Luminescence dating of fine grained sediments from Lake Baikal

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Lake sediments yield continental records of past environmental fluctuation and dating is important to extract quantitative information from those sediments. The combination of radiometric age determinations, such as ^{14}C and ^{137}Cs datings, and physical property analyses, such as grain size distribution and water content, provides reliable and continuous geochronological information. However, few radiometric dating methods are applicable to the age range older than 50000 years. Luminescence dating, which observes the natural accumulated radiation damage caused by radioisotopes such as U and Th, etc. as the form of glow after stimulation by heating or lighting, has the potential to date samples of hundreds of thousands years old. In this study, the luminescence dating was applied to fine grained sediments from the Lake Baikal to test its applicability. VER98 st.5 core taken from the Academician Ridge is used. Seven aliquots are taken from depths of 268, 308, 510, 598, 664, 708 and 750 cm (2C-32, 2D-06, 3B-16, 3C-11, 3C-41, 4A-18 and 4A-37, respectively) and are measured by several analyses.

For luminescence analysis, D_e is determined by RTL, BTL, OSL and IRSL. Polymineral sediments are used by all luminescence dating and quartz aliquots extracted from polymineral sediments are measured by RTL. D_e are measured successfully for all experimental settings with the precision of 10 %. However, D_e are clearly different among methodologies. Despite the sensitivity to sunlight, D_e of OSL is the largest in all D_e data. D_e of quartz by RTL is larger than that of polymineral.

Annual dose is calculated by radioisotope concentrations which are measured by the LA-ICP-MS. ^{29}Si is used as an internal standard, whose concentration is measured beforehand by XRF along with K concentration, which is also necessary to calculate annual dose. Powder sample is pelletized to measure the chemical concentration by LA-ICP-MS. Errors of resulted chemical concentrations are small (1 - 16 %, Ave. 8 %) and agree with the results by alpha-spectrometry within the error ranges.

In conventional annual dose estimation, the equation of Adamiec and Aitken, 1998, which requires elemental concentration, is used. However, since radioactive disequilibrium is reported in Lake Baikal sediments, the equation of Stokes et al., 2003 is applied in this study. In Stokes et al., 2003, the equation was built on the basis of radioactivities. Therefore, this equation is slightly modified to apply the result by the LA-ICP-MS. Additionally, annual dose variation through the time, due to the radioisotope concentration change caused by radioactive disequilibrium and water content change caused by consolidation during burial, is considered.

The age is estimated based on measured D_e and annual dose. The age is mainly lower than expected age which is estimated by correlating the water content fluctuation to the Marine Isotope Stage (MIS). To understand why the estimated age is not concordant with expected age, additional experiments would be necessary to determine the exact measurement procedure of luminescence dating of fine grained sediments from Lake Baikal.

Adamiec G. and Aitken M., 1998. Dose-rate conversion factors: update. Ancient TL 16, No. 2, 37-50.

Stokes S., Ingram S., Aitken M. J. Sirocko F., Anderson R. and Leuschner D., 2003. Alternative chronologies for Late Quaternary (Last Interglacial-Holocene) deep sea sediments via optical dating of silt-sized quartz. Quaternary Science Reviews 22, 925-941.