Short communication

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Correlating paleolimnological results with radiocarbon dating of Lake Ladoga sediment sequences

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ABSTRACT. Despite of a long period study of the sediments sequences of Lake Ladoga there are currently only two cores with a series of radiocarbon dates. Now the radiocarbon dates for one more core have been received. The results of new multi-proxy studies have been obtained. The new series of radiocarbon dates allows the obtained data to be correlated with other dated cores. Our studies show different sedimentation conditions in different parts of Lake Ladoga in the same time periods. In this regard, for a correct reconstruction of the history of Lake Ladoga, it is necessary to continue multi-proxy studying of the cores with a series of radiocarbon dates.

Keywords: lake sediments, Late Pleistocene, Holocene, Ladoga, AMS radiocarbon data

1. Introduction

Lake Ladoga is the largest lake in Europe. The study of Lake Ladoga sediments began with the Ladoga complex expedition of the Institute of Limnology of the Academy of Sciences of the USSR led by N. I. Semenovich in 1959 (Semenovich, 1966). The first conclusions on the features of lake sedimentation were made based on the pollen and diatom data (Abramova and Davydova, 1966; Abramova et al., 1967). Age estimations were determined according to pollen analysis. All further numerous results of paleolimnological studies were also mainly dated by the pollen method (Sapelko et al., 2021). Despite a long period of study of the sediments sequences in Lake Ladoga, until recently only a few occasional radiocarbon dates were available. The reason for this is a very low organic content in the Ladoga sediments insufficient for routinely applied bulk sediment dating. A radiocarbon age of 6660 ± 240 yr BP (LU-2817) was obtained from the sediment section in the north-eastern part of Lake Ladoga at a depth of 121m (61°33′ 25″ N, 31°20′7″ E). The Atlantic age of the sediments was confirming by pollen analysis (Arslanov et al., 1996). At the sediment core near the Valaam Island (61°23′ 0″ N, 30° 55′ 8″ E) the age of the 185 cm-thick sediments retrieved at a depth of 3 m was 7310 ± 1230 yr BP (LU-3042), which is also confirmed by the results of pollen analysis (Subetto et al., 1998). A wood fragment accidentally found in the varved clay retrieved from the south-eastern part of Lake Ladoga (60°42′75″ N, 32°34′75″ E) was dated to 15620 ± 50 (LU-2815; Arslanov et al., 1996). In 2013, in the framework of the Russian-German project PLOT, a deep water drilling was performed (Andreev et al., 2019). A series of radiocarbon (AMS) and pollen stratigraphy data a 20-m long sediment sequence at a depth of 111 m in the northwestern part of the Lake Ladoga, near the Konevets Island (60°59020.2″N, 30°41027.1″E, Co1309, Fig.) was received (Savelieva et al., 2019).

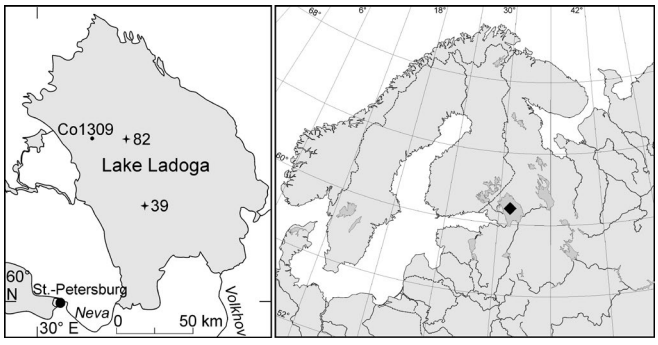

Fig. Location map and sites with a series of radiocarbon dates.

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2. Materials and methods

In summer 2016 and 2020, sediment cores were retrieved in the central and southwestern open parts of Lake Ladoga (Fig.) at the station 82 (60° 59.104′ N; 31° 08.982’ E, depth 68 m) and the station 39 (60°33, 919’N; 31°23, 57’E, depth 54 m) (numeration according to the network of the stations for regular observations of the Institute of Limnology, RAS, (Ladoga, 2013). The analyses included lithology, loss-on-ignition (LOI), phosphorus, metals, grain-size distributions, sediment density, pollen, diatoms and radiocarbon AMS dating. The radiocarbon dates were obtained by accelerator massspectrometry (AMS) at the Laboratory of radiocarbon dating and electronic microscopy, Institute of geography RAS (Moscow, Russia).

3. Results and discussion

Now we received the new results of the multy-proxi study of the Lake Ladoga sediment sequence at southwestern parts of Lake Ladoga (station 39). We can compare results of all methods to the data for other dated sediment cores in the in the central (Sapelko et al., 2019) and northwestern parts of Lake Ladoga (Savelieva et al., 2019). For the first time for Lake Ladoga, changes in phosphorus during the Holocene dated by the radiocarbon method were obtained, for cores of station 39 and Co1309 (Gromig et al., 2019).

Lake Ladoga was characterized with low ecosystem productivity with low diatom abundance, low diatom species diversity and mineral sedimentation (LOI not exceeding 3-5%) in the large and deep-water basin during the Late Glacial-Early Holocene. The content of clay fractions was highest. The concentrations of metals in the studied cores were differ, which may indicate the local specifics of sedimentation in the Ladoga basin. The phosphorus content in sediments does not exceed 1 mg g^{-1}. The cool and dry climate is indicated by periglacial landscapes. The cold climate of the Late Glacial period was recorded in all three dated cores. Radiocarbon dates (AMS) of 12718 cal. ka BP fixed the Late Glacial period in core 39. Radiocarbon dates (AMS) of 14124±69 cal. ka BP and 12834±68 cal. ka BP fixed the Late Glacial period in core Co1309 (Savelieva et al., 2019).

For the Holocene period a series of radiocarbon dates have been obtained to confirm the pollen stratigraphy and to date changes in sedimentation conditions in Lake Ladoga. Several radiocarbon dates in the upper parts of the cores of the open part of the Lake Ladoga showed the lowest rate of sedimentation in the modern period. In the northern part of open Ladoga, about 27–35 cm of sediments accumulated over a period of about 2500–2860 years (Sapelko et al., 2019; Savelieva et al., 2019). At the same time, no more than 20 cm accumulated during 1863–1737; in the period of *ca.* 1338–1292 - no more than 10 cm, and in the period of 1320–1289 - no more than 5 cm (Sapelko et al., 2019). In the southern part of open Ladoga (station 39), about 30 cm of sediments were formed in 3300 years and no more than 10 cm of sediments were formed in 2585 years.

4. Conclusions

Our studies show different sedimentation conditions in different parts of Lake Ladoga in the same time periods. It is impossible to obtain a complete picture of the Late Glacial – Post Glacial history of Lake Ladoga from a single sediment sequence selected from one point. For a correct reconstruction of the history of Ladoga, it is necessary to continue a multy-proxy study of cores from different parts of the lake with radiocarbon dating.

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Conflict of interest

The authors declare no conflict of interest.

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