

NA-ALKALI SILICATE METASOMATISM IN MANTLE XENOLITHS FROM SOUTHERN ALPS (VENETO VOLCANIC PROVINCE)

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ABSTRACT

The peridotitic xenoliths hosted by the Paleogenic lavas of the Veneto Volcanic Province (Southern Alps, Italy) are mainly constituted by spinel-bearing lherzolites, with subordinate harzburgites. All the xenoliths show protogranular textures represented by well-equilibrated assemblage of olivine, orthopyroxene, clinopyroxene and spinel. Superimposed pyrometamorphic textures are widespread, with the development of secondary phases in reaction relationships with primary paragenesis:

Type A texture is characterised by reaction areas around orthopyroxene (in contact with spinel), generating a secondary assemblage made up of small crystals of olivine, clinopyroxene, feldspar, spinel and glass in decreasing order of abundance.

Type B1 and B2 textures are similar to the previous one, but comparatively greater glass abundance within the secondary phases is observed. In B1 glass is usually black or dark brown in colour with skeletal feldspar often associated with it. In B2 glass is pale brown, with subehedral crystals of olivine, spinel, feldspar and clinopyroxene as reaction products.

Type C texture is constituted by spongy clinopyroxene, sometimes replaced by secondary assemblages of clinopyroxenes and glass.

In-situ analysis (EMP and SIMS) of the phases in the different textural domains allowed to constrain the metasomatic processes evidenced by the pyrometamorphic textures. Secondary olivines show a marked enrichment in FeO and CaO with respect to primary olivines. Primary clinopyroxenes are compositionally homogeneous from core to rim and show restricted ranges of Al_2O_3 (6.17-8.09 wt% in lherzolites; 4.00-6.56 wt% in harzburgites) Na_2O (1.16-1.86 wt% in lherzolites; 0.67-1.37 wt% in harzburgites) and TiO_2 (0.36-0.58 wt% in lherzolites; 0.05-0.62 wt% in harzburgites) contents. The primary clinopyroxenes in lherzolites are unzoned with LREE depleted patterns ($(La/Yb)_N=0.014-0.025$), whereas they are slightly zoned and enriched in LREE ($(La/Yb)_N=0.64-3.99$) in harzburgites. Secondary clinopyroxenes show a restricted range of variation in major elements compositions with lower amounts of Al_2O_3 and Na_2O with respect to the primary clinopyroxenes. However, the clinopyroxenes recrystallized from pre-existent clinopyroxenes (type C texture) show more marked enrichment in FeO and TiO_2 with respect to the clinopyroxenes grown at the expense of orthopyroxenes (type A and B textures). Both clinopyroxenes show typical LREE-enriched patterns ($(La/Yb)_N=3.36-5.38$). Spongy clinopyroxenes (type C texture) are characterised by a wide range of compositional variation and always appear markedly zoned from core to rim. Their major element compositions encompass the entire compositional range of primary and secondary clinopyroxenes. The inner portions of the crystals do not appear to be involved in any reaction and have LREE depleted patterns

($(La/Yb)_N=0.01-0.08$) similar to those of primary crystals, whereas the marginal and more "spongy" portions show generally LREE enriched patterns ($(La/Yb)_N=0.27-1.97$).

Spinel shows a typical inverse correlation between Cr# ($Cr/(Cr+Al)*100$) and Mg# ($Mg/(Mg+Fe)*100$) values, the secondary spinels having the higher Cr# values and lower Mg# values.

Feldspars range from andesine to K-oligoclase, anorthoclase and Na-sanidine, very similar to those reported in the xenoliths of Lake Bajkal (Ionov et al., 1995) and the Ytong region (Xu et al., 1996).

Glasses are typically silica- (55.9-61.52 wt%), alkali- (8.38-16 wt%) and Al_2O_3 -rich (20.49-23.65 wt%) with low MgO (0.17-1.36 wt%), CaO (0.37-2.06 wt%), FeO (0.77-2.24 wt%) and TiO_2 (0.89-1.91 wt%) contents, and relatively constant Na_2O/K_2O ratios (between 1 and 2). They are moderately enriched in LREE ($(La/Yb)_N=24-40$) and do not show any Zr or Ti negative anomalies.

A multistage evolution model can be invoked to explain the complex textural and chemical features shown by these xenoliths. The LREE depleted patterns in primary clinopyroxenes of lherzolites suggest that the initial process was a partial melting that can be modelled using the equation of non-modal fractional melting proposed by Johnson et al. (1990). The calculation results give a degree of melting variable from 3% to 5% for lherzolites and around 26% for harzburgites. Successively the depleted mantle was enriched by interaction with a metasomatic agent, responsible for the development of the pyrometamorphic textures, whose nature was defined using major and trace elements mass-balance calculation model. The best fit was obtained using a nephelinite erupted in the Veneto Volcanic Province or a lamprophyre of Calceranica (Southern Alps; Galassi et al. 1994) as hypothetical metasomatic agents.

In order to tentatively constrain the timing of metasomatic event, the inward diffusion model of Griffin et al. (1989), using the linear equation of Crank (1975) and assuming a solid-solid diffusion coefficient (D_s) of 10^{-15} for the REE (Sneeringer et al. 1984), was applied. Taking into account size and enrichment profile of spongy and secondary clinopyroxenes, it may be put forward that the most recent metasomatic processes occurred shortly (3,000-79,000 y) before the xenoliths were entrapped by the host magmas.

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