Gesis of vesiculation in basalt sills of the Shimokawa ophiolite in the northern Hidaka belt, Hokkaido with influence on basalt sill of the Ab-Kfs vein

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Vesiculation of magma depends on volatile components in the magma and the eruption depth. Basaltic rocks with N-MORB features from the Shimokawa ophiolite generally show poor vesiculation. However some of massive basalts are vesiculated up to 10 vol. %. Miyashita (1999) proposed that the high vesiculation is caused by an interaction between sediments and intruding magmas. We present new finding of Ab-Kfs veins, size distribution and bulk composition of the vesiculated massive basalt sills. We discuss how Ab-Kfs vein affects massive basalt sills.

The Shimokawa ophiolite is exposed in the northern part of central Hokkaido. Serpentinized harzburgite and gabbro occur at the lowest part. The lower part of the main body consists of alternation of dolerite and sediments, the upper part consists of pillow lava, and the middle part shows intermediate features between the upper and lower parts. (Miyashita and Watanabe, 1988). High vesicular massive basalt sills interlayered between sediments are found from three locations. The sediments are silicified along the contacts.

Massive basalt sill 1 about 22 m thick occurs at the lowest horizon in the vesiculated massive basalt sills. This sill contains many irregular shaped xenoliths of sediments, indicating that the sill intruded into unsolidified sediments.

The Shimokawa ophiolite shows typical N-MORB signatures (Zr/Nb>17). High vesicular basalts tend to be high LIL elements contents than poorly vesiculated basalts. REE ratios exhibits that there are two types in the Shimokawa ophiolite, about 0.8 La/Yb ratios with N-MORB patterns (sill 2, most of sill 3, most of pillow lava), and about 1.2 La/Yb ratio with T-MORB patterns (sill 1, some sill 3, some pillow lava). However, HFS elements that are immobile during alteration processes reveal N-MORB features. Therefore, LIL elements and light REE are probably modified from the primary compositions.

The Ab-Kfs veins are >2 mm width and thicker than later calcite veins. The border of the Ab-Kfs vein is not straight and waves. It is noted that the Ab-Kfs veins do not cut primary igneous crystals. We measured vesicularities of 22 samples from the massive basalt sill 1. The marginal part within 50 cm from the contact is not vesiculated. Vesicularities increase upward until about 18 m from the lower contact. But basalts containing Ab-Kfs veins show high vesicularity. Plagioclase number densities (PND) show a systematic variation. The margin shows a high value (40 number/mm^2) and inside shows low values (4-6 number/mm^2), implying that the margin is fine-grained and inside is coarse-grained. The PND of basalt containing the Ab-Kfs vein is higher than surrounding rocks (15 number/mm^2), indicating fine-grained than surrounding basalts. Cr_2O_3%(cpx) shows that inside of sill 1 is evolved (Cr_2O_3% (cpx) 0.25%), but surrounding Ab-Kfs vein is less evolved (Cr_2O_3% (cpx) 0.8%) as similar with those of the margin. Above facts suggest that the Ab-Kfs veins were formed before the solidification of the sills.

When magma intruded into thick unsolidified sediments, neighboring sediments are rapidly dehydrated and solidified due to heating by magmas. Expelled hydrothermal fluids from the sediments could not escape from the sills because of sealing effects of overlying solidified sediments, leading mixing with magmas.

The Ab-Kfs veins were formed before the solidification of magma, as described above. Surrounding basalts of the Ab-Kfs veins are highly vesiculated and fine-grained. Furthermore pyroxene compositions of neighboring basalts are less evolved. Therefore, the Ab-Kfs veins affect cooling rate, volatile components and differentiation of injected magmas. Silicified sediments release H_2O, LIL elements such as K_2O and Rb, and CO_2 due to dissolution of organic carbon. The released elements are entrained in the intruding magma via the Ab-Kfs veins, resulting in high vascularity of magma.

[1]Miyashita and Watanabe, 1988. [2]Miyashita, 1999.

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