Precipitation variation for the last 140 years recorded in stable isotope ratios from Indonesian stalagmite

Y. WATANABE[1]*, H. MATSUOKA[1], S. SAKAI[2],
M. YAMADA[3], S. OHSAWA[3], M. KIGUCHI[4],
T. SATOMURA[1], S. NAKAI[5], B. BRAHAMANTYO[6],
K.A. MARYUNANI[6], T. TAGAMI[1], K. TAKEMURA[3]
AND S. YODEN[1]

[1]Division of Earth and Planetary Sciences, Graduate School of Science, Kyoto University, Kyoto 606-8502, Japan (*correspondence: yumiko@kueps.kyoto-u.ac.jp)
[2]Japan Agency for Marine-Earth Science and Technology, 2-15, Natsushima-cho, Yokosuka, Kanagawa 237-0061, Japan
[3]Institute of Geothermal Sciences, Kyoto Univ., Beppu 874-0903, Japan
[4]Institute of Industrial Science, Univ. of Tokyo, 4-6-1, Komaba, Meguro-ku, Tokyo 153-8505, Japan
[5]Earthquake Research Institute, Univ. of Tokyo, 1-1-1, Yayoi, Bunkyo-ku, Tokyo 113-0032, Japan
[6]Department of Geology, Faculty of Earth Sciences and Mineral Technology, Institut Teknologi Bandung, Jl. Ganesa 10, Bandung 40132, Indonesia

It is critical that we reconstruct climate variability over the last several centuries because the tropics appear to play an important role in global climate (Garreaud & Battisti, 1999; Linsley *et al.*, 2000; Evans *et al.*, 2001). In order to reconstruct ancient precipitation for the topics, we performed the systematic comparison between temporal variation in precipitation and those in stable isotopic ratios (i.e., δ^{18}O and δ^{13}C) of a stalagimite, which is collected in Ciawitali Cave, West Java, Indonesia, and also reconstructed precipitation variation for the last 140 years based on isotopic data.

First, we analyzed a stalagmite collected in Ciawitali Cave, and found that the number of growth bands is coincident with the uranium series disequilibrium age within the error. Next, annual variations of isotopic data were compared with that of precipitation since 1950, showing significant, negative correlations. This result suggests that stable isotopic ratios in stalagmites are applicable as effective proxies for ancient precipitation in the study area (Watanabe *et al.*, submitted). Furthermore, we reconstructed precipitation variation for the last 140 years based on stable isotopic ratios of the stalagmite. In this presentation, we will discuss past precipitation variation and the controlling factor.

Why anomalous S isotope signatures disappeared at ~2.4 Ga ago?

Y. WATABABE* AND H. OHMOTO

NASA Astrobiology Institute and Dept. of Geosciences, Penn State University, University Park, PA 16802, USA
(*correspondence: yumiko@geosc.psu.edu)
(ohmoto@geosc.psu.edu)

There exist at least two different theories for the cause of anomalously fractionated sulfur isotopes (AFSI) in pre-2.4 Ga sedimentary rocks and the reason why large AFSI apparently disappeared at ~2.4 Ga ago. The first theory, widely accepted by geoscientists, postulates that AFSI were produced by UV photolysis of volcanic SO_2 in an anoxic atmosphere and that its disappearance was caused by a dramatic rise in atmospheric pO_2 at ~2.4 Ga ago. The second theory, proposed recently by us (Ohmoto *et al.*, 2006; Lasage *et al.*, 2008; Watanabe *et al.*, in review), suggests that AFSI were produced by chemisorption reactions involving solid organic matter and S-bearing species at elevated temperatures, especially during thermochemical sulfate reduction (TSR) involving reactive organic matter (e.g., immature kerogen that still contains abundant amino acid functional groups) and sulfate-rich solutions at T > ~70°C. Due to the fact that neither bacterial sulfate reduction (BSR) nor bacterial sulfur disproportionation produce AFSI, we propose that geologically favorable conditions for TSR, but not for the bacterial processes (e.g., BSR), disappeared at ~2.4 Ga. The conditions are: (I) a nearly-closed marine basin developed in a submarine rift system where a large amount of organic matter accumulated; (II) increased seawater sulphate content due to evaporation; and (III) basin water temperature increase to T >~70°C by large-scale submarine hydrothermal activity.

The disappearance of favorable conditions for TSR near the seawater/sediment interface at ~2.4 Ga may have been caused by the combined effects of: (a) a decrease in heat flux from the mantle; (b) a decrease in large-scale submarine volcanism and hydrothermal activity; (c) a decrease in the formation of submarine rift basins; (d) a decrease in the global ocean temperature; and (e) a decrease in the proportion of reactive organic matter (e.g., simple amino acids) due to the evolution of more complex organisms.

We will present various lines of evidence from the geological (e.g., stratigraphic relationships with ore deposits), geochemical (e.g., multiple sulfur isotope ratios of sulfides, carbon isotope ratios of carbonate, major and trace element contents) and biological (e.g., nature of kerogens) record in Archean rocks to dispute the first theory and support the second theory for the disappearance of AFSI signatures at ~2.4 Ga ago.