New evidence and significance of biogenic Mn oxides in 12Ma carbonaceous sedimentary rocks in the Hokuroku district, Akita: constrain from fossil DNA and magnetic field

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Mn oxides are commonly found on the modern seafloor or around the terrestrial hot springs. Role of Mn-oxidizing bacteria has been discussed by previous investigators to promote precipitation of Mn oxides. However, it has been challenging to distinguish biogenic Mn oxides from abiogenic Mn oxides, because of their mineralogical similarity. It will become possible to identify biogenic Mn oxides, by accumulating unique characteristics of biogenic Mn oxides and clarifying differences with abiogenic Mn oxides. Such characteristics of biogenic Mn oxides will be used as a tool, i.e., mineral bio-marker, to find the evidence of Mn-oxidizing bacteria in the ancient rocks, in particular from Archean.
Stratified and disseminated Mn ore deposits are present in the Hokuroku district, Akita prefecture. Significant amounts of Mn were mobilized in host rocks by ca. 12 Ma submarine hydrothermal activities and then Mn oxides were precipitated on or beneath the seafloor. One type of ore has a colloform structure, which resembles the stromatolite, with Mn oxides (todorokite) and reduced carbon.
Fossil DNA extraction was successful from this Mn ore, excluding the possibility of later contamination. This is the first success of DNA extraction, specific for Mn-oxidizing bacteria (Acinetobacter and Pseudomonas), in geological samples as old as 12 Ma. As a result, two kinds of Mn-oxidizing bacteria, which are commonly found in the surface of modern ferromanganese crusts, are identified. In addition, magnetic field was detected on Mn oxides in colloform structure by magnetic field microscopy (MFM). Magnetic field is generated when Mn oxide has high cation vacancies and abundance of Mn^{4+}, which are common in biogenic Mn oxides.
The above comprehensive analyses on the same Mn oxides indicate that Mn oxides in colloform structure are biogenic in origin. This study will be utilized in the search for ancient biogenic Mn oxides and give a hint to understand the ancient Mn cycles.

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