Serpentinization of peridotite in the Central Indian Ridge: implications for H_2 production process during serpentinization

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The submarine hydrothermal system has been considered as a birthplace of life since the discovery of hydrothermal vent field at the Galapagos spreading center in 1977. Takai et al. (2004) discovered hyperthermophilic subsurface lithoautotrophic microbial ecosystems (HyperSLiMEs) dominated by methanogens as a primary producer from the Kairei field near the Rodriguez triple junction in the Indian Ocean. Takai et al., (2006) proposed a hypothesis that the HyperSLiME is the Last Universal Common Ancestor (LUCA) based on theoretical constraints. Ultra-H^3 linkage (Ultramafic rocks, Hydrothermal activity, Hydrogen and HyperSLiME: Ultra-H^3) hypothesis was also proposed based on hydrothermal experiments that focused on hydrogen generation with serpentinization of peridotite. The existence of Ultra-H^3 linkage is confirmed at present ocean sea floor ay the Kairei and Rainbow fields. In this study, we propose a new hydrogen production process on the basis of the texture and mineral composition of serpentinized peridotites collected from Ocean Core Complex (OCC) near the Rodriguez triple junction.

25 degree S OCC is located along the Indian Central Ridge, near the Rodriguez triple junction that is formed by three ridges (the Southeast Indian Ridge, Central Indian Ridge, and Southwest Indian Ridge) and located where three plate boundaries (Africa Plate, Indo-Australian Plate, Antarctic Plate) meet (Georgen and Lin, 2002). The half-spreading rates of those plates are 3.0, 2.7, and 0.65 cm/yr, respectively (Gamo et al., 1996).

The sampled peridotites were strongly serpentinized, but some relict minerals are preserved. The alteration minerals are mainly serpentine and magnetite, while the relict minerals are orthopyroxene (opx), olivine, clinopyroxene, and spinel. Serpentine minerals show two types of texture; the one is bustite and the other is mesh texture. Magnetite is found in rim of mesh texture, and is not present in bustite and in inner part of mesh texture. The relict olivine and orthopyroxene are rarely preserved in the center of mesh texture and/or bustite. On the basis of their composition, serpentine minerals were classified into two groups; the one is the low-$Mg^{\#}{}_{-}$(90-94) type, which has comparable $Mg^{\#}$ with the relict minerals, and the other is the high-$Mg^{\#}{}_{-}$(96-98) type, which shows distinctly higher-$Mg^{\#}$ than the relict minerals. The low-$Mg^{\#}$ type occurs around the relicts and in bustite, while the high-$Mg^{\#}$ type composed the most part of the mesh texture. Based on laser Raman analysis, all serpentine minerals were identified as lizardite. FE-EPMA analysis revealed that the samples contain neither brucite nor talc. These detailed mineralogical investigations provide a new serpentinization process that include at least two stages; the one is H_2-generation associated with the formation of magnetite in the serpentine and the other is serpentinization without magnetite and H_2-generation.