BPT23-20 会場:104 時間:5 月 25 日 15:45-16:00

CO_2 に富む条件下での komatiite の熱水変質実験（250° C、500 bars）
Experimental hydrothermal alteration of komatiite under CO_2-rich condition at 250 Celsius degrees and 500 bars

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The serpentinization-influenced hydrothermal system has been considered as one of the most probable places where the emergence and early evolution of life took place because serpentinization of ultramafic rocks potentially generates a H_2-rich fluid that is essential for the prebiotic chemical evolution and the earliest metabolisms such as methanogenesis (e.g. Takai et al., 2006; Russel et al., 2010). However, Hadean oceanic crust is considered to have been much thicker than modern equivalents, because of the higher potential mantle temperature at that time. Thus, the exposure of mantle peridotite frequently observed near modern slow-spreading ridges without sufficient magmatic supply was probably rare, suggesting that Hadean H_2-rich hydrothermal environment was mainly driven by komatiite volcanism.

Previously, some hydrothermal alteration experiments have been conducted to understand reactions between komatiite and water (e.g. Yoshizaki et al., 2009). Nevertheless, many geological records and theoretical considerations indicate that the partial pressure of atmospheric CO_2 in the early Earth was much higher than the present level (e.g. Walker, 1985; Kasting, 1993). To reconstruct Hadean komatiite-hosted hydrothermal fluid, laboratory experiments on hydrothermal alteration of komatiite should be conducted under such high CO_2 pressure conditions.

In this study, a hydrothermal alteration experiment was performed using an Inconel-alloy autoclave at JAMSTEC. The komatiite used in this experiment was synthesized from a mixture of standard reagents; its chemical composition was adjusted to Al-depleted komatiite occurring in the 3.5Ga Barberton greenstone belt (Smith et al., 1980). The komatiite was reacted with CO_2-rich (400 mmol/kg) NaCl solution at 250 Celsius degrees and 500 bars for about 2760 hours.

Through the hydrothermal alteration of komatiite, the CO_2 concentration in fluid was decreased to ca. 30 mmol/kg due to the precipitation of carbonate minerals. The H_2 concentration was increased but did not exceed 0.03 mmol/kg, which is comparable to those of modern basalt-hosted hydrothermal fluids and much lower than the results obtained from experiments on hydrothermal alteration of komatiite under CO_2-free condition. Alteration minerals in this experiment were mainly dolomite and clay minerals. Remarkably, FeO content in the dolomite is up to 8 wt.%. We could not identify any iron oxide such as magnetite based on EPMA and XRD analyses. It is therefore suggested that the FeO originally contained in komatiite was incorporated into dolomite as $FeCO_3$ minor endmember, which limited the sufficient formation magnetite and hydrogen production during the hydrothermal alteration. Our results implies that hydrothermal systems at low temperatures such as 250 Celsius degrees under CO_2-rich condition did not have the potential to produce hydrogen enough to sustain H_2-based ecosystems in the early ocean.

Keywords: komatiite, CO2-rich, the early Earth, hydrothermal alteration, laboratory experiment