

Geochemical study on microfossils and coexisting minerals from 1.9 billion years Gunflint Formation, Canada

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In this study, we revealed new geochemical differences in microfossils corresponding to the different sedimentary environments from the Gunflint Formation. The Gunflint Formation consists of chert, carbonate, sand, and iron formation deposited ca. 1.9 billion years ago (Ga). It is also known with occurrences of various types of well-preserved forms of fossilized micrometer scale organisms (=microfossils) [1]. After the Great Oxidation Event, which occurred ca. 2.4 Ga, the atmospheric oxygen concentration rose rapidly, changing the oceanic elemental circulation drastically [2]. Therefore, it is conceivable that anaerobic organisms still have existed locally while aerobic organisms dominated majorly of the ecosystems. Such ecosystem should relate with the sedimentary environment in the Gunflint ocean. The most of microfossils from the Gunflint Formation have been interpreted as oxygenic photosynthetic bacteria (cyanobacteria) and/or iron-oxidizing bacteria based on their morphological similarity with the living bacteria. Recently, in addition to morphological differences, carbon isotope and light elemental distributions of individual microfossils were measured to reveal their metabolisms and species [3,4]. Such researches are revealing the microfossil species more clearly, however, they are still not enough to specify the species of them and relationship between the microbial activity and sedimentary environments such as ocean chemistry and redox state.

In this study, we analyzed the chemical composition of microfossils based on their morphology and observed coexisting minerals. The goal of this study is to verify the relationship between the sedimentary environment and the microbial ecosystem in the Gunflint ocean. We performed geological survey at Ontario, Canada; Schreiber beach, Mink Mountain, and White Fish River area. Stromatolites samples were collected from these area together with surrounding sedimentary rocks. These area locate in the east and west ends of the Gunflint Formation with obviously different lithofacies. Stromatolites exposed at Schreiber beach area were embedded in the black chert. They have a circular structure up to 1 meter scale. Microfossils in this stromatolite had well-preserved carbonaceous cell wall. They were divided into at least six types based on their morphology. Four out of six types were majority in this area; thick-walled *Huroniospora*, thin-walled *Huroniospora*, cell-type *Gunflintia*, and sheath-type *Gunflintia*. The detailed observation of thick-walled *Huroniospora* and cell-type *Gunflintia* were carried out using a Scanning Electron Microscopy and Energy Dispersive Spectrometry. As a result, these microfossils included fine iron minerals intracellularly. Such characteristic is inconsistent with the typical modern iron-oxidizing bacteria accumulating iron minerals on the surface of their bodies. This finding is expected to provide the new interpretation of microbial ecosystem in the Gunflint Formation.

In contrast, stromatolites from the Mink Mountain and White Fish River area were embedded in hematite-rich jasper layer and have finger-like structures not likely to the Schreiber Beach area. Microfossils in this stromatolite were hematitized, and little organic matter is remained. Only two types of microfossils of *Huroniospora* and *Gunflintia* were found here.

We revealed that not only types of microfossils and the occurrences of coexisting minerals, but also the shape and size of stromatolites differed due to sedimentary conditions. These results would reflect differences in microbial ecosystem and elemental cycles in the depositional environments in the Gunflint

ocean.

[1]Tyler and Barghoorn, 1954, *Science*, [2]Holland, 2006, *Phil. Trans. R. Soc. B.*, [3]Wacey et al., 2013, *PNAS.*, [4]Williford et al., 2013, *Geochim. Cosmochim. Acta*

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