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Comparison of Stable Isotope Time Series of Stalagmite and Meteorological Data from East Java, Indonesia

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Speleothems continuously grow up and can be accurately dated by U-Th disequilibrium. Because of these characters, in recent years, speleothems attract attention of scientist as geological materials from which a paleoclimate is reconstructed.

Climatic phenomena of the Southeast Asia equatorial region affect climates all over the world (e.g. El Nino-Southern Oscillation). However, there are only a few paleoclimatological studies using speleothems in the region. These preceding studies have an agreement that precipitation is the factor of stable isotopic variations on stalagmites. However, they disagree about stable isotope fractionation and process controlling d18O and d13C values of stalagmites. Each stalagmite may have individual stable isotope fractionation and individual process controlling d18O and d13C values of the stalagmite.

In this study, firstly, we constructed a high-resolution age model by comparing the U-Th disequilibrium age with the counts of the bandings in the stalagmite BRI09a, which was collected in Bribin Cave, East Java, Indonesia. Secondly, we checked for equilibrium vs. kinetic fractionation on the stalagmite BRI10a, which was collected in Bribin Cave, East Java, Indonesia. Thirdly, we compared d18O and d13C values of the stalagmite BRI10a with instrumental precipitation data on Yogyakarta, Indonesia, in order to judge whether its d18O and d13C variation are proxies of paleo-precipitation.

We constructed a high-resolution age model by comparing the U-Th disequilibrium age with the counts of the bandings in the stalagmite BRI09a. U-Th disequilibrium age of the stalagmite BRI09a was 1038+/-52 yrs. The result of bands counting of the stalagmite BRI09a was 879+/-10 layers at the top of the dated section and 1018+/-38 layers at the base of the dated section. In the thin section of the stalagmite BRI09a, We did not observe hiatus and, when we collected the stalagmite BRI09a, it was growing. These results suggest that the growth layers of BRI09a are dominantly annual. However, the top edge of BRI09a in thin section may be chipped, because of difference between U-Th disequilibrium age and the result of bands counting.

For oxygen and carbon stable isotope time series determinations of the stalagmite BRI10a, in which we constructed a high-resolution age model (Fukunaga, 2010, graduation thesis), 70 samples collected along the growth axis on the stalagmite BRI10a was analyzed using a mass spectrometer. d18O and d13C variations of the stalagmite BRI10a have the good correlation ($R=0.75$, $p<0.01$). d18O and d13C values of the stalagmite BRI10a are higher than an estimated d18O and d13C values from the drip water on the supposition that equilibrium fractionation occurred on the stalagmite BRI10a. These results suggest kinetic fractionation with CO2 degassing.

d18O and d13C variations of the stalagmite BRI10a show the good correlation with precipitation in rainy season on Yogyakarta ($R=-0.59$, $p<0.01$, $R=-0.44$, $p<0.01$). Oxygen and carbon stable isotope time series of the stalagmite BRI10 were proxies of local precipitation. However, SOI and NINO-4, which are El Nino-Southern Oscillation index, do not show the good correlation with d18O and d13C variations of the stalagmite BRI10a because of the difference of the season in which precipitation show correlation with them. Accordingly, oxygen and carbon stable isotope time series of the stalagmite BRI10 were not good proxies of SOI and NINO-4.

We constructed a high-resolution age model in the stalagmite BRI09a and showed that d18O and d13C variations of the stalagmite BRI10a are useful proxies of local precipitation. We will be able to compare between d18O and d13C variations of two stalagmites, BRI09a and BRI10a which were collected from the same cave. After this study, a comparison between two stalagmites, BRI09a and BRI10a will advance our knowledge of stable isotope variations of stalagmites and relation between stable isotope variations of stalagmites and precipitation.