Ubiquitous old depleted mantle in the oceanic mantle

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Abyssal peridotites (AP) are believed to be the residue of recent partial melting of the MORB source mantle. Thus their petrologic and geochemical characteristics have been interpreted within the framework of recent melting of a fertile convective mantle. However, a number of studies have shown that the "magmatic" history of AP are much complex and record multiple episodes of melt percolation/reaction. Recent isotopic data (e.g. Re-Os) have prompted doubts on whether AP are direct residues of recent MORB melting. Magmatic sulfides are the main carrier of highly siderophile elements (HSE) in the mantle, including Os and Re. Recent studies have shown that several sulphide populations characterised by different microstructural types and compositions occur on the thin section scale and record the various episodes of melting and melt/rock reaction events. Therefore the decay of ^{187}Re to ^{187}Os provides an exceptional tool to unravel the sequence of melt extraction and percolation.

Petrographic and geochemical charaterisation of sulfides coupled with in-situ Re-Os in abyssal peridotites (or related rocks) from the MAR, the SWIR, EPR (Hess Deep) and from the Ligurides and Oman Ophiolites indicate that typically 3 types of sulfide are present in AP. *Type 1 magmatic sulfides* (M1) sulphides are either hosted in Opx or occur as relicts within the serpentine matrix. They consist of pentlandite (Pn) ± pyrrhotite (Po) and small amounts of chalcopyrite (Cp) (with Pn>Po>Cp). Their microstructural occurrence, mineralogical and chemical composition, and their HSE systematics indicate that they are residual after melting. *Type 2 magmatic sulfides* (M2) are spatially associated with Cpx_2±Spl_2 clusters. They have convoluted form (low dihedral angle) and occur as large grains (≥100μm) or as a swarm of smaller sulfide blebs (≤50μm) and networked veinlets. They show a high abundance of Cu-rich phases (Cp ± Bornite (Bo)≥5%). These features along with their high Pd/Ir ratio indicate that M2 sulphides were precipitated during melt-rock reaction. *Type 3 Hydrothermal sulfides* occur as veins, however as shown by mass balance calculations their bearing on the whole-rock Os composition are trivial.

^{187}Os/^{188}Os of magmatic sulfides define a large range from 0.109 to 0.167 and can be recorded in a single sample. M1 sulfides have unradiogenic Os and low ^{187}Re/^{188}Os<0.4 indicative of long term evolution in a Re-depleted environment. T_{RD} ages in excess of 2.2 Ga are found in each locality. M2 sulfides show either radiogenic composition (^{187}Os/^{188}Os >0.13) with ^{187}Re/^{188}Os≥0.4 or have a consistent unradiogenic ^{187}Os/^{188}Os ≈ 0.109, despite a large variation in Re/Os as found in Leg209. Along with their association with extremely depleted cpx this suggests that leg209's M2-sulfides are derived form an old (2.6 Ga) depleted mantle also sampled through melt inclusion in MORBs (Sobolev and Shimizu, 1993, *Nature* 363:151.). These old ages are robust estimates and are not due to model artifacts.

Together with previous findings these results suggest that contrary to the accepted geodynamic model, the oceanic mantle beneath active mid-oceanic ridge contains significant proportion of old depleted mantle blobs (reminiscent of Archean to Proterozoic sub-continental mantle) and survived convection resetting for time ≥ 2 Ga.