Mantle-crust isotopic relationships along Mid Ocean Ridges: constraints from the analysis of time series

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Isotopic relationships between parent mantle and daughter MORBs have been used to reveal the composite nature of the source tracking the missing components in their isotopic fingerprints. An opportunity to address this issue is given by temporal sections of single ridge segments where MORB and residual parent mantle peridotites can be assessed together. The possibility has been offered by the flexured and uplifted lithospheric slab that exposes, on the sea floor along a seafloor spreading flow line, a zero to 26 Ma relatively undisturbed lithospheric section (Vema Lithospheric Section or VLS) generated at the 80 km long Mid Atlantic ridge segment (EMAR) at 11°N.

Temporal variations of the Nd isotopic composition of crustal basalts and parental mantle along the VLS reveal a large dispersion of residual isotopic composition with respect to the melt products. Equilibration with partially mixed melts can account for the observed relationships in the mantle rocks. The mean MORB isotopic composition and the average composition of the residues do not match because of the preferential extraction of the low-melting component. The compositional difference in both isotopic and elemental distribution is a function of the average degree of melting of the mantle. This observation can only be justified by progressive melting of composite lithologies where mantle potential temperature and amount of dispersed low-melting lithologies control the relative extent of melting of the mantle host and that of the dispersed heterogeneities resulting in differential fractions of mixed melts in the final products. This observation is confirmed by global correlations in Nd isotopes and chemical indicators of degree of melting from other portions of the mid ocean ridge system.