How to disclose local equilibrium in subducted metapelites from the Cima Lunga Unit (Central Alps)

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Subducted metapelites are more prone to re-equilibrate during exhumation than mafic or ultramafic rocks to the point that recognizing high-pressure (HP) relics is often very challenging. Geologic evidence from the Cima Lunga Unit (Central Alps) show this apparent discrepancy between high to ultra-high pressure metamorphism (28 kbar and 780 °C) recorded in mafic/ultramafic lenses, and Barrovian metamorphism (<10 kbar, 650°C) in the adjacent metapelitic rocks. We collected a white mica – garnet – biotite – plagioclase – kyanite (+ quartz, + zircon, + rutile) bearing metapelite adjacent to the garnet metaperidotite lens that displays an apparently well equilibrated Barrovian mineral assemblage (garnet + plagioclase + biotite), with no macroscopic or microtextural indication of a HP and/or HT metamorphic event (e.g. omphacite crystals; migmatitic texture; polyphase inclusions). Nevertheless, microstructures like atoll-like garnet or large white mica flakes surrounded by biotite and ilmenite replacing rutile suggest incomplete re-equilibration. We investigated garnet and phengite crystals by electron probe and laser ablation-ICP-MS mapping. Major and trace element mapping reveals very complex mineral zoning in both minerals. In particular, high Ti content in phengite and increasing P and Zr contents in pyrope-rich garnet indicate that the studied rock underwent a HP-HT event. This is also supported by Zr in rutile thermometry that indicates temperatures well above the Barrovian metamorphism (T > 700 °C). We combined detailed textural analysis with petrological-geochemical data and thermodynamic modelling to reconstruct the metamorphic evolution of the studied rock. We show that, thank to incomplete re-equilibation, the rock documents an evolution from prograde to UHP-HT peak (27 kbar and 800 °C) to retrograde (Barrovian) conditions (10 kbar and 620 °C). Noteworthy, peak metamorphic conditions of metapelite coincide with peak metamorphic conditions of the garnet metaperidotite. Lastly, geochemical evidence for minor wet melting of the studied metapelite at HP-HT conditions was recognized and is likely linked to the dehydration of chlorite to form garnet peridotite in the adjacent ultramafic body. We propose that metapelites and ultramafic rocks were coupled before subduction or at least in its early stage. This finding opens new scenarios for the geodynamic interpretation of the Cima Lunga unit. We propose that the ultramafic lenses at Cima di Gagnone were parts of the exhumed and serpentinised mantle emplaced at the hyper-extended European continental margin of the Piemont-Ligurian ocean. Slices of the margin were detached and tectonically mixed in the subduction channel. These new constraints call for re-evaluation of the paleogeographic position of the Adula-Cima Lunga nappe.