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Characterization of P-T conditions and age of the mid-crustal material involved in the Alpine continental subduction (Dora Maira Massif)

Francesco Nosenzo[1], Paola Manzotti[1], Marc Poujol[2], Michel Ballèvre[2], and Jessica Langlade[3]
[1]Department of Geological Sciences, Stockholm University, 106 91 Stockholm, Sweden (francesco.nosenzo@geo.su.se)
[2]Univ. Rennes, CNRS, Géosciences Rennes-UMR 6118, F-35000 Rennes, France
[3]Microsonde Ouest, Ifremer – Centre de Bretagne, Technopole Brest Iroise, BP70, F-29280, Plouzané, France

The basement units of the Alps offer an excellent example to study how the Palaeozoic continental crust was recycled during the Alpine orogeny. The reconstruction of the pre-Alpine evolution of the continental basement is challenging and mainly relies on information provided by low-strain volumes, where mineralogical relics and isotopic data on accessory minerals can be safely investigated.

The knowledge of the pre-Alpine history of the Palaeozoic basement places severe constraints on its behaviour during the Alpine continental subduction. Firstly, its location in the (lower, middle, or upper) crust has implications for material balance during the Alpine orogeny. Secondly, its mineral content will determine how much water is needed for its transformation into an equilibrium eclogite-facies assemblage, with major implications for its metastability, hence its density and rheology during the Alpine history.

Here we investigate the pre-Alpine continental basement of the Dora Maira Massif (Western Alps), worldwide renowned for its Alpine quartz- to coesite-eclogite facies metamorphism. However, little is known about its pre-Alpine history. Spectacular polycyclic garnet-staurolite micaschists associated with garnet-biotite orthogneisses represent exceptional witnesses for reconstructing the Palaeozoic evolution of this region. Both lithologies contain mineralogical relics, such as a first generations of garnet, staurolite, muscovite and biotite indicative of a regional pre-Alpine amphibolite-facies metamorphism. Thermodynamic modelling on the micaschists constrains this pre-Alpine metamorphism at 640-660 °C, 6-7 kbar. Detrital zircon geochronology indicates that the youngest age population in the micaschists ranges from 450 Ma to 600 Ma and represents the maximal depositional age for the Palaeozoic sediment. U-Pb zircon geochronology in the garnet-biotite orthogneisses points to crystallization of the magma in the earliest Silurian (442 ± 2 Ma).

Detrital zircons in the micaschists display metamorphic overgrowths, characterized by high U content and very low Th/U ratios, as reported previously in amphibolite to granulite facies rocks. These metamorphic overgrowths yield U-Pb ages of 303 ± 2 Ma. These data constrain the timing of the Barrovian metamorphism in the Dora Maira Massif and confirm the hypothesis of a genetic

link between this metamorphic episode and the Variscan orogeny.

The eclogite-facies polycyclic rocks from the Dora-Maira Massif therefore derive from upper crustal late Carboniferous lithologies, similar to those found in the Gran Paradiso and Monte Rosa, but different from the granulite-facies, lower crustal, rocks found in the Sesia Zone.