Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)


APE34-26 Room:103 Time:May 21 14:15-14:30

# Oxygen isotope of stalagmites in Itoigawa, Niigata Prefecture and intensity of East Asian winter Monsoon

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Stalagmite oxygen stable isotopic records from Chinese and Japanese caves have demonstrated the intensity of East Asian summer monsoon (EASM) in late Quaternary. In our study, we analyzed a stalagmite collected from Itoigawa on the Japan Sea side of Japan to reconstruct East Asian winter monsoon (EAWM) intensity during Holocene (from 9.8 ka). Climate of the locality is characteristic in wet winter and nearly 60 percent of the annual precipitation occurs from November to March when EAWM brings moisture from the Japan Sea warmed by the Tsushima Warm Current. Rainwater oxygen isotope values reveal a negative correlation with precipitation amounts at Toyama; indicating the amount effect.The oxygen isotope profile of the stalagmite showed the similar trend to the high-resolution records of eolian fraction from China, and to winter precipitation observed near the cave since 1924, supporting that oxygen isotope record of our stalagmite reflects the EAWM intensity. Comparison of our profile with EASM record from Chinese stalagmite, the inverse correlation was recognized only in early Holocene (9.8-5.3 ka), and apparent positive correlation was in the following interval (5.3-4.5 ka). We suggest that the former was caused by the southward migration of intertropical convergence zone, and the latter was likely due to reduced seasonality in insolation, which could weaken both EASM and EAWM. Late Holocene oxygen isotope profile after a period of mild winter of ˜4.5-3.0 ka exhibits high-amplitude changes that could not be observed in the Chinese stalagmites, and two pulses around 1.0 and 2.5 ka were associated with short-lived intensification of NAWM and/or Tsushima Warm Current.

The average oxygen isotope value in 21-30 ka are higher than that in Holocene by about 1.0 permil. To explain this low oxygen isotope during the ice age, we need to consider decline in oxygen isotope values of Japan Sea surface water, the main source of moisture. Japan Sea was isolated from outer ocean due to fall of sea level during this period, and low density fleshwater from the Russian Far East and the Japanese Islands is considered to have been stratified from high density deep water. Stalagmite record from Itoigawa supports this oceanographic reconstruction and suggests that the low salinity surface water of the Japan Sea was developed at least in 30 ka and accelerated in 23 ka.

Keywords: stalagmite, oxygen isotope, EAWM, Holocene