

## The relative rate of hydrogen production between olivine-H<sub>2</sub>O and olivine-orthopyroxene-H<sub>2</sub>O systems

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Serpentinization of mantle peridotite is accompanied by oxidation of Fe(II), which produce hydrogen to sustain microbial activity within the oceanic lithosphere [1]. Mantle peridotite contains several minerals such as olivine and orthopyroxene, and thus the reaction pathways and their rates heavily depend on temperature and local silica activity [2][3]. However, the systematic studies on iron partitioning and hydrogen generation as a function of temperature and starting minerals are still limited [4].

In this study, we conducted two series of batch type experiments in the systems of olivine (Ol)-H<sub>2</sub>O and Ol-orthopyroxene (Opx)-H<sub>2</sub>O. First one was conducted for understanding the temperature dependency in a range of 200-400°C during 576 h. Second one is the temporal evolution of both systems from 576 to 6212 h at 300°C. After the experiments, we analyzed the samples by the thermogravimetry, EPMA(Electron Probe Micro Analyzer), VSM (Vibrating Sample Magnetometer), and XAFS analysis(X-ray Absorption Fine Structure) to clarify the reaction rate, and iron partitioning during serpentinization. The thermogravimetric results showed that the reaction progress of olivine or orthopyroxene depends on experimental temperatures. At temperature range of 200-250°C, the areal ratio of reacted olivine and orthopyroxene (re-Ol/re-Opx) is higher than 1.0, which means the replacement of olivine more proceeds than that of orthopyroxene, whereas at >250°C, the ratio of re-Ol/re-Opx is lower than 1.0, which indicates the replacement of orthopyroxene becomes dominant.

The analyses of the saturation magnetization of the products revealed that larger amount of magnetite formed as reaction temperature increase, and with time in Ol-H<sub>2</sub>O system. Besides, the produced magnetite amount was much smaller in Ol-Opx-H<sub>2</sub>O system than that those in Ol-H<sub>2</sub>O system without temperature and duration time dependence.

The Fe(III) exists not only in magnetite, but also serpentine minerals, and we conducted XAFS analysis to measure the total amount of the ratio of ferric iron ( $\text{Fe}^{3+}/\text{Fe}_{\text{total}}$ ). The determined  $\text{Fe}^{3+}/\text{Fe}_{\text{total}}$  was 0.23 and 0.22 in Ol-H<sub>2</sub>O and Ol-Opx-H<sub>2</sub>O systems of 4248 h, respectively. We will conduct the XAFS analysis of all experimental products, and we discuss the systematics of the iron partitioning and hydrogen production in both systems. The results of the present study suggest that during the cooling of oceanic plate away from the mid-ocean ridge, the dominant mineral of serpentinization in mantle peridotite changes from Opx to Ol.

### Reference

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