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LATE PLEISTOCENE-HOLOCENE ENVIRONMENTAL AND CLIMATIC CHANGES IN THE BAIKAL REGION INFERRED FROM MULTI-PROXY LACUSTRINE RECORDS

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Humanity today lives in an unusual time. It is proved that greenhouse gas concentrations are increasing rapidly and are now much higher than they have been for at least 420,000 years. Global average temperatures exceed anything seen in the last thousand years. In general, climate on Earth naturally undergoes changes driven by external factors and internal causes. Natural forcing mechanisms will continue to operate and will play a role in future climate variations. By studying the records of climate variability and forcing mechanisms in the relatively recent past, it is possible to understand how the climate system varied under "natural" conditions, before anthropogenic forcing became significant. Lakes are one of the best objects for studying the climate of the past since they act as excellent "sentinels of change" (Williamson et al., 2009) by providing signals that reflect the influence of climate change in their much broader catchments. Their sediments provide natural archives for past environmental change. In many cases, the study of lake's bottom sediments (i.e., paleolimnology), and the biotic and abiotic components in particular, that combine information from the water column, catchment area, atmosphere, can help assess baseline conditions for different physical, chemical, and biological systems (e.g., climate, ecosystem development), as well as the recovery times after disturbances of ecosystems (Pienitz, Lotter, 2009).

A large share of paleolimnological research in Baikal Region has focused on climate records from lakes located in the vast areas of boreal taiga-forest and semi-arid areas of western Baikal Lake shore

and in Trans-Baikal region. These environmental and climate records are concerned with changes in temperature, precipitation or effective moisture. Most of these lakes are fresh or brackish with various depths. The most commonly used proxies are pollen, diatoms, stables isotopes ($\delta^{13}C$, $\delta^{18}O$), grain size and various geochemical variables.

Among the lacustrine records, proglacial and moraine lakes, lava-dammed lakes as well as lakes of tectonic origin, are often considered to be especially well suited for paleoenvironmental studies. Reconstructions of the Baikal Region environment and climate history using multi-proxy lacustrine records testify to the global teleconnection of climate variability at glacial-interglacial, orbital and shorter time scales but also reveal distinct regional climate processes.

The most recent studies have made an important contribution to the detailed reconstruction of the natural environment, climate and vegetation of the Baikal region in the last glacial-interglacial cycle and, especially, to the understanding of the post-glacial history of regional.

For example, results of drilling in Lake Kotokel (southeastern coast of Lake Baikal), Lake Baunt (northeastern wing of the Baikal Rift Zone hollows), several glacial and lava-dammed lake in the Zhom-Bolok River valley (the Eastern Sayan Mountains, the area of the largest manifestations of Holocene eruptions in the Central Asia) contribute to the continuous debate concerning the degree of climate amelioration and the chronological framework of the MIS3 interstadial and the Holocene climatic optimum in Siberia.

The discontinuous pollen, diatom, diatom-inferred oxygen isotope, geochemical data from the abovementioned lakes were used to infer a drier/colder-than present late Pleistocene climate in the southern part of eastern Siberia even during the interstadial episodes of climatic amelioration that are visible in the taiga (maxima) and steppe (minima) biome scores. The reconstructed pattern of changes in the regional environments demonstrates that the late Pleistocene climate dynamics in southern Siberia were more complex than previously thought, and resemble the temperature variations (e.g. Greenland interstadials and Heinrich events) expressed in the δ18O record from Greenland ice and the East Asian Monsoon intensity signal in the δ18O record from Chinese stalagmites. Minor inconsistencies could be explained by the lower accuracy of regional age models, the lower resolution of the regional records in comparison to the above δ18O records.

The full glacial occurs in the regional pollen, diatom, XRA records at ~30/28–17 kyr BP and is marked by an increase in herbaceous taxa percentages, the highest scores for steppe and the lowest scores for taiga biome, suggesting an increased aridity/continentality of the regional climate and the predominance of open herbaceous communities in the landscape. The noticeable decrease in diatom concentrations followed by the virtual disappearance of diatoms from the KTK2 sediment (laminated grey silty clay) at ~31.5–17 kyr BP might be another indicator of the dry and cold climate with strongly pronounced seasonality. A similar dramatic reduction in diatom abundance occurred in Lake Baikal during periods of climate deterioration during the MIS3 interstadial (Mackay, 2007). The highest percentages of Ranunculaceae pollen at ~30–23 kyr BP support a shift of meadow/wetland communities closer to the coring point, suggesting that regional lakes was much smaller in size than today during this probably the dry interval.

The reappearance of diatoms in small quantities might be a sign of a slight amelioration of the regional climate at ~24–22 kyr BP, which might have influenced the aquatic ecosystem of small lakes. Both herb/grass-dominated pollen assemblages, the absence of aquatic macrophytes at ~22–17 (21-18) kyr BP point to a second phase of climate deterioration, conventionally associated with the Last Glacial Maximum.

A gradual increase in tree/shrub pollen percentages after ~18 kyr BP and changes in the diatom, lithology and geochemical records after ~17 kyr BP indicate the late-glacial climate amelioration in the region. The multi-proxy records from different lakes (e.g. decrease in woody cover, increase in tundra biome scores, marked changes in the diatom assemblages, geochemical indices, elemental ratios) clearly identify the YD stadial in the Lake Baikal region, allocating it within ~13–11.5 kyr BP.

The Holocene vegetation and climate dynamics in the region under study was reconstructed from the Kotokel Lake and Lake Baikal pollen records (Tarasov et al., 2009). The chronological sequence

of environmental change reconstructed from several lacustrine records shows great similarity with the previous study. The maximal spread of the boreal forest (taiga) communities is associated with higher-than-present July and January temperatures and precipitation, reconstructed at ~10.5–7 kyr BP (Tarasov et al., 2009). A noticeable increase in *Pinus sylvestris* pollen recorded after ~7 kyr BP reflects the spread of Scots pine in the Lake Baikal region (Demske et. al., 2005; Bezrukova et al., 2011), in line with the onset of drier and colder (similar to present) climate.

The relatively high temporal resolution and reliable AMS-based age models of several lacustrine pollen, diatom, geochemical records enable their comparison with the reference palaeoclimatic archives representing North Atlantic (e.g. Svensson et al., 2008) and North Pacific regions (Yuan et al., 2004). This comparison suggests that the reconstructed shifts in late Pleistocene–Holocene vegetation and environments in the Lake Baikal Region could have been controlled by the major factors controlling NH climate.

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THE CHEMICAL COMPOSITION OF SEDIMENTS AS A CRITERION FOR ASSESSING THE STATE OF LAKES IN THE HUMID ZONE (ON THE EXAMPLE OF THE KARELIAN LAKES)

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An assessment of the condition of the reservoir is a difficult task. Most often it is solved on the basis of a multidisciplinary approach, which includes a set of physical, hydrological, chemical, and biological criteria. Bottom sediments are natural archives, storing information about the evolution of the lake throughout its history. The possibilities of using the characteristics of sediment as criteria for assessing the state of the lakes to date remain insufficiently studied.