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High resolution paleoclimatic reconstructions by geochemical indices from recent lake sediments: assessment of source material and methods

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Trends of annual climate change for the last 2000 years appear to be similar over North Eurasia due to global forcings. They are mainly recovered by tree ring series and ice cores. Recent lake sediments are also perspective for time series construction by using of its‘ element composition, as it is shown in literature and based on our work experience in extra tropical Asian lakes such as Teletskoye, Baikal, Arachlei, Telmen, Issyk-Kul. Actually climatic conditions affect the element content of sediments with significant reproducibility. Moreover modern core scanners allow efficiently analyzing fresh sediment cores by 0.1 mm step. The method of scanning X-ray Fluorescence Analysis with synchrotron radiation (SR XRF) is used to determine contents more than 30 elements in a range from 1 up to 10000 ppm. Scanning is carried out in the Siberian Synchrotron Radiation Centre (BINR, Novosibirsk). At the same time this approach makes certain demands to source material.

Preferable objects. Studying lakes have to be situated beyond the reach of anthropogenic impact, what is necessary for correct calibration of geochemical time series by instrumental data. Annual climatic change is really recorded in sediments, if residence time of suspension input is shorter than 1-2 years. Hydrodynamic regime in sampled area ought to provide undisturbed sedimentation, for example, water depth more 15-20 m may be safe against storm resuspension. Annually laminated sediments

are evidently the best subject of investigation to prove age model and to identify winter or summer layers. Optical studying of thin sections combined with XRF seems to be especially promising.

Sediment accumulation rate and grain size. High resolution analysis is the most reliable for fine grained (silt-clay) sediments accumulated continuously at a rate 0.5-2 mm per year. On the one hand linear accumulation lower 0.5 mm/yr may not provide enough instrumental resolution. On the other hand sediments deposited faster 2 mm/yr usually contain sand and define unstable hydrodynamic conditions. Besides X-ray sensor in 0.1 mm have high probability to analyze single sand grains instead of silt-clay unit.

Element composition. Actually each kind of lacustrine sediments reveals own ensembles of elements and their ratios which are used as climatic proxies in the statistical modeling. Optimal sediment would contain both mineral and organic components. The first one response to runoff and the last one more reflect temperature via productivity. In that case element content variability is the most significant and detectable. Mineral part is correlated with x-ray density. It includes “clastophillic” rock-forming - Si, Al , Ti, Fe, Mg, Ca, K and trace elements such as Sr, Rb, Y, Zr, REE etc.

Organophillic elements are Br, I, U, Mo and others correlated with organic Carbon or LOI$<500^{o}$. Carbonate material makes difficulties for interpretation because weak safety of primary quality: authigene carbonates replace organics, as well they are easy recrystallised and disturb solid-water ratios. Forming of individual carbonate layers may result more contrast composition, meanwhile resolution for interpretation decreases.

The combination of extracting sub millimeter resolution XRF data, isotope Cs-Pb-C age models, and regression based artificial neural network calibration are used to reconstruct records of past temperatures, precipitation beyond instrumental and tree ring limits. Annual climate variables were restored for Teletskoye Lake from BC 900 to AD 2000 under sediment accumulation rate 0.5 mm per year, for Baikal - AD 1400-1990, 0.9 mm/yr, and for Arachlei, AD 1550-1990, 0.47 mm/yr. The work is supported by the Russian Foundation for Basic Research, Grants No. 05-05-39004, 06-05-64365, and 06-05-64931.