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Quantifying seawater assimilation across a single MORB pillow
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Halogens and noble gases are critical tracers of volatile interaction between geological reservoirs. The incompatibility of the heavy halogens (Cl, Br, I) coupled with their unique elemental composition and concentrations within surface reservoirs make them suitable tracers of volatiles recycled back into the mantle [1]. However, as the halogens are concentrated within seawater and other marine reservoirs it is possible that they are also incorporated within submarine basalts during eruption, causing the original mantle volatile signature of the basalt to be overprinted [2].

This study combines halogen (Cl, Br and I), noble gas, K and H_2O concentrations within a single pillow basalt to quantify the amount of seawater assimilation during eruption, and to further elucidate the mechanisms of assimilation. In order to determine the scale and heterogeneity of seawater contamination within the pillow, multiple sections taken at 2.5mm intervals were analysed along a transect from the glass rind to the crystalline interior.

The two outer sections of the glass rim show enrichment in the halogens compared to the deeper glass and crystalline section of the pillow, which have distinctly MORB-like I/Cl and Br/Cl ratios. Lower K/Cl and Br/Cl ratios measured within the outermost sections (#1 and #2) indicate the glass has incorporated a Cl rich seawater component. The H_2O/Cl ratios within sections #1 and #2 show that the assimilant is a high salinity brine produced by hydrothermal boiling and phase separation of seawater caused by the eruption of the basalt.

The extent of brine assimilation within the glass ranges between 8% in section #1 to $>$50% in section #2 indicating brine assimilation within basaltic glasses is considerably heterogeneous. The high level of brine contamination within the glass as calculated from the halogens is in contrast with the noble gases within the glass, which still retain their magmatic signatures. This suggests that the halogen and noble gases within submarine basalts may be decoupled, with loss of atmospheric noble gases from the assimilant during hydrothermal boiling.

The crystalline interior shows an increase in the Xe and I concentration relative to the glass rim. The $^{132}Xe/^{36}Ar$ ratio and elevated iodine concentrations when compared to the rest of the pillow indicate the pillow contains a sedimentary component within its interior, most likely due to incorporation of fine sediments during eruption.

Combined halogen, noble gas, K and H_2O data presented here for a single pillow basalt demonstrates that contamination from the marine environment can be variable and extensive. This combined analytical approach demonstrates the need for careful characterization of samples to ensure only samples free from contamination are chosen for analysis of mantle volatiles.

[1] Sumino et al (2010) EPSL, 294, 163 - 172 [2] Kumagai and Kaneoka (1998) Geophys. Res. Lett. 25(20), 3891 - 3894

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