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Uranium Isotopes in the Sediments of Lake Baikal as Geochronometers and Proxy for Paleo-Humidity

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Introduction. Major climate responsible signal in the sediments of Lake Baikal is the content of diatoms. Diatoms in Lake Baikal sediments provide a continuous record of paleoclimates in North-East Asia over the last few million years [1-5]. It varies in pace with the changes in global climate. The reason for the orbitally-forced oscillations in diatoms content was not known. Recently, few not biogenic signals, which are climate sensitive, have been found in the sediment of Lake Baikal [6-10]. Gavshin et al. [6] have found that diatom-rich intervals of the sediments deposited in warm climates contain abnormally high concentrations of uranium. Edgington et al. [7, 8] have found that layers of sediment rich in diatoms and uranium also contain significant amounts of unequlibrium ^{234}U: the ratio of the activities of ^{234}U and ^{238}U (A4/A8) in them can be as high as 1.9. Diatom-barren intervals do not contain excess of ^{234}U.

The aim of this paper is the detailed investigation of uranium isotopes in the sediments of Lake Baikal to receive the records of uranium signals with the resolution ca 200 y over the last 100 ky and ca.2 ky over the past 1 Ma.

Materials and Methods. Bottom sediments were sampled from the top of Akademichesky Ridge: st.2 -96 and BDP-96-2 [1-5]. High-resolution (ca. 200 y) measurements of U and Th isotopes from st.2 have been performed by ISP-MS (VG PlasmaQuad II PQs instrument) using both peak jumping and scanning modes. The contents of total U and Th with resolution ca. 2 ky in the sediments of BDP 96-2 over the last 1 Ma have been measured by SRXFA (XFA with synchrotron radiation produced by a VEPP-3 storage ring) in the Budker Institute of Nuclear Physics. Sample treatments, spikes used, methods of enrichment and measurements are described in more details in [11, 12].

The results and discussion. Direct U-Th dating of sediments from st.2 was based on the geochemical model [7,8] implying that excess ^{234}U is delivered into Lake Baikal in a dissolved form by rivers (mainly the Selenga River), and the sediment contained no ^{230}Th at the time of burial. According to the same model, about 30% of dissolved uranium supplied into Lake Baikal is adsorbed on settling terrigenous particles and becomes buried. Besides the authigenic uranium absorbed from water, with excess ^{234}U (A4 $>$ A8), the suspended particles themselves contain some terrigenous uranium in which ^{238}U, ^{234}U, and ^{230}Th are in secular equilibrium (i.e., A8ter = A4ter = A0ter). The time dependence of the A0/A4 ratio in the sediments is given by the R(t) function, which is slowly dependent on the initial (A4/A8)$_{t=0}$ [13]. Our ICP-MS results give a value of (A4/A8)$_{t=0}$ = 2.05 for U dissolved in the water of Lake Baikal, in an accord with the data of alpha-counting [7] and we used this ratio in the U-Th geochronometer for the dating of 6 depth intervals of core investigated [11, 13]. Thus, we used six direct U-Th ages obtained and age of the peak of *Stephanodiscus flabellatus* (14.7ky) for creating of depth-age model for the last 150 ky. New data confirm the earlier U-Th ages of the sediments of Lake Baikal deposited during MIS 5.5 [13]. Independent ages for MIS 5.3 and MIS5.1 in the sediments from Lake Baikal have been obtained for the first time.

The age dependences of (A4/A8) and A8/A2 of Baikal sediments are in good accord with the changes in global climate, as revealed by comparison with the records of GRIP2 and SPECMAP (during last 1 Ma) profiles. Globally warm periods are clearly accompanied by the increasing of (A4/A8), A8/A2 and A8 in the sediments of Lake Baikal. The most important finding is that contents of autogenic ^{238}U and ^{234}U in the sediments were approached almost zero at each ice age and at some cold events of warm stages during the last 1Ma. In our opinion, the zero concentrations of autogenic ^{238}U at ice ages are interrelated with the weakening of river runoff during these periods due to increased aridity. Thus, without river water, there was no input of nutrients such as dissolved silica, and diatoms could not thrive.

Conclusion. The excess of ^{234}U over secular equilibrium relative to ^{238}U and the lack of autogenic U in the sediments of Lake Baikal during ice ages (f.e. MIS 2 and MIS4) suggest that there was no input of river water and hence U dissolved into Lake Baikal. Without river water, there was no input of nutrients such as dissolved silica, and diatoms could not thrive. Thus, collapses in the abundance of diatoms in the sediments of Lake Baikal, which were pervasive in the Pleistocene can now be explained in terms of changing paleo-humidity in East Siberia.

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