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Two different mantle types as evidenced from a geochemical and petrological study of peridotites from the Ivrea-Verbano Zone

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A petrological and geochemical study was performed on 5 selected samples of peridotites from two different sites (Finero and Balmuccia) outcropping in the Ivrea Verbano Zone, with the aim to investigate the processes occurring in the deep lithosphere and the possible interaction with the lower crust.

The peridotites from Finero area fall in the harzuburgite (FIN1, FIN3, FIN4) field whereas those from Balmuccia are lherzolithes (BALM1) and werlhites (BALM4), highlighting respectively the presence of a more fertile and primordial mantle for two sites.

The rocks from Finero are featured by higher MgO (42-45.7 wt%) and lower Al_2O_3 (0.6-2.4 wt%), CaO (0.42-2.09 wt%) content with respect to Balmuccia (MgO: 39.6 wt%, Al_2O_3: 2.9 wt%; CaO: 2.8 wt%) as a consequence of their harzburgitic nature. They display an enrichment in large-ion lithophile elements (LILE), light rare earth elements (LREE, La_N/Yb_N:13.6) and depletion in high field strength elements (HFSE) differently from the Balmuccia peridotites, which are featured by a light depletion in LREE (La_N/Yb_N:0.4-0.8) and nearly flat HREE pattern. The LILE and LREE enrichment measured in the Finero peridotites could suggest that a portion of the mantle below Ivrea Verbano area was influenced by metasomatic fluids/melts. The BALM4 sample is characterized by anomalously low values of MgO (16.05 wt%) and high values of Al_2O_3 (16.3 wt%) and CaO (14.5 wt%), reflecting the high modal proportion of spinel.

Even the higher Sr ($^{86}Sr/^{87}Sr$= 0.70736-0.72571) and lower Nd ($^{143}Nd/^{144}Nd$=0.51236) isotopic values measured in selected mineral phases from Finero with respect to Balmuccia ($^{86}Sr/^{87}Sr$= 0.70268-0.70644; $^{143}Nd/^{144}Nd$=0.51334) allow to speculate a relation with crustal fluids in the Finero mantle.

The composition of fluid inclusions entrapped in olivine and pyroxene crystals from Finero peridotites evidenced CH_4 and CH_4-N_2 associated with antigorite and magnesite whereas prevalent CH_4 associated with antigorite, magnesite and graphite was measured in the rocks from Balmuccia area. The origin of CH_4 could be related to synthesis via reduction of CO_2 by H_2 from internal/external serpentine to minerals or re-speciation of initial CO_2-H_2O fluids associated to graphite precipitation during cooling by obduction after orogeny; differently, the CH_4-N_2 fluids could be introduced by past subduction-related processes.

The isotopic helium ($^3He/^4He$ ratio) varies between 0.08 and 0.17 Ra in the Finero peridotites and among 0.18 and 0.48 Ra in the Balmuccia ones, evidencing an isotopic difference between the two sites that cannot be explained by ^4He radiogenic production. Differently, the Finero-Balmuccia variability could reflect the helium signature recorded in deep by subduction events and confirm the previous petrologic and geochemical evidences in favour of a metasomatised mantle by crustal fluids in the Finero area with respect to a more primordial in the Balmuccia one.

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