Terrestrial paleoclimate since 80 ka recorded in stable and clumped isotopes of two stalagmites obtained from the Pacific side of the Japanese islands

*Shota Amekawa[1], Hirokazu Kato[1], Akihiro Kano[1], Kenji Kashiwagi[2], Taiki Mori[3], Ryoko Senda[3], Chuan-Chou Shen[4]

1. Graduate School of Science, The University of Tokyo, 2. Graduate School of Science and Engineering for Research, University of Toyama, 3. Graduate School of Integrated Sciences for Global Society, Kyushu University, 4. Department of Geosciences, National Taiwan University

Terrestrial paleoclimate during late Quaternary has been broadly reconstructed by oxygen isotope ($\delta^{18}O$) of stalagmites. Previous studies have pointed out that stalagmite $\delta^{18}O$ is largely associated with change in $\delta^{18}O$ of meteoric water due to amount effect and shift of vapor sources, but also can be influenced by temperature change. One of solutions for evaluating the temperature effect is carbonate clumped isotope thermometer. Clumped isotopes are isotopologues in which rare isotopes are doubly or multiply substituted. In case of CO_2 generated from reaction of carbonate and phosphoric acis, the measuring target is $^{13}C^{18}O^{16}O$ (mass of 47). Previous studies have shown that measured abundance of clumped isotopes is slightly more than the stochastic abundance and its excess or "clumping" (Δ_{47}) comes from thermodynamic stability, which allows us to reconstruct temperature during carbonate precipitation only by Δ_{47} of the generated CO_2. In this study, Δ_{47} and stable isotopes are applied to two stalagmites from the Pacific side of the Japanese islands, which should not be affected by vapor from Indian Ocean and Japan Sea.
Two analyzed stalagmites (KA01 and 03) were obtained from Taiki town, Mie prefecture, Japan. 32 U-Th age points determined at National Taiwan University reveal that KA01 was dated from ca. 14 ka to ca. 1 ka and KA03 (Mori et al., 2018) was from ca. 80 ka to ca. 20 ka as well as the Holocene. $\delta^{18}O$ changes of KA01 and KA03 show similar trends with the cave records in south Chinese (e.g. Hulu cave), but the amplitude of the $\delta^{18}O$ changes was reduced in half.
Results of our Δ_{47} values require reconsideration of the previous interpretation for the Chinese stalagmite $\delta^{18}O$, dominant control by $\delta^{18}O$ of meteoric water. A reconstructed temperature at the top of KA01 is consistent with modern temperature at the cave. The whole trend of reconstructed temperature combined with $\delta^{18}O$ of modern rainfall indicates that $\delta^{18}O$ changes of KA01 are mainly controlled by temperature changes instead of rainfall $\delta^{18}O$. Δ_{47} of KA03 yields higher temperature during cool periods of Heinrich events (HE), which apparently contradicts with previous studies. Before and after HEs, the carbon isotopic value increases by 0.5–1 ‰, indicating degassing of ^{13}C-depleted CO_2 from dripwater and carbonate precipitation in the conduit of the host rock because of reduced water supply. Drying during HEs could have made the surface of the stalagmite dry and resulted in apparent contradictory temperature. This study verifies that $\delta^{18}O$ change should be used together with Δ_{47} for robust interpretation of the stalagmite records.

Keywords: clumped isotope, speleothem paleoclimatology

