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Zr-enriched clinopyroxenes from Cerro del Fraile mantle xenoliths (Southern Patagonia)

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Anhydrous spinel-bearing mantle xenoliths from Cerro del Fraile (Southern Patagonia, Argentina) have been studied with the aim of understanding the nature of metasomatizing agents which affected this lithospheric section. The studied area is located less than 25 km eastward of the main Andean volcanic zone, and its proximity to the arc trench represents a good opportunity for sampling suprasubduction mantle material. Host basalt composition as reported by Kilian & Stern (2002) has intermediate features between an alkaline and an arc-related basalt, resembling the Kamchatka NEAB (Nb-Enriched Arc Basalts) defined by Kepezhinskas et al. (1996).

Xenoliths are mainly constituted by lherzolites (Ol% 87- 48), with a minor amount of harzburgites, and orthopyroxenites. Few samples are composite, with clino- and orthopyroxenite veins cutting an harzburgitic or dunite matrix. Second generation protogranular and polygonal are the most common textures among the xenoliths, testifying at least one deformation and recristallisation event for the sampled lithospheric column. All textures are characterized by medium to coarse grain size, with olivine and orthopyroxene (opx) reaching 7-10 mm in diameter. In some samples opx shows reacted rims when it comes into contact with small veins infiltrating the xenoliths.

Two different kinds of clinopyroxene (cpx), always smaller than olivine and opx, can be found: the first is represented by large primary clean matrix crystals (cpx1), and the second comprises large and/or small cloudy to spongy minerals. Spongy rims consist of micrometric assemblage of secondary crystals of cpx, olivine and spinel. Spinel is the only aluminous phase, and can be found both enclosed in olivine and associated

with cpx. When associated to spongy cpx spinel forms spongy rims or develops into a pseudomorph cluster of smaller, darker individuals.

Fo in primary olivine of harzburgites and lherzolites vary from 90.3 to 87.8, but decreases quickly (down to 78.2) toward the veins and/or the xenolith-host basalt contact. In the same lithologies opx have similar mg# (89.5-91.3), and as for olivine, this index decrease toward the veins. Opx in the orthopyroxenite have lower mg# (77.4, far from wall rock-86.8, close to wall rock) and SiO_2 and higher Al_2O_3 contents. Mg# of cpx1 varies from 91.8 to 93.5, and decrease to 87.7 close to the orthopyroxenite and to 89.5 close to basaltic veins. Spongy cpx and cpx of clinopyroxenite vein have higher TiO_2, Al_2O_3, Na_2O, and lower CaO respect to primary cpx; Cr_2O_3 is comparable between cpx1 and cpx in the clinopyroxenite but is higher in the spongy cpx.

Primary cpx can be divided into two groups according to the trace element content. The first group is the most common and consist of LREE-enriched cpx characterised by a spoon-shaped pattern, with $(La/Sm)_N$ ranging from 7.51 to 1.42 and $(Sm/Yb)_N$ always lower than unity at Yb about 6xChondrite. Zr/Zr* [Zr*= $(Nd_N+Sm_N)/2$] varies from 0.29 to 0.78, and Sr/Sr* [Sr*= $(Pr_N+Nd_N)/2$] from 0.39 to 3.41. The cpx of the second group are variably enriched in LREE but do not have a spoon shape pattern [$(La/Sm)_N$ = 8.75-8.92 and $(Sm/Yb)_N$ = 1.30-1.61], Sr/Sr* varies from 0.29 to 0.61 and they display a marked negative Ti anomaly. Spongy cpx have similar HREE content, higher LREE values [$(La/Sm)_N$ = 4.67-7.20 and $(Sm/Yb)_N$ = 0.56-1.68] but an ubiquitous Zr positive anomaly (Zr/Zr*= 1.65-2.84). Cpx from the clinopyroxenitic vein have a flat trace element pattern, with $(La/Sm)_N$ ranging from 1.10 to 1.56 and $(Sm/Yb)_N$ from 1.11 to 1.17 at Yb about 7xChondrite, and they are characterized by a noticeable Sr positive anomaly (Sr/Sr*= 2.77-6.72). All cpx are enriched in U and Th, with values ranging from 0.09 to 0.67ppm and from 0.31 to 2.49ppm, respectively.

Zr and Sr positive anomalies, together with the high Th and U contents, may indicate an interaction between a subduction-related melt and the lithospheric mantle beneath the area, in agreement with what already reported from various localities in Southern Patagonia (Kilian & Stern 2002; Rivalenti et al., 2004). The transit and interaction of silica-saturated melt is also suggested by the presence of orthopyroxenite veins and xenoliths.

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