Possible evidence for incipient decompression melting in the Dora-Maira Massif

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One of the most intriguing aspects of UHP metamorphism regards petrologic and dynamic processes acting during deep subduction and subsequent exhumation. The increasing evidence for partial melting of suitable UHP lithologies during decompression (e.g. Greenland Caledonides; Cao et. al., 2019) made this process relevant for both petrology and geodynamics, because it can be responsible for the recycling of crustal material in the mantle wedge and for the exhumation of the UHP terranes.

Deformed quartz-feldspathic layers occur within dam- to hm-scale impure marble lenses scattered in the paragneiss of the Polymetamorphic Complex of the UHP (~4.0 GPa and ~730 °C: Castelli et. al., 2007) Brossasco-Isasca Unit (BIU; Dora-Maira Massif).

Under the microscope, the quartz-feldspathic layers are paragneisses mainly made by variable modal amounts of Qtz + Wm + Zo + Kfs + Grt + Plg. Peak mineral assemblage consisted of Coe (now Qtz) + Phg + Zo, whereas Kfs + Grt + Plg formed during decompression. The quartz-feldspathic layers preserve peculiar microstructures such as: i) tiny, optically continuous, Qtz and/or Plg films enveloping Zo + Qtz aggregates; ii) poikilitic Kfs and Grt including Qtz, Zo and Phg. Such microstructures, never reported in the Dora-Maira Massif, are commonly interpreted as evidence for incipient partial melting (e.g. Vernon, 2011). They suggest that, during exhumation of the BIU, an incipient melting of the quartz-feldspathic layers produced small volumes of melt, subsequently crystallized into melt pseudomorphs. The inferred P-T path of the BIU (Castelli et. al., 2007) confirms that, during nearly-isothermal decompression in the Qtz stability field, the Unit reached P-T conditions compatible with the "wet solidus" curves experimentally determined for granitic and pelitic systems (e.g. Huang and Wyllie, 1973; Hermann and Spandler, 2007).

Cao, W., Gilotti, J.A., Massonne, H.J., Ferrando, S., Foster, J.C.T. (2019) Partial melting due to breakdown of an epidote-group mineral during exhumation of ultrahigh-pressure eclogite: An example from the North-East Greenland Caledonides. Journal of Metamorphic Geology 37(1): 15-39.

Castelli, D., Rolfo, F., Groppo, C., Compagnoni, R. (2007) Impure marbles from the UHP Brossasco-Isasca Unit (Dora-Maira Massif, western Alps): evidence for Alpine equilibration in the diamond stability field and evaluation of the X(CO_2) fluid evolution. Journal of Metamorphic Geology 25(6): 587-603.

Vernon, R.H. (2011) Microstructures of melt-bearing regional metamorphic rocks. Geological Society of America Memoirs 207: 1-11.

Huang, W.L., Wyllie, P.J. (1973) Melting relations of muscovite-granite to 35 kbar as a model for fusion of metamorphosed subducted oceanic sediments. Contributions to Mineralogy and Petrology 42(1): 1-14.

Hermann, J., Spandler, C.J. (2007) Sediment melts at sub-arc depths: an experimental study. Journal of Petrology 49(4): 717-740.