Pollen isotope records from Lake Suigetsu, Japan

*Keitaro Yamada[1], Takayuki Omori[2], Ikuko Kitaba[3], Yamasaki Akiteru[4], Takeshi Nakagawa[3]

1. Research Organization of Science and Technology, Ritsumeikan University, 2. The University Museum, The University of Tokyo, 3. Research Centre for Palaeoclimatology, Ritsumeikan University, 4. Fukui Prefectural Satoyama-Satoumi Reserch Institute

Interactions of atmosphic, marine, terrestrial, and cryospheric realms are important factors in considering mechanisms of climate change (Lowe et al., 2008). Climatic leads and lags between these realms are keys to understand triggers and responses of climate change. Pollen analysis is one of the most widely used methods to provide terrestrial proxy (e.g. IPCC, 2013). However, vegetation sometimes responds with inertia to the climate change, which implies that the obtained terrestrial proxy based on pollen assemblage potentially contain lags (e.g. Williams et al., 2002).

Stable isotope analysis can be a solution to this issue. Fossil pollen grains are composed of extremely chemically inert biopolymer of sporopollenin including carbon, oxygen and hydrogen (e.g. Li et al., 2019) and potentially provides isotopic signals which has applications within palaeoclimatology (Loader and Hemming, 2004). In spite of these potentials, pollen isotope analysis had not been used routinely due to the difficulty of high-purity extraction of fossil pollen grains from sediments. In order to solve this problem, in this study, we established a method to extract fossil pollen grains using cell sorter and measured pollen stable isotope ratios. We then tested the method with the varved sediments from Lake Suigetsu, Japan.

Lake Suigetsu (35˚35'N, 135˚53'E, 0 m a.s.l.), Fukui prefecture, central Japan, is one of Mikata Five lakes, which measures 3 km east-west by 3 km north-south and the maximum water depth of ca. 34 m. Lake Suigetsu preserves annually laminated sediments over the last ca.70 kyr with a significant number of event layers. Two long cores (SG93, SG06) have previously been recovered from the centre of the lake (Takemura et al., 1993; Nakagawa et al., 2012) and an exceptionally precise age model has been established for the cores through a combination of over 800 radiocarbon ages and high precision varve counting (Staff et al., 2011; Marshall et al., 2012; Schlolaut et al., 2012; Bronk Ramsey et al., 2012; Schlolaut et al., 2018).

In this study, we extracted pollen fossils from the well-dated SG06 cores using cell sorter. Cell sorter is able to separate specified particles using electrostatic deflection using differences in size, shape, and fluorescence as diagnostic keys. Pollen fossils can be sorted using cell sorter because sporopollenin which constitute fossil pollen grains are naturally auto-fluorescent (Tennant et al., 2013). After pre-treatments with acid, alkali, heavy media, and sieves, pollen-enriched suspension was introduced into cell sorter to make high-purity pollen pellets. In this study, we collected about half a million grains of pollen per sample. After drying and weighing, $\delta^{18}O$ of the pollen pellets were measured using High Temperature Conversion Elemental Analyzer (TC/EA, Thermo Scientific) in the University of Tokyo.

Pollen grains were extracted at >98% purity (based on number of particles) and were composed of multiple pollen species. The percentage ratios of pollen types were distorted after extraction by cell sorter, but the major components as well as their relative dominance stayed similar. We measured $\delta^{18}O$ of more than 40 such highly concentrated pellets of fossil pollen grains. Pollen $\delta^{18}O$ fluctuates in rough synchronism with those of NGRIP and Hulu Cave. However, pollen $\delta^{18}O$ values are inversely correlated with Hulu $\delta^{18}O$ and have much larger amplitude. The isotope fractionation mechanism of pollen $\delta^{18}O$ is not yet fully understood. However, these results indicate that pollen isotopic changes have potential to

become sensitive indicator of past terrestrial climate. Investigating correlation between modern pollen isotope values and instrumentally observed weather/climate, as well as species-dependencies, is the next step towards more robust interpretation of the pollen $\delta^{18}O$ fluctuations.

Keywords: Pollen, flow cytometer, stable isotope, Lake Suigetsu, varve

