Hydrothermal alteration in the eastern flank of Juan de Fuca ridge, IODP Expedition 301

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During IODP Expedition 301 cruise, the basement was cored from 351.2 to 582.8 mbsf (86 to 317.6 m subbasement) in the Hole 1301B, and the studies of alteration of basaltic rocks are important to establish linkages between fluid circulation, alteration, and microbiological processes. In this presentation, we will report the hydrothermal alteration feature of basaltic basement in the eastern flank of Juan de Fuca ridge from the result of alteration mineralogy and bulk rock chemistry.

Site 1301 is located in, so called, Second Ridge in the eastern flank of Juan de Fuca ridge. The water depth, temperature at the surface basement and age are 2680m, 63Cº and 3.5Ma, resepectivelly. The extent of alteration generally increased from west to east, along with crustal age and basement temperature in the eastern flank of Juan de Fuca ridge (Marescotti et al., 2000; Hunter et al., 1999). The basaltic basement in the Hole 1301B consists of basalt-hyaloclastite breccia, aphyric to phyric pillow basalts and massive basalt. Eight units were defined on the basis of changes in morphology, rock texture and phenocryst grain size. The basaltic rocks show the high Zr/Nb ratios (more than 25) and are the normal depleted MORB.

The hydrothermal alteration in the upper oceanic rocks is characterized as alteration halos adjacent vein expressed the various color (e.g. gray, brown, black). Though the core, the alteration minerals are recognized, and are mainly the saponite, celadonite, Fe-oxyhydroxide (Fe(O,OH)x), carbonate, pyrite and zeolite (phillipsite), and they occurs as filling vein and fracture, replacing phenocryst (olivine), filling vesicles, and interstitial mesostasis and glass. The alteration types are divided, on the basis of alteration mineral associations, into the 3 types main branches that are (1) saponite, saponite+carbonate and saponite+pyrite in the gray halo, (2a) saponite+FeO(O,OH), (2b) saponite+celadonite and (2c) saponite+celadonite+Fe(O,OH)x in the black, brown and red halo, and (3) saponite+zeolite, saponite+pyrite and saponite+zeolite+carbonate in the hyaloclastite breccia and interstitial glass. The bulk rock chemistry, effect of the hydrothermal alteration, is examined between gray (type 1) halo and black or brown halos (type 2). The brown and black halos are richer in Fe2O3 and K2O and slightly poorer CaO, MgO and Al2O3 than the adjacent gray halo. These results are stem from the alteration minerals as saponite, celadonite and Fe(O,OH)x.

The basaltic rocks in the Hole 1301B are suffered the oxidized (type 2) and non-oxidized (type 1 and 3) alterations, and these alterations mean the open and closed circulation of seawater, respectively. The alteration sequence is first celadonite dominant alteration, second Fe(O,OH)x dominant alteration and third saponite dominant alteration as deduce from alteration mineral zonation in the vesicle and vein. More detailed alteration sequence will become clearly by future study. These alteration features are very similar to other ODP drilling hole, for instance, Hole 504B (Alt et al., 1986), 896A (Teagle et al., 1996 and Laverne et al., 1996) and 801C (Alt and Teagle, 2003). The alteration temperature in the Hole 1301B is estimated to be lower than 100Cº by the alteration mineralogy and previous study (e.g. Laverne et al., 1996). The seawater circulation style in Second Ridge will be clearly by a CORK system. However, further consideration is necessary for whether this site is upwelling or downwelling or horizontal flow of a hydrothermal circulation cell in the past.

Reference

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