Geochemical fingerprinting of the lithospheric mantle using high-precision olivine analyses

D. A. Ionov[1,2] and A. V. Sobolev[2,3]

[1]UMR-CNRS 6524, Departement de Geologie, Universite J. Monnet, 42023 Saint-Etienne cedex2, France (*correspondence: dmitri.ionov@univ-st-etienne.fr)
[2]MPI fuer Chemie, Postfach 3060, 55020 Mainz, Germany
[3]Vernadsky Inst. Geochemistry, Russian Acad. Sci., Kosygin 19, 117975 Mocsow, Russia (sobolev@geokhi.ru)

Olivine is the dominant mineral in the lithospheric mantle. Worldwide compilations of Mg# $[Mg/(Mg+Fe)_{at}]$ and minor components in olivine generally show broad scatter related to low precision of routine electron probe data and complexities of mantle processes. We have obtained high-precision Mg# and abundances of Ni, Mn, Co, Ca, Al and Cr in olivine from ~400 mantle peridotites on a Jeol JXA8200 electron probe using high sample current, extended counting time and continuous monitoring [1]. Trace element abundances in olivines were obtained by laser ablation ICPMS. The samples are xenoliths in basalts, andesites and kimberlites as well as abyssal and massif peridotites with a broad range of modal, major- and trace-element whole-rock compositions.

Spinel peridotite xenoliths in intra-plate basalts, abyssal and massif peridotites that show little or no metasomatism (i.e. no volatile-bearing minerals and no Fe-enrichments [2]) define a negative linear trend (r^2 ~0.97) on a Mg#-MnO plot from $Mg\#_{ol}$ ~0.891 and MnO_{ol} ~0.148% to $Mg\#_{ol}$ ~0.922 and MnO_{ol} ~0.115%, with Fe/Mn_{ol} decreasing from 72 to 68. The positive Mg#-NiO correlation is poor (r^2 ~0.45), possibly due to Ni partitioning to sulfides. Olivine in the most fertile garnet lherzolites (8-12% garnet) has higher Mg# (0.898) and Fe/Mn (75-81) and lower MnO (0.127%) than olivine in the most fertile spinel lherzolites due to preferential partitioning of Fe and Mn to garnet. Olivine in metasomatised spinel peridotites tends to have higher MnO and lower Fe/Mn (60-68) at given Mg# than for melting residues. Ca abundances are positively correlated to temperature and define a good geothermometer. The contents of incompatible trace elements in olivine decrease from fertile to refractory rocks, but olivine in garnet peridotites contains more Ti, V, Zr, Cu, Zn than in spinel peridotites. Overall, high-precision olivine analyses may constrain degrees and conditions of partial melting and/or metasomatism, tectonic settings, modal compositions and equilibration conditions of mantle peridotites.

[1] Sobolev *et al.* (2005) *Nature* **434**, 590-597. [2] Ionov (2007) *CMP* **154**, 455-477.

Highly siderophile elements and $^{187}Os/^{188}Os$ in the parental melts of Hawaiian picrites

T.J. Ireland* and R J. Walker

Department of Geology, University of Maryland, College Park, MD 20742 USA (*correspondence: tireland@geol.umd.edu)

Absolute and relative abundances of the highly siderophile elements (HSE: including Os, Ir, Ru, Pt, Pd and Re) were measured in 54 Hawaiian picrites (MgO >13 wt%) and 6 tholeiitic basalts (~7 to 12 wt% MgO) from nine volcanic centers (Mauna Kea, Mauna Loa, Hualalai, Loihi, Koolau, Kilauea, Kohala, Lanai and Honomanu). The parental melts for all the volcanic centers are estimated to contain ~16 wt% MgO. Samples with higher MgO contents contain accumulated olivine. Samples with lower MgO contents have lost olivine.

The HSE abundances for the parental melts of each volcanic center are estimated by consideration of the intersections of HSE-MgO trends with 16 wt% MgO. The estimated HSE abundances in the parental melts of most of the volcanic centers are very similar: 0.5 ± 0.2 ppb Os, 0.45 ± 0.05 ppb Ir, 1.2 ± 0.2 ppb Ru, 2.3 ± 0.2 ppb Pt, and 0.35 ± 0.05 ppb Re. All Hualalai samples contain higher absolute abundances of Os, suggesting a parental melt with ~1.1 ppb Os. This difference is the only hint of a discernible HSE heterogeneity that can potentially be linked to the mantle source. Effects of crustal contamination and volatile losses on parental melt compositions were likely minor, except for Re and possibly Ir.

Two types of HSE patterns are observed among the various picrites. One type of pattern is characterized by greater fractionation between Os, Ir, Ru versus Pt and Pd, with higher Pt/Ir and Pd/Ir ratios compared to the other type of pattern. Both pattern types are present in most of the volcanic centers. The differences between the two patterns are attributed to the inter-relationship between partial melting and crystal-liquid fractionation processes, and mirror both differences in residual sulfides and the loss of sulfides during magma ascent. These residual sulfides mask any source heterogeneities in terms of HSE.

The $^{187}Os/^{188}Os$ ratios of our suite of picrites range from ~0.129 (Mauna Kea) to ~0.138 (Lanai). There is no resolvable correlation between $^{187}Os/^{188}Os$ and Os (or other HSE) abundance estimated for parental melts, as might be expected if isotopic variations reflect the presence of variable proportions of recycled oceanic crust added to a common source, as has been commonly proposed.