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GARNET TO SPINEL FACIES TRANSITION AND RELATED METASOMATISM IN THE MANTLE WEDGE OF SOUTHERN PATAGONIA (PALI AIKE)

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ABSTRACT

The Pali Aike volcanic field (longitude 67.7°W, latitude 52.1°S) is the only occurrence in extra-Andean Patagonia (back-arc) recording garnet- to spinel-peridotite facies transition.

Garnet-facies peridotites are lherzolites with dominantly protogranular texture. In some cases garnet is accompanied by Cr-rich spinel. Spinel-facies peridotites are distinguished into: i) harzburgites with Cr-rich spinel and secondary recrystallised texture and ii) harzburgites and lherzolites with protogranular texture. Hydrous phases (phlogopite and pargasite) and glass may occur in all the peridotite facies. In the garnet-facies samples, garnet is always surrounded by a kelyphitic rim of minute crystals of opx, cpx and brown, euhedral Al-rich spinel, representing the breakdown reaction ol + gnt = sp + opx + cpx.

The garnet peridotites equilibrated in the range 985 ÷ 1190°C and 2.2 ÷ 2.7 GPa. When they contain Cr-spinel, equilibration range is 895 ÷ 1165°C and 1.7 ÷ 2.3 GPa. Protogranular spinel peridotites have significantly lower temperatures of equilibration than the secondary recrystallised, but similar pressure (T = 730 ÷ 970°C and P = 1.43 ÷ 1.9 GPa as compared with 1010 ÷ 1143°C and P = 1.2 ÷1.6 GPa) (Fig. 1).

Major element variations with respect to fertility indexes display correlations consistent with melting and basalt extraction. Samples containing metasomatic phases deviate from the main trend toward lower CaO and higher TiO_2 concentrations. The REE patterns vary from LREE depleted and flat from MREE to HREE, to variably LREE enriched. The LREE-enriched profiles vary from spoon-shaped, with inflections at Nd or Eu, to extremely fractionate. These latter predominate in the spinel-facies peridotites. In bulk rock Sr and HFSE (Nb, Hf, Ti, Zr) concentrations increase at decreasing MgO concentration, as expected from a depletion process caused by basalt removal. In most cases the HFSE anomalies are modest and vary from positive to negative. Only the samples which contain metasomatic phases show marked positive anomalies in HFSE (Ti/Ti^* = 1.30 ÷ 10.91, Zr/Zr^* = 2.51 ÷ 7.89). Sr and Nd isotopic composition of whole rocks, clinopyroxene and phlogopite separates show a variation range of ε_{Nd} = 3.12 ÷ 20.03 and ε_{Sr} = -2.83 ÷ -23.65, respectively (Fig. 2). Most of the samples plot within or close to the mantle array. The field of the host basalt is contained in the xenolith range but it is much less variable. Two samples deviate from the variation trend toward high $^{87}Sr/^{86}Sr$ values. Lead isotopic determinations on bulk rock and clinopyroxenes define an array overlapping the field of the host basalt, the Nazca sediment and the Pacific MORB.

The observed REE profiles are traditionally explained by a chromatographic fractionation of fluid or melt percolating a previously depleted mantle. The LREE enrichment and the absence of significant HFSE anomalies in most peridotites suggest that these features are characteristics of the metasomatic component. They are typical of OIB melts and characterise also the host basalt, which has, furthermore, similar incompatible trace element ratios and isotope composition overlapping part of the peridotites. These evidences strongly support the hypothesis that the host basalt was an important metasomatic component. However, the different behaviour of some elements (mainly LILE) in modally metasomatised samples and the isotopic signatures suggest a contribution from slab-derived components.

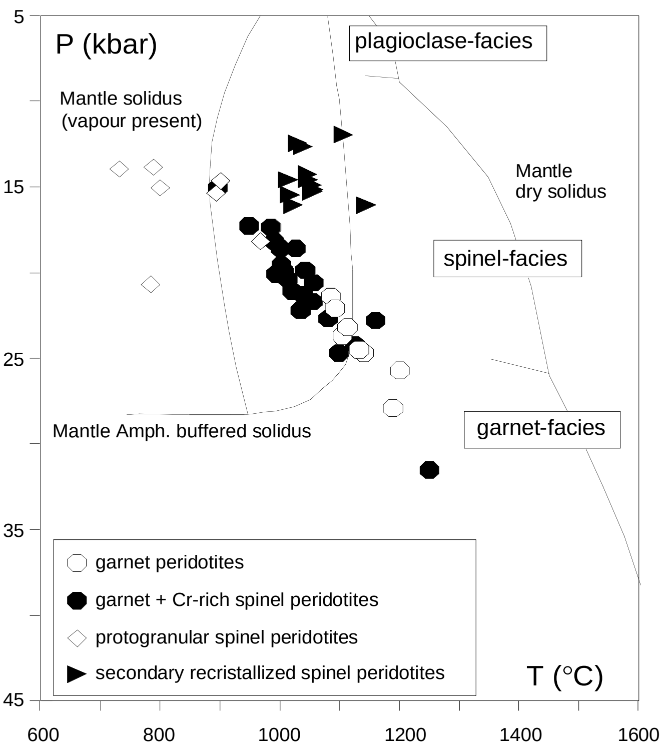

Figure 1 - Temperatures and pressures of the investigated xenoliths.

We suggest that the Pali Aike mantle column (straddling the garnet- spinel-facies boundary) has been repeatedly infiltrated by metasomatic agents, consisting of slab-derived components and, later on, alkali basalts. These latter underwent chromatographic fractionation under the observed T, P gradient and variously overprinted previous metasomatic signatures.

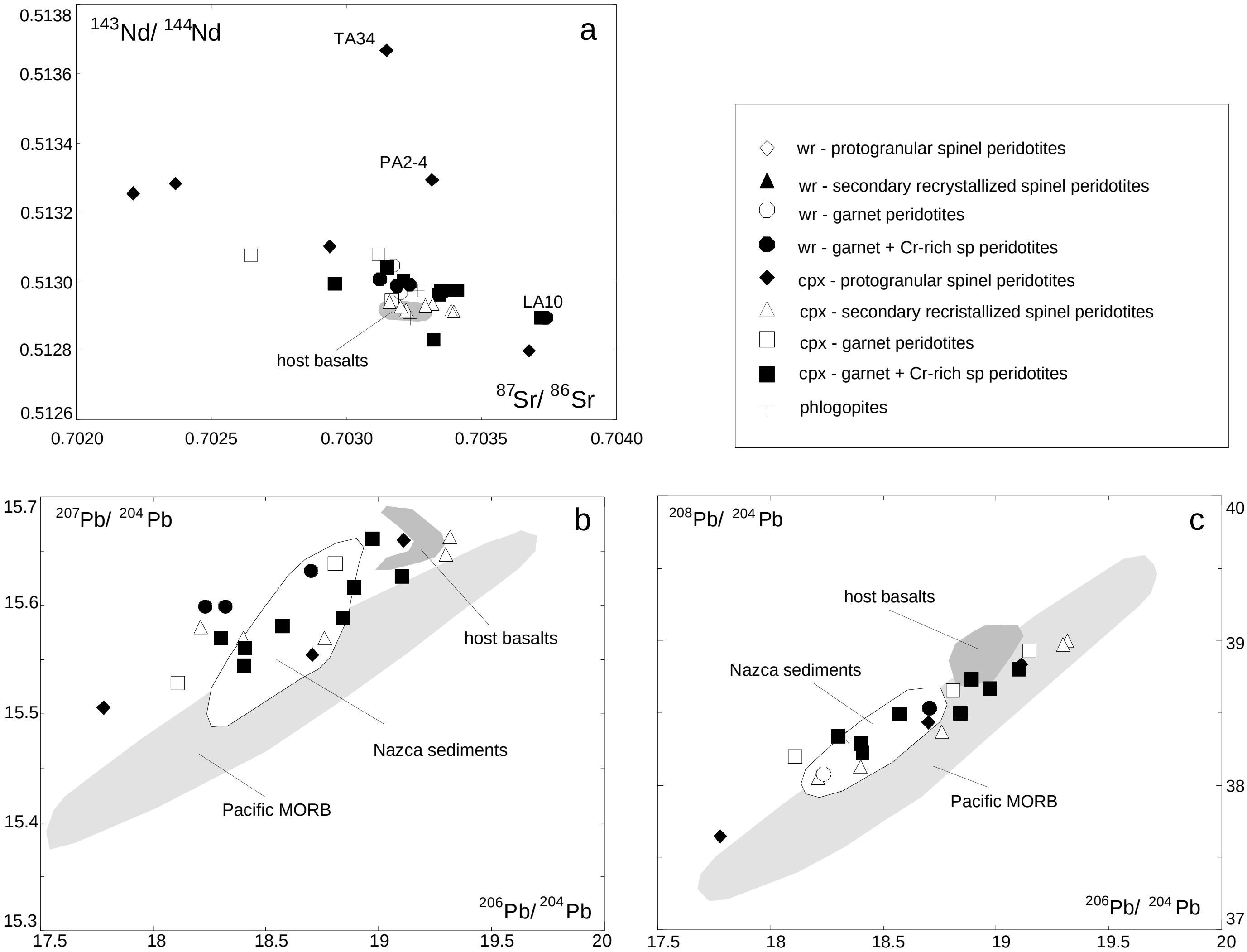

Fig. 2 - Plots of $^{87}Sr/^{86}Sr$ vs. $^{143}Nd/^{144}Nd$ (a) $^{206}Pb/^{204}Pb$ vs. $^{207}Pb/^{204}Pb$ (b) and vs. $^{208}Pb/^{204}Pb$ (c) for Pali Aike minerals and whole rocks.