Short communication

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Composition of the terrigenous component in the bottom sediments of the Lake Onego different areas

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ABSTRACT. This article touches upon the terrigenous component of the Lake Onego bottom sediments. The terrigenous component represented by quartz, feldspar, and muscovite is spread throughout the lake's water area and corresponds to the composition of the parent rocks of the lake's catchment area. Dark-colored minerals (amphiboles, pyroxene, epidote, etc.) are unevenly distributed, and reflect local sources of terrigenous material in some bays and areas of the lake (Petrozavodsk Bay, Central Onego, South Onego). In the areas of Big and Small Onego, Povenetsky and Zaonezhsky Bays, local sources of terrigenous material are not found in the upper horizons of the bottom sediments.

Keywords: Lake Onego, bottom sediments, terrigenous component, dark-colored minerals, accessory minerals

1. Introduction

Lake Onego is the second-largest water body in Europe (Onezhskoe ozero..., 2010), in terms of both size (9720 km^2), volume of water mass (291.7 km^3) and the catchment area 62.8·10^3 km^2 (Onezhskaya paleoproterozojskaya struktura..., 2011) and has a complex morphology. The lake is divided into large areas, for example, Kondopoga, Great, Unitsky, Lizhemsky, Povenetsky and Zaonezhsky Bays are in the north, Petrozavodsk Bay is in the west, the areas of Big, Small and Central Onego are in the center of the lake. The South Onego is in the southern part of the lake. The Lake Onego depression is located in the northwest part of the European Russia in the contact zone of the Baltic crystalline shield (early Precambrian formations composed of 80% rocks of the tonalite–trondyemite–granodiorite (TTG) series) and the Russian Plate (the Vendian-Paleozoic platform cover) (Onezhskaya paleoproterozojskaya struktura..., 2011). Quaternary deposits are represented by moraines of cover and mountain glaciers, glacial-lake and fluvioglacial sediments.

The lake receives a variety of material: solid phase of river runoff, atmospheric aerosols, coastal abrasion material, anthropogenic substance, and biogenic component.

The work aimed to characterize the mineral composition of the terrigenous component in various parts of Lake Onego.

2. Materials and methods

The sample morphology, phase, and elemental composition were determined with a scanning electron microscope (SEM) Mira 3 Tescan (Tescan, Brno-Kohoutovice, Czech Republic). The current modification of the equipment used a Si(Li) energetic detector (Oxford, Oxford Instruments, Abingdon, UK). The method enabled to carry out a quantitative chemical analysis on micro volumes. The INCA Energy 300 program (Labspec 5) was used for a quantitative chemical analysis with reference standards. All microphotographs presented in this work were taken using the SEM Mira 3 Tescan. X-ray diffractometry (XRD) was applied to determine a sample mineral composition (ARLX'TRA, Thermo Fisher Scientific (Ecublens) SARL, Waltham, MA, USA) (emission CuKα).

Analytical work was done at the Analytical Center for Multi-Elemental and Isotope Research SB RAS, Novosibirsk.

3. Results and discussion

The geochemistry and mineralogy of the Lake Onego bottom sediments were previously considered in several publications of the authors of this work (Strakhovenko et al., 2018; 2020). However, dark-colored and accessory minerals were not detailed for each part of the lake. Analysis by X-ray diffractometry and scanning electron microscopy shows that quartz,

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feldspar and muscovite predominate among the terrigenous minerals in all samples of bottom sediments (alkaline and medium plagioclase, and to a lesser extent potassium feldspar) regardless of the part of Lake Onego (Fig.). It is caused by the wide distribution from the northwestern through the northern to the northeastern part of the lake watershed of the early Precambrian formations of the TTG series, in which quartz and feldspar prevail.

The set of dark-colored and accessory minerals in the bottom sediments in general also corresponds to the composition in the early Precambrian formations of the TTG series and multiple intrusions of basic, medium and acidic composition (gabbro, diorites, granodiorites, granites, etc.). Dark-colored minerals are biotite, pyroxenes (mainly diopside) and amphiboles (most often hornblende), epidote, muscovite. In smaller quantities, there are accessory minerals: rutile, ilmenite, magnetite, titanite, zircon, monazite and hematite (Fig.). Dark-colored and some accessory minerals are unevenly distributed across the lake area.

The grain size of the terrigenous fraction in the bottom sediments varies from 1 to ~50 μm, regardless of the part of Lake Onego (Fig.).

Some dark-colored and accessory minerals are found only in certain bays and areas of Lake Onego, for example, aegirine and chromite are found only in Central Onego. This may be due to the outcrops of the Middle Proterozoic ultramafic and basalt rocks in the catchment area of the river Vodla flowing into Lake Onego in the area of Central Onego. Barite occurs in Central Onego and Petrozavodsk Bay, which may be associated with effusive rock outcrops in the Petrozavodsk Bay area. A specific feature of South Onego is the presence of kaolinite and phlogopite in the bottom sediments. The presence of kaolinite correlates with the weathering of feldspar rocks, which prevail in the lake's catchment and phlogopite can come with aeolian material. This distribution of the terrigenous dark-colored minerals relates with the peculiarities of the composition of rocks of the catchment area in general and each bay, and the lake area in particular. There is a large number of fragments and grains of epidote, hornblende, actinolite, and diopside in the Lake Onego bottom sediments. However, there are almost no pyroxenes and hornblende in the Big and Small Onego areas.

If for the above-mentioned areas of the lake, the rock`s composition of the catchment area reflects the composition of bottom sediments, then the terrigenous component of carbonate and shungite composition is not traced in the bottom sediments of the northwestern and northeastern bays of Lake Onego, although there are outcrops of the corresponding rocks on the shores.

4. Conclusions

Based on the Lake Onego location and morphology, the composition of the terrigenous component of the bottom sediments reflects the composition of the rocks of its catchment area in general and each bay in particular. The main part of the terrigenous component is quartz and feldspar for the entire water area of Lake Onego. Accessory and dark-colored minerals are unevenly distributed.

The main distinctive features of the content of dark-colored minerals in the bottom sediments are observed by (a) the content of pyroxenes: aegirine is found only in Central Onego, diopside is found in almost all bays, and there is a complete absence of pyroxenes in the Big and Small Onego areas; (b) the presence of kaolinite and phlogopite in South Onego; (c) the absence of shungite and carbonate material in the north-western and north-eastern bays of Lake Onego.

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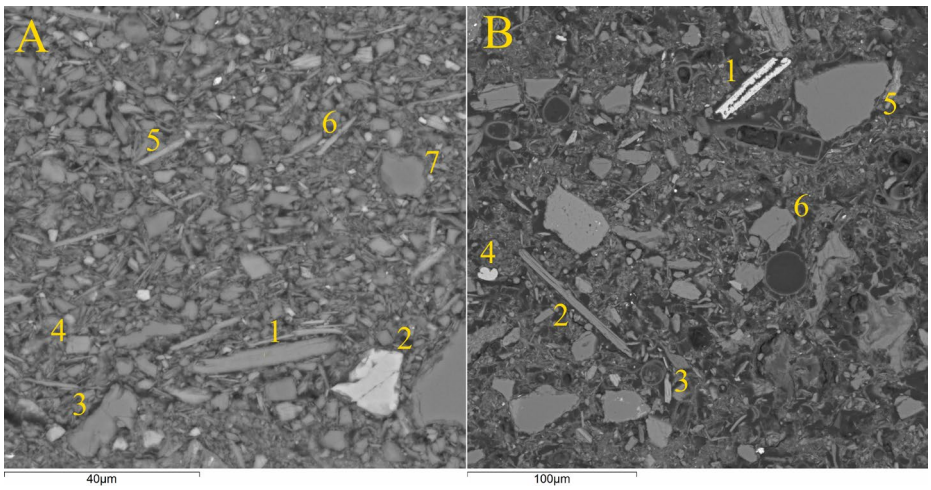

Fig. Terrigenous component of the bottom sediments of (A) Zaonezhsky Bay (northern part of the lake): 1-muscovite, 2 – titanite, 3 – oligoclase, 4 – potassium feldspar, 5 – chloritoid, 6 – chlorite, 7 – quartz; (B) South Onego (southern part of the lake): 1 – ilmenite, 2 – muscovite, 3 – pyroxene, 4 – rutile, 5 – quartz, 6 - potassium feldspar.

Conflict of interest

The authors declare no conflict of interest.

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