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Insight into Material Input from the Slab into the Mantle Wedge: an Application of In-Situ Trace-Element Analysis of Minerals by LA-ICP-MS

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The Japanese Islands are located immediately above the oceanic slab sinking beneath the Eurasia continent. The slab is expected to change by progressive metamorphism associated with dehydration as it goes downward. In accordance with this, it is expected that the physical and chemical properties of the mantle wedge change. The peridotite that exists around the boundary with slab has important information for our understanding of tectonics of the island arc: e.g., deep earthquake, generation of island arc magmas. However, samples of the peridotite are rarely available because of their deep seat.

In this study, we examined peridotite xenoliths sampled at Green Knobs, New Mexico, USA, by Prof. Douglas Smith (Department of Geological Science, The University of Texas). The peridotite xenoliths from Green Knobs have been famous to contain various amounts of secondary hydrous minerals. The involvement of hydrous fluids from a descending slab has been suggested. The purpose of this study is to clarify the trace element compositions of all phases present in the xenoliths and to discuss the geochemical interactions between the mantle wedge and the slab-derived fluids.

We have examined the following four samples:

N53GN	Olivine + Opx + Cpx + spinel ± hornblende ± sulfide
N106GN	Olivine + Opx + Cpx + spinel + chlorite ± garnet ± hornblende ± sulfide ± ilmenite
N156GN	Opx + Cpx + hornblende ± spinel ± sulfide
N23GN	Olivine + Opx + Cpx + chlorite + Na-tremolite + Ti-clinohumite ± sulfide

The degree of hydration increases from N53GN to N23GN. The N53GN is almost anhydrous.

In N53GN almost all grains of Cpx and Opx are associated with spinel. N106GN contains garnet formed between Cpx and spinel, and hornblende (pale green in thin section) around the grain boundary of Cpx. N156GN has hornblende veinlets cutting other silicate minerals. N23GN is characterized by Na-tremolite and Ti-clinohumite, which are around chlorite, and Cpx forms symplectite with other minerals (e.g., orthopyroxene and hornblende).

We used an excimer laser (193nm; ArF) coupled to a quadrupole inductively coupled plasma mass spectrometry (LA-ICP-MS) for *in-situ* measurement of trace elements in minerals at Incubation Business Laboratory Center of Kanazawa University.

There are no remarkable geochemical differences between the core and rim of Cpx in N53GN. The Cpx grains are LREE-depleted and HREE-enriched; however, the Cpx free of associated spinel has a positive anomaly at La (Figure 1a). With an increase of the amount of hydrous minerals, the core of Cpx tends to be LREE-enriched and HREE-depleted. There are remarkable geochemical differences between the core and rim of Cpxs in N106GN (Figure 1b). HREE contents are lower at the rim than at the core. HREE contents decreases especially in the rim of Cpx near garnet. HREE contents are higher in garnet than in the core of Cpx. On the other hand, LREE contents are higher in hornblende than at the rim of Cpx. The Cpx and hornblende have positive anomalies at La. There are remarkable geochemical differences between the core and rim of Cpx in N156GN; the LREE contents are higher at the rim than

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at the core (Figure 1c). Furthermore, the Cpx and the hornblende show positive anomalies at La, Ce and Pr in N156GN (Figure 1c). The REE pattern of Cpx in N23GN is lower in HREE (Figure 1d) than in other samples (Figure 1a-c). The Na-tremolite is LREE (to MREE)-depleted and HREE-enriched, and has positive anomaly at La and Ce (Figure 1d).

The N53GN has been very slightly modified by metamorphism, if any, because constituent minerals are almost anhydrous and the Cpx grains have no geochemical differences between the core and rim. LREE contents of Cpx and hornblende increase with an increase of the degree of hydration, possibly indicating the rocks have been enriched with LREE with a progress of hydration. Almost all grains of Cpx, hornblendes and Na-tremolite examined have positive anomalies at LREE (La, Ce and Pr), being in accordance with the effect of LREE-enriched fluid of slab origin. The garnet, which favors HREE, observed between Cpx and spinel in N106GN may be a reaction product involving Cpx, decreasing HREE contents of residual Cpx (= the rim of initial Cpx). On the other hand, the pattern of Cpx that is not associated with garnet is relatively flat from MREE to HREE (Figure 1b). The HREE contents are remarkably lower at the core of Cpx in N23GN than other Cpx grains in other samples, although no HREE-rich minerals (e.g., garnet) were found. The origin of the "cryptic" HREE-rich mineral(s) in this sample is a subject for future research.

It was clarified to be reactive from the change in the trace element with fluid from the slab and the peridotite of the mantle wedge by this study. After this, the metamorphic condition of each mineral will be considered, and examine the reaction between slab and mantle wedges in details.

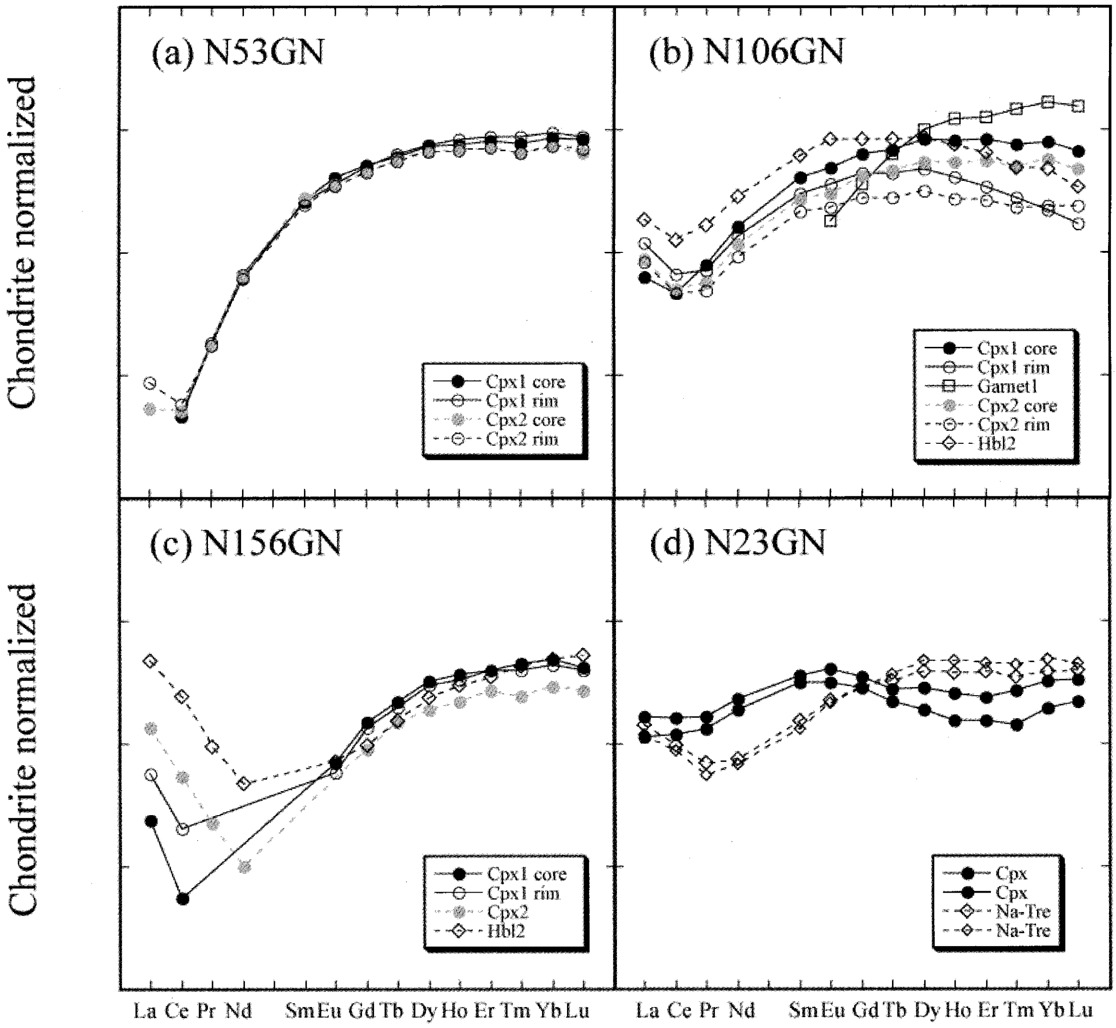

Figure 1 Chondrite-normalized REE patterns, using data from McDonough and Sun (1995).
(a) Cpx1: Cpx accompanied with spinel. Cpx2: Cpx without associated spinel.
(b) 1: Garnet between Cpx and spinel. 2: Hornblende around the boundary of Cpx and olivine.
(c) 1: About 1mm across. 2: Cpx accompanied with hornblende (Hbl). Cpx and Hbl are about 0.5mm across.
(d) Two Cpxs are different grains. Cpx forms symplectite.