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Evidence for meteoric diagenesis during Gaskiers glaciation recorded in the Ediacaran carbonate in South China

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Carbon isotope ratios fluctuate globally in association with environmental changes in atmosphere and ocean system. The major carbon isotopic excursions happened in Earth history would be linked to biological evolutions and extinctions and these causes have been investigated actively (e.g. Grotzinger et al., 2011). The Ediacaran period when multicellular animals dramatically evolved also have two major excursions reflected from the Gaskiers glaciation (Sawaki et al., 2010) and the Shuram event (Fike et al., 2006). The Ediacaran Yangtze block in South China is unmetamorphosed sedimentary rocks, and high-resolution carbonate carbon isotopic data have been extensively reported from this block (e.g. Jiang et al., 2011). Although these data could have reflected characteristic oceanic structure and influenced by oceanic oxidation in Ediacaran, those causes have been not fully understood. This study investigated the Yangjiaping section that records large fluctuation of bulk carbonate carbon isotope (e.g. Kunimitsu et al., 2011) and analyzed the cause of fluctuation by measuring the bulk strontium isotope ratios and the carbon-oxygen isotopes of cement components.

Yangjiaping section is about 470 m thick and divided into the Nantuo Formation, the Doushantuo Formation and the Dengying Formation in ascending order. The Nantuo Formation is extensively distributed as post-Marinoan diamictite in the Ediacaran Yangtze platform. The Doushantuo Formation consists of carbonate, black shale, chert and phosphate and the Dengying Formation consists of carbonate and chert. Kunimitsu et al. (2011) subdivided the Doushantuo Formation into Unit 1, Unit 2 and Unit 3 in ascending order, based on the trends of carbonate carbon isotope. The large fluctuation of carbon isotope occurs in Unit 3. Coarse-grained carbonate in upper Unit 2, Unit 3, and the Dengying Formation are available for analyzing isotopic composition of the cement components. Unit 2, lower part of Unit 3 and the Dengying Formation exhibit only minor difference between the bulk and the cement parts in carbon and oxygen isotopes. While, middle to upper parts of Unit 3 record significantly lower isotopic composition of the cements, which are lower than the bulk values by ˜25 permil for carbon and by ˜7 permil for oxygen. Additionally, the strontium isotopic ratios in Yangjiaping section ranging from 0.7079 to 0.7105 indicate an increasing trend from Unit 3 to upward.

Extremely low carbon isotope of the cement parts is responsible for the large fluctuation of the bulk values in Unit 3. It was formed by secondary addition of cement in meteoric diagenetic environments. Upper part of Unit 2 and Unit 3 consist of very shallow water lithofacies implying that the platform was easily exposed during sea level fall. Oxygen-rich meteoric diagenetic water induced remineralization of organic matter that occurred in pore spaces, and formed low carbon isotope of the diagenetic water. Additionally, increase of strontium isotope in Unit 3 reflected an enhanced continental fluxes that could be attributed to the promotion of continental weathering at the Gaskiers glaciation (ca. 580 Ma). The line of evidence suggests that very shallow part of the Yangtze platform was exposed above sea level during the Gaskiers glaciation.

Keywords: South China, Ediacaran, meteoric diagenesis, the Gaskiers glaciation, carbon isotope