Deep-seated hydrothermal circulation beneath the rdige axis: a case study of crustal diopsidite from Oman ophiolite

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Hydrothermal circulation beneath the ridge axis plays a significant role in the exchange of energy and mass between the solid Earth and the oceans. The hydrothermal circulation occurs when seawater intrudes downward into the oceanic crust through fractures, and becomes buoyant rising rapidly back to the seafloor. In recent times, deep-seated hydrothermal circulation down to crust/mantle boundary has been introduced regarding geological investigations and numerical models. The deep-seated hydrothermal circulation can be one of the necessary processes maintaining plate tectonics due to mantle hydration lowering mantle viscosity. In order to assess the reaction mechanisms of the deep-seated hydrothermal circulation and the host rocks beneath the ridge axis, we present a series of intense investigations for aqueous fluid inclusions in crustal diopsidites from Oman ophiolite. The crustal diopsidite is considered as a reaction product between gabbro (lowermost crustal material) and seawater-derived hydrothermal fluids en route from the mantle to the crust. We estimated the formation age of the crustal diopsidite at 97.48 ±2.3 Ma using U-Pb geochronology of titanite in the crustal diopsidite. Indeed, this age overlaps with the timing of the formation of the ophiolite crust. Considering that Cr-rich minerals such as chromian spinel (Cr-spinel) and chromian garnet (uvarovites) are contained in the crustal diopsidites, the hydrothermal fluids involved transported Cr from the mantle. A few micrometer-sized inclusion of aqueous fluid with chromian spinel grains was frozen with a nitrogen gas-cooled cold stage, and investigated with a focused ion beam equipped with a scanning electron microscope and an energy dispersive X-ray spectrometer (cryo-FIB-SEM-EDS system). The results showed that the Cr-spinel-bearing aqueous fluid inclusion contains Cl. Regarding the mass and chemical composition of the Cr-spinels in the aqueous fluid inclusion, Cr content in the aqueous fluid was estimated at ~71400 ppm. Although Cr is considered relatively insoluble in aqueous fluids, solubility of Cr was enhanced due to complexation reactions with Cl contained in the seawater-derived hydrothermal fluids.

Keywords: Hydrothermal water, Moho, cryo-FIB-SEM-EDS, microthermometry, Chromium

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