Timing of crustal melting and magma emplacement at different depths: insights from the Permian in the Western Alps

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The pre-Alpine basement of the Adriatic plate in the Southern Alps exposes an exceptionally complete section across the continental crust (Ivrea Verbano: lower crust; Serie dei Laghi: upper crust). The section was weakly reworked during Jurassic extension and Cretaceous to Miocene Alpine shortening. The Insubric Line, an Alpine crustal-scale south-vergent backthrust, separates the Southern Alps from the Alpine nappe stack. The pre-Alpine basement of the Adriatic palaeomargin is intensely reworked in this stack, and is now part of the Sesia-Dent Blanche nappes (Manzotti et al. 2014) and other, smaller, Adria-derived units (e.g. Emilius).

The less deformed part of the Sesia-Dent Blanche nappes are the IIDK and Valpelline Series. Based on lithological similarities, they have been correlated with the Ivrea-Verbano Zone (Carraro et al. 1970). This equivalence has been confirmed by subsequent studies, including detailed U-Pb zircon ages of metamorphic (Kunz et al., 2018) and magmatic events. The other units of the Sesia-Dent Blanche nappes (the Arolla Series, the Gneiss Minuti, and the Eclogitic Micaschists) have been pervasively reworked during the Alpine orogeny, from greenschist to eclogite-facies. Identification of the age and nature of their pre-Alpine protoliths, and of the grade and age of their pre-Alpine metamorphism heavily relies on field and petrological data on key outcrops, supported by U-Pb dating.

If the IIDK and Valpelline Series represent the lower Adriatic crust, the other units may derive from the upper Adriatic crust, i.e. may be similar to the Serie dei Laghi in the Southern Alps. Alternatively, they may also represent pieces of the Adriatic lower crust that were pervasively re-hydrated during the Jurassic extension and/or the Alpine subduction (Engi et al., 2018), thus allowing re-equilibration at HP conditions during Alpine deformation.

This contribution will summarize a range of field, petrological, and geochronological data (obtained by LA-ICP MS on zircon, combined with in situ-oxygen isotope data measured by SIMS). This data set reveals significant differences in the timing of crustal melting, as well as magma emplacement at different depths. It can be concluded that the history of the Adriatic crust in the Alpine stack is comparable with that of the Southern Alps, with implications for the mechanical behaviour of the crust during the Alpine orogeny.
Carraro et al. (1970). Memorie della Società Geologica Italiana, 9, 19-224
Engi et al. (2018). Geochemistry, Geophysics, Geosystems, 19, 865-881