Climatic records of a stalagmite for the past 20 ka - a case study in NE Hiroshima Prefecture

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High-resolution paleoclimatological data of the last thousands years are significant to verify climatological models that predict the future climatic change. The data mainly have been collected from annually-layered material, such as ice sheet and reef coral skeletons. However, the problem is that such paleoclimatic observatories are distributed in particular geographic locations. Because the main purpose of the climatic prediction is to avoid the threat to human society, paleoclimatic sources from densely populated temperate-subtropical areas are required to be established to solve the problem of paleo-observatories.

The most potential research materials are stalactites and tufas that are developed in caves and springs in limestone area. They have advantages for analyzing, in terms of having visible annual lamination providing a precise time scale, as reef corals do. They are ubiquitous because carbonate rocks (limestone or dolostone) occupy more than 10% of the global land surface. Previous studies have revealed that the oxygen isotopic and trace elemental compositions of speleothems (stalagmites) and tufas record water temperature and amount of rainfall, and thus the methodology is currently developing. Paleoclimatology using stalagmites has been mainly conducted in China and Europe, but seldom demonstrated in Japan.

Many speleothem-bearing caves are distributed in the Carboniferous-Permian limestone areas in Chugoku province. One example is Maboroshi Limestone Cave in Jinseki-kogen Cho (NE Hiroshima Prefecture). The cave was first found in 1929, but left unexplored for a while until the rediscovery in 1992. Recent drainage of the cave water enabled to expose a 740-m-long passage that is the longest explorable cave in Hiroshima Prefecture.

The specimen of this study is a 13-cm-long stalagmite that was exposed by the water drainage. U/Th dating of this pure calcitic stalagmite shows that the specimen started deposition about 20 ka. The stalagmite is divided into the white-colored upper and light grey-colored lower parts by a clear discontinuous surface at the 5.5cm horizon. Ages below and above the boundary are about 11 and 7.5 ka, respectively, and the boundary might have been formed by a climatic change associated with the Younger Dryas Event. Both oxygen and carbon isotopic values increase around the boundary. These increases indicate water evaporation on the stalagmite surface likely due to decreasing dropping water and dry climate in NE Hiroshima Prefecture.