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Heavy Metals of Benthal Deposits of Some Lakes of Khanty-Mansi Autonomous District-Yugra, Surgutsky Region

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Abstract: Experimental data were obtained on the gross content as well as on the content of movable forms of heavy metals, cuprum, manganese, cobalt, nickel, zinc, chromium in benthal deposits of some lakes of Khanty-Mansi Autonomous District-Yugra, Surgutsky Region. Elements under study in the order of mineral dressing of benthal deposits can be arranged in the descending sequence: Cr>Cu>Zn>Co>Ni>Mn. Calculated clarkes of concentration (K_k) for microelements were: for Mn-0.041; Ni-0.39; Co-0.43; Zn-0.44; Cu-0.53; Cr-0.73. The local geochemical background of benthal deposits is not exceeded for all studied elements. It was elicited that up to 68% of Co, 51% of Mn up to 30% of Zn, 8.4% of Cr, 5.5% of Ni and 3.2 % of Cu are in the movable form ejected with acetate-ammonium buffer solution (pH = 4.8). Contents of heavy metals were determined with the use of flame Atomic Absorption Spectrophotometry (AAS) method on AA 6300 spectrophotometer of "Shimadzu" company.

Key words: Heavy metals, benthal deposits, clarke, gross content, Russia

INTRODUCTION

To date, monitoring of water bodies aims to estimate the concentration of pollutants in the water, suspended substances or in benthal deposits. Estimation results are compared with MPC values for water bodies or with their natural background. However, the residence time of pollutants in water and suspended phase is rather limited therefore it is possible to fix their content and spread in water body only by carrying out the regular complete monitoring. In practice, it is almost impossible to fulfil since in water bodies constantly take place self-purification processes, especially of watercourses which concentration decreases in time. Thus, pollutants can transform and precipitate or rush out in the water body. From above follows that study of benthal deposits is very urgent task when solving the problem of aquatic ecosystems monitoring (Mezandrontsev, 1990).

Benthal deposits being in constant exchange with the aquatic environment, accumulate all the information concerning history of the water body development and processes in water-collecting territories. Due to this, it is possible to use benthal deposits as indicators at assessment of aquatic systems condition and pollution control. Historical profiles of metal content provide the information about their natural and anthropogenic accumulation too.

In this regard, the most complete information can be gained when studying benthal deposits of lake ecosystems. From the early age of civilization, freshwater lakes are the cultural development center. The danger of pollution became the most pressing just for such objects as a result of industrialization and population growth. In some regions, geochemical and anthropogenic anomalies in particular heavy metals content, can superimpose on one another (Bilyavsky *et al*., 2002).

Among great many of pollutants that fall into natural waters Heavy Metals (HM) are of the particular significance. They can actively integrate into migration cycles and accumulate in various elements of aquatic ecosystems. Particular danger of HM lies in that they are stable in water systems and only change their speciation. At the present time, sufficient number of articles in the world is devoted to this problem (Papina, 2001; Shigabaeva and Akhtyrskaya, 2014).

MATERIALS AND METHODS

About 15 samples of benthal deposits were taken for analysis sampled from 15 lakes of Khanty-Mansi Autonomous District (KMAD)-Yugra, Surgutsky Region. Data on samples of benthal deposits are presented in Table 1.

All lakes belong to the class of polluted, anthropogenic loaded by gas and oil production enterprises. Selection of lakes was based on their uniform distribution in the area under study. Content of 7 microelements which follow industrial production was

Table 1: Data on samples of benthal deposits

Sample No.	Sampling place
1	KMAD-Yugra, Surgutsky Region, unnamed lake, N60°55'50,399", E064°24'5,662"
2	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°3'21,511", E073°01'14,523"
3	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°39'03,0", E073°56'07,6"
4	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°38'16,0", E073°55'02,5"
5	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°33'21,0", E074°00'36,2"
6	KMAD-Yugra, Surgutsky Region, unnamed lake, N62°19'47,6", E074°19'23,9"
7	KMAD-Yugra, Surgutsky Region, unnamed lake, N62°18'05,7", E074°15'42,9"
8	KMAD-Yugra, Surgutsky Region, unnamed lake, N62°13'57,3", E074°07'43,0"
9	KMAD-Yugra, Surgutsky Region, Soromlor Lake, N62°07'20,8", E073°51'20,3"
10	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°02'40,621", E069°58'22,966"
11	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°00'20,052", E068°06'55,42"
12	KMAO-Yugra, Ponamorperimlor Lake, N61°44'50,0", E072°02'19,9"
13	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°58'28,833", E072°05'22,976"
14	KMAD-Yugra, Surgutsky Region, unnamed lake, N61°27'52,631", E071°42'13,205"
15	KMAD-Yugra, Surgutsky Region, Tyrkinlor Lake, N61°34'36,7", E071°59'40,0"

determined in samples of benthal deposits with AAS method. Soil samples were dried up to the air-dried state. Samples with weight of about 0.2 kg were selected by quartering method, ground in the porcelain mortar and 1 mm sifted after removing roots and other foreign particles.

Determination of HM gross content was performed with AAS method according to the standard Federal Environmental Regulation (FER) 16.1:2.2:2.3.36-02 procedure (Environmental Federal Regulations, 2002). Content of HM's movable forms was carried out according to Authorizing Document (AD) 52.18.289-90 (http://www.libussr.ru/doc-ussr/usr-16135.htm).

For quality verification of obtained results, the acceptability assessment of measurement results under conditions of repeatability (convergence) and reproducibility was carried out. Satisfactory results were obtained. However, good reproducibility does not withdraw the problem of results reliability, particularly of spectral measurements. Therefore, the appropriate standard-State Standard Sample (SSS) of soil was analyzed wherein the content of a number of elements was determined quantitatively. As a result, obtained values of HM content in a control sample meet within permissible error according to the procedure, the certified value of elements in a control sample (soil SSS). Thus, obtained results are acceptable and reliable.

RESULTS AND DISCUSSION

Based on the obtained results of the chemical analysis, mean values of gross HM content and contents of movable HM forms in benthal deposits were calculated. Results are given in Table 2. Evaluating results through mean values is justified since mean values and median are close to each other.

It is necessary to take into account clarkes of elements to comprehend in the proper way the patterns of chemical elements migration processes. Different incidence of elements in nature determines their different behavior in both laboratory conditions and nature. The more the clarke decreases, the more element's active concentration reduces the dropout of solid phase from aqueous solutions and formation of independent mineral species by other mechanisms become impossible. Therefore, capability of independent mineral formation depends not only on element's chemical properties but on its clarke too.

However, there exist and even spread enough independent mineral phases of a certain range of elements with low clarkes. The reason is that there are mechanisms in nature ensuring formation of increased concentrations of certain elements; as a result, their content in some areas can exceed clarke in many times.

To characterize accumulation of microelements in benthal deposits of Surgutsky Region lakes the clarke of concentration (K_k) was used. This index was calculated as the ratio of chemical element's content in natural object under study to clarke in sedimentary rock. For this purpose, gross contents of microelements in lake's benthal deposits were compared with clarkes of sedimentary rock. To compute clarkes of concentration the tables of clarkes were used compiled by Vinogradov (1957). Mean content of elements in sedimentary rock sensu Vinogradov, mean and median values of the gross content, clarke of concentration (K_k) are given in Table 2. The value of clarke of concentration indicates that local geochemical background of benthal deposits is not exceeded for all microelements (K_k varies within the range from 0.041-0.75). Elements under study in the order of mineral dressing of benthal deposits can be arranged in the descending sequence: Cr>Cu>Zn>Co>Ni>Mn.

Thus, it is possible to make the conclusion that concentration of Mn, Cr, Ni, Zn , Cu, Co and Sr in benthal deposits is not observed. Investigation results indicate low capability of benthal deposits to accumulate microelements associated with industrial production.

Table 2: Gross content, content of HM movable form in benthal deposits

No.	Mn (mg kg^{-1})	Cr (mg kg^{-1})	Ni (mg kg^{-1})	Zn (mg kg^{-1})	Cu (mg kg^{-1})	Co (mg kg^{-1})
Gross content of HM in benthal deposits (dissolution in mixture HF and HCI)						
Mean	35±10	14.3±4.3	12.8±3.8	21.8±6.5	10.5±3.2	3.4±1.0
Median	27.1	12.2	11.1	17.2	10.1	2.6
Clarke	850	19	33	50	20	8
K_K	0.041	0.75	0.39	0.44	0.53	0.43
Content of movable HM forms in benthal deposits (acetate-ammonium buffer extraction, pH = 4.8)						
Mean	17.9±5.4	1.20±0.36	0.70±0.21	6.5±2.0	0.34±0.10	2.3±0.69
Median	15.4	0.94	0.68	5.9	0.27	2.1

Rate setting of HM in natural objects should be complemented with movable form data. Just movable form is accessible for aquatic organisms and plants. Comparative analysis of results of the gross content and content of movable HM forms shows that movable form, extracted with acetate-ammonium buffer solution, contains up to 68% of Co, 51% of Mn, up to 30% of Zn, 8.4% of Cr, 5.5% of Ni and 3.2 % of Cu. Low value of copper movable form content is due to the fact that copper forms stable complexes with humic and fulvic acids.

CONCLUSION

Thus, it is possible to conclude that clarke concentration value is not exceeded in all studied samples of benthal deposits of Surgutsky Region lakes.

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