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Holocene oxygen isotopic records of Itoigawa stalagmites and climate change

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A stalagmite is a valuable paleoclimatic proxy and it is known that its stable isotopes record temperature, rainfall amount and vegetation changes. Especially in tropical and monsoonal regions the oxygen isotope shows inverse correlation with rainfall amount. Previous studies suggested that oxygen isotopic records from caves in south China reflected the intensity of Asian Summer Monsoon (ASM).

We examined stalagmites (FG01 and FG02) collected from a cave in Itoigawa, Niigata Prefecture. They have transparent appearance and relatively straight growth center. Stable isotope analysis was conducted by means of mass spectrograph (Finnigan Delta-plus) and the age was determined by U-Th isotopic compositions measured using MC-ICP-MS (Finnigan NEPTUNE). The dating results showed that the upper part of FG01 was deposited during Holocene and the lower part of FG01 and FG02 were during the Late Pleistocene (mainly 21-30 ka).

The oxygen isotopic record in FG01 is considered to reflect rainfall amount, meaning that heavier rain has lower oxygen isotopic ratio. This was supported by oxygen isotope of rainwater in Toyama and the rainfall record over the past 90 years in Takada, SW Niigata Prefecture. With the relatively stable value from Hendy Test, it can be considered that the isotopic equilibrium has been maintained between the cave drip-water and precipitated calcite.

Two factors are considered to have affected oxygen isotope of FG01. First is the Asian Winter Monsoon (AWM). The isotopic trend of FG01 is different from that of the stalagmite collected in Dongge Cave, SW China. This is because of the difference in dominant moisture source. Rainfall in Southern China is mainly brought by the ASM, of which intensity is recorded in the stalagmite oxygen isotope. On the other hand, climate in Niigata is largely influenced by the AWM leading heavy snowfall, so the stable isotope of the Itoigawa stalagmites probably reflects its strength. The isotopic profiles of FG01 show an inverse correlation with that of Dongge Cave between 4500 and 1000 year B.P. This suggests that the two monsoons worked inversely with each other during the period. However, the inversed trend was not observed in the older period that includes the Holocene Climate Optimum. Moreover, isotopic value of FG01 tends to decrease during this warm period. This is opposite to the general expectation in the warming climate: AWM and winter snowfall likely decreased and stalagmite oxygen isotope increased. Therefore, the second factor, the Tsusima Warm Current (TWC), may affect the stalagmite oxygen isotope in Fukugahuchi by providing moisture to cold-dry air of AWM. Indeed, the abundance of Dictyocoryne spp, dominant species in TWC, in the Holocene core sediment from offshore of Oki Island is well correlated with the isotopic curve of FG01. This indicates that the intensified inflow of Tsushima Current in early Holocene increased winter rain and snowfall in the Japan Sea side.

Keywords: stalagmite, Holocene, climate change