CARBONATED PERIDOTITE XENOLITHS FROM THE MANTLE WEDGE: THE PATAGONIA CASE

Angela Laurora*, Giorgio Rivalenti*, Maurizio Mazzucchelli*, Pierantonio Bottazzi, M. Adelaide Barbieri*, Carlos A. Cingolani***** and **Riccardo Vannucci****

** Dipartimento di Scienze della Terra, Università di Modena, P.le S. Eufemia 19, Modena, Italy.*

*** C.N.R.-Centro di Studio per la Cristallochimica e la Cristallografia (CSCC) and Dipartimento di Scienze della Terra, Università di Pavia, via Ferrata 1, 27100 Pavia, Italy.*

**** Centro de Investigaciones Geológicas, Universidad Nacional de La Plata, 644 Calle No. 1, 1900 La Plata, Argentina.*

ABSTRACT

Carbonated mantle xenoliths are mainly documented in intraplate environments. Here we provide evidence that carbonated mantle also occurs in the wedge of the back-arc region related with the Andean subduction. Along the whole length of the Argentinean Andes, this region is characterised by alkali basalt volcanic centres containing abundant mantle xenoliths. The xenoliths of the easternmost volcanoes bear evidence of mantle interaction with a CO_2-rich component. In the volcanic centre of Gobernador Gregores (Santa Cruz Province, Southern Patagonia) this interaction produces abundant carbonates. Here a large diatreme constituted by pyroclastic deposits contains mantle xenoliths up to 60 cm.

The peridotites are dominantly lherzolites and subordinate harzburgites, wherlites and dunites, whose texture varies from secondary-protogranular (recrystallized) to weakly foliated.

The relationships between the forming phases indicate the following events: an original mineral assemblage of olivine (ol_1), clinopyroxene (cpx_1), orthopyroxene and spinel (spl_1) is overprinted by a subsequent mineral assemblage, constituted by new clinopyroxene (cpx_2), pargasite and sometimes phlogopite; in turn, this mineral assemblage reacts with a further metasomatic agent which causes instability of cpx_2 and of the hydrous phases. As an effect of the latter episode, cpx_2 and hydrous phases are surrounded by pockets of carbonate plus silicate glass. Carbonate also occurs in veins at the crystal boundaries, as blebs in the silicate glass. Euhedral olivine (ol_2), clinopyroxene (cpx_3), spinel (spl_2) and rarely rutile crystallise from the silicate glass. Apatite occurs both in the silicate glass and in the carbonates.

Forsterite concentration in olivine varies from 87÷91 in ol_1 to 89÷93 in ol_2, which also contains high CaO (0.15÷0.80 wt%). Cpx_3 is characterised by higher Al_2O_3, CaO, TiO_2 and lower Na_2O with respect to cpx_2. Spl_2 contains higher Al_2O_3 and TiO_2 with respect to spl_1. Carbonate is calcite with $MgCO_3$ concentrations up to 4%. Glass composition varies from trachiandesitic to tefriphonolitic.

Trace element characteristics of clinopyroxenes vary markedly from cpx_1 to cpx_3 (Figs. 1a, b, c). Cpx_1 is LREE depleted, whereas cpx_2 is the richest in REE and has a fractionated REE pattern (La_N/Yb_N = 9.6÷14.8) with a maximum at Ce. Cpx_3 has a lower REE concentration with respect to cpx_2; its REE pattern (La_N/Yb_N = 1.8÷2.9) shows a maximum at MREE. HFSE anomaly are negative and variable in cpx_2 and cpx_3 (La_N/Nb_N, Ti/Ti* and Zr/Zr* range 6.77÷ 52.13, 0.02÷0.24, 0.08÷0.34 respectively in cpx_2 and 0.76÷0.88, 0.10÷0.16, 0.14÷0.22 respectively in cpx_3). Amphibole has REE patterns (Fig. 1d) similar to cpx_2 ($^{parg/cpx2}D_{REE} \approx 1$), but with marked positive Nb spikes ($^{parg/cpx2}D_{Nb}$ = 42.3÷148.4) and positive Ti and Sr anomalies ($^{parg/cpx2}D_{Ti}$ = 5.4÷8.2; $^{parg/cpx2}D_{Sr}$ = 1.7÷1.9). Zr is preferentially partitioned into amphibole ($^{parg/cpx2}D_{Zr}$ = 1÷1.5). Glass is LREE enriched and has smoothly fractionated patterns from La to Yb (La_N/Yb_N = 10.0÷29.6). It has remarkable positive Nb anomalies (La_N/Nb_N = 0.1÷0.6) - much higher respect to the associated amphibole ($^{parg/glass}D_{Nb}$ = 0.4÷ 0.7) - and generally negative Zr and Ti spikes (Fig. 1e).

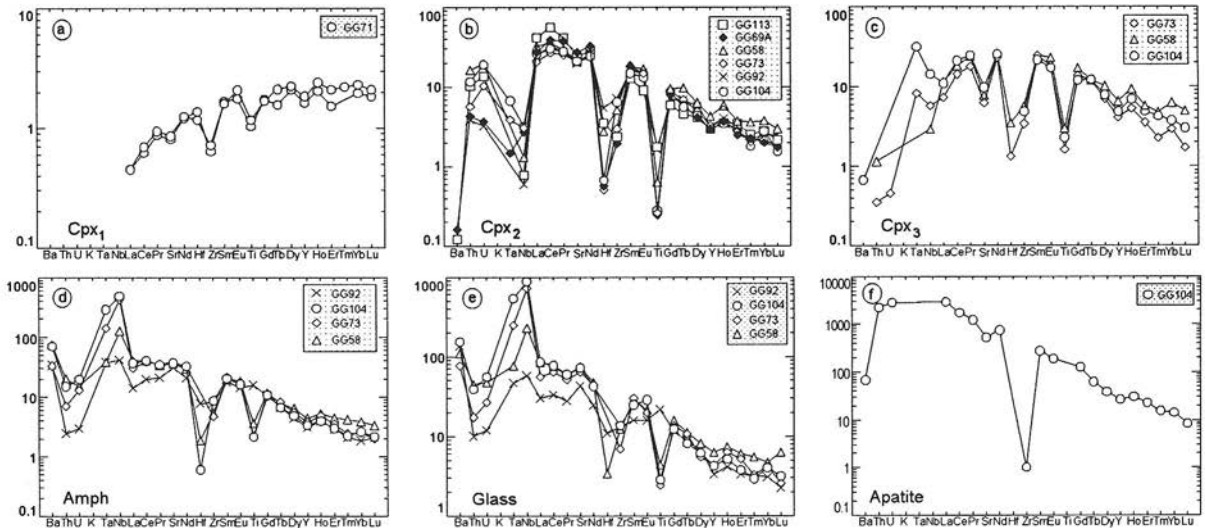

Fig. 1. - Incompatible trace element diagrams of (a) cpx1, (b) cpx2, (c) cpx3, (d) amphibole, (e) glass, (f) apatite.

Apatite has a very high LREE concentration ($La_N \approx 4300$) and $La_N/Yb_N \approx 3500$ (Fig. 1f).

The last metasomatic episode is mass balanced by the following reaction:

$1.00anf + 0.26opx + 0.02carb = 0.41cpx_3 + 0.05spl_2 + 0.36ol_2 + 0.46glass$.

The relationships above described indicate that litospheric spinel facies mantle was affected by metasomatic episodes consistent with the former addition of a hydrous component followed by a CO_2-rich component. The P-T range of these metasomatic events is 8.3 - 22.4 kbar and 890 - 1230°C (Fig. 2). Amphibole and cpx_2 instability increases with increasing T and P, so that the more marked carbonatation occurs in the higher T-P range.

Although the metasomatic agents, including the CO_2-rich one, are possibly related with dehydration and decarbonation of the slab, their provenience needs to be isotopically constrained, since Gorring et al. (1997) propose that at this latitude the slab had windows through which the mantle underlying the slab interacted with the wedge.

REFERENCES

Gorring M.L., Kay S.M., Zeitler P.K., Ramos V.A., Rubiolo D., Fernandez M.I., Panza J.L., 1997. Neogene Patagonian plateau lavas: Continental magmas associated with ridge collision at the Chile Triple Junction. Tectonics, 16: 1-17.

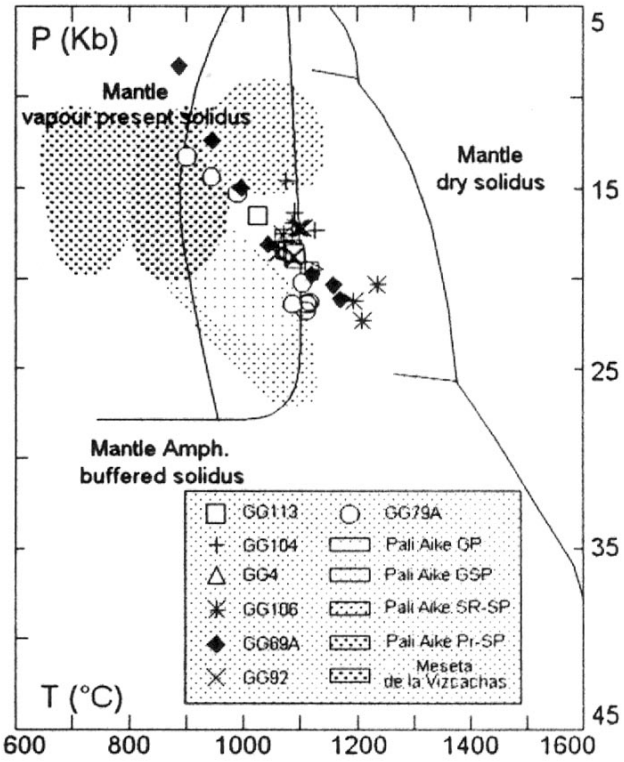

Fig. 2 - Temperatures and pressure of the investigated xenoliths.