Evidence for ultrahigh-pressure origin and low-pressure magmatic process: podiform chromitites in the Luobusa ophiolite, Tibet

Shinji Yamamoto[1]; Tsuyoshi Komiya[2]; Shigenori Maruyama[3]

[1] Earth and Planetary Sci. Tokyo Institute of Technology; [2] Earth & Planet. Sci., Tokyo Inst. Tech.; [3] Earth and Planetary Sci., Tokyo Institute of Technology

Recently, the podiform chromitites in the Luobusa ophiolite, Southern Tibet, have received much attention, because of the presence of micro-diamonds (Bai et al., 1993; Pearson et al., 1995; Yang et al., 2007), coesite (Yang et al., 2007) and highly reduced metal phases (Bai et al., 2000; Robinson et al., 2004) in heavy mineral separates. The occurrence of diamond, which is stable over 150 km deep, suggests that the podiform chromitite in the Luobusa may have a deep mantle origin (Yang et al., 2007). However, this conclusion is still controversial because the ultrahigh-pressure (UHP) minerals were obtained only from mineral separates, and also because the podiform chromitites are thought to be formed by magmatic processes under the low-pressure conditions (e.g. Arai, 1997; Ballhaus, 1998; Zhou et al., 1996). Therefore, we focus on an in-situ investigation of UHP signatures within chromites in the podiform chromitite.

We discovered unusual silicate lamellae within chromites of podiform chromitites in the Luobusa ophiolite, southern Tibet. Using analytical transmission electron microscopy, we found coesite, clinopyroxene and $MgSiO_3$ phase as exsolution lamellae in the host chromites. The presence of coesite lamellae in a chromite directly indicate that podiform chromitites originate from deep mantle environment.

These silicate lamellae in chromites are restricted in the nodular- and massive-type chromites, and disseminated-type chromites show no lamella. Therefore we can classify chromites of the podiform chromitite into two types based on the occurrence of silicate lamellae; (1) high-pressure type with abundant silicate exsolution lamellae and (2) low-pressure type with no lamellae. Significantly, dunitic orbicular-type chromitite consists of both centered-nodular chromite (high-pressure type) within coarse-grained olivine matrix and fine-grained disseminated-chromites (low-pressure type) scattered in the interstitial part of the olivine matrix. Petrographic investigations reveal that nodular-type chromites with numerous lamellae gradually change their morphology into disseminated-type chromites with no lamellae. The characteristic features of the disseminated- and banded-type chromites, such as their interstitial distribution, euhedral to subhedral morphology and absence of exsolution lamellae, suggest they formed under low-pressure magmatic conditions.

To reveal the nature of the magma involved in chromitites we investigated REE concentration of the clinopyroxene scattered in the interstitial part of the olivine matrix in the dunitic orbicular-type chromitites with using LA-ICP-MS. Chondrite-normalized REE concentrations of the melt in equilibrium with clinopyroxene using clinopyroxene/melt distribution coefficients are depleted in middle-REE and similar to typical boninite REE pattern.

On the basis of these results we infer that boninitic melts, which percolated through the chromitites, modified the chromites from high-pressure type with to low-pressure type. In summary, the chromites without lamellae were largely recrystallized or newly precipitated by a shallow-level magmatism. Therefore, we conclude that the podiform chromitites at Luobusa retain evidence of their multi-stage development from ultrahigh-pressure environment to low-pressure magmatic processes.