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A model of appearance of iron-based microbial ecosystem in deep-sea hydrothermal system and its experimental evaluation

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It is hypothesized in the project TAIGA that there are unseen aquifers below the seafloor, called sub-seafloor TAIGAs (great rivers) (Urabe et al., 2009). Chemosynthetic ecosystems supported by chemical energy supplied from Earth may be present in the sub-seafloor TAIGAs. The sub-seafloor TAIGAs are classified into four representatives based on the energy sources, i.e., hydrogen, sulfur, methane and iron. Iron is abundant in oceanic crusts. Iron-based ecosystems are thought to be present in sub-seafloor aquifers (Bach and Edwards, 2003), i.e., iron-based TAIGA. The distribution of the iron-based TAIGA is much wider than that of the others. The iron-based TAIGA could significantly affect the energy flux and elemental cycling on the global ocean. However, our knowledge of the iron-based TAIGA is extremely limited.

We examined geochemical and microbiological characteristics of hydrothermal fluids and deposits in the Southern Mariana Trough, a back-arc basin hydrothermal field. We showed that Zetaproteobacteria including iron-oxidizers are predominant in crustal fluids up to 30oC (Kato et al., 2009). Thermodynamic calculation with the chemical compositions of the collected fluids indicated that the bioavailable energy yield by iron oxidation is higher than those by hydrogen, methane or sulfur oxidation. Based on the microbiological, geochemical and thermodynamic analyses, for the first time, we proposed a model of appearance of iron-based microbial ecosystem in deep-sea hydrothermal system (Kato et al., 2012).

Furthermore, we developed a novel flow-type hydrothermal apparatus to simulate the iron-based TAIGA in laboratory. We were successful to monitor iron dissolution of basalts in high-temperature and high-pressure conditions (Kato et al., in press). Further modifications and experiments are needed to simulate the iron-based TAIGA.

Keywords: Sub-seafloor TAIGA, Iron-oxidizing bacteria, Microbial ecosystem, Hydrothermal system, Flow-type hydrothermal apparatus