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The peculiar case of Marosticano xenoliths: a cratonic mantle fragment affected by carbonatite metasomatism in the Veneto Volcanic Province (Northern Italy)

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The Tertiary Magmatic Province of Veneto, known as Veneto Volcanic Province (VVP), in the Northern Italy, represents one of the most important volcanic provinces of the Adria Plate. It is composed by five volcanic districts: Val d'Adige, Marosticano, Mts. Lessini, Berici Hills and Euganean Hills. Most of the volcanic products are relatively undifferentiated lavas, from nephelinites to tholeiites in composition. Commonly VVP nephelinites and basanites carry mantle xenoliths. This study presents a petrological characterization of the new xenolith occurrence of Marosticano and comparison with previously studied VVP xenolith populations (i.e. from the Lessinean and Val d'Adige areas), which represent off-craton lithospheric mantle fragment affected by Na-alkaline silicate metasomatism (Siena & Coltorti 1989; Beccaluva et al., 2001; Gasperini et al., 2006).
Marosticano (MA) peridotites are anhydrous spinel-bearing lherzolites and harzburgites, which are geochemically well distinguishible from the other VVP mantle xenoliths. Primary minerals record the "most restitic" composition of the VVP sampled mantle, even calling the geochemical features of a sub-cratonic mantle. Olivines in both lherzolites and harzburgites show high Ni contents compared with the Fo values (Ni→ lherzolite: 2600-3620 ppm; harzburgite: 2600-3540 ppm; Fo → lh: 91-92; hz: 90-93) that follow the trend of olivine from a cratonic area (Kelemen, 1998). Orthopyroxenes have mg# values with 1:1 ratio with coexisting olivines and $Al2O_3$ contents always <4 wt%, even for the most fertile lherzolite. Low $Al2O_3$ (<5 wt%) associated with high $Cr2O_3$ (>0.5 wt%) contents are also the chemical characteristics of the clinopyroxenes. On the whole both MA pyroxenes show major element contents that recall the characteristics of those from cratonic (sp-bearing) peridotites (e.g. from Greenland, South Africa and Tanzania; Downes et al., 2004). In addition, the relationship between the high Fo content of olivine and the high chromium contents (cr#=(Cr/(Cr+Al)X100); lh: 30-53; hz: 38-67) in coexisting spinel, out of the typical OSMA array (Arai, 1994b) is observed in typical on-craton mantle rocks (Downes et al., 2004).
To corroborate the cratonic "flavour" of these peridotites, in-situ trace element analyses show that Marosticano clinopyroxene have modified their residual characteristics by interaction with deep metasomatic melt, which was able to strong enrich in U, Th, LILE (Rb-Ba) and LREE with respect to the restitic preserved HREE and HFSE (e.g. Nb, Ta, Zr and Hf) contents. The general clinopyroxene trace element distribution and elemental ratios ((La/Yb)N and Ti/Eu; Coltorti et al., 1999) are consistent with enrichment provided by a carbonatitic rather than a silicate metasomatizing agent.
To characterize the chemical-physical frame of the MA mantle segment, peridotites equilibration temperatures and oxygen fugacities were also estimated and compared with those of the other VVP xenoliths. The latter comparison leads to i) Marosticano samples record relatively high oxidation conditions (as Mts. Lessini peridotites) in agreement with the range assigned to continental lithosphere (Foley et al., 2011) and ii) these T-fO_2 values account for CO_2 mole fractions dissolved in a potential metasomatic melt close to 1, further supporting the carbonatitic nature of the infiltrating melt.
In this case it can be speculated that the usually low oxidizing conditions of the cratonic mantle have been augmented by the interaction with a carbonatitic melt or with a CO_2-rich fluid released by the reaction with a peridotitic matrix.

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