南中国陡山沱累層エディアカラ紀リン酸塩微化石の化学分析：化学古生物学に向けて
Chemical mapping of the Ediacaran phosphatized microfossils from Doushantuo Formation, South China and extant organisms of animals and algae: Toward establishment of chemical paleontology

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The Ediacaran is a period when the living biota was born. Thus, its fossil records are important, especially phosphatized ones, that are elaborately preserved. Various kinds of the Ediacaran phosphatized microfossils have been found from the Doushantuo Formation, South China. The Doushantuo Formation is comprised of alternative layers of phosphorite and dolomite, and was deposited just after the Marinoan glaciation in the Cryogenian. Most of the Doushantuo spheroidal microfossils are several hundreds μm across, and some are divided into 2 to 100 cells, and others have chorion on which spiny ornaments are distributed. Some specimens have both. It was considered that the Doushantuo microfossils have affinity with dormant metazoan embryos or algae based on those shapes, but their phylogenetic position is still controversial.
Previous studies focused only on morphological structures of the Doushantuo microfossils by microscopic, SEM and μCT observations, and inferred the phylogenetic position based on morphological comparison between the microfossils and living organisms. For example, Chen et al. (2009) pointed out that some of the microfossils resemble living bilaterians at cleavage stages when they are divided into some macromeres and micromeres, and postulated that the Doushantuo microfossils were derived from bilaterian embryos. However, generally speaking, the shapes of fossils are easily modified through diagenesis or taphonomy so that it is difficult to obtain robust evidence only from the physical structures. On the other hand, combination of chemical analyses and morphological observations of the fossils provides a powerful method to more quantitatively obtain the phylogenetic position of Doushantuo microfossils. The geochemical identification of fossils is named as chemical paleontology hereafter. A purpose of this work is finding key elements to identify the origin of Doushantuo microfossils toward establishment of the chemical paleontology.
We performed chemical mapping of the Doushantuo microfossils and extant organisms on thin sections with LA-ICP-MS at the Gakushuin University and The University of Tokyo. The extant organisms comprise multicellular rhodophyta and some species of cnidarian embryos. The latters, especially, are selected at various developmental stages because it is considered that the morphological variations of the Doushantuo microfossils are partially due to the difference in their developmental stages. The living organisms were cast into methacrylate-resin disks and cut into some thin sections.
We obtained chemical mapping of 10 bioessential elements, which comprise three major elements (Mg, P and Ca) and seven trace elements (B, Al, Fe, Cu, Zn, Sr, Ba and Pb), on three developmental stages of the coral embryos and three embryo-like microfossils from the Doushantuo Formation. Identical elemental distribution and concentration between the living organisms and Doushantuo

microfossils were not obtained yet, but some new findings have been obtained.
First, some elements (Sr, Ba, and Pb) are concentrated on their outer membranes of the living coral embryos, and the distribution patterns become homogenized with the developmental stages. Second, the elemental distribution patterns in brown phosphate parts vary among the microfossil specimens whereas the patterns in gray phosphate parts are almost similar among the specimens. The compositional variation is possibly due to vestiges of the precursors because the brown phosphate parts contain more organic matter so that they possibly preserve more primitive elemental distribution than the gray phosphate parts.
The good correlation between elemental distributions and tissues provides a potential for chemical paleontology. But, further analyses of more microfossils on brown phosphates with much organic matter as well as various extant organisms should be necessary to find the key elements to identify the Ediacaran microfossils.

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