Geochemistry of bottom sediments in the limnosystems of the Baraba Lowland (South of Western Siberia) as an indicator of the technogenesis processes

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INTRODUCTION & AIM

Human activities that affect the environment are becoming more widespread and threaten the ability of natural systems to maintain their balance. The flat lands of southern Western Siberia act as natural plates, accumulating and reflecting the geochemical composition of the entire demolition area. This paper examines the ecological and geochemical composition of bottom sediments from five small lakes near regional industrial centers in the Baraba Lowland, southern Western Siberia.

The bottom sediments of the small lakes we studied are organic-mineral sediments, such as sapropel and mineral silt, which are used in various industries, including agriculture and cosmetology, etc.

Sapropel is organomineral bottom sediments of reservoirs formed as a result of biochemical, microbiological, and mechanical processes from the remains of dying plant and animal organisms, authigenic minerals, and organic and mineral impurities introduced into reservoirs (Korde, 1969; Kemp et al., 1999; Strakhovenko et al., 2014).

The aim of work: To study the ecological and geochemical composition of bottom sediments of small lakes in the Baraba lowland to assess the current state of natural systems under conditions of technogenesis.

Sapropels of lakes are (a) tobacco-green with filamentous remnants of vegetation and (b) black fatty sapropel with shells of small mollusks.

METHOD

Prior to selecting the testing point, we conducted preliminary studies on the lake bottom relief using the Garmin ECHOMAP Plus 62CM echo sounder. Bottom sediment sampling was carried out in the center of the lake from the PVC boat "Stormline Adventure" (South Korea) using a cylindrical sampler (Ø = 82 mm, L = 120 cm) with a vacuum seal (Taifun RPA, Russia). Cylindrical sampler allowed us to collect stratigraphic sediment cores and keep the water-bottom sediment boundary undisturbed.

Analytical studies of the lake components were conducted in the Analytical Center for multi-elemental and isotope research SB RAS, Novosibirsk, Russia. The ash content (A, %) of bottom sediments was studied by calcining 50 g of the sample at 550 °C. Major and trace elements were determined via atomic absorption using a Solaar M6 instrument equipped with a Zeeman and deuterium background corrector (Thermo 130 Electron, USA). The major element composition was determined by X-ray fluorescence analysis (ARL-9900-XP, Applied Research Laboratories, USA). The total Hg content in the sediments and soil samples was determined according to the accredited methodology M 03-09-2013 using the RA-915M analyzer with RP-91S attachment (Lumex, Russia). The sample morphology and elemental composition were determined using a scanning electron microscopy (SEM) (Mira 3 Tescan, Tescan, Czech Republic). The INCA Energy 300 program (Labspec 5) was used for quantitative chemical analysis with reference standards. The bottom sediments were analyzed using a "shashka"-type tablets, made of epoxy resin (Ø = 2cm, H = 0.5 cm) via method, developed by [Malikov, 1984]. X-Ray Powder Diffraction was used to determine mineral composition (ARL X'TRA, Thermo Fisher Scientific (Ecublens) SARL, USA) (emission CuKα).


RESULTS & DISCUSSION

The samples quantity and general data on the Baraba limnosystems

Lake	N	E	Alt, a. s. l., m	BS core depth, cm	Water depth, m	BS* samples quantity
Bugristoe	55.373550	78.391901	111	75	1.8	15
Chistoe	55.402035	78.366838	109	60	2.5	12
Peschanoe	55.411118	78.347440	115	70	2.5	12
Bol'shie Kajly	55.416489	78.299718	107	90	2	18
Mostovoe	55.462691	78.207293	108	60	2	11

Note. Alt – altitude; BS – bottom sediment

Most of the normalized (C_n/C_{UCC}) values are between 0.2 and 1.0, indicating that the bottom sediments of all five lakes have a lower concentration of most elements compared to the average composition of the upper continental crust. This suggests that the sediments may have been diluted by organic matter or authigenic carbonates, or that the parent rocks (loess-like loam) were initially poorer in these elements.
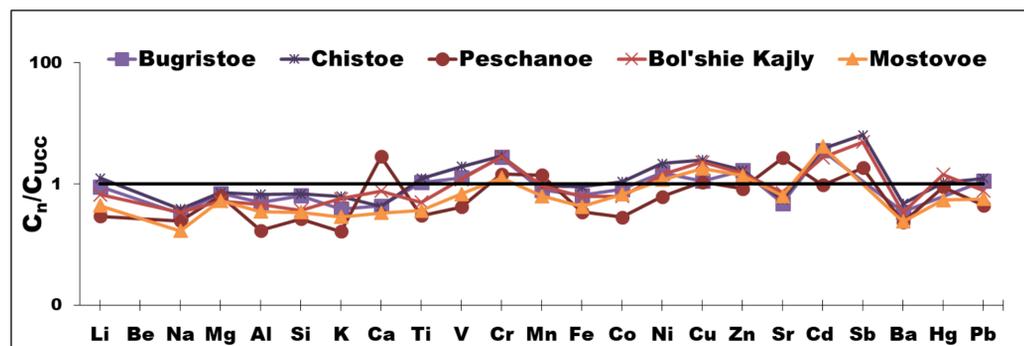
Most of the normalized values ($C_n/C_{average\ Baraba\ Lowland\ BS}$) are in the range from 0.3 to 1.0, which indicates that the bottom sediments of all five lakes have almost the same concentration of most elements compared to the average composition of bottom sediments of the small lakes of the Baraba lowland (30 lakes). This indicates the overall nature of the sedimentation process in the study area.
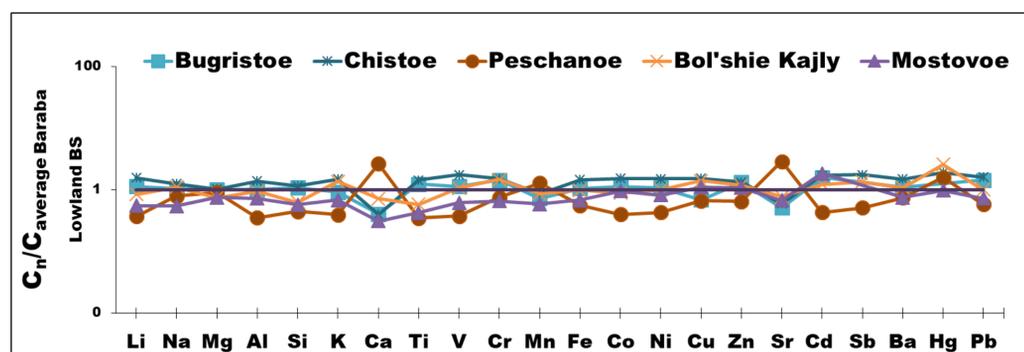
CONCLUSION

Despite the generally low content of most elements in the sediments, local geochemical anomalies have been detected, indicating the impact of human activity. This is particularly evident in the lakes, where concentrations of elements that are indicators of industrial pollution, such as Cu, Zn, Cd, Ni and Co, were found. However, such values are not significantly elevated for the regional background in the sediments. Local increased concentrations of Ca and Sr in the bottom sediments of Lake Peschanoe are associated with the formation of authigenic carbonates.

Comprehensive analysis methods have allowed us to determine the average regional background concentrations of major- and trace elements. These results provide a foundation for understanding current processes of sedimentation and element migration in the small lakes of the Baraba lowland. The patterns and anomalies that have been revealed can be used to predict the future development of natural ecosystems under increasing anthropogenic pressure. They can also serve as the basis for further environmental monitoring and the development of environmental protection measures in the region.

FUNDING