Eur. J. Mineral.
PrePub DOI: 10.1127/ejm/2019/0031-2860

PrePub Article
Special Issue:
Honour Christian Chopin

What's in the sandwich? New *P–T* constraints for the (U)HP nappe stack of southern Dora-Maira Massif (Western Alps)

Chiara GROPPO[1,2,*], Simona FERRANDO[1], Manuele GILIO[1], Serena BOTTA[1], Francesco NOSENZO[1], Gianni BALESTRO[1], Andrea FESTA[1] and Franco ROLFO[1,2]

[1]Department of Earth Sciences, University of Torino, Via Valperga Caluso 35, 10125 Torino, Italy
*Corresponding author, e-mail: chiara.groppo@unito.it
[2]CNR-IGG, Via Valperga Caluso 35, 10125 Torino, Italy

Abstract: The Brossasco-Isasca Unit (BIU) of the southern Dora-Maira Massif (DMM), Western Alps, is one of the most studied ultra-high pressure (UHP) units in the world. However, the interpretation of UHP metamorphism in the BIU is still a highly debated and challenging issue. The structural and tectonometamorphic setting of the southern DMM is described in the literature as a tectonic "sandwich", with the UHP unit in the middle, bounded by two high-pressure (HP) eclogitic units in the footwall (the San Chiaffredo Unit, SCU) and hanging wall (the Rocca Solei Unit, RSU), respectively. These three units are in turn sandwiched between two blueschist-facies units (the Pinerolo Unit, PU, at the bottom, and the Dronero-Sampeyre Unit, DSU, at the top). In contrast to the well-constrained *P–T* evolution of the BIU, peak *P–T* conditions for its bounding HP units are poorly constrained, most studies dating back to over 20 years ago and mostly relying on conventional thermobarometric methods. This study aims to update our knowledge about the *P–T* evolution experienced by the whole tectonometamorphic package of the southern DMM. For the first time, peak *P–T* conditions and prograde evolution for the five units (PU, SCU, BIU, RSU, DSU) forming the southern DMM tectonic "sandwich" are estimated using the same, internally consistent and therefore comparable, modern thermobarometric approaches. The study focuses on metapelites (*i.e.*, garnet-bearing phengitic micaschists) and combines multi-equilibrium thermobarometry (Average *PT*) with the *P–T* pseudosection approach. Our results demonstrate that most of the southern DMM nappe stack (*i.e.*, SCU, RSU and also the PU, that was originally considered as a blueschist-facies unit) experienced eclogite-facies metamorphism under similar peak *P–T* conditions (500–520 °C, 20–24 kbar), and followed the same prograde path, suggesting similar burial mechanisms. The UHP BIU followed an early prograde evolution similar to that of the other eclogitic units of the southern DMM tectonic "sandwich". The attainment of UHP peak conditions occurred through an earlier steep, almost isothermal increase in pressure and a later increase in temperature. The DSU is the only unit of the southern DMM nappe stack that did not experience eclogite-facies metamorphism (peak metamorphism at blueschist-facies conditions: 450–470 °C, 17–18 kbar) and it is separated from the eclogitic units by a shear zone (the Valmala Shear Zone), whose interpretation requires further studies. These new data represent the inescapable starting point for any conceptual model aiming for a deeper understanding of the subduction/exhumation processes of UHP continental units.

Key-words: (U)HP metamorphism; southern Dora-Maira Massif; peak *P–T* conditions; prograde evolution; *P–T* pseudosections.

1. Introduction

The first discovery, more than 30 years ago, of coesite in continental crustal rocks (Chopin, 1984; Smith, 1984), demonstrated the possibility for continental crust to reach ultra-high pressure (UHP) conditions. However, the geodynamic processes responsible for the formation and exhumation of continental UHP units are still debated (*e.g.*, Schenker *et al.*, 2015; Reuber *et al.*, 2016; Solarino *et al.*, 2018). Conceptual and numerical models that try to explain how a continental crustal unit can reach (and can be exhumed from) UHP conditions are calibrated against geological and petrological data available from the tectonic nappe stack which includes the UHP unit itself (*e.g.*, Li *et al.*, 2010; Burov *et al.*, 2014; Schmalholz *et al.*, 2014; Gerya, 2015; Schenker *et al.*, 2015). Precise knowledge of peak pressure and temperature (*P–T*) conditions experienced by both the UHP unit and its adjacent, often high-*P* (HP) units is therefore the crucial starting point to test the validity of the models (*e.g.*, Manzotti *et al.*, 2015, 2018).

The Brossasco-Isasca Unit (BIU) of the southern Dora-Maira Massif (DMM) in Western Alps, is one of the most studied UHP units worldwide and has been widely used in the past as a natural laboratory to discover new UHP minerals and to investigate metamorphic processes occurring during subduction at extreme pressures (*e.g.*, Chopin & Ferraris, 2003; Schertl & O'Brien, 2013 and references therein). The models assuming subduction of continental crust to mantle depths (*e.g.*, Chemenda *et al.*, 1995; Chopin, 2003; Stöckhert & Gerya, 2005; Gerya & Stöckhert, 2006;

https://doi.org/10.1127/ejm/2019/0031-2860
0935-1221/19/0031-2860 $ 8.55