Quantitative combined multiscale structural and minero-chemical analysis to unravel the tectono-metamorphic evolution of cordierite-migmatite gneiss from the Valpelline Unit (Dent-Blanche Nappe, Western Italian Alps, Valle d'Aosta)

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Migmatitic rocks represent one of the most fascinating types occurring along orogenic chains, due to their huge variety of mineral assemblages and complex meso- and microstructures resulting from the interplay between multistage deformation and melt production. For this reason, it is often difficult to reconstruct the relative chronology of the deformation events during the high-temperature (HT) tectono-metamorphic evolution through traditional structural analysis. The Valpelline Unit represents a fragment of pre-Alpine lower continental crust that underwent HT deformation and partial melting during Permian lithospheric extension and that is now exposed in the Austroalpine Domain within the axial sector of the Alpine chain. This unit is made by migmatite-gneiss, sillimanite-gneiss, acid granulites, amphibolites, marbles/calcsilicates and pegmatite dykes (Manzotti & Zucali, 2013). This work presents a multiscale and multidisciplinary approach aimed at reconstructing the tectono-metamorphic evolution of the Valpelline Unit (Dent-Blanche Nappe, Western Italian Alps) migmatites, by combining quantitative multiscale structural analysis and minero-chemical data, aimed at discriminating different generations of superimposed structures and tectono-metamorphic stages. In particular, mesostructural data have been extracted by processing 3D outcrop models acquired through an iPad Pro 11" equipped with a LiDAR (Light Detection and Ranging) sensor and a Parrot® Anafi drone on a smoothed surface, where Crd-migmatite gneiss and different families of leucosomes and pegmatites are well exposed. Our microstructural analysis combines quantitative microstructural data extracted through Micro-Fabric Analyzer tool (Visalli et al., 2021) and EMPA mineral analyses and X-ray maps processed through the Quantitative X-ray Maps Analyzer tool (Q-XRMA, Ortolano et al., 2018). Three main deformation stages have been defined at the meso- and microscale: the first (D_1) is preserved as an S_1 foliation within metabasite boudins; the second (D_2) is related to the development of the regional foliation (S_2), associated with cordierite and garnet growth, and melt production; (iii) the third deforms and locally transposes the S_2 foliation forming an S_3 sillimanite-rich foliation. Also, the described approach allows the reconstruction of the intersection relationships among the different pegmatite dykes systems cross-cutting all the HT migmatitic structures.

Manzotti P. & Zucali M. (2013) - The pre-Alpine tectonic history of the Austroalpine continental basement in the Valpelline unit (Western Italian Alps). Geol. Mag., 150, 153-172. https://doi.org/10.1017/S0016756812000441.

Ortolano G., Visalli R., Gaston G. & Cirrincione R. (2018) - Quantitative X-ray Map Analyser (Q-XRMA): A new GIS-based statistical approach to Mineral Image Analysis. Comp. Geosci., 115, 56-65. https://doi.org/10.1016/j.cageo.2018.03.001.

Visalli R., Ortolano G., Godard G. & Cirrincione R. (2021) - Micro-Fabric Analyzer (MFA): A New Semiautomated ArcGIS-Based Edge Detector for Quantitative Microstructural Analysis of Rock Thin-Sections. ISPRS Int. J. Geo-Inf., 10, 51. https://doi.org/10.3390/ijgi10020051.