The effect of melt density, assimilation, and eruption location on volatile and halogen contents in MORB glasses: an example from IODP Site 1256

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A continuous section of ~700 m-thick lava pile at Integrated Ocean Drilling Program Site 1256 provides important depth variation of volatile (H_2O, CO_2, S) and halogen (Cl) contents in fresh glasses to understand style of eruption, condition of magma storage, and degree of hydrothermal assimilation. The lava pile is divided into two groups based on eruption location: off-axis basalts of upper portion (250-534 m beneath seafloor, mbsf) and on-axis basalts of lower portion (534-941 mbsf). Majority of the lava pile is composed of pillow, sheet, and massive lavas, but both groups have short (1-2 m) intervals of hyaloclastite layers (e.g., Wilson et al., 2006, Science).

H_2O contents of hyaloclastite samples are distinctly higher than those of lavas, suggesting that the high H_2O would induce explosive eruption to produce the hyaloclastite materials. CO_2/Nb and S/Dy in most fresh glasses are smaller than degassed ratios (e.g., Saal et al., 2002, Nature), and these facts indicate shallow degassing and CO_2 and S losses during transport to the seafloor. Saturation pressures calculated by dissolved H_2O and CO_2 contents are wide range from pressure of seafloor (~25 MPa) to pressure of magma chamber (~60 MPa). The saturation pressure positively correlates with melt density, but obvious differences between off-axis and on-axis samples are not identified. These observations may imply that the melt density is important factor to estimate degassed pressure. When the melt density is low, the melt can ascent from melt lens (top of magma chamber) to shallow place within oceanic crust and highly degassed before reach to seafloor. Conversely, dense melt would not ascent to the shallow place and less degassed at deep level near the melt lens.

The most distinctive character for the Site 1256 glasses is higher Cl/Nb and Cl/K than any other MORB glasses. The strong Cl enrichment is explained by assimilation of highly hydrothermally influenced crust (e.g., Sano et al., 2008, 2011, G-cubed). Beneath the Site 1256, melt lens was very shallow (<1.5 km) and hydrothermal circulation of high-salinity brines would easily reach to roof crust of the melt lens.

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