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High-resolution geochemical proxies of environmental change in annually laminated lake sediments and tree-rings

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Annually laminated lake sediments (varves) are very important continental archives with exact chronology and the high resolution records, reflecting not only annual, but also seasonal climate and environmental variations. Traditionally, geochemical properties have been measured on discrete samples with spatial subsampling resolution of several millimeters ($\sim$ 5 mm). It corresponds to the time resolution in 3 - 10 years when sedimentation rates are equal 0,5 - 1,5 mm/year. The method of scanning X-ray fluorescent analysis with synchrotronic radiation allows to determine contents more than 30 trace elements in a range of concentration from 1 up to 10000 ppm in annual layers with the spatial resolution of 0,1 mm [1, 2]. The set of analyzed elements and range of concentration are determined by selection of energy excitation and time of measurement in a point.

Bottom sediments from Teletskoe Lake (Altai), Telmen Lake (Mongolia), Lehmilampi Lake (Finland) [3], containing annual layers (varves) by thickness 0,3 - 1,8 mm, were investigated. Samples with the size 120õ13õ1,8 mm have been prepared by dehydration and impregnated low-viscosity epoxy. Scanning was carried out in the Siberian Synchrotron Radiation Centre (BINP, Novosibirsk) by a technique [2]. Contents of the following elements have been determined (in brackets detection limits in ppm are presented): K (350), Ca (250), Ti (200), V (150), Cr (100), Mn (50.0), Fe (30.0), Ni

(10.0), Cu (5.0), Zn (3.0), Ga (1.0), As (1.0), Br (0.5), Rb (0.5), Y (0.5), Zr (0.5), Nb (1), Mo (1) , Cd (5), Sn (5), Sb (5), I (3), Ba (2), La (2), Ce (2), Th (2), U (3). Also tree-rings samples collected around of investigated lakes were scanned.

The received results have allowed to find the cyclic geochemical signals, marking started also the end of each annual layer. These geochemical markers were used for automatic count of annual layers in bottom sediments and constructions of time series. For layers with thickness more than 1 mm it was possible to receive the detailed change of element composition marking the seasonal periods of sedimentation: spring - summer, autumn - winter.

Geochemical proxies of terrigenous (Ti, Rb, Y, Zr, Nb, Ba, Th) and organogenous (Zn, Br, U) components of sediments have been determined. The empirical functions connecting the contents of elements in a core of a bottom sediment on a historical interval in 120 years (1880 – 2000 AD) with climatic parameters (temperature and an atmospheric precipitation) have been created. Variations of geochemical signals in bottom sediment and tree-rings samples well correlates with meteo data.

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