

Structural and geochemical revaluation of appinite dikes along the Cossato-Mergozzo-Brissago Lineament, Ivrea-Verbano Zone, NW Italy

Zucali M.*, Moroni M., Tiepolo M., Masoch J., Romanelli G. & Ferrari E.S.

Dipartimento di Scienze della Terra “A. Desio”, Università di Milano.

Corresponding author e-mail: michele.zucali@unimi.it

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The Appinite Suite in NW Italy consists of swarms of amphibole-rich, ultrabasic to acidic dikes emplaced on both sides of the major Cossato-Mergozzo-Brissago Lineament (CMB) separating the Ivrea-Verbano Zone (IVZ) and the overlying Serie dei Laghi domain (SdL), commonly attributed to the deep and middle crust, respectively. Our study involved macro- to microtextural and petrographic characterization of dikes and host rocks (kinzigites, amphibolites and sillimanite-bearing micaschists), followed by mineral chemistry, thermobarometric estimates and C-O isotope analyses. Hornblendite and gabbro dikes display the most complex assemblages and textures, with pargasite-rich chilled margins often enclosing wide pegmatoidal cores with evidence of polyphasic crystallization. Zoned amphibole oikocrysts show wide brown pargasite cores made turbid by ilmenite microinclusions and Fe sulfide droplets and mottled by round pyroxene and anorthite remnants. The green amphibole in the oikocryst coronas and in the plagioclase-rich matrix are intergrown with titanite and calcite. Gabbro-diorite dikes are biotite-rich. Moderate deformation, often localized along chilled margins, caused foliation marked by biotite and green amphibole. Thermobarometric estimates on the complex appinite assemblages suggest a crystallizing path evolving from ~ 10 kbar (30-35 km) down to 6-3 kbar (10-20 km).

Basement rocks recorded prograde paths, from greenschist- to amphibolite-facies with progressive T and P increase to the development of deformation related to CMB shearing. This prograde path is associated with the development of a pervasive foliation, marked by sillimanite and HT-biotite in metapelites wrapping appinite bodies. This event and the final P-T stage recorded in appinite dikes are coincident. Hence, the appinite emplacement might have been coeval with or controlled by the activation of the CMB Lineament, tentatively dated to Permian. However, a pervasive foliation observed in a porphyritic gabbro dike is marked by a peculiar green amphibole-anorthite-quartz-titanite assemblage, interpreted as caused by HT shearing in presence of supercritical brines. Such foliation might be caused by movements along the CMB after the appinite emplacement, hence titanite might provide valuable geochronological data. Our structural and petrological data confirm the current model for IVZ appinites by emplacement of mantle-derived magma, variably contaminated by crustal, anatectic melts, while ascending along deep crustal shear zones like CMB (Mulch et al., 2002). However, our study highlighted both the textural and mineralogical complexity of appinites and their enrichments in magmatic volatiles, including CO₂ and S. In particular, C-O isotope compositions of magmatic calcite in hornblendites show mantle-affine signatures concordant with those from the volatile-rich ultramafic pipes and intrusions marking the final magmatic events in the IVZ (Blanks et al., 2020; Chong et al., 2021).

Blanks D.E., Holwell D.A., Fiorentini M.L., Moroni M., Giuliani A., Tassara S., Gonzalez-Jimenez J.M., Boyce A.J. & Ferrari E. (2020) - Fluxing of mantle carbon as a physical agent for metallogenic fertilization of the crust. *Nature Communications*, 4342.

Chong J., Fiorentini M.L., Holwell D.A., Moroni M., Blanks D.E., Dering G.M., Davis A. & Ferrari E. (2021) - Magmatic cannibalisation of a Permo-Triassic Ni-Cu-PGE-(Au-Te) system during the breakup of Pangea – Implications for craton margin metal and volatile transfer in the lower crust. *Lithos*, 388-389, 106079.

Mulch A., Rosenau M., Dörr W. & Handy M.R. (2002) - The age and structure of dikes along the tectonic contact of the Ivrea-Verbano and Strona-Ceneri Zones (Southern Alps, Northern Italy, Switzerland). *Schweizerische Mineral. Und Petrogr. Mitteilungen*, 82, 55-76.