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Plagioclase-bearing harzburgite from the Mariana Trough: Evidence for melt impregnation in shallow mantle

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Upper mantle-derived plagioclase peridotite has been explained as a re-equilibrated mineral assemblage at the plagioclase stable P-T condition (Green and Ringwood 1967) and modified mantle peridotite by melt impregnation or melt-rock reaction (e.g. Dick et al., 2010). Here, we examine plagioclase-bearing samples from the Mariana Trough (JAMSTEC KR02-01: Arima et al., 2002) to understand modification through melt impregnation into the residual peridotites.

Chiba et al. (2008) reported that the residual mantle peridotites beneath the Mariana Trough are lherzolite to lherzolitic harzburgite. These rocks attain 71% of 129 samples examined. The major element chemistry of the primary cores of olivine (Mg#=90.0-91.7, NiO=0.31-0.48 wt%), orthopyroxene (Mg#=90.2-91.5, Al_2O_3=2.76-4.58 wt%), clinopyroxene (Mg#=91.0-93.9, Al_2O_3=3.69-5.57 wt%), and spinel (Mg#=67.0-74.6, Cr#=24.0-42.5, TiO_2=0.06-0.22 wt%) indicates a residual mantle peridotite with a small to moderate degree of partial melting.

Interstitial plagioclase, 0.1-0.7 mm in size, have been found in 4 samples of the residual harzburgite, showing trails with small grains of secondary olivine, orthopyroxene, clinopyroxene and spinel among coarse protogranular grains of primary harzburgite minerals. The modal% of plagioclase is 0.3-0.7.

The coarse protogranular grains of primary olivine cores (Mg#=89.5-91.6, NiO=0.31-0.45 wt%), orthopyroxene cores (Mg#=89.2-91.7, Al_2O_3=1.94-5.73 wt%) and clinopyroxene cores (Mg#=90.1-93.8, Al_2O_3=2.27-6.30 wt%) have similar chemical compositions to those of the residual peridotite, whereas the small grains of secondary orthopyroxene (Mg#=90.3-91.6, Al_2O_3=1.30-2.56 wt%) and clinopyroxene (Mg#=91.8-94.0, Al_2O_3=1.79-4.43 wt%) have lower content in Al_2O_3. Characteristically, small grain of spinels have lower Mg# (43.8-64.5), higher Cr# (37.2-54.3), and higher content in TiO_2 (0.07-0.33 wt%).

Concludingly, the plagioclase harzburgite from the Mariana Trough can be explained as a modified residual peridotite by primary melt impregnation, generated in a shallow mantle. These harzburgite resembles 'P-type peridotite' of the Parece Vela (Ohara et al., 2003), 'plagioclase-bearing peridotite' of the southern Mariana Trench (Michibayashi et al., 2009), 'impregnated peridotite' of the Romanche Fracture Zone (Tartarotti et al., 2002) and 'plagioclase peridotite' of the Paleo-MAR (Dick et al., 2010). Such a modification by melt impregnation seems to be frequent in the back-arc lifting and the mid-ocean ridge systems.

References

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