Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 128
© 2000 Cambridge Publications

# In-situ Analysis of Highly Siderophile Elements and Re-Os Isotopes by LAM-ICPMS and LAM-MC-ICPMS Reveals the Residual and Mobile Nature of Mantle Sulfides

**Olivier Alard**[1], **William L. Griffin**[1], **Jean-Pierre Lorand**[2], **Norman J. Pearson**[1] & **Suzanne Y. O'Reilly**[1]

[1] GEMOC, School of Earth and Planetary Sciences, Macquarie University, Sydney, North Ryde, NSW, 2109, Australia
[2] Laboratoire de Mineralogie, Museum National d'Histoire Naturelle, Paris, France

The Platinum Group elements (PGE), Au and Re form a coherent group of highly siderophile and variably chalcophile elements, which behave very differently to lithophile elements during mantle processes and provide a different perspective on the formation and evolution of the lithospheric mantle. In addition, the Re-Os isotopic system may provide reliable melt depletion ages. The geochemistry of the highly siderophile elements (HSE) potentially carries large amounts of information on mantle processes and further understanding of the evolution of the lithosphere. However, the distribution and behavior of the HSE in the mantle is poorly understood. Although base metal sulfides are thought to be the main host for these elements, little attention has been paid so far to sulfide abundance, distribution, mineralogy and microstructural sites in mantle samples. Further understanding of HSE behaviour in the mantle will depend on studies of the relationships between HSE distribution, Re/Os isotope systematics, and the abundance and composition of sulfide phases. We have developed in-situ techniques using the Laser Ablation Microprobe linked to quadrupole ICP-MS (LAM-ICPMS)or Multicollector-ICP-MS (LAM-MC-ICPMS) in order to further investigate distribution of HSE ( et al., 2000) and variability of Os isotopes (Pearson et al., this volume) in mantle sulfides, respectively. The main results of these studies are:

1: The extreme variability of the chondrite-normalised HSE patterns; Pd/Ir ranges from 0.002 up to 48.

2: The high solubility of PGE in base metal sulfides (BMS); Os and Ir contents in mono-sulfide solid solution (MSS) can be as high as 1000 ppm. These data confirm the extreme compatibility of such elements in the BMS of mantle peridotites, and emphasise that the Os budget of mantle rocks is completely controlled by the sulfide phases.

3: The HSE patterns define two groups, which reflect differences in major element chemistry and microstructure. MSS enclosed in silicates show high Os and Ir contents but low to very low Pd/Ir. The chemistry, occurrence and HSE patterns of these enclosed sulfides suggest that they are residual following partial melting. This type of sulfide has nonradiogenic Os isotope compositions, consistent with ancient melt depletion and isolation from the convecting asthenospheric mantle for time periods similar to the age of the overlying crust. Enclosed sulfides may be found in rocks showing textural and mineralogical evidence of extensive melt/rock reactions suggesting that the silicates have efficiently shielded the enclosed sulfide from reaction (Burton et al., 1999). In contrast, interstitial sulfides, which typically are lower in S but higher in Cu (e.g. Cu-rich pentlandite) than the enclosed MSS, have low Os-Ir contents but high Pd/Ir. These sulfides usually dominate in samples having high S contents (330 to 600 ppm), and are interpreted as being metasomatically introduced. Their $^{187}Os/^{188}Os$ display radiogenic values up to 0.175. and they have extremely variable $^{187}Re/^{188}Os$. Both types of sulfide often occur in the same sample; such samples may have normal sulfur contents (e.g. S< 200 ppm). The interstitial sulfides are likely to have been added either via volatile-rich metasomatism (e.g. Mtf 37, Figure 1), or through asthenosphere-lithosphere interaction as inferred for the high-T garnet-rich sheared peridotite xenoliths from the Kaapvaal Craton (e.g. FS-8, Figure 1).

The in-situ analysis of PGE and Os isotopes provides crucial information on the behaviour and distribution of the HSE and on the evolution of the lithosphere (depletion/metasomatism). However, care must be exercised in interpreting whole rock PGE and Re/Os data without detailed information on sulfide mineralogy and abundance. Since many of the mantle samples studied here contain sulfides having both Pd-enriched and Pd-depleted patterns, and both radiogenic and nonradiogenic Os, we suggest that many of the whole-rock analyses reflect mixing between several sulfide generations. It is therefore hazardous to draw conclusions on Earth formation and differentiation processes based upon whole rock PGE abundances or Os isotopes.

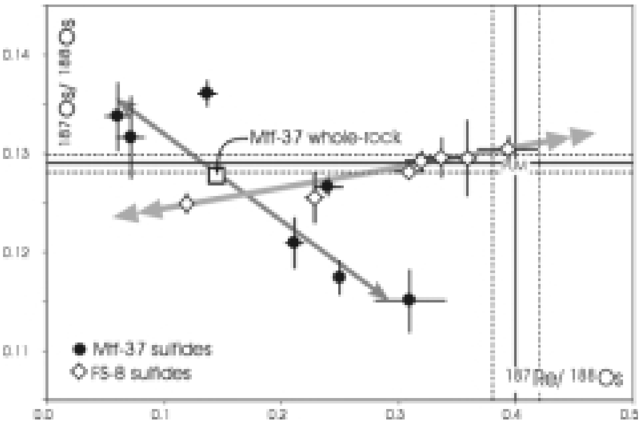

Figure 1: $^{187}Os/^{188}Os$ versus $^{187}Re/^{188}Os$ for individual sulfides grains in a peridotite xenolith from Montferrier, Languedoc, France (Mtf-37) and in a garnet-rich sheared peridotite xenolith FS-8 (T=1250ºC) from Kaapvaal Craton.

Alard O, Griffin WL, Lorand JP, Jackson SE & O'Reilly SY, *Nature*, **Submitted**, (2000).

Burton KW, Schiano, P, Birck, JL & Allègre CJ, *Earth planet. Sci. Lett*, **172**, 311-322, (1999).

Meisel Th, Walker RJ, Irving AJ & Lorand JP, *Ceochem. Cosmochem. Acta*, **Submitted**, (2000).