Theoretical constraints on the origin of chloritite at the uppermost gabbro unit in the Oman ophiolite

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Subseafloor hydrothermal circulation plays a major role regarding the elemental exchange between lithosphere and hydrosphere. In the past several decades, particular attention has been paid to hydrothermal circulation and water-rock reaction at mid-ocean ridges (e.g., Tivey, 2007). It is now commonly considered that the vigorous hydrothermal circulation at the ridge axes confined primarily to the basaltic extrusives and sheeted dikes of the upper part of the oceanic crust. On the other hand, there are petrological and isotopic lines of evidence indicating that significant quantities of seawater-derived fluids penetrate into deeper part of oceanic crust and reacted with lower oceanic crust at high temperatures (e.g., Stakes et al., 1984; Kawahata et al., 2001; Alt and Bach, 2006). Fluid circulation in the lower oceanic crust would have significant impact on not only elemental fluxes but also magmatic processes at mid-ocean ridges. However, hydrothermal processes at lower oceanic crust are still largely uncertain.

An abnormal hydrothermally altered rock called chloritite has been reported from the Troodos and Oman ophiolites (Vokes et al., 1991; Neo et al., 2004), although such types of altered rocks have not been reported from ocean floor. Chloritite bodies occur only at the uppermost horizon of the gabbro unit, corresponding to a root zone of sheeted dike complex. Chloritite is mostly composed of iron-rich chlorite with accessory epidote, titanite, anatase and apatite. Bulk-rock compositions show considerable enrichment of FeO as well as strong depletions of SiO_2, CaO, and LIL elements, reflecting the presence of iron-rich chlorite replacing pre-existing igneous and/or alteration minerals. These geological and geochemical lines of evidence suggest that chloritite is an important key to understanding hydrothermal circulation in the lower oceanic crust. In the present contribution, we will discuss the origin of the chloritite based on its geological, petrological, and geochemical characteristics.