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Features of migration of Fe, Mn, Al, Cu and Zn in the Onego Lake

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ABSTRACT. The paper presents the first results on the study of migration forms of Fe, Mn, Al, Cu, and Zn in the Onego Lake. The mineralogical composition of the suspended matter was studied. The uneven distribution of elements and forms of their migration across the lake's water area is revealed.

Keywords: suspended matter, migration forms, metals, Lake Onego

1. Introduction

Processes occurring in lake ecosystems cannot be considered without taking into account the flows of sediment entering the bottom sediments, including the material composition of suspended matter in natural waters and migration features associated with hydrodynamic, chemical and biological processes in the reservoir. The purpose of this work was to study the material composition of the water suspension of Lake Onego.

2. Material and methods

The catchment area of Lake Onego is 53,100 km³. The waters of Lake Onego belong to the hydro-carbonate class of the Ca group and are characterized by low mineralization (32-45 mg/l). The lake is an oligotrophic reservoir, large bays (Petrozavodskaya and Kondopozhskaya bays) that are subject to anthropogenic influence have a mesotrophic status (Onezhskoe ozero, 1999). The main role in the formation of the lake's water composition belongs to river flow. It accounts for 91% of the total intake of dissolved and 65% of suspended matter (Lozovik, 2020).

Water samples were collected in September 2019 across the entire water area of lake Onego, including Petrozavodskaya, Kondopozhskaya, Unitskaya, Lizhenskaya, Velikaya Guba, Povenetsky and Zaonezhsky bays, Central and Southern part of the lake.

The selection of the water sampling horizon was carried out after nephelometric sounding using the CTD-90 MSea&Sun Technology multiparameter probe at depths with the highest light scattering, which is a sign of an increased content of suspended matter. A bathometer was used for water sampling. The

suspension was isolated "in situ" by vacuum filtration using specially prepared pre-weighted membrane filters with a pore diameter of 0.45 mm. Filters with a suspension were placed in Petri dishes. Water filtrates were preserved with concentrated nitric acid at the rate of 1 ml of acid per 100 ml of sample for the subsequent determination of metals and trace elements in them. Chemical analyses of water samples and water suspension were carried out on the scientific equipment of the Core Facility of the Karelian Research Centre of the Russian Academy of Sciences (Petrozavodsk) and the analytical Centre of the IGM SB RAS (Novosibirsk). The concentration of the suspended substance was determined according to the PND F 14.1:2:4.254-09 (2017). To determine the metal content, the suspension was transferred to the liquid phase together with the filter as a result of treatment with concentrated nitric acid in the SpeedWave four microwave decomposition system. The metals were analyzed using atomic absorption (AA6800, Shimadzu) and ICP-MS (Agilent 7500a) methods. The morphology, phase and chemical composition of the suspension was studied using a scanning electron microscope (SEM) MIRA 3 TESCAN.

3. Results and discussion

The study of the chemical composition of water and suspended matter of Lake Onego showed that the content of metals and suspended matter in water samples from various areas of Lake Onego is higher in the bottom horizon, and is much lower than the regional background values for the Republic of Karelia. It was found that Mn and Al migrate in the suspended form, while Cu and Ni migrate in the dissolved form. The ratio of suspended and dissolved forms for Fe and Zn varies

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depending on the area of the lake, the suspended form predominates mainly in bays subject to anthropogenic load (Petrozavodskaya and Kondopozhskaya bays). The terrigenous component of the suspension on filters from different parts of the lake has a similar composition: it is represented by fragments of large and small grains of quartz, feldspars, muscovite, chlorite (containing the ratio $Fe \approx Mg$) and numerous small grains of accessory minerals (Magnetite, Rutile, Titanite, Hematite, Apatite, Zircon, Monazite, etc.). It is important to note that the bulk of matter on the filters in all areas of the lake lay the skeletons of diatoms. The chemical composition of their skeletons almost always contains Al and Fe impurities up to 1.5%, which is in good agreement with the literature data for the composition of diatoms in the Northern territories.

According to SEM, interesting data was obtained at stations B1 and L1811, located in reagonis: Bol'shoe Onego and Maloe Onego. In the composition of terrigenous material, presented in the bonding with leafy secretions of Muscovite and Hematite, there are grains of irregular shape of Cu and Zn oxide, with a sharp predominance in the composition of Zn in L1811. Chemical analysis of the suspension of these filters did not reveal increased concentrations of Cu and Zn relative to other filters.

Elevated levels of copper and zinc were observed at the C1 station, but the filters of this station were not studied on the SEM. Since Zn oxide is not found in nature, this indicates their man-made source.

4. Conclusions

Based on the results of the study, it can be concluded that the content of metals and suspended matter in water samples from various areas of lake Onego is higher in the bottom horizon, and is much lower than the regional background values for the Republic of Karelia. Migration in the weighted form

was detected for Mn and Al, and in the dissolved form for Cu and Ni. The ratio of suspended and dissolved forms for Fe and Zn varies depending on the area of the lake, the suspended form predominates mainly in bays subject to anthropogenic load (Petrozavodskaya and Kondopozhskaya bays). The bulk of the suspended matter represents of skeletons of diatoms. The terrigenous component of the suspension from different parts of the lake has a similar composition: it is represented by fragments of large and small grains of quartz, feldspar, Muscovite, chlorite (which contain the $Fe \approx Mg$ ratio) and numerous small grains of accessory minerals.

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