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Composition of carbonate chemical species in the Phanerozoic ocean estimated from fossil cyanobacteria

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The major ionic composition of Phanerozoic ocean has been mainly estimated from evaporates. On the other hand, there have been difficulties for estimating the carbonate chemical species due to the lack of appropriate indicator, despite that it is essential for reconstructing e.g. global carbon cycle. Although some previous studies attempted to estimate carbonate composition by applying assumptions such as constant alkalinity throughout the Phanerozoic (Royer et al. 2004, GSA Today 14, 4-10; Riding & Liang 2005, Palaeo3, 219, 101-115; Locklair & Lerman 2005, Cham. Geol. 217, 113-126), their results were significantly varied by applied assumptions.

The present study focused on fossil cyanobacteria as a potential indicator for the composition of carbonate species in the Phanerozoic ocean. Cyanobacteria are calcified by photosynthesis-induced $CaCO_3$ precipitation, and its degree is considered to reflect the ambient carbonate composition. Therefore, its fossil record is expected be a good indicator for ancient ocean carbonate composition.

For this purpose, it is necessary to clarify the chemical parameter reflecting the degree of cyanobacterial calcification. The previous studies based on simulation suggested that the parameter would be "$CaCO_3$ saturation state increased by photosynthesis" (Arp et al. 2001, Science 292, 1701-1704; Aloisi 2008, GCA 72, 6037-6060). However, actual measurements using microelectrodes revealed that the parameter should be "$CaCO_3$ saturation state achieved by photosynthesis" (Shiraishi 2012, GCA 77, 157-174).

Based on this finding, the composition of carbonate chemical species in the Phanerozoic ocean was calculated from fossil record of calcified cyanobacteria. Estimated range and trend are similar to those of previous studies, but exhibited more frequent changes. In a future study, it is necessary to understand the relationship between $CaCO_3$ saturation state achieved by photosynthesis and calcification amount, in order to increase the reliability of estimation.