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Density model of the Permo – Triassic lithospheric mantle of the Ivrea Verbano Complex

Luca Faccincani[1], Federico Casetta[1], Barbara Faccini[1], Maurizio Mazzucchelli[2], Fabrizio Nestola[3], and Massimo Coltorti[1]

[1]University of Ferrara, Department of Physics and Earth Sciences, Ferrara, Italy (luca.faccincani@unife.it)
[2]University of Modena and Reggio Emilia, Department of Chemical and Geological Sciences, Modena, Italy
[3]University of Padua, Department of Geosciences, Padua, Italy

The Ivrea – Verbano Zone (IVZ) is a virtually complete lower-to-middle continental crustal section exposed in the Western Italian Alps in result of exhumation processes during the Alpine orogenic cycle. To the northwest, the IVZ is juxtaposed to the basement of the Austro-Alpine Domain by the Insubric Line; to the southeast, it is separated from the middle-to-upper crustal levels of the Strona – Ceneri Zone by the Pogallo and the Cossato-Mergozzo-Brissago (CMB) lines. The IVZ crustal section is constituted by two main units: the Kinzigite Formation, amphibolite- to granulite-facies sedimentary and igneous metamorphic rocks, and the Mafic Complex, a thick, composite gabbroid-to-dioritic intrusion.

Additionally, the lower crustal rocks of IVZ embed a series of kilometre-scale peridotite bodies; Baldissero, Balmuccia and Finero are the most relevant. These peridotites are thought to represent remnants of the oldest portion of subcontinental lithospheric mantle (SCLM) beneath Europe. Geochemical and isotopic studies indicate that peridotitic bodies experienced an Upper Devonian partial melting event followed by protracted enrichments while resident in the mantle. Field and structural relationships coupled with radiometric dating suggest that the emplacement of the mantle peridotite bodies at crustal levels has occurred since the end of the Variscan orogeny, prior to the intrusion of the Mafic Complex.

The Balmuccia Massif is dominated by fresh spinel lherzolites recording moderate degrees of melt extraction, subordinated harzburgites, reactive dunites and diffuse cross-cutting websteritic dykes. The melt extraction and melt-fluid/rock-reactions preserved in the Balmuccia peridotite, together with the lack of substantial low-temperature alteration, enable to track the evolution of the SCLM prior to its uplift and emplacement in crust. Therefore, reconstructing the density structure of the Balmuccia body could have major implications on the comprehension of the geodynamic evolution of the oldest portions of the European lithospheric mantle.

In this study, we modelled the density structure of the spinel lherzolite from the Balmuccia Massif, starting from the chemical composition and modal abundance of its main phase constituents. It is well known that the bulk density is function of modes, compositions and elastic properties of constituent minerals and can be explored from the perspective of their Equations of State (EoS)

(see also Faccincani et al., 2021, abstract to session GD7.3 for a more holistic view of the density structure of the lithospheric mantle). By assuming that the EoS for a polyphase aggregate (e.g., a rock) may be calculated as weighted mean of the EoS of the constituting minerals (in our case olivine, orthopyroxene, clinopyroxene, spinel and garnet at increasing depths), we investigated the density structure of a virtual 1-D vertical profile of the lithospheric mantle below the IVZ at pre-Variscan ages.