Compositional changes in volatile elements across the Kamchatka arc were studied by electron microprobe and SIMS analysis of major, trace, and volatile elements (S, Cl, F) in homogenized melt inclusions from high-Mg olivines from arc basalts, which have been collected along the E-W transect of the Kamchatka arc, from Eastern Volcanic Front to back arc region (Churikova et al., 2001).

Highest sulfur concentrations (2500 ppm) occur in the melt inclusions from Central Kamchatka Depression (CKD) lavas. Chlorine concentrations in melts from Eastern Volcanic Front (EVF) and CKD are similar (750 to 1100 ppm) and higher than for Sredinniy Ridge back arc (SR, 500 ppm). In contrast, the EVF and CKD melt inclusions are depleted in fluorine (300 to 450 ppm), while the SR melts are enriched (800 ppm), increasing the F/Cl ratio from arc front to back arc by a factor of five. Our data show that the melts were partially (Cl, S) or undegassed (F) for most melts before entrapment.

Volatile element - trace element ratios in general correlate with fluid-mobile elements (B, Li) and suggest successive changes in fluid compositions in these arc magmas with increasing slab depth. In detail, we identify three distinct fluid compositions. In the eastern volcanic arc front (EVF), fluids are highly enriched in B, Cl and chalkophile elements. This fluid carries additionally LILE (U, Th, Ba, Pb), F, S and LREE (La, Ce), having relatively low U/Th. This fluid is dominating EVF sources and is reduced in the central Kamchatka volcanic zone (CKD) and is not documented in the back arc region.

The second CKD-fluid affects the Kluchevskaya Group of volcanoes and is enriched in S and U, which results in the highest S/K2O and U/Th and low Cl/S ratios. Additionally this fluid unusually enriched in 87Sr, 18O and 11B.

The third fluid observed for back arc volcanoes of the Sredinny Ridge (SR) is highly enriched in F, Li and Be, carrying also high amounts of LILE, LREE and probably some Nb, which results in correlations of F/Ce with Li/Yb, Li/Dy, Sr/Y, Ba/Y, and Nb/Yb. This fluid starts to be released below CKD and becomes the dominant fluid in the back arc region.

We argue that the dehydration of different water-rich minerals at different depths from the arc front (low P-T conditions) to back arc (high P-T conditions) explains the difference in fluid composition and the decoupling of B and Li across the Kamchatka arc. In the arc front fluids derived from the amphibole and serpentine dehydration would be water-rich, low in silica and high in B, LILE, sulfur and chlorine. It was shown (Bureau and Keppler, 1999) that such fluids, derived from the first stage of slab dehydration, could be very mobile and carry large amounts of water, producing high degrees of melting, like in the EVF and CKD.

Stalder and Ulmer (2001) showed that dense hydrous magnesian silicates (DHMS) like clinohumite (H2O = 2-3%) and phase A (H2O = 13%) could carry about 10% of the initially subducted water to the depth up to 400 km. The released fluids at such pressure would be highly enriched in silica and magnesium and would be more viscous and less mobile, but still distinct from hydrous melts and could metasomatize upper mantle below SR, producing melts highly enriched in Li, F, LILE, LREE and HFSE. The subduction trace element patterns, however, would still be maintained.

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Reference