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Pyroxenitization of dunites in the lower continental crust: evidence from the Ivrea Mafic Complex (Italian Alps)

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The processes driving the chemical differentiation of mantle-derived magmas emplaced at deep levels of the continental crust are mostly unknown. Melt compositions may be modified through interplay of fractional crystallization, magma mixing, crustal assimilation and melt-rock and melt-crystal mush reactions. These processes may play a major role in dictating the compositions of evolved magmas rising at shallow crustal levels. The Ivrea Mafic Complex from Italian Alps is a km-scale gabbronorite-diorite body intruding the lower continental crust during the post-Variscan transtensional tectonics, and includes several ultramafic bodies of inferred cumulate origin at its deepest levels. To shed light on the magmatic processes occurring in the lowermost continental crust, we have carried out new petrographic and petrological investigations of a cumulus ultramafic lens exposed near the Balmuccia mantle massif.

The studied ultramafic lens consists of tens of meters thick dunites mantled by pyroxenites along the contacts with the enclosing gabbronorites. The pyroxenites have highly variable thickness, which never exceeds 10 meters. Near the contact with the dunites, the pyroxenites include irregularly shaped, cm-thick dunite lenses elongated subparallel to the dunite-pyroxenite contact. The contact between the pyroxenites and the enclosing gabbronorites is characterized by irregular alternations, cm- to tens of cm-scale in thickness and in most cases folded, of pyroxenites, melagabbronorites and gabbronorites. The dunites have olivine with low forsterite proportion (81-82 mol%) and spinel with low Cr# (10-14). The pyroxenites are olivine- and plagioclase-bearing near and away from the contact with the dunites, respectively. Pyroxenites also occur as subparallel cm-scale thick veins within the dunites. Taken as a whole, the pyroxenites have up to 30 vol% amphibole (titanian pargasite) and include accessory amounts of ilmenite, Al-spinel and Fe-Cu sulfides. Along mm-scale transects from the dunites to the included pyroxenite veins, we observed a gradual decrease in Mg# and Cr# in pyroxenes, amphibole and spinel. The enclosing gabbronorites are amphibole-free and ilmenite- and quartz-bearing. They have markedly lower Mg# than the pyroxenites and nearly flat chondrite-normalized REE patterns with positive Eu anomaly. The REE pattern of the pyroxenites is distinct in the marked LREE depletion and negative Eu anomaly.

We propose that the pyroxenites developed by reaction between dunites and infiltrating melts,

relatively rich in SiO_2, which had already undergone plagioclase fractionation. The compositions of these reacting melts cannot be reconciled with those of the melts forming the enclosing gabbronorites. The gabbronorite parental melts presumably interacted with the pyroxenites to give rise to the melagabbronorites. We speculate that pyroxenitization of the dunites occurred during the early stages of the building of the Ivrea Mafic Complex.