Multi-stage Metasomatism of Peridotite in Mantle Wedge (Alag Khadny Accretionary Wedge, Western Mongolia)

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Hydration and metasomatic reactions of mantle wedge are important to understand global material circulation and geological processes within the subduction zone. In this study, we present outstanding alteration textures of orthopyroxene and primary olivine (P-Ol) serpentinization in peridotites from the Alag Khadny accretionary wedge, western Mongolia as evidence for significant Ca- and Si-metasomatisms within the mantle wedge.
We perform petrological and geochemical analyses on seventeen samples collected from southern belt (mainly serpentinized peridotite with minor of limestones, and epidote-amphibolites) of the Alag Khadny accretionary wedge which is located in the Chandman area, western Mongolia, Central Asian Orogenic Belt. Northern belt of the accretionary wedge is composed largely of orthogneiss, and eclogite body with minor of micaschist, marble and small serpentinite bodies. The peridotites contain P-Ol, orthopyroxene (Opx), clinopyroxene (Cpx), and spinel (Cr#=0.3-0.5). The peridotites were suffered by various extents of metasomatism and hydration. P-Ol was replaced by antigorite (Atg) with various extent, whereas primary Cpx was preserved without reactions. Notable feature is intense replacement of Opx (>60 vol.%). The replacement is divided into two types: secondary Cpx (S-Cpx) + tremolite (Tr) and S-Cpx + Tr + S-olivine. The replacement consisting of S-Cpx and Tr is dominantly observed in nine of ten locations. Multi-trace element pattern shows enrichment of LILE, small Sr peak, and weak Zr depletion relative to REE, suggesting geochemical signatures of mantle-wedge peridotite.
Based on Mg-Ca-Si-water system, mass-balance calculation for the replacements (S-Cpx + Tr and S-Cpx + Tr + S-Ol) shows the gains of Ca (62 g/100 cm^3 of Opx and 35 g/100 cm^3 of Opx) and water (3.7 g/100 cm^3 and 0.9 g/100 cm^3), and losses of silica (-13 g/100 cm^3 and -71 g/100 cm^3) and Mg (-61 g/100 cm^3 and -53 g/100 cm^3). Due to the lack of Ca source in the primary minerals, it suggests infiltration of the external fluids causes significant amount of Ca metasomatism. The products (S-Cpx and Tr) of Ca-metasomatism are rarely cut by Atg veins, indicating that main hydration occurred simultaneously with Ca-metasomatism. Mass balance calculation (SiO_2 = 56 g/100 cm^3 of Ol; MgO = -0.5 g/100 cm^3 of Ol and H_2O = 53 g/100 cm^3 of Ol) for Atg formation after P-Ol suggests suggests that silica released from Opx replacement supports hydration to proceed in P-Ol area. The stability field of mineral assemblage of the Opx replacement was consistent with the P-T conditions of eclogite bodies in the Alag Khadny accretionary wedge (T= 590-630 ˚C and P=11-16 kbar), implying the hydration and metasomatism were caused by a supply of fluids derived from dehydration of the subducting slab. Thus, mantle wedge peridotite in the Alag Khadny accretionary wedge records novel mass transport of Ca as well Si in subduction zone.

Keywords: Metasomatism, Mantle wedge, Orthopyroxene replacement, Western Mongolia

