# Paleotemperature and precipitation history (18.1−4.5 ka) in stalagmite bulk and clumped isotopes from Hiroshima, Japan

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Variation in stalagmite $\delta^{18}O$ is basically controlled by two major factors, temperature and isotopic composition of cave dripwater derived from the local precipitation. It is however not easy to separate relative impacts from these two fundamental controls by conventional oxygen isotope alone.
A possible solution is applying carbonate clumped isotope thermometry that can reconstruct the temperature without information of the isotopic compositions of the environmental water. The principle of the clumped isotope thermometry is based on the temperature-dependency of the abundance anomaly of $^{13}C^{18}O^{16}O$ ($\Delta_{47}$) from acid digestion of carbonate.
In this study, carbonate clumped isotope ($\Delta_{47}$) was measured from 50 layers of Hiro-1 stalagmite from Hiroshima Prefecture by purification line and MAT 253 settled at Kyushu University. The growth interval of the stalagmite is from 18.1 to 4.5 ka and includes two hiatuses in 10.8–7.7 ka and 12.8–11.4 ka.
The $\Delta_{47}$ values of 50 layers in Hiro-1 range from 0.683 to 0.741‰, which correspond to 3.2−23.4 ºC by temperature calibration on the basis of tufa measurements (Kato *et al*., 2019).The temperature range of each time-series is 5.2−12.5 ºC (7.4 ºC in average; 18.0−16.0 ka), 10.4−12.8 ºC (11.9 ºC in average; 15.9−14.5 ka), 3.2−9.4 ºC (6.1 ºC in average; 14.2−12.6 ka), 6.8−12.4ºC (9.2 ºC in average; 11.0−10.7 ka), 7.6−23.4 ºC (15.7 ºC in average; 7.7−4.9 ka) and 3.9−9.7 ºC (8.2 ºC in average; 4.9−4.5 ka).
The $\Delta_{47}$ temperature record from Hiro-1 is broadly consistent with already-known climatic stages. For instance, the temperature recovery from LGM, lowering around Younger-Dryas, increase into Holocene and the peak of warming around Hypsithermal. Temperature difference between LGM (18.0−16.0 ka) and mid-Holocene (7.7−4.9 ka) is 8.3 ºC. Isotopic data in the period of 15.9−14.5 ka, and also at 10.7 ka has the features from the kinetic effect, i.e., high $\delta^{18}O$ values and low $\Delta_{47}$ values comparing to the data of adjacent intervals. These intervals are characteristic in high prior calcite precipitation (PCP) of Hiro-1 stalagmite as suggested by Hori *et al*. (2013) and this shift was likely caused by some disequilibrium effect.
The $\delta^{18}O_{Hiro-1}$ profile can be corrected by subtraction of temperature effect and $\delta^{18}O_{MW}$ which represents isotopic composition of past meteoric water was obtained. The reconstructed $\delta^{18}O_{MW}$ value shows 1−2‰ rising from the last glacial period to Holocene. The shift has probably reflected an increase of summer precipitation by strengthened EASM in Holocene and the lowering of continentality by advance of Seto Island Sea.

Reference

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