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Effects of partial mantle melting and variable composition of slab components on the origin of across-arc geochemical zoning in Kamchatka arc

M. Portnyagin (1,2), K. Hoernle (1), P. Plechov (3), N. Mironov (2)

(1) IfM-GEOMAR, Kiel, Germany, (2) Vernadsky Inst., Moscow, Russia, (3) Moscow State University, Moscow, Russia (mportnyagin@ifm-geomar.de)

New data on concentrations of volatiles (H2O, Cl, F) and trace elements in primitive melt inclusions in olivine Fo80-90 are used to quantify extents of partial mantle melting, composition and amount of slab components involved in the origin of volcanic front and rear-arc magmas in Kamchatka. Estimated degrees of mantle melting decrease across the arc from 10-25% at the volcanic front to 5-10 % at the rear-arc (20 to 80 km behind the volcanic front). The extent of mantle melting correlates positively with the amount of water (0.1-0.8 wt %) in the mantle source suggesting predominantly water-triggered melting beneath both frontal and rear-arc volcanoes. Mass-balance calculations reveal significant compositional variations of water-bearing, presumably, slab-derived components involved in mantle melting beneath Kamchatka. The entire compositional spectrum of the components can be explained through mixing between two end-members. Both end-member components are water-bearing and could trigger mantle melting but have contrasting trace element patterns and different spatial distribution across the arc. One end-member component is rich in boron (up to 600 ppm) but relatively poor in LILE, LREE, Th and U and has very high H2O/K2O=30, Cl/K2O=0.7 and B/La=30. Substantial contribution of this component is seen exclusively in volcanic front magmas. We interpret this component as low density fluid resulting from relatively shallow ($<$120 km) dehydration of altered oceanic crust and/or serpentinite in the subducting plate. The second end-member component is rich in both ‘fluid-mobile’ (e.g., LILE, U) and ‘fluid-immobile’ elements (e.g., Th, LREE) but relatively poor in B and has low H2O/K2O=2, Cl/K2O=0.1 and B/La=1. The amount of this component is broadly similar in volcanic front and rear-arc magmas. This second component is primarily responsible for introducing typical ‘island-

arc signature' (enrichment in LILE and LREE over HFSE) in trace element patterns of Kamchatkan arc magmas. Given the remarkable enrichment of the component in fluid-immobile elements, we interpret it as likely solute-rich fluid or hydrous melt from the upper part of the subducting slab. In summary, the new data on volatiles and trace elements in Kamchatkan magmas suggest generation of hydrous slab fluids at shallower depths ($<$120 km) and water- and incompatible-element-rich slab melts at deeper depths. The melts and fluids trigger partial mantle melting but the extent of melting is lower at the rear-arc because total amount of water released from the slab decreases with depth.