Uranium and Thorium Isotopes Distribution in a Bottom Sediment Core from the Academician Ridge, Lake Baical, Siberia

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Lacustrine sediments include continuous and high-resolution records of environmental changes with local and/or global scales. Reconstruction of the paleoenvironmental changes has been attempted with the appropriate approach by using physical, chemical and biological signatures inferred from the lake sediments.

Lake Baikal in southeastern Siberia is located in a crucial area for reconstructing insolation-related, long-term climate changes. Studies so far made in sediment cores mainly from Academician Ridge in the central part of lake have revealed that some sensitive indicators of paleoclimate reconstruction are the distributions of biogenic silica (Bio-SiO_2, mainly come from diatomaceous algae), organic matters (carbon) and microelements, primarily uranium (U). Lake bottom sediments contain U and Th isotopes originating mainly from two sources: one are U(Th) fraction in soil itself derived from river and direct discharge (hereafter referred to as terrigenous U(Th)) and the other is U(Th) fractions which is formed mainly from a dissolved phase within the lake and its input rivers (hereafter referred to as authigenic U(Th)). Uranium is a redox-sensitive and biologically-related element, while thorium is an element mostly associated with terrestrial materials.

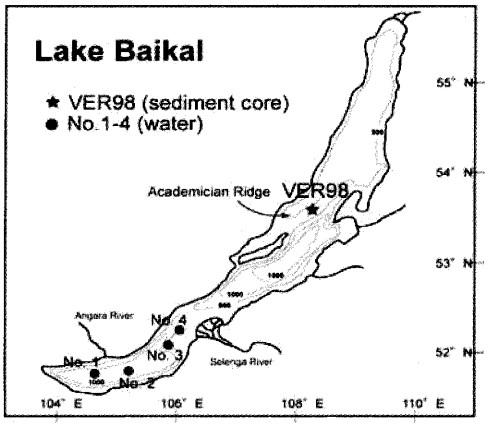

Figure 1 Map of sampling points.

In this study, we attempted to get information on U and Th isotopes using sediment core from the Academician Ridge in Lake Baikal. The concentrations of U and Th isotopes (^{238}U, ^{234}U, ^{232}Th and ^{230}Th) were measured. This long sediment core (ca. 230 kyr in history) was already dated well, as well as the measurements of other physical and chemical parameters of sediments.[1] Therefore, the core is suitable not only for understanding of U sedimentary behavior, but for verification of dating using ^{234}U-^{238}U and/or ^{230}Th-$^{238}U(^{234}U)$ chronometers.

One sediment core, VER98st6, (53°44.767' N, 108°24.633' E, ca.10 m) was taken in 1998 at points of Lake Baikal as shown in Figure 1. The sample was cut into 2.0 cm segments from the surface of sediments. Lake water samples (ca. 10 L) were also collected in order

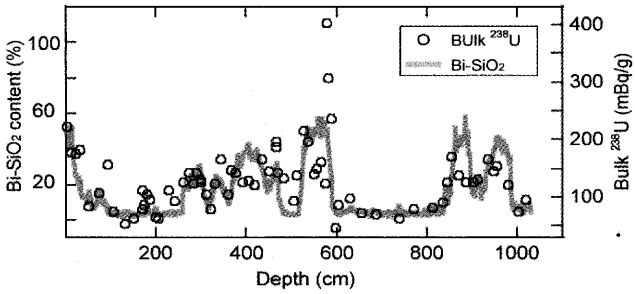

Figure 2 Depth distributions of Bio-SiO_2(%) and ^{238}U(mBq/g) in sediments from Lake Baikal.

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to get information on ^{238}U concentrations and their $^{234}U/^{238}U$ activity ratios at selected depths of the water column in 2003.

Uranium and Th isotopes in samples were determined by alpha-spectrometry after radiochemical separation. A sequential leaching of U in sediments was performed using the reported methods. In addition, it was attempted to give derails of sediment composition by using SEM and TEM.

Dissolved ^{238}U concentration in the lake water was as high as ca. 6 mBq/L, with a distinctly high $^{234}U/^{238}U$ activity ratio of ca. 2, irrespective of the sampling positions and depths.

The depth distribution of ^{238}U concentration for bulk sediment samples are presented in Figure 2, together with Bio-SiO_2 contents which drastically changed from 1.3-58.5% corresponding to the glacial-interglacial cycles.[1] The distribution of bulk ^{238}U seems to coincide with that of Bio-SiO_2 contents, in which both contents are high in interglacial periods and low in glacial ones. These results are consistent with the previous data from the Academician Ridge.[2] It is inferred that the layers with a high content of Bio-SiO_2 had increased content of U. The bulk ^{238}U was distinguished between two sources with some assumptions: terrigenous and authigenic U. Authigenic ^{238}U was responsible for the total ^{238}U variation with depth. This means that the variation pattern of authigenic U correlates well with that of Bio-SiO_2(%). In order to achieve a better understanding of the enrichment of authigenic U, sequential leaching for the speciation of U was examined in samples from selected layers of the core. Although the ^{238}U in the Bio-SiO_2 fraction is the focus of this study, the enrichment of ^{238}U in the carbonate and Fe-Mn oxyhydroxides fractions is clear. The Bio-SiO_2 fraction showed a very small ^{238}U content (several %). The dating of this sediment core carried out by using techniques of ^{238}U-^{234}U and Ionium (^{238}U-^{230}Th) methods (Figure 3). Assuming that the $^{230}Th/^{232}Th$ activity ratios in surface layers and the uranium series radioequilibrium are retained in lithogenous phases of all segments, authigenic U and ^{230}Th were estimated with ^{232}Th contents. The sedimentation rates were estimated to be 3.47±0.38 and 4.46±0.24 cm/kyr with ^{238}U-^{234}U and Ionium methods, respectively. These values were not so largely different from the rate dated with ^{14}C and susceptibility method.

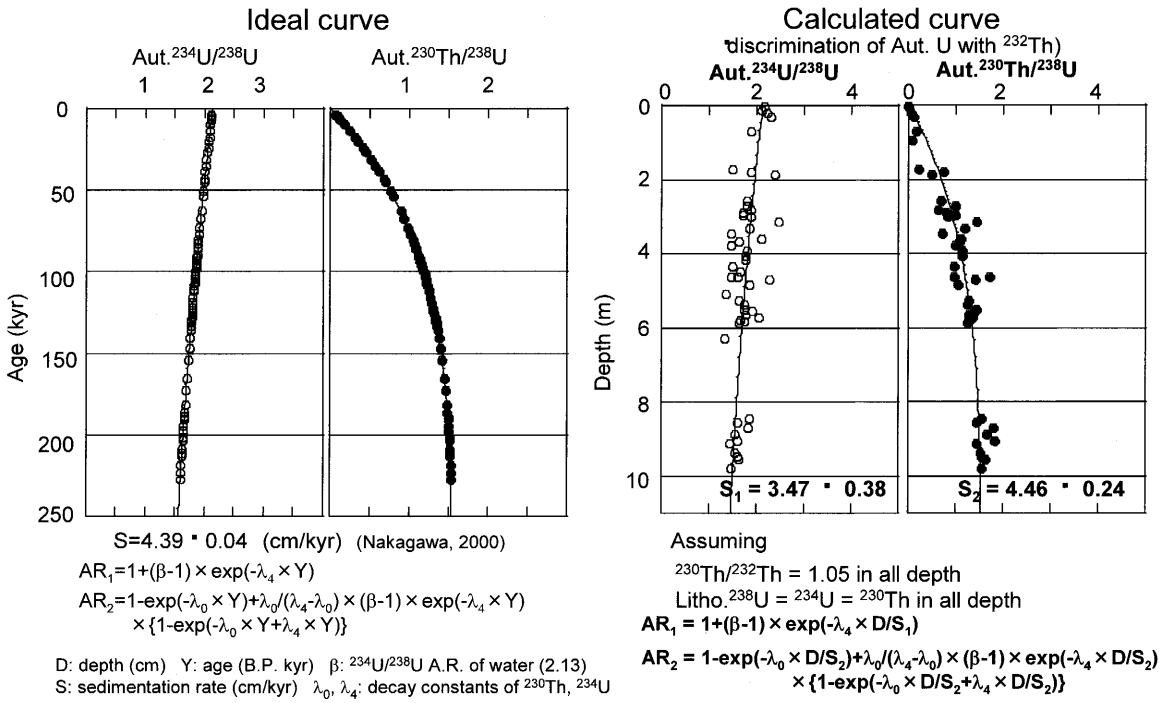

Figure 3 Application of $^{234}U/^{238}$ and $^{230}Th/^{238}U$ dating techniques for sediments.

References

1. Nakagawa, H., 2000. Master Thesis, Kanazawa-Univ.

2. Edgington, D. N., J.A. Robbins, S.M. Colman, *et al.*, 1996. Earth Planet. Sci. Lett., 142: 29-42.