Allocation of zones with prospective high fissuring has been done on the basis of the frequencies map calculated in an interval of Low-Tytleym subseries depositing.

In fig. 5 one example of comparison of speed map and frequencies within the limits of the revealed oil deposit in Low-Tytleym subseries deposit is shown (layer UK_0).

The complex of methodical techniques of reservoirs mapping can be applied within the limits of zones where investigated deposits have been formed in similar conditions of sedimentation, and, accordingly, characterized by close mineral structure and structurally-textural features which allows using attributes of seismic record.

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HYDROCHEMICAL DRAIN IN THE MIDDLE OB RIVER BASIN

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Results of studying the hydrochemical drain in Middle Ob basin (Western Siberia) and conditions of its formation are shown. Average values of ejection of the main ions, microelements, organic and biogenic substances with waters of the rivers: Ob, Tom, Chulym, Ket, Tym, Vasyugan, Parabel, Chaya for years 1997-2000 are established. It is shown, that the main part of hydrochemical drain is represented by the main ions and formed under the influence of mainly natural factors. Anthropogenous transformation of hydrochemical drain shows itself in the increase of hydrocarbons ejection, compounds of nitrogen and some other substances.

Introduction

In the process of the global water cycle, its continuous interaction with rocks and movement of huge quantity of the dissolved substances is happening. As a result, never ending transformation of the earth's crust is realized, and according to «the principle of indissoluble relation of alive and dead», proved by V.I. Vernadsky, and evolution of biosphere [1, 2]. Taking that into account, the hydrochemical drain plays exclusively important role in functioning of biogeocenosis of different levels and, in its turn, reflects the most essential changes in their structure and ecologo-geochemical condition of water objects. The given circumstance allows us to consider the problem of formation and changes of hydrochemical drain as the component of more general problems of interaction of the geospheres, natural and anthropogenous environment and climate transitions [3, 4].

Many known scientists at various times have been engaged in studying of this problem, including O.A. Alekin, V.P. Zverev, A. Lerman, A.M. Nikanorov, T. Paches, A.I. Perelman, E.V. Posochov, S.L. Schwarz, and others. Thanks to their works the scales of land denudation and mass-streams sizes of surface and underground hydrosphere at level of planet, continents, catchment basins of oceans and seas had been established. Much has been done in the way of studying of mechanisms of formation of chemical compound of natural waters of the top hydrodynamical zone. Nevertheless, many questions connected with necessity of studying the distribution of hydrochemical drain inside of large river basins and its formation in conditions of anthropogenous influence, till now remain unresolved. It essentially limits the opportunity of development of reliable long-term forecasts of quality change in natural waters and developments of optimal regional strategy of wildlife management, which

causes urgency for researches of hydrochemical drain and conditions of its formation.

The studying of hydrochemical drain and conditions of its formation for the section of the Ob basin in its midstream receives a special value. The given territory is located in southeast and central parts of Western-Siberian plain and northern part of the Sayano-Altai highland in the area of more than 500 thousand km^2. The population of region exceeds 3 million people, where most of them are city dwellers. The specificity of economic complex in many respects is defined by presence of rich natural resources. Within the limits of considered territory mountain areas (southern and southeast parts of the Tom river reservoir, upstream of the Chulym river), forest-steppe (midstream and upstream of the Tom river, midstream of the Chulym river, part of the Shegarka river reservoir) and wood zones (other territories) are allocated. Flat relief and weak degree of drainage of region plain part in combination with superfluous atmospheric humidification, severe enough thermal mode and a number of other factors have caused exclusively wide circulation of bogs, and also have created conditions for dense river network formation and have defined the main features of hydrological mode of the territory, characterized by well expressed latitude zoning of water drain distribution and big enough share of its underground component. The most abounding in region water rivers are the Ob, Tom and Chulym.

Presence within the limits of the Ob basin of the largest in Russia enterprises of metallurgical, coal, chemical, radiochemical and oil-and-gas industry has allowed a number of experts to draw a conclusion about significant or even a key role of anthropogenous factors in formation of a hydrochemical drain and chemical compound of region river waters. If similar judgments are really true, it is possible to speak, at least, about regional scales of very significant anthropogenous transitions of considered territory environment, as a whole, and water objects, in particular. Considering the scientific and practical importance of this question, realization of its detailed study is expedient, which would allow us to draw authentic quantitative conclusions on the size of hydrochemical drain, character and the mechanism of its natural-anthropogenous transformation in the Ob basin. Such purpose has been set during performance of considered researches.

Research technique

Researches have been done by the author in 1993–2006 in sequences: 1) studying of water drain and water mode; 2) the hydrochemical analysis, including revealing of existential changes of chemical compound of river and underground waters; 3) definition of a total and underground hydrochemical drain, revealing long-term changes of ionic drain; 4) the analysis of formation conditions of hydrochemical drain and its natural-anthropogenous transformation. Performance of each of the specified stages included study of questions of the decision methodical maintenance of problems that were set during work and was based on the basin approach.

During drain studying the geographo-hydrological, landscape-geochemical, statistical methods, mathematical modeling of hydrochemical processes have been used, which has defined the main kinds of the executed works, including: 1) field works on selection and preservation of water samples for further definition of their chemical and microbiological structure in stationary laboratories, and also to definition in field conditions of rapidly-changing components concentration; 2) generalization and statistical analysis of hydrochemical and hydrological data (more than 8000 samples of water have been analysed, at the same time the main part of the used material has made up the data of Tomsk polytechnical university, Institute of geology of oil and gas of the Siberian Branch of the Russian Academy of Science, Open Society «Tomskgeomonitoring» and Federal Hydrometereology); 3) development and approbation of mathematical models of chemical compound formation of river waters and hydrochemical drain. Earlier, in [5–8], the technique and the basic results of researches of river water chemical compound, changes of hydrological and hydro-geological mode of territory, sizes of ionic drain and conditions of its formation have been stated. In concerned work the generalization of these and other materials is lead and the general picture of hydrochemical drain in the basin of the Middle Ob is presented.

Results of researches and their discussion

Ionic drain

River ionic drain of the Middle Ob basin has been defined for each year by summation of values for 12 months; each has been calculated as a product of monthly water drain and the monthly average sum of main ions Σ_I. Last size has been calculated on linear dependence between urgent values Σ_I and charges of water. The sequences of values of an annual ionic drain of the Ob and its inflows, received within the limits of the homogeneous periods of water drain formation, have been subjected to randomness and uniformity check [7]. The results of this analysis have allowed a conclusion about rather steady, during 1970–2000, annual ionic drain of the majority of the rivers of considered territory and at the same time – about certain increase in a winter ionic drain of the rivers Tom, Chulym, Tym, Vasyugan, Parabel and Chaya. Authentic infringements of uniformity within the limits of the considered time intervals are revealed in case of the Tom river at Novokuznetsk city and the Ket river at village Maksimkin Yar.

For the homogeneous periods mean annual values of total ionic drain have been calculated (table 1), for the Middle Ob they have made 17...24 million t/year (1...1,2 g/(s·km^2)), and for its main inflows – from 0,3 up to 4,2 million t/year (0,4..2,4 g/(s·km^2)). Based on results of calculations it has been established, that the greatest values of the ionic drain module (more than 2 g/(s·km^2)) noticeably exceed, showed in the work [9], the average value of Ob basin (0,44 g/(s·km^2)) and are noticed in the upstream and midstream of the Tom river. It is explained by the raised intensity of water exchange within the limits of this territory and testifies about sig-

Table 1. *The average annual drain of the main ions (Σ_i), carbon of organic substances (C_{org}), nitrogen of inorganic connections (N), phosphorus (P), general iron (Fe) and oil products (Нп) for the years of 1970-2000, one thousand t/year*

River – point	Drain	Substances drain					
		Σ_i	$C_{org.}$	N	P	$Fe_{comm.}$	Нп
The Ob – Kolpashevo city	total	17893,04	470,21	50,59	2,68	15,09	40,99
	underground	8392,69	102,67	22,66	0,49	2,81	9,85
The Ob – Aleksandrovskoe village	total	23862,20	1177,70	118,78	12,60	61,64	69,79
	underground	13840,08	329,74	35,63	3,53	19,11	9,07
The Tom – Novokuznetsk city	total	2809,53	73,14	12,73	0,83	2,41	10,30
	underground	556,46	7,23	2,37	0,07	0,33	1,73
The Tom – Tomsk city	total	4228,28	139,47	37,55	1,70	8,48	15,53
	underground	1071,30	27,44	9,80	0,21	0,68	2,53
The Chulym – Baturino village	total	4017,45	163,00	11,03	0,67	7,42	–
	underground	1801,60	24,60	5,77	0,05	2,36	–
The Ket – Volkovo village	total	1541,52	178,65	–	–	20,24	–
	underground	986,90	13,22	–	–	–	–
The Tym – Napas village	total	347,53	53,78	–	–	7,20	–
	underground	231,60	8,12	–	–	1,84	–
The Vasyugan – Sredniy Vasyugan village	total	612,76	76,32	–	0,38	3,59	–
	underground	265,60	9,97	–	0,09	1,03	–
The Parabel – Novikovo village	total	468,23	55,69	6,41	0,07	1,55	1,61
	underground	276,30	3,85	0,53	0,01	0,13	0,39
The Chaya – Podgornoe village	total	512,45	44,84	29,80	0,37	1,70	1,15
	подземный	403,10	7,22	8,02	0,27	0,72	0,08

nificant redistribution of hydrochemical drain inside of reservoir. The least values of the ionic drain modules are related to boggy northern and northeast parts of the Middle Ob basin where the greatest distribution has been received by head and transitive bogs.

Besides the analysis of numbers of annual and seasonal ionic drain, long-term transformations of the underground ionic drain have been studied. The results of this research testify to the certain increase in the underground ionic drain in last decades. These changes are especially noticeable for some plane inflows of the Middle Ob flowing in strongly marshed territories [7]. The norm of the underground drain of the Ob during the years of 1960–2000 has not essentially changed. As a whole, the underground component of the ionic drain varies in the range from 20..35 % in the Tom river reservoir up to 70...80 % in the plain part of the Ob basin, and its growth in process of reservoirs marshiness increase and reduction of modules of the water drain is observed. The underground drain of the Ob consistently increases from 47...58 % at Kolpashevo city up to 50...67 % at Prochorkino village.

Microelements drain

Satisfactory dependences between water expenditures and concentration of microelements generally have not been possible to sort out. For this reason the seasonal average annual ejection of microelements with river waters of the Middle Ob basin has been determined as product of average seasonal values of substances concentration and water drain, the annual drain – as the sum of seasonal values, and its underground component – as product of average annual underground water drain on average annual substance concentration for December-March. The analysis of the data obtained by specified way has shown that for Ob river the average annual drain Cu makes 0,9...1,3 thousand t/year, Al – 0,8...1,8 thousand t/year, Pb – nearby 0,6 thousand t/year (table 2). Underground component usually makes less than 50 % of an annual microelements drain, which shows a significant matriculation of these substances into a river network with a surface drain from water-modular territory during snow-melting period and rain floods. Thus, it is necessary to note that content level, at least, of some microelements is defined by their relation to quantity pH and organic acids content, supervising the processes of microelements migration in water environment [5].

Table 2. *Average annual drain of some microelements with waters of the Ob and the Tom rivers, thousand t/year*

River – point	Drain	Substances drain			
		Cu	Zn	Pb	Al
The Ob – Kolpashevo city	total	0,910	–	0,657	0,822
	underground	0,114	–	0,152	0,217
The Ob – Aleksandrovskoe village	total	1,263	–	–	1,825
	underground	–	–	–	–
The Tom – Novokuznetsk city	total	0,158	–	0,208	0,469
	underground	0,017	–	0,011	0,048
The Tom – Tomsk city	total	0,155	0,337	0,143	1,243
	underground	0,018	0,057	0,017	–

Biogenic substances drain

Satisfactory dependences on water expenditures as a whole have not also been noted for biogenic substances, that has defined the use of the same, as for microelements, way of an estimation of their drain. Based on findings, with river waters of the Middle Ob basin a significant by absolute value quantity of compounds N, P, Fe and Si (modules of hydrochemical drain of the Middle Ob: N – 3...5 mg/(s·km^2); P – 0,2...0,5 mg/(s·km^2); Fe – 1...2,5 mg/(s·km^2); Si – 23...24 mg/(s·km^2)) are being washed out. However, in comparison with the main ions,

the biogenic substances drain is much less and usually does not exceed several percent from the total drain of the main ions, biogenic and organic substances (table 1). The underground component of the annual drain of biogenic substances in considered territory as a whole increases in process of increase in marshiness of reservoirs and reduction of modules of the water drain and averages 20...50 %.

Organic substances drain

Drain of organic substances has also been defined as the sum of values of the seasonal drain calculated by multiplication of seasonal average annual values of substances concentration water expenditures. In case of the Ob river it makes from 400...500 tS/year (about 30 mg/(s·km^2)) in southern and central parts of the Tomsk region up to 770 tS/year (49 mg/(s·km^2)) and more in northern part of considered territory, and in case of its main inflows – from several dozens up to 178,7 tS/year (table 1). At the same time, the certain increase in a share of organic substances in a total hydrochemical drain of inflows of the Ob and the underground component in the general drain of organic substances is observed, on the one hand, in process of growth of marshiness of reservoirs and the total water drain, and on the other hand – at reduction of modules of the latter. The most part of organic substances being washed out with the surface drain, and the significant amount of oil products and easily oxidized organic substances comes with storm and thawed snow from the urbanized territories. Considering this circumstance and results of the analysis of time changes of mid-annual values of biochemical and chemical consumption of oxygen (BPK_5 and HPK) and the content of oil products, it is possible to assume that exactly the drain of organic substances taking the second place on size after the drain of the main ions, has experienced the most significant change in the Middle Ob basin for the last some decades. At the same time, it is necessary to note that in conditions of an annual gain of bogs changes of hydrochemical drain should be happening inevitably [8].

Conditions of hydrochemical drain formation

During research of natural-anthropogenous transformation of hydrochemical drain by the complex of interconnected techniques of estimation of hydrochemical drain conditions formation in the Middle Ob basin has been developed by the author, and most important – inflow of substances on considered territory and washing out from it, matriculation from atmospheric air, matriculation in the process of soil water erosion, inflow into a river network from bogs, dump of sewage, matriculation from unorganized anthropogenous sources, change of water chemical compound as a result of interactions in the system «water – rock – organic substance». Description of the specified techniques is shown in [5, 8, 10]. The executed calculations of substance matriculation into water objects allow to get the general picture and to allocate the most important sources and processes (table 3).

Among them, first of all, it is necessary to note loss of substances from the atmosphere. The significant contribution to formation of hydrochemical drain also brings matriculation of substances as a result of interactions in the system «water-rock», and also inflow of substances from bogs, whose role consists not only in variation of washing out of those or other substances, but also in formation of the geochemical environment as a whole. The most significant anthropogenous influence is connected with matriculation in the atmosphere, and then in water objects of nitrogen compounds and hydrocarbons, and also with unorganized washing out from the urbanized territories of biogenic and organic substances.

Table 3. *Correlation of matriculation of the main ions, carbon of organic substances, nitrogen of inorganic compounds, oil products from various sources to an increment of washing out with waters of the Ob river in its average current, %*

Source(process)	Main ions	C_{org}	N	Oil products
Atmospheric fall outs	37,4	16,3	150,0	13,6
Matriculation as a result of interactions in the system «water-rock»	50,7	–	–	–
Washing out from soils as a result of their water erosion	–	32,8	9,7	–
Drain from bogs	–	44,3	–	–
Effluent discharge	3,8	1,7	18,0	0,8
Unorganized anthropogenous matriculation	8,7	4,9	37,1	40,8
Factors of formation	Mainly natural	Mainly natural	Natural-anthropogenous	Natural-anthropogenous

The lead calculations have not allowed receiving hydrochemical balance for the basic parameters in the sum of 100 %. In case of the main ions it is explained by not crediting enough roles of interactions in the system «water-rock», and in case of organic substances – the underestimated estimation of bogs influence. Taking that into consideration, the contribution of interactions to the system «water-rock» in the ionic drain from the territory of Middle Ob basin can make up to 50 % (6201 thousand t/year), and the contribution of bogs to the drain of organic substances on C_{org} – up to 44 % (442 thousand t/year). Unexpected, at first sight, result of matriculation calculations in the region rivers of nitrogen inorganic compounds is presumably connected with the biogeochemical processes leading to a significant decrease of nitrogen concentration in river waters, and significant residual substances balance identified as oil products, is explained by the natural origin of not less than a half of their washing out weight with river waters.

According to [11], admissible residual of water-management designs makes 5...20 %. Considering the specified values, lets suppose that at the contribution of anthropogenous factors to the increment of the hydrochemical drain at a rate of less than 5 % the content of substance in surface waters is defined by natural factors, in a range 5...20 % – mainly natural, more than 20 % – natural-anthropogenous. Proceeding from it, it is possible to draw a conclusion on mainly natural ori-

gin of the main part of the hydrochemical drain in the Middle Ob basin.

Conclusion

As a result of the complex analysis of the hydrochemical, hydrometric and hydro-geological information the average annual values of the total hydrochemical drain in the Middle Ob basin are established, making directly for the Ob river 18...25 million t/year and more, and for its main inflows – from 0,5 up to 4,4 million t/year. The main part of the hydrochemical drain is represented by macrocomponents (85...90 % and more). Appreciable enough contribution brings the drain of organic substances (from 2 up to 13 %). Drain of other substances usually does not exceed several percent from the total hydrochemical drain. Distribution on territory of modules of the hydrochemical drain (1,0...1,2 g/(s·km^2) – for the rivers Ob and Chulym, more than 2 g/(s·km^2) for the Tom river and its inflows, less than 1,0 g/(s·km^2) – for plain inflows of the Ob river) it is caused by latitude zonal value of the water drain and mineralization of river waters. The underground component of various substances drain varies in wide enough range. For the ionic drain it will vary from 20 % in mountain areas up to 60 % and more for plain inflows of the Ob river with strongly boggy reservoirs. The underground ionic drain of the Ob consistently increases from 47...58 % at Kolpashevo city up to 50...67 % at Prohorkino village. The underground component of microelements drain, many biogenic and organic substances usually makes less than 50 % from the corresponding annual quantity.

Studying of existential changes and conditions of formation of the hydrochemical drain (considering results, earlier stated in [5]) has allowed drawing following conclusions. First, the most part of the hydrochemical drain in the Middle Ob basin, presented by macrocomponents and difficultly oxidized organic substances on size HPK, is formed as a result of action of mainly natural factors. Secondly, anthropogenous transformation of the hydrochemical drain within last decades basically is shown in increase of washing out of the hydrocarbons, easily oxidized organic substances on BPK_5, inorganic nitrogen compounds, microorganisms, matriculation in a river network of toxic technogenic organic microimpurity and is connected, first of all, with pollution of atmospheric air and unorganized matriculation of substances from the urbanized territories.

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