Non-Chondritic Ratios of Os, Re, Ir, Ru, Rh, Pd and Au in Orogenic Lherzolites from Lanzo (Italy) and Ronda (Spain); Inferences on HSE Systematics of the Terrestrial Mantle

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The high contents and approximately chondritic relative abundances of Pd, Ir, Re, Os and Au in continental mantle peridotite xenoliths suggest that the upper mantle is not in equilibrium with the core with regard to the highly siderophile elements. Many authors therefore proposed that the highly siderophile element (HSE) content of the upper mantle was delivered with a late accretionary component (about 0.5 % unfractionated chondrite-like material) which never attained equilibrium with the core. Spettel et al. (1991) found differences in Ir of a factor 2 between mantle xenoliths from various provenances, which they attributed to incomplete mixing of a late accretionary component in the primitive mantle. Meisel et al. (1996) defined a primitive upper mantle (PUM) reservoir with an $^{187}Os/^{188}Os$ ratio (0.1290±0.0007) in the range of enstatite or ordinary chondrites, thus supporting the late-veneer hypothesis. If upper mantle HSE patterns are indicative of such a late accretionary component, then highly siderophile element ratios should be uniformely chondritic (i.e., unfractionated). Recently, 20-40% overabundances of light PGEs (Ru, Rh, Pd) relative to chondritic PGE ratios have been reported in orogenic lherzolites tectonically emplaced into the crust, in Mesozoïc ophiolitic peridotites and in modern abyssal peridotites.

In this paper, we report new HSE data on weakly to partly serpentinized spinel and plagioclase lherzolite samples from the Lanzo and Ronda orogenic massifs (Schmidt and Palme, 1996). These samples were analysed using neutron activation (NAA) which allows all the HSE, i.e. platinum-group elements, Au and Re to be analysed simultaneously (Schmidt et al., 2000). The Lanzo and Ronda orogenic massifs were selected because they sampled the upper mantle in quite different environments. Lanzo plagioclase lherzolites are Mesozoïc equivalents of the Atlantic MORB source mantle and provide good on-land analogs of abyssal peridotites. Ronda spinel-plagioclase lherzolites are interpreted as middle proterozoïc asthenospheric diapir accreted to the sub-continental lithospheric mantle 1.3 Ga ago (Reisberg and Lorand, 1995) which were then percolated by asthenosphere-derived volatile-rich small-melt fractions and strongly deformed just before or during the final emplacement of the massif into the crust, about 22 Ma ago (e.g. Van der Waal and Bodinier, 1996). These samples may help to study how late-magmatic and hydrothermal geological processes could have altered the primary mantle HSE patterns.

Nine plagioclase/spinel lherzolites from Lanzo (Italy) and Ronda (Spain) were analysed for Re, Os, Ir, Ru, Rh, Pd, and Au using neutron activation after NiS fire-assay. All samples show similar enrichments of Rh and Pd over Os and Ir as were recently observed in abyssal peridotites and orogenic lherzolites. The Pd/Ir and Rh/Ir ratios are very similar in both suites (2.46±0.32 vs. 2.42±0.21 and 0.46±0.07 vs. 0.45±0.10, respectively). The Ru/Ir ratio is slightly higher at Ronda (2.25±0.25) than at Lanzo (1.99±0.14). The Os/Ir ratios range from chondritic values at Lanzo (1.09±0.13) to higher than chondritic at Ronda (1.37±0.17). Re and Au variations in both suites indicate mobilization by hydrothermal fluids. The higher Os contents of the Ronda lherzolites are interpreted in terms of high-temperature mobilization by volatile-rich small-melt fractions. Our study provides additional indications for non-trivial variations of Rh/Ir and Pd/Ir ratios throughout the upper mantle, irrespective of geological processes that occur in the lithosphere.