

Deep segregations of ultra-depleted melts in abyssal pyroxenite layers

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Ultra-depleted melts may form by melting residual mantle portions that have experienced prior melting processes. Geochemical records of ultra-depleted melt percolation and concomitant mantle refertilization have been recognized in abyssal peridotites and ophiolitic mantle sections. So far, however, direct evidence of ultra-depleted melts in erupted Mid-Ocean Ridge Basalts or as crystallized melt veins in abyssal peridotites is missing. Here, we report evidence for segregations of such ultra-depleted melts in the form of discrete pyroxenite layers within abyssal peridotites from the Doldrums fracture zone (8°N) at the Mid Atlantic Ridge. The pyroxenites crystallized from highly incompatible element depleted melts in the lithospheric mantle at more than 27 km beneath the ridge axis (at T ~1250°C using the geothermometer by [1]), with little or no modification by interaction with the host mantle. Following their emplacement, the pyroxenites experienced exhumation, decompression and partial re-equilibration under plagioclase-facies conditions at ~1060°C and ~15 km depth. Notably, despite their high Hf isotope ratios ($\epsilon_{\text{Hf}} = 40.3$), which indicate a formation from a source that experienced ancient melt depletion (high Lu/Hf), their Nd isotopes plot in the field of MORBs ($\epsilon_{\text{Nd}} = 10.6$), implying a long-time evolution with low Sm/Nd. We relate these compositions to a mantle source that experienced partial melting and reacted with migrating melts, prior to recent melting under the Mid-Atlantic Ridge. This ancient process of refertilization produced local enrichments in incompatible elements, allowing re-melting of refractory, ancient mantle residues. This study underlines the potential of discrete pyroxenite layers to preserve the chemical fingerprint of melts from single ultra-depleted and refertilized mantle components that are not passive elements in the asthenosphere, but may contribute to the chemistry of melts at the surface.

[1] Taylor, W.R., 1998, *Neues Jahrbuch für Mineral Abh* 172:381–408