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# Refertilization of oceanic mantle by old depleted melts beneath a slow spreading ridge: An Os isotope study of the peridotites drilled at ODP Site 1274 (15°20 FZ, Mid-Atlantic Ridge)

O. Alard (1), Y. Gréau (1,2), M. Godard (1), J.-P. Lorand (3), and S. Y. O'Reilly (2)

(1) CNRS - Université Montpellier 2, Géosciences Montpellier, Montpellier, France (marguerite.godard@univ-montp2.fr), (2) GEMOC, Macquarie University, Sydney, Australia, (3) Laboratoire de Minéralogie, CNRS & Muséum National d'Histoire Naturelle, Paris, France

During ODP Leg 209, a magma-starved area of the Mid-Atlantic Ridge was drilled (Site 1274) in the vicinity of the Fifteen-Twenty Fracture Zone that offsets one of the slowest portions of the spreading ridge. Bulk rock geochemistry indicates that Site 1274 peridotites represent the most depleted peridotites sampled so far at a slow spreading ridge. Their composition can be explained by open system partial melting and incomplete melt extraction; nevertheless, observation of interstitial clinopyroxene (Cpx) and local variations in bulk trace element contents suggests the occurrence of a late melt freezing reaction with melts from different mantle sources (Godard et al, 2008).

Recent studies of mantle-derived peridotites have shown that several sulphide populations, characterised by different microstructural occurrences and elemental and isotopic compositions, coexist at the thin section scale. Thus by establishing the Re-Os isotopic systematic of the different sulphide populations together with an in situ trace element characterization of the associated silicates, we can shed some light on the intricacy of melt-extraction and melt-percolation processes beneath mid-ocean ridges.

Site 1274 peridotites show several sulphide populations. Sulphides 1 (Sulf-1) are either enclosed in relict Ol1 and Opx1, or form isolated round blebs of sulphide within the serpentine matrix (Ol1). Their mineralogical and microstructural features are mostly characteristic of sulphide residual after melting. Sulphide-2 are partly embayed in Opx1 porphyroclasts and show an abnormal Cu-rich composition more akin to the solidification products of a sulphide partial melt. Finally, a third type of magmatic sulphide (Sulf-3) formed of pentlandite and primary bornite occurs as large (100-500 $\mu$m) convoluted patches intimately associated with Cpx2. Microstructural features suggest that the Sulf3–Cpx2(±Spl2) assemblage represents the crystallization product of a Cu-Ni-rich sulphide-bearing melt, trapped under lithospheric conditions and post-dating the crystallization of Sulf-2. Despite its obvious metasomatic origin, the extremely low light REE content of the Cpx2 suggests that they crystallized from an ultra depleted melt not in equilibrium with melt produced locally.

187Os/188Os obtained by LA-MC-ICPMS on c.a. 60 individual sulphide grain vary between 0.1097 and 0.1396 encompassing the range obtained on separated sulphide grains and whole-rocks (Harvey et al., 2006). Thanks to the spatial resolution of the LA-MC-ICPMS we were able to recognize that the sulphide populations described above are characterized by distinct 187Re/188Os -187Os/188Os systematics. Sulf-1 and Sulf-2 define a broadly positive correlation between 187Re/188Os and 187Os/188Os similar to the one described for the sulphides in Kane FZ abyssal peridotites (Alard et al., 2005). We interpret this relationship as a mixing line between sulphides residual after melting (Sulf-1) and sulphide (Sulf-2A) precipitated from a partial melt. The age of the first melting increment of this mantle section is thus given by the TRD model ages obtained on Sulf-1 (2.16 ±0.30 Ga).

Sulf-3 shows constant non-radiogenic Os-isotope compositions (weighed mean = 0.11044±0.00019, n = 27) despite extremely variable 187Re/188Os (0.15-1.05). This indicates that Sulf-3 crystallization was recent, as no significant in-situ ingrowth of 187Os by 187Re decay has taken place. This is consistent with the microstructural occurrence of Sulf-3 and the quenched microstructure of Spl2-Cpx2 intergrowths. Although Sulf-3 are clearly metasomatic, they are significantly less radiogenic than Sulf-1. Such unradiogenic Os compositions require a long-term evolution in a Re-depleted reservoir (in agreement with the Cpx2'REE patterns). The minimum time required to develop such compositions is given by the TRD model ages of Sulf-3, c.a. 2.5±0.1 Ga.

Thus in the case of Leg 209 the oldest ages and most depleted signature are found in the metasomatic assemblage (Sulf-3-Cpx2). Such metasomatic melt must have been derived from the partial melting of an old (≥2.5 Ga, Archean) and highly depleted mantle.

REFERENCES: Alard, et al., 2005, Nature, 436: 1005-1008.; Godard et al., 2008, Earth & Planet. Sci. Lett., 267:410-425 ; Harvey et al., 2006, Earth & Planet. Sci. Lett., 244: 606-621.