EVIDENCE OF MELT STAGE REFERTILIZATION AND METASOMATISM IN ABYSSAL PERIDOTITES FROM HESS DEEP (ODP LEG 147)

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Abstract
It is commonly accepted that abyssal peridotites (AP) are simple residue of recent partial-melting due to the upwelling of convective and fertile mantle under mid oceanic ridges. Numerous authors have argued that given this straightforward history and their short residence time into the lithosphere, AP should be representative of the Earth's fertile mantle. This study examines samples from the Hess Deep, the triple junction between the East-Pacific Rise and Cocos-Nazca propagator (ODP Leg 147). Despite extensive alteration (80%) due to serpentinisation and seafloor alteration (a common feature in AP), two assemblages can be recognised in samples from this locality: (1) a primary relict assemblage with large porphyroclasts of orthopyroxene (Opx1) and olivine (Ol1); (2) a secondary assemblage formed of interstitial and vermicular clinopyroxene (Cpx2), which may also occur in symplectitic association with spinel (spl) and sulfide. The textural occurrence of this assemblage 2 suggests that it represents the crystallization of an infiltrated melt Abyssal peridotites from this leg are harzburgites with the average modal composition: 80% Ol, 15% Opx, 3% Cpx and 2% Spl. Major element analyses of primary phases show that they are residual after extensive degrees of fusion and that a chemical disequilibrium between Cpx2 and Ol1-Opx1 has been preserved. Inductively coupled plasma-mass spectrometer (ICP-MS) analyses on whole rocks and Laser Ablation ICP-MS analyses of Cpx2 and Opx1 show that trace-elements concentrations are among the most depleted observed so far in abyssal peridotites. Rare-earth element (REE) patterns of Cpx2 are very depleted in comparison with those from the literature. Moreover, Cpx2 are not in equilibrium with Opx1 concentrations. Enrichment in light rare-earth elements and in large ion lithophile elements (LILE, e.g., U, Th, Pb and Sr), both in Opx1 and Cpx2 indicates a late stage metasomatic event. It is worth noting that U, Pb, Sr enrichments in whole-rock are commonly ascribed to seawater alteration. Here the fact that fresh Cpx2 and Opx1 core show such enrichment, coupled with enrichment in Th and LREE (not affected by alteration processes) suggesting a magmatic rather than an alteration origin.

So we can conclude that:

- Abyssal peridotites from Hess Deep have experienced a primary episode of melting of about 15%, as calculated from the heavy and medium REE composition of Opx1.

- Textures of Cpx2 and disequilibrium between Cpx2 and Opx1 suggest that Cpx2 has crystallised from a percolating melt. The Spl-Cpx2 clusters are reminiscent of a quenching texture and indicate that part of this melt has crystallised under lithospheric (cold) conditions.

- Such high depletion of REE in clinopyroxene indicates that this melt is derived from a very depleted mantle source. Calculated melt in equilibrium with Cpx2 is similar to the ultra depleted melt (UDM) evidenced as melt-inclusion in olivine phenocryst in MORBs by [Sobolev et al., 1993].

This suggests a widespread occurrence of those UDM.

Thus APs are not simple residues of partial melting but record a complex and protracted history of multiple events of melt extraction and percolation-reaction. This recall what have been observed in the sub-continental lithospheric mantle and suggest that the mantle section sampled by APs is not as young as one could expect. UDM giving the Cpx2 are clearly derived from an old and extremely depleted mantle reservoir. The occurrence of such mantle volume/component in such geodynamic setting is at odd with the assumed young and convective nature of the oceanic mantle. However, the occurrence of old and depleted mantle component within the oceanic convective mantle is also suggested by other studies of AP [Seyler et al., 2004] on a worldwide basis and especially by recent Re-Os isotopic investigations [e.g. Alard et al., 2005; Author's unpub data].