Melt transport and compositional heterogeneity of the mantle: a case study of peridotite, dunite, and wehrlite from Atlantis Massif

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Harzburgitic, dunitic, and wehrlitic rocks drilled at Atlantis Massif (Mid-Atlantic Ridge, 30˚N), where mantle-derived rocks were exhumed to the sea floor via detachment faulting, were investigated employing *in situ* geochemical analyses. Since dunitic and wehrlitic rocks are commonly interpreted as fossil melt channels, they likely represent transported parental melts of mid-ocean ridge basalt (MORB) beneath the paleo-ridge axis. Although the rocks are severely serpentinized, primary olivines, chromian spinels, orthopyroxenes, and clinopyroxenes were found in several samples. The Cr/(Cr + Al) ratios (Cr#) of the chromian spinel show a bimodal distribution, where one group records higher Cr# (0.35–0.5) and the other group is represented by lower Cr# (0.2–0.3). The extent of mantle melting is strongly correlated to the Cr# of the chromian spinel, thus the mantle-derived lithologies of the Atlantis Massif record at least two end-members with regards to the extent of melting: refractory mantle material with higher Cr#, and enriched mantle material with lower Cr#. To quantitatively evaluate mantle melting and melt transport mechanisms in the suboceanic mantle beneath this section of the Mid-Atlantic Ridge, a one-dimensional, steady-state decompositional mantle melting model was carried out based on rare-earth element concentrations of clinopyroxene. Our modelling results demonstrate that the melting region of the mantle extends unevenly across the ridge axis, with deeper melting occurring on-axis from the garnet-stability field, and shallower melting occurring off-axis from the spinel-stability field. We propose that depleted melts generated at depths in the absence of garnet within the off-axis region were possibly focused to the ridge axis via fracture-induced melt channels and produced wehrlite. It is likely that fracture-induced melt migration was dominantly a response to a decrease of temperature as the mantle was exhumed during detachment faulting.

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