Metasomatism within the mantle wedge inferred from NaCl equivalent content of aqueous fluid inclusions in sub-arc mantle peridotites from the Kamchatka arc

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Hydrated oceanic lithosphere supplies aqueous fluids to the mantle wedge through dehydration processes, i.e., progressive metasomatism, of the subducted slab, and such aqueous fluids can dissolve various components, especially LILE (large-ion lithophile elements). The aqueous fluids could also contain Cl as an important component controlling the solubility of Si, Al, Ca, alkalis and other elements [1]. Such saline fluids derived from the subducting oceanic lithosphere have a role of transporter of such elements to and within the mantle wedge. Salinity of the aqueous fluids is changeable through the interaction with the surrounding rocks and possibly provides us with the information how they reach there from the source.

We determined the NaCl equivalent content of aqueous fluid inclusions in minerals in Avacha peridotite xenoliths (8 samples), derived from the mantle wedge beneath the volcanic front of the southern Kamchatka arc, by using Linkam THM600 heating-freezing stage at Kyoto University. The peridotite xenoliths are spinel harzburgites and of residual origin after a high degree of mantle melting assisted by slab-derived aqueous fluids/melts [2]. In addition, multi-stage metasomatic events by several agents are recorded in those samples [2,3]. A typical metasomatic event observed in the Avacha peridotites is silica addition: the formation of secondary orthopyroxenes replacing olivine. We can observe two types of secondary orthopyroxenes, Opx II-1 and Opx II-2, and they thought to be involved with silica-rich aqueous fluids and H2O-rich silicate melts, respectively [2]. Among the 8 samples, the amount of secondary metasomatic orthopyroxenes is variable from <1 to 20 vol.%, and some of them contain silica-rich glasses as interstitial film, associated with Opx II-2, or as inclusions in chromian spinel. Estimated NaCl equivalent contents of aqueous fluids in harzburgites containing Opx II-2 are lower than those in harzburgites containing Opx II-1: 0.4-5.0 wt% in the former and 1.0-15 wt% in the latter. On the other hand, the NaCl equivalent contents are rather high (1.4-17 wt%) in aqueous fluid inclusions in harzburgites with low modal amount of secondary orthopyroxenes (Opx II-1) relative to the more intensely metasomatized harzburgites (total Opx II > 2 vol.%). These results probably imply the differences in degree of interaction of the aqueous fluids with surrounding mantle wedge peridotite as well as in the source of NaCl-bearing aqueous fluids, and convince us of the multiple (or constant) metasomatic events within the mantle wedge, especially in the sub-frontal mantle.

1. Newton and Manning (2010) Geofluids, 10, 58-72.
2. Ishimaru et al. (2007) J. Petrol., 48, 395-433.
3. Ishimaru et al. (2009) Earth Planet Sci. Lett., 284, 352-360.