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CIRCULATION REGIME AND REDOX-CONDITIONS IN SALINE LAKE SHIRA (KHAKASIA, SIBERIA): FROM MODERN OBSERVATIONS TO PALEO-RECONSTRUCTION

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Meromictic lakes are lakes in which the deep recirculation does not include the entire water body. In meromictic state the nutrients accumulated in the monimolimnion with the sedimentation flow of organics are not available for the primary producers. Thus, in case of meromixis destruction, nutrients are released from the monimolimnion, resulting in outbreaks of phytoplankton bloom, i.e. in deterioration of water quality and changes in the species composition of plankton organisms. The weather conditions are among the main reasons for destruction of meromixis. Another reason for destruction of meromixis is change in water level. Since the change in mixing regime gives rise to changes in the composition of the sediments, the alterations between mixing regimes can be reconstructed for the long period of a lake history (Schmidt et al., 2002). In particular, hydraulically closed water bodies located in arid climates sensitively react by changes in water level to the changes in the balance of precipitation and evaporation in the area. In turn, the change in water level may result in change in mixing regime. Therefore reconstruction of mixing regimes of closed lakes provides valuable information on their level dynamics, consequently – about effective moisture of local climate.

Lake Shira (N 54.30, E 90.11) is located in Southern Siberia, in the steppe zone of the northern part of the Minusinsk valley (Republic of Khakassia, Russia). The average salinity in the mixolimnion during the summer stratification is about 15 g l^{-1}, and in the monimolimnion — about 19 g l^{-1} We analyzed the long-term field data on the vertical structure of Lake Shira and demonstrated for the first time the documented change in the lake stratification regime from meromictic to holomictic (Rogozin et al., 2017). The disappearance of purple sulfur bacteria from monimolimnion was a consequence of meromixis breakdown.

It was shown that in the period from 2002 to 2007 an increased inflow of fresh water caused the lake level rise, increasing the stability of the water column and consequently decreasing the depth of the autumn mixing. In the period from 2007 to 2015 the water level did not increase, reducing the stability of the water column and making the lake mixolimnion more sensitive to the wind stress. We assume that the most influential factor contributing to the winter mixing in 2015 was strong wind action due to early ice melt in the spring of 2014. The established causal relationship between meromixis stability and the level increase can be used for the reconstruction of paleo-climate humidity based on the indicators of anoxia in bottom sediments.

From bottom sediments of saline closed Lake Shira we estimated the switches between meromictic and holomictic conditions caused by climate-induced fluctuations of water level. The fossil carotenoid of phototrophic sulfur bacteria (okenone) was considered as a proxy of anoxia in water column (Zykov et al., 2012). Our latest observations on purple sulfur bacteria in Lake Shira confirmed that their biomass tends to increase in years of 2002-2007 when stable meromixis took place in the lake due to level increase. And vice versa: in the years of 2008-2016 the decrease in purple sulfur bacteria was correlated with constant level and weak meromixis (Rogozin et al., 2017). So we presume that

stable meromixis developed at the periods when the lake level increased due to increase in annual atmospheric precipitation. Consequently, we presume that the older sediment layers with high okenone content indicate the periods of sharp increases in Lake Shira level.

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ENVIRONMENTS OF SOUTHWESTERN SIBERIA AND NORTHWESTERN MONGOLIA IN THE LATE HOLOCENE (BASED ON THE LAKE SEDIMENTS STUDY)

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The Southern part of West Siberia and neighboring Northwestern Mongolia are regarded a key connection for human migrations between the Central Asian steppes and the North Asian forest-steppe. Holocene environmental changes are hypothesized to have had a significant influence on the development of the human societies in this region. Many well-studied world-famous archaeological objects from the Bronze, Iron and Middle Ages are situated in Southwest Siberia (e.g. Chicha, Tartas, Vengerovo, Pazyryk).

This study has an overarching goal to establish the link between past climate change, human migration and society development at the boundary of Asian steppe and North Asian forest-steppe. The first specific task of the research is providing a general scheme of environmental dynamics in Southwestern Siberia and Northwestern Mongolia as a natural transitional area between North and Central Asia during the Holocene by combination of bioproxy records from the key sites and previously published data.

To address past linkages between humans and climate in NW Asia, we have collected a suite of lake sediment archives over the region based on the following criteria: (a) location at the steppe/forest boundary sensitive to past climate variations, and (b) location within the corridor for human migrations in Bronze, Iron and Middle Ages. The time span of our study is Late-Holocene (last 4 kyr BP) which is presented in all our studied lake sediment cores.

Our studied lakes (Fig. 1):

1. Bolshie Chany and Bolshie Toroki (Zhilich et al., 2017) in the Baraba forest-steppe (Novosibirsk region, Russia).

2. Kuchuk in ghe Kulunda steppe (Altai region, Russia).