Mafic crystal aggregates from the top and bottom of the middle crust found in basalts erupted at West Zealandia Seamount, southern Mariana Arc

Alexander Nichols[1], Yoshihiko Tamura[1], Robert J. Stern[2], Hiroshi Shukuno[1], Akiko Nunokawa[1]

[1] IFREE, JAMSTEC, Japan.
[2] University of Texas at Dallas, USA.

West Zealandia Seamount (~16° 53' N) is part of the Sarigan-Zealandia volcanic complex within the southern seamount province of the Mariana Arc. West Zealandia is located about 15 km west of the volcanic front, towards the back-arc. Different volcanic centres in the Sarigan-Zealandia complex were sampled in several ROV Hyper-Dolphin dives during cruise NT09-08, June 2009. Even though West Zealandia is only 15 km behind the volcanic front, major and trace element chemistry, together with crystal assemblage compositions, suggest that its volcanic front signature is not as strong as those centres located at the volcanic front. In a dive on the north-western slope of West Zealandia wehrlite and dunite crystalline aggregates were found in primitive porphyritic basalts. The aggregates were analysed by electron microprobe (EPMA) to assess whether they are mantle xenoliths. Their crystal chemistry suggests that while they crystallised at pressure from primitive melts, they did not form in the mantle. Further evidence for a crustal origin is provided by the presence of glassy silicate melt inclusions in aggregate olivines. H_2O and CO_2 dissolved in these inclusions were analysed by micro-Fourier-transform infrared spectroscopy to constrain where in the crust the aggregates crystallised, while their major (EPMA) and trace elements (laser ablation inductively coupled mass spectrometry) were also measured. H_2O and CO_2 up to 4.23 wt.% and 809 ppm, respectively, suggest that inclusions within the wehrlite olivines were trapped at the deepest pressures (~300 MPa), equivalent to depths of ~11 kmbsl beneath West Zealandia. This corresponds to the lower-middle crust boundary. Inclusions within the dunite aggregates and olivine phenocrysts reflect crystallisation from more evolved melts at the middle-upper crust boundary, ~6 kmbsl (~180 MPa). For the inclusions to preserve volatile contents reflecting high pressures ascent must have been rapid. It is possible that wehrlite aggregates were picked up from melt stalled at the lower-middle crust boundary, and then the dunite aggregates and phenocrysts were picked up from an earlier melt that had become more evolved and was stalled at the middle-upper crust boundary. The rapid ascent may explain why, despite an area of low velocity middle crust existing beneath West Zealandia, there is little evidence for these primitive lavas having interacted with any silicic material.