Sub-axial asthenospheric flow revealed by a plume-spiked mantle

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Interaction between actively upwelling deep mantle plumes and mid-ocean ridges usually result in excess melting, thickened oceanic crust and unusually shallow ridge depths. The Foundation plume, in contrast, is characterised by only a weak temperature anomaly (<20K) and a small plume volume flux (~1.0 km^3 a^{-1})[1], thus limiting the plume's physical impact on the adjacent Pacific-Antarctic Ridge (PAR). However, the Foundation plume delivers material compositionally distinct to the PAR mantle source and provides thus a unique opportunity to study the dispersal of the 'plume-spiked' mantle along a single, 550 km-long ridge segment.

Radiogenic Sr-Nd-Pb isotope data indicate the involvement of at least three distinct mantle components in the Foundation-PAR system. One corresponds to the ambient MORB mantle source but the two others are likely to be entrained in the Foundation plume conduit. One of these components has lower $^{206}Pb/^{204}Pb$ but slightly higher $^{87}Sr/^{86}Sr$ relative to the ambient MORB mantle and the enriched plume component is similar to PREMA (FOZO).

Radiogenic isotopes as well as incompatible trace element ratios (e.g., Nb/Zr, La/Sm) indicate an asymmetric dispersal of plume material along the adjacent ridge axis. Close to the plume-ridge intersection, all three components are present and the enriched component vanishes with increasing distance from the plume centre. Further to the south, off-axis volcanism traps a source that contains lower proportions of the enriched plume component than the respective on-axis ridge section. This indicates that, in the Foundation-PAR case, plume material is dispersed along the ridge axis exclusively by a shallow sub-axial asthenospheric transport mechanism. An overlapping spreading centre in the north of the Foundation-PAR intersection and the asymmetric geochemical anomaly along the PAR indicate a preferred southward transport direction, consistent with models of the sub-axial asthenospheric flow[2,3] and regional geodynamics.

[1] Maia, M., *et al.* (2000): Marine Geology 167, 61–84.
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[3] Carbotte, S.M., *et al.* (2008): G-cubed 9, Q08001.