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Petrology of mantle peridotites and orthopyroxenite cumulates from Cerro del Fraile, (Argentina)

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The southernmost part of the South American continent has seen a very complex evolutionary history, dominated by the subduction of Nazca and Antarctic plates beneath the South American plate from the late Cenozoic to present day. The subduction of the Chile Ridge resulted in differential subduction angles and sinking speeds of the two plates together with the development of a slab-window, which enabled asthenospheric upwelling and extensive eruption of plateau lavas from late Miocene to recent times (Kilian et al., 1999; Wang et al., 2007). During Pliocene to Quaternary the Antarctic plate was slowly subducted (2-3 cm/y) and partially melted, generating adakitic melts (Kilian & Stern 2002).

Ultramafic xenoliths found in Quaternary lava flows and diatreme breccias at Cerro del Fraile, 25 km east of the main AVZ (Austral Volcanic Zone), represent fragments of the mantle wedge above the downgoing slab, providing valuable material in the study of the interaction between slab melts and peridotite. They mainly consist of lherzolites, with minor harzburgites and plagioclase-bearing orthopyroxenites. One composite sample is characterized by dunitic domains cut by orthopyroxenite veins. According to Mercier & Nicolas (1975) most of the mantle xenoliths are protogranular with superimposed metasomatic textures. Based on the grain size, xenoliths are medium to coarse-grained and fall within the C-type group (Arai et al., 2004). Opx can be found in two textural occurrences: i) it forms large irregular crystals often clustered in groups, with triple junctions and well-developed exolution lamellae or ii) it presents smaller grain size, disseminated between olivines, and does not show exolution lamellae. Cpx can be found as primary, smaller in size and often cloudy or as

secondary crystals within melt patches. Spinel is dark brown with subhedral shape when enclosed in ol and/or opx, or as vermicular aggregates when associated with cpx and opx.

Plagioclase-bearing orthopyroxenites present ortho-cumulitic texture. Euhedral to subhedral brown opx are large (up to 4 mm) containing many small spinels and showing fibrous rims which underwent uralitisation processes. Plagioclase is found as large crystals filling the intercumulus space together with small crystals of secondary ol, cpx, ilmenites and rhönites.

Both primary cpx (cpx1) and cpx in melt patches (cpx2) in peridotites have mg# ranging from 88.5 to 93.6, while cpx of pyroxenites show lower mg# (74.1–77.0). Mg# of opx in the peridotitic matrix ranges from 88.0 to 91.4 while opx in pyroxenites are characterized by lower and more variable mg# (71.9-86.9) and SiO2 (49.8-55.0). In Chondrite-normalized REE diagrams cpx1 can be divided into two groups. Group1 presents convex downward pattern shapes from Gd to Lu, and shows variable enrichments from Eu to La: (La/Yb)N varies from 0,05 to 4,04. The group is characterized by positive Sr anomalies, variable but high Th and U contents, an increasing positive Zr-Hf anomalies and a narrow range of Ti/Ti* (0,48 – 0,81). With respect to Group1, Group2 cpx1 has lower HREE at comparable LREE, leading to higher (La/Yb)N (1,83 – 14,23). It is characterized by the highest Th and U contents (up to 86 x Ch), Sr anomalies variable from negative to slightly positive, the widest Zr-Hf positive anomalies and remarkable Ti negative anomalies (Ti/Ti*= 0,04 – 0,75).

Two types of opx can be found in the peridotites, even in the same sample: the first, more abundant, is characterised by depleted HREE patterns (Dy=0.14-0.43 xCh; Lu= 0.55-1.83 xCh), negative anomalies of Sr (Sr/Sr*= 0.26-0.67) and flat LREE. The group's (La/Yb)N ranges between 0.01 and 0.70. The second group presents identical HREE values but Sr anomalies vary from negative to positive (Sr/Sr*= 0.22-1.55); this group is also enriched in LREE, with (La/Yb)N ranging from 1,18 to 2,81. Opx of pyroxenites are very different, with flat REE patterns at about chondritic values and Sr and Ti contents higher than those of peridotites' opx. Host basalts are basaltic-trachyandesite, with mg# varying between 46.4 and 53.1. Their apparently slightly fractionated character seems in contrast with the presence of ultramafic xenoliths. Compositionally they are very similar to the Nb-enriched arc basalts reported by Kepezhinskas et al. (1996).

Geochemical compositions of cpx and opx in peridotite xenoliths are consistent with interaction and hybridization with a Si-Na-rich melt, deriving from the melting of the subducting Antarctic plate. Slab melt metasomatism produced both Na and LREE enrichment in pyroxenes and positive Zr-Hf anomalies in cpx. The melts hybridized with peridotites and reached the Moho, where they resided and fractionated orthopyroxenites. The slab-window allowed asthenospheric upwelling and incoming of OIB-like magmas, which mixed within the mantle wedge already contaminated by the subduction resulting in the formation of Nb-enriched trachybasalts that brought the xenoliths to the surface.

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