Record of thickness and fluorescence intensity of annual layers in a stalagmite of Shiraho Saonetabaru Cave, Ishigaki Island

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Various paleoenvironmental proxies, such as fluctuations in oxygen isotope ratio and Mg/Ca, have been extracted from stalagmites using geochemical analyses. In these studies, fluorescent annual layers observed in stalagmites are often used as a proxy for time. Although the thickness of these layers has been interpreted as a proxy for precipitation in some paleoenvironmental studies (e.g. Burns et al., 2002), some items, particularly concerning the formation process of the annual layers, remain unclarified. Furthermore, implications regarding the fluorescence intensity of annual layers have not yet been examined. In this study, a lamina analyzing method, developed by Sasaki et al. (2015), was applied to a stalagmite obtained from the Shiraho Saonetabaru Cave, Ishigaki Island. Accumulative changes in thickness and fluorescence intensity of annual layers are examined and these time series are then used to clarify the paleoenvironment.

The study cave is located near New Ishigaki Airport on the east coast of Ishigaki Island. In this area, some caves, including the Shiraho Saonetabaru Cave, developed in the Ryukyu Limestone Formation, which extends from west to east. Numerous fossils, including human and animal bones, were discovered from cave deposits of the Shiraho Saonetabaru Cave (e.g. Nakagawa et al., 2010).

Using the lamina analyzing method, annual layers representing approximately 600 years (2015 - 1415) have been identified. The average thickness of annual layers in the stalagmite is about 0.35 mm, slightly thicker than those of caves on Honshu Island. In time series of annual layer thickness, remarkable thin layers are observed during 1540-1580 and 1790-1810. Commonly, stalagmite growth rate is influenced by dripping water intervals, cave air temperature, and supersaturation degrees with respect to calcite in dripping waters depending on the partial pressure of CO_2 in the cave air. The partial pressure of CO_2 is predominantly affected by the degree of cave air circulation, because cave temperature is almost constant throughout the year. Therefore, significant decreases in layer thickness can be related to periods of decreasing intervals of rain water precipitation or cave air circulation. Relative fluorescence intensity decreases noticeably during 1480-1500, 1530-1540, 1880-1890, and 1960-1990. The fluorescence intensity is thought to be mainly influenced by the growth rate of annual layers and the flux of fulvic acid in dripping waters. Namely, fluorescence intensity is weaker when the growth rate of annual layers is higher and/or the flux of fulvic acid in dripping water is lower. However, both annual layer thickness and fluorescence intensity decreased during the period 1480-1500, suggesting that the flux of fulvic acid in that period was significantly low. We discuss the potential for paleoenvironmental proxies suggested by these results.

References

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Keywords: annual layer, stalagmite, time series analysis

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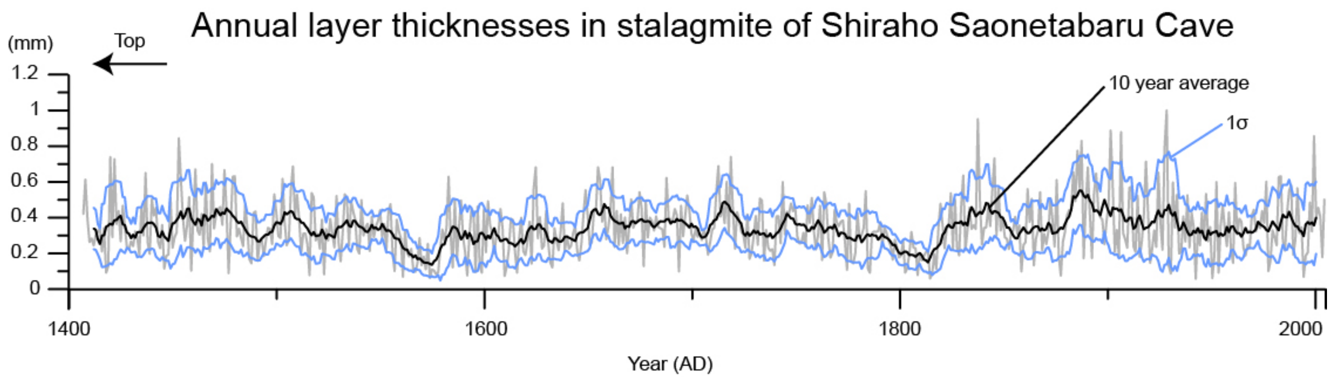

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