3. *Ogureyeva G.N.* Botanicheskaya geographiya Altaya [Botanical geography of Altay]. – Moscow: Nauka, 1980. – 189 p.
4. *Rabotnov T.A.* O biogeotsenozakh [About biogeocenoses] // Byulleten MOIP, otdel biologicheskiy. 1976. – Vol. 81. – No. 2.
5. Atlas Altayskogo kraya [Altay kray atlas]. Moscow, Barnaul: Glavnoye upravleniye geodezii i kartografii. 1978. – Vol. 1. – 222 p.
6. Trudy Tigirekskogo zapovednika. Vyp. 4. Biota Tigirekskogo zapovednika [Proceedings of Tigireksky zapovednik. Volume 4. Biota of Tigireksky zapovednik].

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MINERALIZATION OF RIVER WATERS IN GORNY* ALTAI AND ITS SPATIAL AND SEASONAL VARIABILITY

Abstract. *Judging from the rate of total mineralization of natural waters, it is possible to rather quickly and easily estimate the degree of variability of indicators of their chemical composition. In the presented work, the greatest attention is paid to the consideration of this indicator. Changes in the mineralization of waters in Gorny Altai depend on many factors, some of which are determined by geographical conditions of the environment. In Gorny Altai these conditions are very diverse. The elevation above sea level varies from 250 to 4,500 m. Watersheds rise over the bottoms of river valleys and hollows from 200 up to 1,000 meters and more. All characteristics of the chemical composition of river waters are within the limits close to background values. The results of the research reflect the general tendency of gradual increase in general mineralization downstream in the rivers.*

In the majority of river basins in Gorny Altai, the mineralization of waters is higher in winter than in summer. However, there are basins where seasonal dynamics have the opposite tendency.

The increase in mineralization in the river basins near the settlements is of great concern to the authors.

Key words: *Mountainous country, natural water, mineralization, variability of chemical composition of natural waters.*

Introduction. The majority of Gorny Altai is located within the limits of the Altai Republic. The Altai Mountains are a part of Altai-Sayan Mountainous Country. They are located in its southwestern part and occupy the highest position (here the highest peak of Siberia, Mt. Belukha, is situated).

The objective of this research is to study the specific character of distribution of chemical elements in the surface waters in the Altai.

Research goals: 1) to study the character of distribution of chemical elements in the major river basins; 2) to reveal the sites with background and abnormal indicators of chemical composition of river waters; 3) to estimate the concentration of heavy metals in the water of the major rivers.

The topicality of the research is determined by the important role of the territory in streamflow formation, the intensification of natural resources usage, including water resources, and also changes occurring in the behavior of the basic characteristics of weather and climate: air temperature and precipitation [Avanesjan, Suhova, 2011].

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Materials and research methods. The results of field works and of monitoring research (from 1992 to 2012) done on the basis of the accredited Republican chemical-ecological laboratory (RCEL) (certificate of accreditation POCC RU 0001.510063) of Gorno-Altaisk State University by order of the Department of Natural Resources of the Ministry of Nature of the Russian Federation in the Altai Republic were used as the information basis. While carrying out laboratory works, researchers used modern physical and chemical methods, and employed techniques approved by the regulatory documentation in accordance with the established procedure for monitoring and ecological control.

Sampling of surface waters was done in various seasons and across the entire territory of Gorny Altai. The most remote and difficult of access sampling points were in the Southeastern Altai (the Ukok plateau), on the Tashanta River (the Chujsky hollow), and in the Eastern Altai along the middle reach of the Chulyshman River (Figure 1).

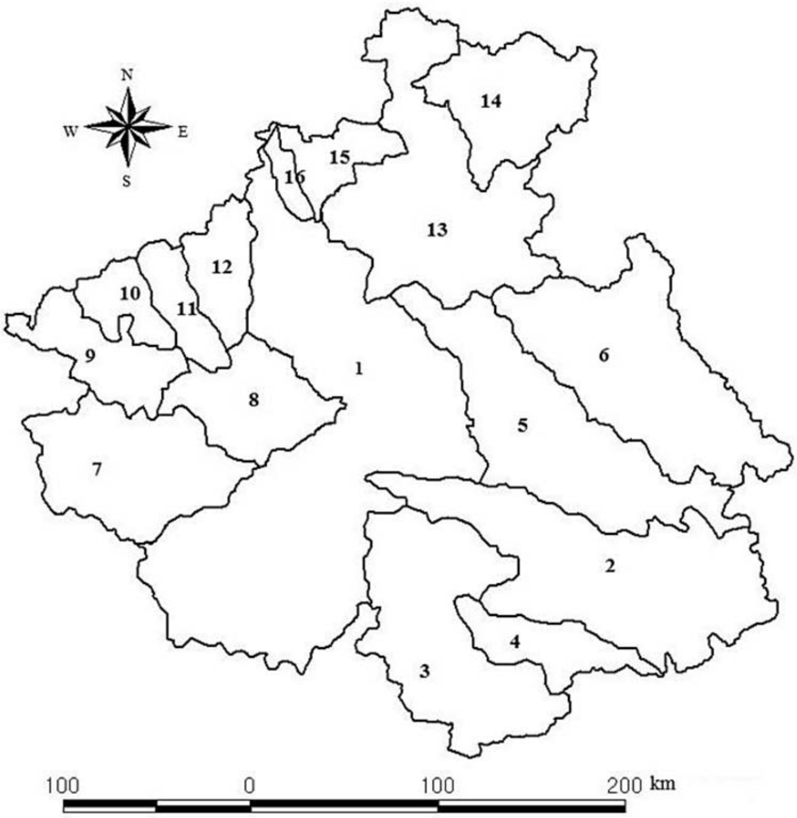

Fig. 1. Major Rivers Basins in the Altai Republic
1 – Katun; 2 – Chuya; 3 – Argut; 4 – Dzhazator; 5 – Bashkaus; 6 – Chulyshman; 7 – Koksa; 8 – Ursul; 9 – Charysh; 10 – Anuj; 11 – Peschanaya; 12 – Sema; 13 – Biya; 14 – Lebed'; 15 – Isha; 16 – Maima

Laboratory research was done by using standard techniques of testing chemical composition of natural waters.

Discussion of results. The Katun River Basin covers the greatest area of Gorny Altai. A high degree of differentiation of its landscape conditions causes a dispersion of values of chemical composition indicators of the river waters. Waters of alkalescent reaction, soft, and falling into hydrogen carbonate class of calcium groups, are characteristic of this basin. Indicators of acidity and general rigidity range from 6.39 to 8.05 – acidity, and from 0.31 to 4.49 mg-ekv/dm^3 – general rigidity.

About half of the winter runoff samples collected in the Katun River Basin had a mineralization index below the average; in the Charysh River Basin, 64% were below the average.

For summer runoff of the Katun River Basin, a background value of general mineralization was calculated. It appeared to be lower than general mineralization value in the low-mountain parts of the basin in the high water period (See Table 1). The maximum difference in the indicators of general mineralization between the high-water and low-water periods was 119 mg/dm ^{3} and was recorded in low mountains.

Table 1

Value of general water mineralization in the Katun River Basin in different seasons

Indicator	April–May	July–August	**July–August** (the Argut, the Chuya, the Koksa; the Katun is not included)
Background value of general mineralization mg/dm ^{3}	305	276	120
Mean square deviation mg/dm ^{3}	54	61	59
Maximum value mg/dm ^{3}	378	368	259
Minimum value mg/dm ^{3}	214	214	40
Range mg/dm ^{3}	164	154	219
Variation coefficient (%)	18	22	49
Arithmetic mean value of general mineralization for low-mountain part mg/dm ^{3}	336	270	–

During winter runoff the average value of general mineralization in the low-mountain part of the basin was 152 mg/dm ^{3}.

An increase in the value of general mineralization of more than one standard deviation was recorded in the settlements: Yelanda and Souzga (the Katun River Basin), Kok-Pash (the Chulyshman River Basin), Ust'-Kan (the Charysh River Basin), and Sychevka (the Peschanaya River Basin).

During the summer period, the general water mineralization in the Katun River in the uppermost sampling point was 251 mg/dm ^{3} (high mountains); in the lowermost sampling point – 222 mg/dm^3 (low mountains). In the low-mountain part of the basin, a mineralization value less than those in the high-mountain part was recorded in only one sampling point, which was located much farther downstream than the others. It should be noted that the leap was recorded after a gradual increase in the mineralization values downstream, and it did not essentially affect the trend character. Similar situations took place in some other big and small basins in the Altai Republic. In our opinion, a more difficult distribution of general mineralization value in comparison with high-water periods is characteristic of the summer period. This fact was indirectly confirmed by the research of correlation of the drainage with the dynamics of temperature and precipitation regimes conducted at Gorno-Altaisk State University [Avanesjan, Suhova 2011].

In the high-mountain part of the Katun River Basin, its tributaries had similar character of their nourishment (except the Chuya River). However, that territory had the greatest variation of mineralization values, hydrogen index, etc. It is necessary to notice that physical and geographical conditions of different areas of the high-mountain part of the Katun River Basin were different. Nominally it was possible to single out two big areas: the Ukok plateau and the upstream area of the Katun River (area of «Kucherla») (See Table 2).

In Table 2, the results of water sampling in the high-mountain part of the Katun River Basin are given. Only the samples taken from the rivers mentioned above are included into the table. In the Table all test samples are arranged 'downstream.' The results of test sampling of those tributaries characterized by a wide range of values are not presented in the Table.

The analysis of dynamics of hydrochemical indicators shows that within the limits of the Ukok plateau it was not possible to unequivocally establish the dependence of those characteristics on the hypsometric height of sample points. Thus, downstream in the Kalguty River, the increase was determined based on only two indicators (from nine examined): hydrogen content and concentration of potassium and sodium ions. Downstream in the Dzhazator River, there was a decrease in the values of four hydrochemical indicators. Downstream in the Katun River («Kucherla» in Table

2) (Figure 1), the values of hydrogen content and concentration of potassium and sodium ions increased, while all other indicators, including the general mineralization, decreased at the decline in hypsometric level of the basin (See Table 2). However, on the whole, the general mineralization in the Katun River Basin increased from high-mountain to low-mountain areas.

Table 2

Indicators of river water chemical composition in the upper part of the Katun River Basin [Kocheeva, Bolbukh, Avdyushkina, 2007]

Indi cators	pH	Total hard ness	Ca^{+}	Mg^{+}	K^{+}+ Na^{+}	HCO_3^{-}	SO_4^{-}	Cl^{-}	Minera Liza tion
the Kalguty River (the Ukok plateau)									
Upper course	6.44	1.65	28.1	3.0	4.6	73.2	26.9	2.7	138.5
Middle course	7.18	0.35	6.0	0.6	5.0	15.3	9.6	3.6	40.0
Lower course	7.25	1.69	22.0	7.1	13.9	106.8	19.2	3.2	172.2
the Dzhazator River (the Ukok plateau)									
Upper course	7.43	1.9	26.1	7.3	12.5	112.9	19.2	5.4	183.3
Middle course	7.0	1.15	16.0	4.3	11.4	54.9	28.8	3.7	119.1
Lower course	7.74	1.23	14.0	6.4	1.1	61.0	9.6	2.7	94.9
the Kucherla River (upper part of the Katun River Basin)									
Upper course	7.36	3.73	46.6	9.8	5.7	173.8	19.2	3.9	259.0
Middle course	7.63	2.48	40.6	5.5	7.1	137.3	19.2	4.3	214.0
Lower course	7.67	1.55	23.1	4.9	14.0	112.9	9.6	4.1	169.0

Test samples taken at the mouth of the rivers Kucherla, Muzdy-Bulak, Tyun, and Chuya showed that water in the major rivers was diluted with their less mineralized tributaries. The maximum dispersion was received for «near-mouth» parts of the rivers: the Kucherla (186 mg/dm³) (tributary of the Katun River) and the Muzdy-Bulak (172 mg/dm³) (tributary of the Kalguty River). The rivers Kalguty and Muzdy-Bulak were the tributaries of the Argut river and were located on the Ukok plateau, one the most difficult to access area, where economic activity was hardly developed and research activity was complicated. However, when the Argut River flowed into the Katun River, the water in the latter substantially changed even visually. The changes in the chemical composition were proved to be true by the results of our test sampling (See Table 1).

The water in the rivers of the high-mountain part of the Katun River Basin was characterized not only by the greatest dispersion of values of chemical composition indicators, but also by minimum values of the general mineralization (See Table 1, 2). For that part of the basin, it was possible to say that all surface waters were poorly mineralized and thus the purest. However, 30 % of test samples showed the increase in the general mineralization by more than one data point of standard deviation calculated for the high-mountain part of the basin. Along with the recorded high gradient of mineralization in the near-mouth parts of some tributaries, it testified to a difficult mechanism of formation of the chemical composition of natural waters and was determined by many environmental and geographical factors, one of which for that part of the basin was the permafrost. Two multidirectional processes of freezing were characteristic for the cryolithic zone: concentration of salts in solutions and ice desalination. Notably, sparingly soluble compounds (carbonates) were captured by ice, while readily soluble compounds (chlorides and sulphates) remained in water [Posokhov, 1985, p. 117; Spravochnoye, 1979].

Numerous deposits and ore occurrence located in the high-mountain parts of the Katun and Chulyshman Basins [Bolbukh, 2005; Gusev, 1998] influenced their water chemical composition, including the value of general mineralization. Sharp jumps in mineralization recorded during the research (the Tjun River) could possibly be explained by the influence of secondary dispersion auras. At the same time glacial clays could adsorb a part of chemical elements dissolved in soil waters, that caused the decrease in their concentration in surface waters (the Kalguty river, See Table 2).

In the Muzdy-Bulak River (the Ukok plateau) we recorded one of the lowest values of permanganate oxidability and content of biogenic elements. 97% of the obtained data coincided with similar values of the Zhumaly River in the area of «Warm Springs,» where radon springs were situated and some kind of radon healing center operated. Therefore, in our opinion, more careful and complex sampling of water in the Muzdy-Bulak River is necessary.

Water quality was influenced by the presence of heavy metals in its structure. During 2004 we studied distribution of heavy metals in water in the rivers of the high-mountain part of the Altai. It was established that the concentration of heavy metals in the rivers of that part of the basin did not exceed the maximum concentration limit (MCL) for fishery waters [Avanesjan, Suhova, 2011]. The test sampling indicated that the concentration of lead, copper, zinc, manganese, and iron reached its minimum values in summer. At the beginning of autumn, the concentration of those elements started to increase. Copper and manganese concentration reached its maximum values in January-March, and lead and zinc in September-January. The iron content in surface water during autumn, winter and spring was characterized by similar values, which did not exceed summer value. Mercury behaved a little differently: the minimum values were recorded from September till March, and in April-May they reached maximum values which exceed MCL two times. Copper content was close to MCL. Iron content was 3-5 times lower than MCL; the concentration of heavy metals was one order less than MCL.

In 2002 the character of intra-annual distribution of heavy metals in the Katun River in the area of Platovo settlement (foothills) was studied. The researchers established that concentration of lead, copper, and zinc reached their maximum values in summer; manganese content at that time was high enough; iron content was minimum and similar to the high-mountain zone. The iron content increased to its maximum value in the spring; in the autumn and winter it was at the level close to the maximum level. The highest values of manganese were recorded in the autumn. Concentration of mercury in water increased in the spring and reached its maximum value in the summer. The maximum concentration of mercury and copper in the Katun River exceeded MCL 9 and 4 times (accordingly); the concentration of lead, zinc and cadmium was below MCL by a factor of one hundred, chrome and manganese by a factor of ten, arsenic by a factor of a thousand, and iron levels were three times less than MCL.

The main source of surface water pollution in the lowland and foothill parts of the Katun River Basin was sewage dumping.

The basins of the rivers: Charysh, Peschanaya, and Anuj were located in the northwestern areas of the Altai Republic. The high population and developing industry made the research of dynamics of water chemical composition in the local rivers very relevant.

The general mineralization values of river waters in those basins were higher than in other basins of Gorny Altai. Thus, the greatest value of general mineralization was recorded in the Kann River (basin of the Charysh River) at 617 mg/dm^3; the mineralization of the Peschanaya River water near the administrative border of the Altai Republic at 508 mg/dm^3, and of the Anuj River – 331 mg/dm^3.

The analysis of the distribution of mineralization values in the Charysh River Basin showed that the mineralization of tributaries in the basin was higher than the mineralization of the major river (See Table 3). Besides, the lowest and the highest mineralization values were also recorded in the tributaries. Evidently there, as well as in the high-mountainous part of the Katun River Basin, a variety of landscape conditions influenced more upon the formation of chemical composition of minor rivers. Their confluence caused the intermixing of waters having different concentrations of basic chemical elements, which in its turn defined a more homogeneous structure of water in the major rivers and a gradual increase in the value of chemical composition indicators downstream.

The seasonal dynamics of the indicator considered in Northwestern Altai was also worth attention. Thus, mineralization of the Peschanaya and the Anuj Rivers during winter season was higher than in summer; in the Charysh River and its tributaries it was lower in winter than in summer (See Table 3).

Table 3

Statistical characteristics of river water chemical composition in the Charysh River Basin (mg/dm³)

River	Winter runoff					Summer runoff				
	$\overline{X}$	σ	V (%)	min	max	$\overline{X}$	σ	V (%)	min	max
the Charysh	218.1	49.6	18	189	255	348.3	60.5	17	296	410
Tributaries of the Charysh	269.9	99.9	37	172	325	399.7	146.7	37	207	607
The whole Charysh River Basin	247.7	76.2	31	172	325	381	118.3	30	207	607

Notes to the Table 3

$\overline{X}$ – Arithmetic mean value of general mineralization; σ – mean square deviation of general mineralization value; V – variation coefficient of general mineralization value; min – minimum of general mineralization value; max – maximum variation of general mineralization value.

In the Charysh River Basin the general mineralization value ranged within one quadratic deviation, i.e. the anomalies of the chemical composition did not form in that basin. The only exception was the deviation of mineralization in one of the tributaries of the Charysh River to more than one standard deviation in summer runoff (See Table 3).

The basin of the Biya River was characterized by rather uneven distribution of residential zones and industrial enterprises. For example, in the Seika settlement there was a mining industrial complex, while in the upper reaches of the Chulyshman River there was not any settlement. To get an objective picture of the chemistry of the natural waters in the Biya River Basin, we did not take into account (See Table 4) the results of the chemical analysis of water in the Seika River Basin since it had experienced the greatest degree of anthropogenic impact [Gusev, 1998].

In whole the water in the Biya River basin was assigned to a hydrocarbonate class of the calcium group. The basic «contribution» to the salt composition of water in the rivers of the Biya Basin, as well as on the whole investigated territory, was made the by ions of hydrocarbonates, calcium and magnesium.

Table 4

Statistical characteristics of river water chemical composition in the Biya River Basin (mg/dm ³) [Kocheeva, Bolbukh, Avdyushkina, 2007**]**

River	Winter runoff					Summer runoff				
	$\overline{X}$	σ	V (%)	min	max	$\overline{X}$.	σ	V (%)	min	max
The Chulyshman River Basin	219	94,2	43	147	357	133,4	48	40	150	330
The Biya	185	58,9	32	127	289	161,1	45,5	28	150	330
The whole Biya River Basin	191	62,6	33	127	357	150,4	45,5	30	150	330

The comparative analysis of behaviour of hydrochemical indicators of the rivers in the Northwestern and Northeastern Altai revealed some similarities in their distribution. Thus, variation coefficients of the general mineralization value in the basins of the Charysh and the Biya were characterized by close values both in summer and winter periods. The variation coefficients in the basins of the mentioned rivers in general also had insignificant differences, while the variation coefficients of the major rivers differed greatly; one was twice the other. (See Tables 3, 4). In the basins of the Charysh and the Biya, the mineralization of their tributaries fluctuated in the bigger range than the mineralization of the major river (See Table 3, 4). The maximum value of the variation coefficient was obtained for the Chulyshman River (Figure 1). In the Katun River Basin, the close value was obtained for high mountain tributaries (See Table 1).

Table 5

Variation coefficient of pH level in river basins of Gorny Altai (%)

The Katun River Basin				**The Chulyshman River Basin**	**The Biya River basin**	**Basins of the Peschanaya, the Anui and the Charysh Rivers**
High-mountain zone		**Mid-mountain zone**	**Low-mountain zone**			
«Ukok»	**«Kucherla»**					
7	4	7	6	4	8	9

The fluctuations of pH level in different basins of Gorny Altai were in close intervals. In the Katun River Basin it changed from 6.44 to 8.04; in the Biya River Basin the recorded fluctuations were in the range of 7.2–8.0; in the basin of the rivers Charysh, Peschanaya and Anuj – 6.5–8.03. Variations in that value in different river basins of Gorny Altai did not exceed 9% (See Table 5). However, the minimum values of the variation coefficient of pH were characteristic of the Chulyshman River and a part of the high mountain zone of the Katun River («Kucherla»). In our opinion, such small variation could be the reason of similar landscape conditions.

Thus, water in the Altai rivers, as well as in the majority of the world's rivers, has low and sometimes moderate mineralization [Kivatskaya, 2006]. The research revealed the absence of sites with abnormal chemical composition of river waters in all basins of major Altai rivers. All characteristics of chemical composition of river waters were within the limits close to background values. However, the background values for the whole territory of the basin, for the major river and for separate parts of the basin sometimes differed greatly. The greatest difference was recorded between the high mountain and foothill parts of the basin.

The conducted research showed that high mountain parts of the Altai rivers' basins were characterized by the most difficult and diverse conditions of formation of river waters chemical composition; they suffered from any external influence to a greater extent. The maximum gradients in distribution of general mineralization value and hydrogen value were recorded in those areas. The minimum values of river waters mineralization were also recorded there.

The concentration of heavy metals in the Katun River Basin was small and tended to increase from highlands to foothills. In the specified parts of the basin the concentration of heavy metals had unequal seasonal distribution that could be caused by various sources of their inflow.

Conclusions. The results of approbation reflect the general tendency to gradual increase in general mineralization downstream the rivers (See Table 2: the Kucherla, the Dzhazator). It is important to stress that such increase in mineralization occurs non-uniformly. Inside the basins, the same non-uniformity in distribution of investigated indicators is characteristic for all tributaries of major rivers (See Table 1 – the Kalguty). In the basins of the the Katun, the Biya and the Charysh rivers, the mineralization of their tributaries is characterized by more essential fluctuations than in the major rivers. The distribution character of other indicators of chemical composition of waters is more complicated, and further complex research to reveal a clear tendency in their behaviour is required. Thus, for example, jumps in the value of indicators of river waters' chemical composition can be caused by frontal atmospheric phenomena (downpour), which at the given stage of research did not occur.

Another important fact revealed by our research team is the decrease in mineralization in the lower part of the Katun River Basin after high water (See Table 1). Probably, more complicated distribution of general mineralization value is characteristic for the summer period in comparison with high water.

The increase in general mineralization in densely populated areas with more developed economic activities (the lower part of the Katun Basin, the basins of the rivers Charysh, Peschanaya and Anui) during the high water period is very important. It reflects the existence of anthropogenic impact on all components of natural systems in the course of year. However, during the cold period, this process is shielded by low air, soil and ground temperatures which determine the speed of exogenous processes.

In the last 20 years, the negative orientation of changes in the maximum drain of the Altai rivers most abounding in water (the Katun and the Biya), which form their drain in all altitude zones, was replaced with the positive [Avanesjan, Suhova, 2011]. Therefore, on such rivers the probability of formation of maximum water levels in the high water period, followed by an exit of flood waters, has increased. The major reason for it is the spring warming, causing simultaneous snowmelt in several altitude zones during the spring high water, conditioning high drainage intensity; whereas in the years before intense warming, the snowmelt spread over altitude zones for a longer time, shifting to summer months, and the high water period was longer. The comparison of an averaged runoff hydrograph of the rivers for the observation period of 1946-1976 and 1976-2000 also testifies to it. Therefore, the probability of high water levels in high water periods, and consequently dangerous flooding on such rivers before modern warming was less.

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REFERENCES

1. *Avanesjan R.A. and M.G. Suhova.* Napravlennost sovremennyh izmenenij gidrometeorologicheskih kharakteristik Altaiskoi gornoi oblasti [Trend of modern changes in hydrometeorological characteristics of the Altai mountain area] // Modern Problems of Science and Education. 2011. No. 6; URL: www.science-education.ru/100-5219 (rus).
2. *Bolbukh T.V.* Raspredeleniye i prirodno-antropogennaya transformatsiya himicheskogo sostava poverhnostnykh vod v basseine reki Katun' (Gorny Altai) [Distribution and nature-anthropogenous transformation of chemical composition of surface water in the Katun River basin (Gorny Altai)]. PhD Thesis Abstract. Gorno-Altaisk, 2005. 22 p. (rus).
3. *Gusev A.I.* Metallogeniya Gornogo Altaya i perspectivy obnaruzheniya netraditsionnykh tipov orudeneniya [Metallogeny of Gorny Altai and prospect of unconventional types of mineralization detection]. Mineralno-syr'yevaya baza Respubliki Altai. Gorno-Altaisk, 1998. Pp. 16–18 (rus).
4. *Kivatskaya A.V.* Ecologo-geohimicheskiye posledstviya kechnogo vyshchelachivaniya zolota (na primere OAO «Rudnik 'Veselyi», Respubliki Altai) [Ecological and geochemical consequence of compact gold extraction (on the example of «Mine 'Veselyi», Altai Republic)]. PhD Thesis Abstract. Tomsk, 2006. 22 p.(rus).
5. *Kocheeva N.A., Bolbukh T.V., Avdyushkina Ye.I.* Prostranstvennaya i sezonnaya izmenchivost' mineralizatsii rechnyh vod Gornogo Altaya [Spatial and seasonal variability of river waters in Gorny Altai]. Bulletin of Russian Geographical Society, 2007. Vol.139. No.6. Pp. 57–64.
6. *Posokhov E.V.* Ionnyi sostav prirodhykh vod. Genezis i evolyutsiya [Ionic composition of natural waters. Genesis and evolution]. Leningrad, 1985. 256 p. (rus).
7. Spravochnoye rukovodstvo gidrogeologa [Hydrogeologist reference manual]. Vol. 2. Leningrad, 1979. 295 p. (rus).

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ОБ ОПЫТЕ КАРТОГРАФИРОВАНИЯ МАРШРУТОВ ПУТЕШЕСТВИЙ П.С. ПАЛЛАСА И И.И. ЛЕПЁХИНА ПО СРЕДНЕМУ ПОВОЛЖЬЮ С ИСПОЛЬЗОВАНИЕ ГИС-ТЕХНОЛОГИЙ

Резюме. *Описывается опыт картографирования маршрута путешествий П.С. Палласа и И.И. Лепёхина в Среднем Поволжье в 1768–1769 гг. с использованием геоинформационных тех-*

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