Meaning of stalagmite oxygen isotopes

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Stalagmite oxygen isotope records have been reported from elsewhere in the world, and explained by intensity of the monsoonal rainfall during Late Quaternary. For example, the records from China where it rains mainly in summer indicate the variability in East Asian summer monsoon (EASM). However, there has been counterstatements that other factors certainly reflect on the stalagmite oxygen isotopes.

Well-dated stalagmites collected from Hiroshima, Gifu and Mie prefectures in Japan appear a similar trend but much smaller amplitude of oxygen isotopic ratio than the Chinese stalagmite. A prominent feature of the 83 kyr record of Mie stalagmite is a long-term trend that follows the change in seawater oxygen isotopes. This is because the seawater is the main moisture source of the meteoric water for the Mie stalagmite. Considering the change in the seawater oxygen isotope, the residual variability can be ascribed to a presumable temperature change in the last 83 kyr. Estimated difference between the mid-Holocene and the last glacial maximum and cooling of Heinrich events were 9ºC and < 3ºC, respectively (Mori et al. 2018). Thus, the intensity of EASM was rather a minor factor for the oxygen isotopes of the Japanese stalagmite.

Stalagmites from Niigata prefecture reveal another example showing importance of the seawater oxygen isotopes. The cave at Itoigawa where moisture from the Japan Sea delivers heavy snow in winter, is unique in an aspect of the stalagmite records. Unusually low oxygen isotopic ratio during the last glacial cannot be explained by lowered temperature neither by intensified East Asian winter monsoon. The most likely factor is the lowered oxygen isotope of the Japan Sea surface water during the last glacial, which has been suggested in the marine isotopic records. Comparison with the Pacific side records, the evaluated amplitude of the lowering was around 3‰.

Control of the monsoonal intensity, i.e. the amount effect is disputable for the Japanese stalagmites, and it should be re-examined for the Chinese records. An understated factor for the oxygen isotopes of the Chinese stalagmite is continentality, i.e. the distance from coast. Because the Chinese coast side of the East China Sea is a shallow shelf, the continentality of the Chinese caves is sensitive to the sea-level change, which amplifies the changes in stalagmite isotopes.

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