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Fine-resolved XRF geochemistry of bottom fills from Asian lakes

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Over the last fifteen years (1994-2009) several teams from Siberian Branch of Russian Academy of Science have carried out numerous studies of cores of bottom sediments from Asian lakes, to perform regional reconstructions of past climate changes. Within these researches, the method of x-ray fluorescence (XRF) has widely been used to predict downcore distributions of elements; high-resolution XRF scanning of cores has been employed since 1999. Experiments have been performed at XRF facilities of Siberian Synchrotron Center.

In this presentation I report (1) 'know-how's of quantitative processing of experimental fine-scanning XRF data for lacustrine cores, and (2) geochemical signatures of sediments from Asian lakes obtained after XRF fine-scanning of cores.

(1) Quantitative prediction of concentrations of elements from fine-scanning XRF data is problematic because of varying water content along scanning profile, as well as due to varying matrix chemistry and sample optical thickness. All these cause varying inter-element influence that changes fluorescence flux through its absorption and/or secondary excitation. To overcome these difficulties we have used an adapted algorithm of fundamental parameters. The mathematical model based on this algorithm accounts for two events of photon/matter interaction. Element concentrations are estimated using reference samples and the internal standard procedure, both with correction of interference effects. The pore water content is inferred from its correlation with the coherent/incoherent scatter intensity ratio. Sediment density is found from water content by a reliable sedimentological law. Normalization to Compton scattering accounts for the irradiated mass of wet sediment controlled by porosity and sampling-related core disturbance. The mathematical model also includes these scattering variations related to lithology, water content, and density of samples. The new method was applied to XRF scans of cores to predict concentrations of ca. 20 elements. Tests against ICP–MS, neutron activation spectrometry and conventional XRF (with traditional pretreatment of samples) show good agreement. Neglect of the disturbing effects may cause errors up to 30–200% for different elements.

(2) Cores studied represent three types of fills: terrigenous silicate sediments, sapropel muds and carbonate-reach deposits. The sediments were collected by bottom drilling from the following Asian lakes: Baikal (53º42'N, 108º21'E), Khubsugul (51º28'N, 100º25'E), Khakas Lakes (Shira: 54º30'N, 90º12'E and Bele: 54º41'N, 90º15'E), East Siberian lakes (Ochki: 51º30'N, 104º53'E; Kotokel: 52º49'N, 108º09'E; Tolondo: 58º18'N, 119º47'E; Kiran: 50º22'N, 106º27'E), West Siberian lakes (Beloye: 55º23'N, 82º41'E; Kirek: 56º12'N, 84º23'E; Teletskoye: 51º39'N, 87º40'E). In current report I also provide data obtained after studying stratified peat archives from East and West Siberia. The following elements have been determined for most of the cores: K, Ca, Ti, Mn, Fe, Ni, Cu, Zn, Br, Rb, Sr, Y, Zr, Nb, Mo, I, Ba, La, Ce, Pb, Th, U; in some experiments Cr, Ga, Ge, As, Se, Cd, Te, Sn, Pr, Nd were also determined. The vertical resolution of measurements was 0.1 to 1.0 mm. In this presentation I give examples of bigenic traces (Br, I and some other); of downcore variations of terrigenous clastic supply (marked by Ti, Zr, Th, as well K, Rb, Nb, La, Ce, etc.); of authigenic enrichment of layers with Fe, Mn; with Cu, Zn; of carbonate and sulphate layers (marked by Ca, Sr and some other); of sulphate/sulphide reducing (marked by Mo); of mobile elements enrichment (Sr, U, etc.); of using ratios of elements as very sensitive markers of changing sources of material supplied into deposits (Ti/Ca, Sr/Rb, Fe/Ti and other).

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