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Magmatic sapphirine from gabbroic veins cutting the Finero mantle sequence (Southern Alps): Petrology, geochemistry and geodynamic context

Tommaso Giovanardi (1), Alberto Zanetti (2), Maurizio Mazzucchelli (3), Tomoaki Morishita (4), Massimo Tiepolo (2), and Riccardo Vannucci (1)

(1) Dept. Earth Sciences, University of Pavia, Italy (tommaso.giovanardi@dst.unipv.it), (2) CNR-Institute of Geosciences and Earth Resources, Pavia, Italy, (3) Dept. Earth Sciences, University of Modena and Reggio Emila, Italy, (4) Frontier Science Organization, Kanazawa University, Japan

A late swarm of sapphirine-bearing amphibole gabbroic veins discordantly crosscut the main layering of the Finero phlogopite-peridotite massif, Western Italian Alps. Sapphirine locally occurs in a melanocratic zone placed between a leucocratic gabbroic band, forming the central part of the intrusion, and the host peridotite. The melanocratic zones are observed on both sides of the leucocratic gabbroic vein and consist of (i) an outer orthopyroxene-rich zone along the host peridotite and (ii) an inner amphibole-rich zone placed along the leucocratic gabbroic band side. Sapphirine either overgrows spinel or occurs as isolated inclusion within large amphiboles in the amphibole-rich melanocratic zone. Spinels without sapphirine envelopes also microtexturally co-exist with independent sapphirine grains. EMPA and LA-ICP-MS analyses of minerals from the melanocratic and leucocratic bands evidence significant differences in terms of both major and trace elements in the composition of the parent melts. In particular, the amphiboles in the melanocratic zones show higher TiO_2, Na_2O and K_2O, M-HREE and HFSE than those in the leucocratic ones. The Al_2O_3 content of amphibole and the Fo in olivine of the host peridotite are significantly higher and lower, respectively, than those in other Finero peridotites far from the amphibole gabbroic veins. Moreover, amphiboles from the host peridotite are characterised by LREE-enriched convex-upward patterns significantly different with respect to those documented in literature for the Finero phlogopite-peridotites [1]. Mineral assemblages and mineral chemistry in both the melanocratic zone and the host peridotites are interpreted as the result of different stages of melt migration associated with melt-rock interaction. In particular, the major and trace element compositions of the amphiboles from the wall peridotite suggest that during an early stage, possibly before the opening of the conduits, the peridotite suffered porous flow migration of a melt more enriched in REE with respect to those forming the gabbroic bands. The crystallisation of the melanocratic bands is related to a second stage, in which the precipitation of large amphiboles was accompanied by a strong reaction between host peridotite and melt flowing into the conduit that determined the complete substitution of peridotite olivine with orthopyroxene at the peridotite-vein contact. A third stage was characterised by with the precipitation of the leucocratic band, associated to a further enlargement of the vein. Petrographic survey highlights that parent melt of leucocratic zone reacted with the minerals of the melanocratic one, inducing sapphirine growth around spinels. The genetic relationships occurring between the parent melts of the melanocratic and leucocratic zones must be yet established. Working hypotheses consider the parent melt of the leucocratic zone either related to a late injection or a residual differentiate after precipitation of melanocratic band in the frame of flow differentiation process. Quantitative considerations suggest that the selective addition of Al-rich phases, like amphiboles and micas, to a basalt can determine the large Al/Si ratios required for sapphirine precipitation. Modelling results indicate that the eutectic T of Finero phlogopite-peridotite is $<1000°C$ and that the first partial melts are saturated in corundum. Thus, it is proposed that injection of basaltic melts triggered the partial melting of limited volumes of phlogopite peridotite producing Al-rich melts: the mixing of such Al-rich components with the migrating basalt is believed to have played a fundamental role in favouring the precipitation of sapphirine.

References. [1] Zanetti, A., Mazzucchelli, M., Rivalenti, G., Vannucci, R. (1999): Contrib. Mineral. Petrol., 134, 107-122.