Microorganisms involved in the formation of distinctive iron oxide in deep-sea environments of Earth and even in extraterrestrial bodies

*Hiroko Makita[1,2], Sakiko Kikuchi[1], Satoshi Mitsunobu[3], Emiko Tanaka[2,1], Yoshihiro Takaki[1], Toshiro Yamanaka[4], Tomohiro Toki[5], Takuroh Noguchi[6], Kentaro Nakamura[7], Mariko Abe[1], Miho Hirai[1], Masahiro Yamamoto[1], Katsuyuki Uematsu[8], Junichi Miyazaki[1], Takuro Nunoura[1], Yoshio Takahashi[7], Ken Takai[1]

1. Japan Agency for Marine-Earth Science and Technology, 2. Kanagawa Institute of Technology, 3. Ehime University, 4. Tokyo University of Marine Science and Technology, 5. University of the Ryukyus, 6. Kochi University, 7. The University of Tokyo, 8. Marine Works Japan Ltd

It has been suggested that iron is one of the most important energy sources for photosynthesis-independent microbial ecosystems in the ocean crust of Earth. Iron-metabolizing chemolithoautotrophs play a key role as primary producers in anoxic-oxic interface environments, but little is known about their distribution and diversity, and ecological roles, particularly iron-oxidizers. Recently, many iron-dominated flocculent sediments have been discovered at the deep-sea hydrothermal fields in the world. These sites are excellent place for studying iron-utilizing microbial communities and their mineralization of Fe-(oxy)hydroxides associated with deep-sea hydrothermal activities. Indeed, it is still unclear how such microbial populations are involved in iron-dominated flocculent deposit formation. In this study, we analysed iron-dominated sediments from various deep-sea hydrothermal environments in the Western pacific by using culture-independent molecular techniques and X-ray mineralogical analyses. The SEM-EDS analysis and X-ray absorption fine structure (XAFS) analysis reveal chemical and mineralogical signatures of biogenic Fe-(oxy)hydroxides species as well as the potential contribution of iron-oxidizing bacteria to the *in situ* production. These key findings provide important insights into the mechanisms of both geomicrobiological iron cycling and formation of iron-dominated sediments in deep-sea hydrothermal fields. In addition, the formation and preservation mechanisms of biological produced iron-dominated sediments point to the possible microbial metabolisms and functions in the fossil records of iron oxide deposits such as banded iron formation (BIF) in the past Earth. Now, many peoples know that iron-oxide mineral deposits are also present in extraterrestrial bodies of our solar system such as Mars and Jupiter’s moon Europa. The formation mechanisms of these extraterrestrial iron-dominating mineral deposits are highly unknown. However, if in situ observations and sample-return-based analyses in future astrobiological exploration of these extraterrestrial red-orange deposits will find certain specific iron oxide structures such as helical, twisted and stringing shapes associated with organic materials, the specific iron oxide structures will be significant bio-markers and will be useful for further detail exploration planning and strategy.