Short communication

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Barents Sea coastline dynamics in the Holocene in the Kola region: grain-size and LOI analyses of lake sediments

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ABSTRACT. The research of Barents Sea coastline dynamics is based on isolated basins method: bottom sediments were sampled in the chain of lakes located in the area of Musta-Tunturi ridge by the Barents Sea coastline and on the isthmus between Sredniy Peninsula and mainland part of the region, the expedition took place in July 2021. This report presents common results of grain-size and LOI (losses on ignition) analyses of 4 lakes' bottom sediments. Deepest uncovered sediments are associated with marine genesis and characterized by the biggest average particle diameter and the lowest percentage of organic matter. Layers previously supposed as transgression sediments also have dissimilar grain-size structure from other layers of the core and low percentage of organic matter.

Keywords: bottom sediments of lakes, sea level change, Barents Sea, Late Glacial, Holocene

1. Introduction

The territory of the northeast of the Fennoscandian Shield is a classic area for studying changes in the position of the sea coastline associated with neotectonic movements of the Earth's crust. In recent years, the method proposed by Scandinavian scientists (Donner et al., 1977) has been used to determine the nature of the movement of the sea coastline. The method is based on determining the spatial and temporal position of the insulating contact – the transition zone from the sea to the freshwater lake, in the columns of bottom sediments from the basins of lakes. Such works were carried out on the Barents Sea coast of the Kola region in the areas of the village Dalnie Zelentsy (Snyder et al., 1997), Nickel (Corner et al., 1999) and Polyarny (Corner et al., 2001), in the valley of the Tuloma River (Tolstobrov et al., 2015; 2016), as well as on the White Sea coast of the Kola Peninsula and Karelia (Kolka et al., 2013; 2014; 2015). At the same time, there remain areas for which there is no data on the amplitude and rate of elevation of the Earth's surface.

2. Materials and methods

In July 2021 the expedition took place and bottom sediments of 8 lakes on interval of elevations 11.0-83.5 m were sampled. Four of them that have been chosen to be analyzed on LOI and grain-size are located on elevations: SR-1 (11.0 m), SR-5.2 (27.0 m), SR-2 (31.2 m) and SR-7.2 (83.5 m). Figure 1 shows the location of the fieldwork area. These samples were delivered to Saint Petersburg. Lithology was described in the previous abstract about first results of this expedition (Tolstobrov et al., 2021).

Both analyses were performed according to the standard methodology (GOST 17.4.4.02-84, 2008) in the laboratory of Rational Environmental Management of the Department of Physical Geography and Environmental Management of the Faculty of Geography of Herzen University. To perform the LOI analysis, the samples were ignited at 550oC, prepared and weighted before and after the ignition to count the losses of weight. It is interpreted as the loss of organic matter (OM). After comparison of different methods the Estonian one was chosen (Vaasma, 2008): every sample was mixed with 40% hydrogen peroxide and heated up to 80oC until the reaction stopped. While the reaction continues it is important to keep adding hydrogen peroxide. Grain-size analysis was performed using LaSca-1C Laser Particle Size Analyzer. The measurement was carried out three times, and their results were averaged.

3. Results and discussion

SR-1 (11.0 m) is characterized with regression sequence of facies – marine, transitive and lake facies change each other showing the regression of the sea. The transition zone between gyttja with silt and silt

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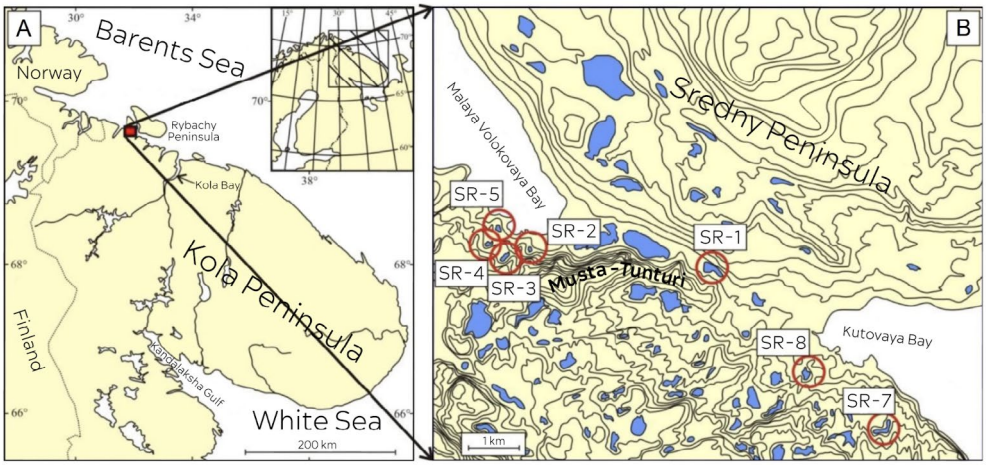

Fig. The location of the fieldwork area (A) and the location of the studied lake basins (B). Contour interval = 20 meters. Lake basins are marked with red circles (Tolstobrov et al., 2021).

sediments correlates with peaks of increasing average particle diameter and percentage of organic matter. The average diameter a bit increases from 10 to 15 μm in these samples. It allows us to suppose the fast change of hydrodynamics of the basin. Soon the results of radiocarbon dating for these layers will also be received. SR-7 (85.3 m) with 7 meters of homogeneous gyttja and 0.3 m of silt with sand has peaks of average particle diameter and the lowest percentage of organic matter in the deepest layers associated with marine sedimentation.

SR-5.2 (27.0 m) has a more complex sequence of facies: marine – gyttja – marine – transitional – gyttja. This sequence reflects the repeated penetration of sea waters into the basin of the lake. Sea level rise is probably associated with the transgression of the sea in the Middle Holocene (Tolstobrov et al., 2021). SR-2 is located close to SR-5.2 and only 4 meters higher, but the transgression horizon wasn't observed. Brown gyttja in this core is divided two times: by thin grey silt layer and thin grey sandy layer with only 4% of OM while the layers deeper and higher contain nearly 30-40% of organic matter, except deepest marine sediments. The first one isn't correlating with some change in the percentage of some fractions, but the second one correlates with pretty large increase of average particle diameter – from 10 to 62 μm. It could be caused by some catastrophic event, probably it could be the Storegga tsunami in the Middle Holocene (Bondevik et al., 1997; Romundset and Bondevik, 2011): radiocarbon dating results will help to prove or disprove this hypothesis later.

4. Conclusions

Gyttja of the studied lakes on average contains about 30-60% of OM, but the lower horizons of all four lakes contain no more than 10%. In the deepest horizons uncovered this value is approximately about 1.5%, which is not typical for lake sediments.

Thus already at the stage of field description and the first laboratory analysis, an assumption about the marine conditions for the formation of sediments in these horizons was made. To determine exactly whether they are of marine origin diatom analysis will help, samples for it were also carried. Quick look at diatoms in some samples of the lower horizons of all four lakes showed that salt-water species of diatoms are found in the sample of the clay and sand horizons. In the transitional gyttja/silt – only freshwater ones, which indicates the isolation of the lakes' basins from the sea and the subsequent formation of freshwater conditions in them.

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Conflict of interest

The authors declare no conflict of interest.

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