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GEOCHEMISTRY OF S, CU AND NOBLE METALS (PGE+AU) IN THE SOUTHWESTERN PART OF THE RONDA PERIDOTITE MASSIF, SOUTHERN SPAIN

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ABSTRACT

Thirty peridotites and eleven pyroxenites collected in the southwestern part of the Ronda peridotite massif have been analysed by iodometric titration, XRF and ICPMS to investigate the effect of the regional porous flow percolation process documented by Van der Wal and Bodinier (1996) on chalcophile/siderophile elements. The peridotites come from the different petro-structural domains now recognised within the Ronda peridotite. These are garnet/spinel peridotites (fertile lherzolites to harzburgites) from the Spinel Tectonite domain, the old (presumably middle Proterozoic; Reisberg and Lorand, 1995) sub-continental lithospheric protolith, lherzolites, harzburgites and dunites from the Granular Domain that extensively recrystallized during a young (Cainozoic?) regional melt percolation and lithospheric erosion event and plagioclase lherzolites from the Plagioclase Tectonite domain, which is a solid-state recrystallization feature resulting from the crustal emplacement of the massif. Each of the three sub-domains defined by Van der Wal and Bodinier (1996) in the Granular Domain has been investigated, i.e. the Coarse-Granular domain (CGD), where melt accumulation below the Recrystallization Front generated extensive recrystallization and silicate grain growth, the Fine-Granular domain (FGD), an area of melt entrapment and cpx-producing reactions (cpx2), and the Layered Granular domain (LGD) which display elongated bodies or layered-like olivine-rich lherzolites, harzburgites and dunites, sometimes rich in chromite, cpx2 and low Ti magmatic amphibole maybe present around spinel. Such olivine-rich lithologies (Mg#=0.88-0.9) may represent channels where percolating melts were focused at high-T, producing olivine by reaction with the pyroxenes (e.g., Bodinier et al., 1999).

Our analyses reveal a much greater complexity in the Cu, S and PGE patterns than previously reported in the Ronda peridotites. This diversity clearly results from the superimposition of several magmatic processes in the mantle. All the lherzolites show S (150-250 ppm), Cu (20-30 ppm) and PGE concentration ranges (0.004-1.2 x CI-chondrites) mostly inherited from the ancient melting event that affected the protolith. Like many orogenic and oceanic lherzolites, they are light PGE-enriched (Ru_N/Ir_N = 1.6-2.6; Rh_N/Ir_N = 0.38-0.48; Pd_N/Ir_N = 1.3-2.4; N = chondrite-normalised). Rather good positive correlations are preserved between S, Cu and fertility indices (r = 0.9) in cpx2-free samples. Palladium and fertility indices behave sympathetically; negatively-slopping CN normalised PGE patterns have survived in some CGD cpx-poor lherzolites and FGD harzburgites. Meanwhile coupled Pd, Cu and S enrichments are observed in cpx2-bearing samples, The olivine-rich LGD peridotites display the greatest diversity of PGE contents and PGE relative abundances. Chrome spinel dunites are strongly impoverished in all chalcophile/siderophile elements but Ru (Ir = 0.001 x CI chondrites; S< 15 ppm; Cu < 5 ppm). CGD and LGD cpx2-rich dunites display positively trending CN PGE patterns (Pt_N/Ir_N = 8; Pd_N/Ir_N = 11), very little S-enrichments and discrete PGE-bearing phases (moncheite) or Ni arsenides (nickeline). Channelled melt percolation at high T generated the conditions of S-undersaturation that enables a full extraction of PGE from the percolated peridotites.

Preliminary data on the pyroxenites support this scheme of percolating melts becoming progressively S-undersaturated and PGE-enriched during the melt percolation event. Type C Ti-rich websterites (asthenospheric alkaline melts according to Garrido and Bodinier, 1999) are S-rich (700 ppm) but PGE-poor (Cu_N/Pd_N > 1; S_N/Pd_N > 1 ;N = protolith normalised). Type D Cr-rich clinopyroxenites, the latest pyroxenite type, are richer in PGE (up to 55 ppb) but much lower in S and Cu (Cu_N/Pd_N < 0.2; S_N/Pd_N < 0.04).

A peculiar Au-, Pd- and As-enrichment trend proportional to the distance from the Recrystallization Front is observed in the harzburgites from the Spinel Tectonite domain. It is ascribed to upward-migration of S-poor but volatile-rich small-melt fractions that escaped from the Granular Domain. Local concentrations of these small-melt fractions could have probably given rise to the PGE-rich Cr-As-Ni mineralizations of magmatic origin that characterise the Ronda peridotite massif (Gervilla and Leblanc, 1990). The type D pyroxenites are likely precursor of these mineralizations.

However, another Au enrichment trend (up to 6 x protolithic values) uncorrelated to the other noble metals also characterise lherzolites and harzburgites from both sides of the recrystallization front. Gold abundances in these rocks would record a widespread circulation of late-magmatic (oxidising) fluids through the south-western part of the Ronda peridotites during the latest stages of the melt percolation process. Because of numerous analogies between our Ronda data and similar rocks in ophiolitic complexes, our study could provide clues to understand the behaviour of chalcophile/siderophile elements in fossil oceanic lithospheres submitted to melt/rock reactions above subduction zone.

REFERENCES

Bodinier J.L, Remaïdi M., Gervilla F., Leblanc M. and Lorand J.P., 1999. Channelling of reactive porous flow at the asthenosphere-lithosphere boundary: Evidence from the Ronda peri-

dotite. Contrib. Mineral. Petrol., (submitted).
Garrido C. and Bodinier J.L., 1999. Diversity of mafic rocks in the Ronda peridotite: evidence for pervasive melt/rock reaction during heating of subcontinental lithosphere by upwelling asthenosphere. J. Petrol. In press.
Gervilla F. and Leblanc, M. 1990. Magmatic ores in high-temperature alpine-type lherzolite massifs (Ronda, Spain, and Beni Bousera, Morocco). Econ. Geol., 85: 112-132.
Reisberg L. and Lorand J.P., 1995. Longevity of sub-continental mantle lithosphere from osmium isotope systematic in orogenic peridotite massifs. Nature, 376 (13): 159-162.
Van der Wal D. and Bodinier J.L., 1996. Origin of the recrystallization front in the Ronda peridotite by km-scale pervasive porous flow. Contrib. Mineral. Petrol., 122: 387-405.