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High-resolution record of uranium and thorium isotopes in Lake Baikal bottom sediments

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A high-performance ICP-MS method of determination of uranium and thorium isotopes in Lake Baikal bottom sediments is developed (Chebykin et al., 2004). In comparison with traditional α-spectrometry, the productivity of an analysis increases 1000 times at the least. Using quadrupole mass-spectrometer VG PlasmaQuad II, the method allows to determine the content of minor nuclides (^{230}Th, ^{234}U) with the accuracy of 1-3%, and of major ones (^{238}U, ^{232}Th) – with the accuracy not worse than 1%.

The method was used for the sediments from a Baikalian core (550 horizons) sampled on a slope of the underwater Akademichesky Ridge. A high-resolution ($\sim$ 200 years) record of uranium and thorium isotopes for the last glacial-interglacial cycle (140 kyr) is obtained for the first time in continental lacustrine sediments. The isotopic data allowed to perform an independent direct "absolute" U-Th dating of six horizons corresponding to MIS 5.1, 5.3, 5.5, and, due to this, to identify unambiguously all marine isotopic-oxygen stages in Baikalian records at the time interval studied. The isotopic records obtained reveal in detail the paleoclimatic nature of an abiogenic uranium signal. The profiles of uranium isotopes and of the ^{234}U/^{238}U ratio (A4/A8, in radioactivity units) correlate well with the diatom signal and show that during warm climatic periods, diatom silts are considerably enriched with the uranium incoming from the water body of the lake. During glacial periods, so-called "Baikalian blue clays" are formed; the diatoms are absent in them, and the uranium content decreases 3-4 times reaching clarke values of rocks surrounding the lake. The isotopic composition of uranium also changes considerably. In the sediments corresponding to warm climatic periods, the value of A4/A8 is high and reaches 1.9. During the maximums of global glaciations, A4/A8 decreases up to 1, this suggests that during that period

mainly terrigenous uranium incame as a rock debris material where it is in equilibrium. In other words, the source of autigenic uranium during the glacial period decreased drastically in comparison with nowadays. This means that rivers supplying dissolved non-equilibrium uranium (À4/À8 $\sim$ 1.3-2.11 in the main lake tributaries) practically did not flow at that time.

On the base of data obtained, the humidity in the water catchment basin of Lake Baikal was reconstructed quantitatively with a high temporal resolution ($\sim$ 200 years) during last 100 kyr (Goldberg et al., 2005). Such reconstruction for the Eurasian continent is obtained for the first time and, due to the huge area of the water catchment basin of the lake (557,000 km^2) can be rather representative for a considerable part of Northern Asia.

The humidity reconstructed allows to explain unambiguously an enigmatic diatom signal in Baikalian sediments: the diatoms disappeared from the open areas of the lake during global glaciations due to “silicon starvation” – decrease of supply of dissolved silica with rivers tributaries due to climate aridization.

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