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Environments for hydrogen generation during serpentinization-An example from natural serpentinites in Mineoka belt-

Iori Kurosaki[1*], Ikuo Katayama[1], Ken-ichi Hirauchi[1]

[1]Hiroshima University

Micro-organisms survive in the sea floor using chemical reactions, including autotroph (methanogen). Hydrogen production is a key for this microbial activity, and a remarkable submarine ecosystem is reported in the serpentinite-hosted hydrothermal fields (e.g., Takai 2004; Kelley et al. 2005). Serpentinites are formed by reaction between hydrothermal fluids and mantle rocks, and released hydrogen and methane in the extremely reduced conditions. The primitive life is considered to create within such extreme conditions in the sea floor. In this study, we analyzed natural example of hydrogen production during serpentinization and discuss environments for these micro-organisms in the extreme conditions in the Earth.

Ultramafic rocks react with H2O to discharge H2 during serpentinization, and produce magnetite (Fe3O4). Magnetite is formed by two-stage serpentinization (Bach et al., 2006). Based on previous studies, there are two quite different models in the second stage reaction forming magnetite,in terms of silica activity: (1) Fe3Si2O5(OH)4 = Fe3O4 + 2SiO2 + H2O + H2 (Frost et al., 2007). (2) 9Fe(OH)2 + 4SiO2 = 2Fe3Si2O5(OH)4 + Fe3O4 + 4H2O + H2 (Bach et al., 2006).
We investigate serpentinites in Mineoka belt located in the Chiba prefecture of Japan. As a result of EPMA analysis, we found that the model (1) is plausible. It seems that silica activity is a key for the magnetite (hydrogen) forming reaction, because no magnetite is observed near opx, where silica activity is significantly high during serpentinization. We also investigate another serpentinite in Mineoka belt, in which sample is completely serpentinized. This serpentinite has a nearly free of magnetite, suggesting that consist with the model (1) for the magnetite forming system.
In addition, we detected hydrogen and methane as serpentine filled inclusion in olivine by Laser Raman spectroscopy, which is a direct evidence for hydrogen generation during serpentinization in these natural systems.

Keywords: serpentinite, hydrogen, magnetite, micro-organism, olivine, silica activity