

Geochemical characteristics of the peridotites from the southern Mariana forearc

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Dehydration of a subducting oceanic plate and infiltration of the fluid/melt released from the oceanic plate are thought to be the key processes to invoke melting of the wedge mantle. Although a number of studies on volcanic rocks in arcs have been conducted to reveal a material recycling process at subduction zone, understanding of geochemical development process within the wedge mantle is still not as far advanced. The southern Mariana forearc is one of the best locations on the Earth to investigate issues above, since serpentinized peridotites are widely exposed on the inner slope of the Mariana Trench. We have collected peridotite samples obtained by dredging and Shinkai diving from 3000 – 7000 mbsl at the southern Mariana Trench. The dredge and dive points are geographically grouped into three sites: site 1 (KH98-1-D1, KH98-1-D2, and 6K-973), 2 (KH03-3, KH98-1-D3, and 6K-1094), and 3 (6K-1095, 6K-1232, 6K-1233, and 6K-1234) from the east to the west. We conducted EPMA and LA-ICP-MS analyses on minerals in the recovered samples to reveal geochemical development process of the wedge mantle.

Peridotites from the easternmost site 1 consist of olivine (Fo# = 90 – 91), orthopyroxene (Mg# = 90 – 91), spinel (Cr# = 40 – 50), clinopyroxene (Mg# = 89 – 93), tremolite (TiO₂ = 0 – 0.4 wt%), pargasite (TiO₂ = 2.0 – 2.5 wt%), plagioclase, and serpentine. Clinopyroxene and pargasite exhibit LREE-depleted (type C1 and A1, respectively) and orthopyroxene LREE- and MREE-depleted patterns (type O1) in a chondrite-normalized diagram.

Peridotites from the westernmost site 3 consist of olivine (Fo# = 91 – 92.5), orthopyroxene (Mg# = 91 – 93.5), spinel (Cr# = 45 – 75), clinopyroxene (Mg# = 94 – 96), tremolite (TiO₂ = 0 – 0.2 wt%) and serpentine. Some clinopyroxene exhibits LREE-enriched convex upward pattern (type C2), others strong LREE- and MREE-enriched REE pattern (type C3). Tremolite and orthopyroxene exhibit LREE-enriched convex upward (type A3) and weakly LREE-enriched convex upward REE patterns (type O2), respectively. HREE, Ti, and Y abundances of type C3 clinopyroxene are higher and their LREE and Sr abundances lower than those of type C1 clinopyroxene.

Peridotites from the middle site 2 show intermediate characteristics between site 1 and 3. They consist of olivine (Fo# = 90 – 92), orthopyroxene (Mg# = 91 – 92.5), spinel (Cr# = 45 – 52), clinopyroxene (Mg# = ~95), pargasite (TiO₂ = 0.8 – 1.7 wt%), tremolite (TiO₂ = 0 – 0.2 wt%), plagioclase and serpentine. Some clinopyroxene exhibits C1-type REE pattern and coexists with A1-type pargasite, while other clinopyroxene exhibits LREE- and MREE-depleted patterns (type C2) coexisting with LREE- and MREE-depleted tremolite with weak enrichment in LREE (type A2).

Compared to results of high-pressure melting experiments on peridotite, monotonous increase of Mg# of olivine, clinopyroxene, and orthopyroxene as well as Cr# of spinel from site 1 to 3 suggests increase of melting degree of the mantle peridotite from site 1 to 3. Monotonous decrease of HREEs, Ti, Y, Zr, and Hf abundance from C1- to C3-type clinopyroxene, from A1- to A3-type amphibole, and from O1- to O2-type orthopyroxene, is consistent with major element variations above. However, in contrast to the observation above, LREE and LILE abundance increase from C1- to C3-type clinopyroxene, from A1- to A3-type amphibole, and from O1- to O2-type orthopyroxene, suggesting involvement of melt/fluid enriched in such elements.

LREE-enriched clinopyroxene and amphibole have been found from mantle xenoliths and subaerial peridotite complex. Those clinopyroxene and amphibole have been interpreted as a product of melting and melt separation involving infiltration of LREE-enriched melt/fluid into the melting system. Similarity of geochemical characteristics of type C3 clinopyroxene and A3 amphibole to those in xenoliths or peridotite complexes may suggest involvement of LREE-enriched melt/fluid to the mantle beneath the southern Mariana forearc.

Keywords: Mariana Trench, peridotite, pyroxene, amphibole, trace element