russ.).

[6] Riley J. and Skirrow G. Chemical Oceanography. Vol. 1. Acad. Press, London – New York, 1965. 183 p.

[7] Beus A.A. Geochemistry of the lithosphere. Edition. 2. M.: Nedra, 1981. 335 p (in Russ.).

[8] Konovalov G.S., Koreneva V.I. The ratio of sodium and potassium in the water of rivers of the Soviet Union // Hydrochemical materials. 1973. T. 59. Pp. 33-41 (in Russ.).

[9] Konovalov G.S., Koreneva V.I. Coefficients for converting the sum of sodium and potassium from mg-egv/l to mg/l // Materials XXVI Hydrochemical meeting (thesis of reports). Novocherkassk, 1975. T. 1. P. 63 (in Russ.).

[10] Almazov A.M., Enaki I.G.The content of sodium and potassium in natural waters of different salinity // Hydrochemical materials. 1968. T. XLIV. Pp. 131-137 (in Russ.).

[11] Mun A.I., Bekturov A.B. Distribution of microelements in reservoirs of Kazakhstan. Alma-Ata, 1971. 261 p. (in Russ.).

[12] Amirgaliev N.A. Hydrochemistry of the Irtysh-Karaganda canal. – L.: Gidrometeoizdat, 1981. 200 p. (in Russ.).

[13] Amirgaliev N.A., Lopareva T.Ya. Distribution of sodium and potassium in the water of the lake Balkhash // Hydrochemical materials. L., 1987. T. 14 (DSP). Pp. 121-130.

[14] Amirgaliev N.A. Artificial water objects of Northern and Central Kazakhstan (Hydrochemistry and water quality). Almaty: «Bastau», 1998. 190 p. (in Russ.).

[15] Amirgaliev N.A., Timirhanov S.R., Alpejsov Sh.A. Ichthyofauna and ecology of the Alakol system lakes. Almaty: «Bastau» publishing House, 2007. 368 p. (in Russ.).

[16] Amirgaliev N.A. Aralo-Syrdarya basin: hydrochemistry and problems of water toxicology. Almaty: Bastau, 2007. 224 p. (in Russ.).

[17] Romanova S.M., Ponomarenko O.I., Niyazbaeva A.I., Amirgaliev N.A. Ekibastuzskaya HPP-1 named after him Bulata Nurzhanova water quality at the cooling reservoir // News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technical sciences. Volume 2, Number 422 (2017), Pp. 90-98.

[18] Karpevich A.F. Survival, reproduction and respiration of mysids in the waters of brackish reservoirs of the USSR // Zoological journal. 1958. T. 37. V. 8. Pp. 1121-1135 (in Russ.).

[19] Chekunova V.I. Influence of some salt ions of brackish waters on the survival of Caspian invertebrates // Information collection of VNIRO. 1959. N 5. Pp. 42-59 (in Russ.).

[20] Epova Yu.V. Makrozoobentos of the Alakol-Sasykkol system of lakes // Proceedings of the Alakol reserve. Almaty, 2004. Pp. 137-172 (in Russ.).

[21] Konovalov G.S., Koreneva V.I. Removal of sodium and potassium in the sea basins of the USSR // Seventh conference on sea chemistry (abstracts). M., 1975. Pp. 17-19 (in Russ.).

[22] Kudrjavceva N.A. On the content of ash and ash elements in some types of rdests and amphibian mountaineer // Materials for the meeting on forecasting the content of biogenic elements and organic matter in reservoirs. Rybinsk, 1969. P. 62-68 (in Russ.).

[23] RD 52.24.415-2007 Mass concentration of sodium in water. Method of performing measurements using a potentiometric method with an ion-selective electrode. Rostov-na-Donu, 2008. 27 p. (in Russ.).

[24] RD 52.24.365-2008 Mass concentration of potassium ions in water. Method of performing measurements using a potentiometric method with an ion-selective electrode. Rostov-na-Donu, 2007. 24 p. (in Russ.).

[25] Vinogradov A.P. Geochemistry of rare and scattered chemical elements in soils. M.: Publishing house of the USSR Academy of sciences, 1957. 239 p. (in Russ.).

[26] Kashinsky P.A. To determine the total content of alkaline metals in water, water extracts of soils and lake mud // Hydrochemical materials. 1936. T. 9. Pp. 143-153. (in Russ.).

[27] Alekin O.A. Fundamentals of hydrochemistry. L.: Gidrometeoizdat, 1970. 442 p. (in Russ.).

[28] Alekin O.A. Chemical analysis of land waters. M.: Gidrometeoizdat, 1954. 199 p. (in Russ.).

[29] Taylor S.R. Trace element abundances and the chondritic Earth model. Geochimicaet Cosmochimica Acta, 28, 1964. P. 1989-1998.

Publication Ethics and Publication Malpractice
in the journals of the National Academy of Sciences of the Republic of Kazakhstan

For information on Ethics in publishing and Ethical guidelines for journal publication see http://www.elsevier.com/publishingethics and http://www.elsevier.com/journal-authors/ethics.

Submission of an article to the National Academy of Sciences of the Republic of Kazakhstan implies that the described work has not been published previously (except in the form of an abstract or as part of a published lecture or academic thesis or as an electronic preprint, see http://www.elsevier.com/postingpolicy), that it is not under consideration for publication elsewhere, that its publication is approved by all authors and tacitly or explicitly by the responsible authorities where the work was carried out, and that, if accepted, it will not be published elsewhere in the same form, in English or in any other language, including electronically without the written consent of the copyright-holder. In particular, translations into English of papers already published in another language are not accepted.

No other forms of scientific misconduct are allowed, such as plagiarism, falsification, fraudulent data, incorrect interpretation of other works, incorrect citations, etc. The National Academy of Sciences of the Republic of Kazakhstan follows the Code of Conduct of the Committee on Publication Ethics (COPE), and follows the COPE Flowcharts for Resolving Cases of Suspected Misconduct (http://publicationethics.org/files/u2/New_Code.pdf). To verify originality, your article may be checked by the Cross Check originality detection service http://www.elsevier.com/editors/plagdetect.

The authors are obliged to participate in peer review process and be ready to provide corrections, clarifications, retractions and apologies when needed. All authors of a paper should have significantly contributed to the research.

The reviewers should provide objective judgments and should point out relevant published works which are not yet cited. Reviewed articles should be treated confidentially. The reviewers will be chosen in such a way that there is no conflict of interests with respect to the research, the authors and/or the research funders.

The editors have complete responsibility and authority to reject or accept a paper, and they will only accept a paper when reasonably certain. They will preserve anonymity of reviewers and promote publication of corrections, clarifications, retractions and apologies when needed. The acceptance of a paper automatically implies the copyright transfer to the National Academy of Sciences of the Republic of Kazakhstan.

The Editorial Board of the National Academy of Sciences of the Republic of Kazakhstan will monitor and safeguard publishing ethics.

Правила оформления статьи для публикации в журнале смотреть на сайте:

www:nauka-nanrk.kz

ISSN 2518-170X (Online), ISSN 2224-5278 (Print)

http://www.geolog-technical.kz/index.php/en/

Редакторы *Д. С. Аленов, М. С. Ахметова, Т. А. Апендиев*
Верстка *Д. А. Абдрахимовой*

Подписано в печать 05.02.2020.
Формат 70x881/8. Бумага офсетная. Печать – ризограф.
11,0 п.л. Тираж 300. Заказ 1.

Национальная академия наук РК
050010, Алматы, ул. Шевченко 28, т. 272-13-19, 272-13-18