Compound-specific ^{14}C analyses of fatty acids as potential dating tools for lake sediments: A case study from Lake Kawaguchi, central Japan

*Shinya Yamamoto[1], Fumikatsu Nishizawa[2], Mitsuhiro Yoshimoto[1], Yosuke Miyairi[3], Yusuke Yokoyama[3], Hisami Suga[4], Naohiko Ohkouchi[4]

1. Mount Fuji Research Institute, Yamanashi Prefectural Government, 2. Kanagawa Prefectural Museum of Natural History, 3. Atmosphere and Ocean Research Institute, The University of Tokyo, 4. Japan Agency for Marine-Earth Science and Technology

Lake sediments contain high-resolution records of Quaternary climate and environmental changes. Terrestrial plant remains are generally considered ideal ^{14}C-dating materials in lake sediments; however, the scarcity of such plant materials often makes it difficult to provide robust age estimates, especially in settings where vegetation cover is limited. Total organic carbon (TOC) may be used as an alternative, but this often contains uncertainties that arise from the reservoir effect, source organic matter heterogeneities, and the contribution of re-deposited old organic matter. In this study, we performed compound-specific radiocarbon analyses (CSRA) of fatty acids over the last 3 ka from a sediment core (KA-1A) obtained from Lake Kawaguchi, located near Mount Fuji, central Japan, to assess their potential for dating sediment in lake environments.The ^{14}C ages of the C_{16}, C_{24}, and C_{26}fatty acids isolated from the core gradually decreased with increasing core depth. However, the ^{14}C ages of the same samples showed a maximum difference of 781 years between the compounds, suggesting source heterogeneity and a contribution from reworked organic materials. On the other hand, the ^{14}C age of the C_{16}fatty acid (983 ± 56 yr BP) was almost identical to the lake reservoir age (937 ±22 yr BP), suggesting that this compound was likely derived from primary producers (mainly diatoms) in the lake. To check the variability of the lake reservoir age, we compared the ^{14}C ages of C_{16}fatty acid and that of plant (leaf) materials contained in the Kawagodaira tephra (Kg) layer at 396.5 to 401.5 cm depth. The differences between the ^{14}C ages of the C_{16}fatty acid and the plant material was 1002 ±73 yr BP, which is consistent with the modern reservoir age of the lake (983 ±56 yr BP) within an error, suggesting that the lake reservoir age did not changed significantly over the last 3 ka. Based on these results, we estimated the depositional age of the Omuro scoria layer that is derived from the largest flank eruption at the base of Mount Fuji over the last 3 ka. The age estimate for the Omuro scoria layer, based on the ^{14}C ages of the C_{16}fatty acid, is 2835 ±35 cal BP, which is in good agreement with ages derived from plant remains in the Lake Kawaguchi core (2931 ±15 cal BP) and in sediment from Lake Motosu (2935 ±137 cal BP). These results indicate that, by correcting the lake reservoir ages, we can estimate depositional ages using the plankton-derived C_{16}fatty acid. This method could be useful to improve chronologies in lake environments where plant remains are limited.

Keywords: lake sediment, radiocarbon dating, fatty acid

