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

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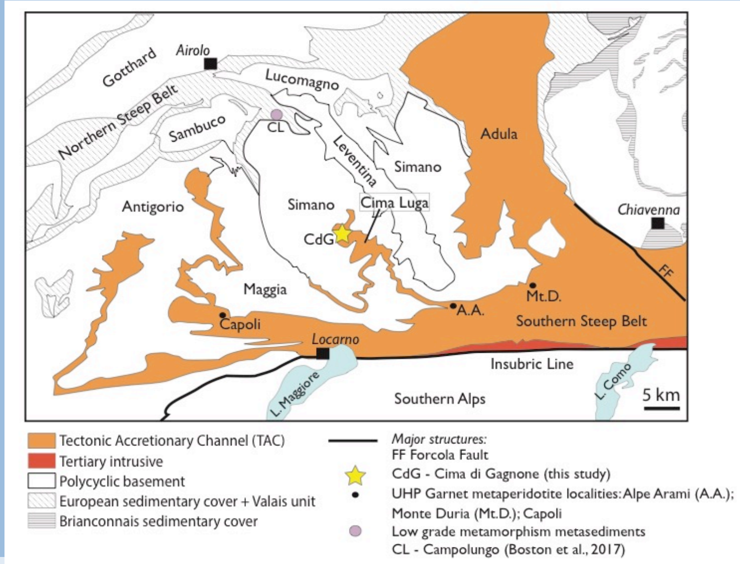

Fig.1: Tectonic map of the Central Alps and sample location (modified after Trommsdorff et al. 2000; Berger et al. 2005; Maxelon and Mancktelow 2005; Janots et al. 2008)

INTRODUCTION

The Adula-Cima Lunga nappe, in the eastern Central Alps, is a chaotic mixture of different rock types, and has been interpreted as a subduction channel-tectonic mélange because of the presence of *HP* mafic eclogite and *UHP* garnet metaperidotite (750-800° C; 2.8 GPa) embedded within lower pressure metasediments (600-650° C; 0.6-0.7 GPa).

Moderate pressures for the metapelitic rocks contrasts with the *UHP* inferred in the ultramafic lithologies and raise a fundamental question on the mechanisms taking place in the subduction channel responsible for the exhumation of *UHP* rocks. We investigate a sample of metapelite associated with the garnet metaperidotite from Cima di Gagnone, in the Cima Lunga unit. **We use petrological, geochemical and theoretical considerations to reconstruct the metamorphic *P-T* evolution of the studied rock.**

Sample petrology

“The different degree of re-equilibration between mafic/ultramafic and felsic lithologies is a major challenge for the tectonic interpretation of the Adula-Cima Lunga” (Heinrich, 1982)

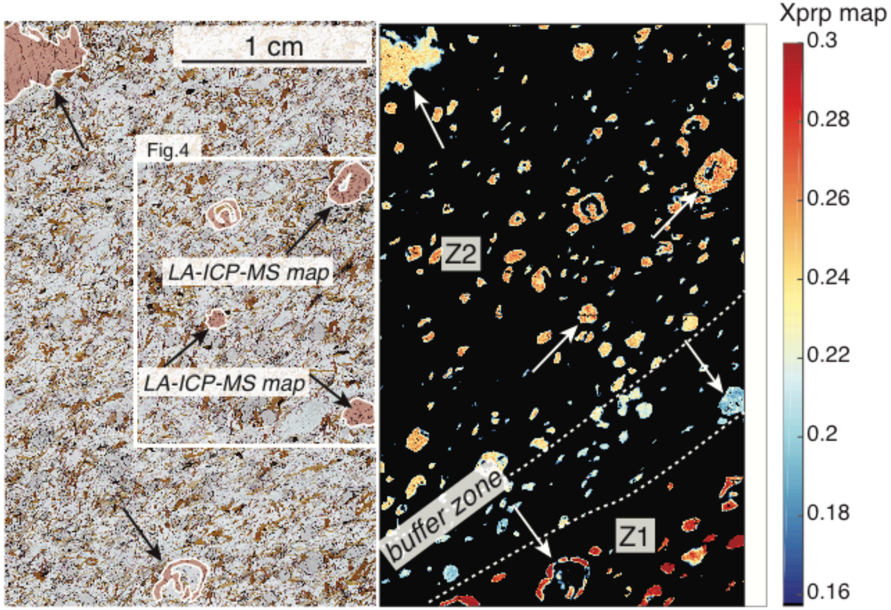

Fig.2: “fossil chemical potential gradients recorded by garnet composition”

The sample is a schistose two micas, kyanite, garnet bearing metapelite (+ rutile, + zircon, + epidote, + quartz) found adjacent to the garnet metaperidotite lens in Cima di Gagnone

Different features are recognized:

- ❑ HP relicts (large phengite flakes, garnet, kyanite, rutile)
- ❑ Barrovian assemblage: biotite + plagioclase (+ prominent garnet resorption textures)

⇩

Need to carefully evaluate local equilibrium in order to properly reconstruct the P-T history

Micro-analytical approach: EPMA + LA-ICP-MS mapping

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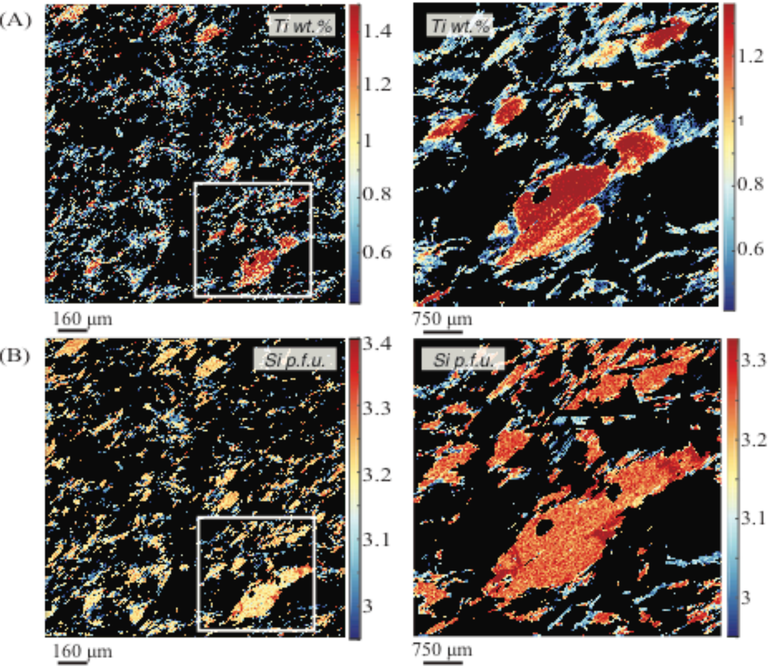

Fig. 3: EPMA maps on large white mica flakes

Chemical maps show that **3 white mica generations** co-exist

- Core: relatively high Si, high Ti (HP-HT)
- Rim: high Si, low Ti (HP-MT)
- Matrix crystals: low Si, low Ti (LP-LT)

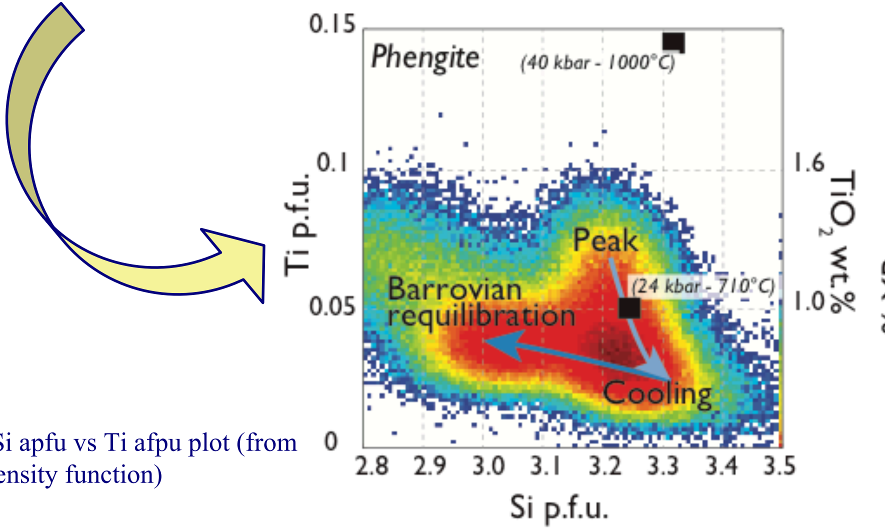

Fig 4: Si apfu vs Ti afpu plot (from pixel density function)

Micro-analytical approach:
EPMA + LA-ICP-MS mapping

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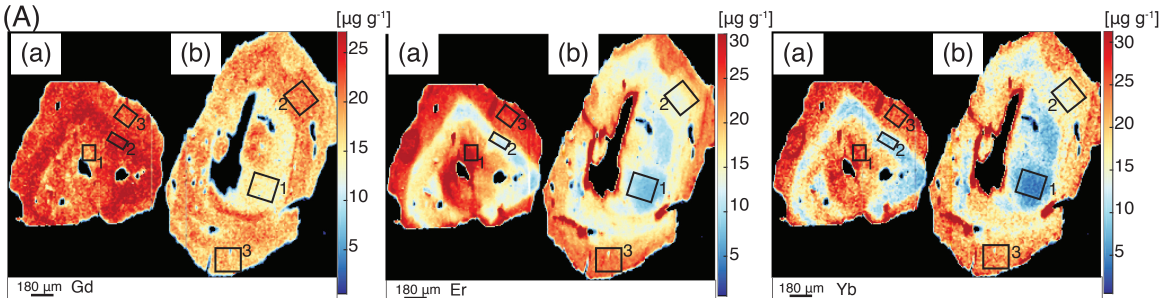

Fig. 5: REE compositional zoning in garnet (LA-ICP-MS maps)

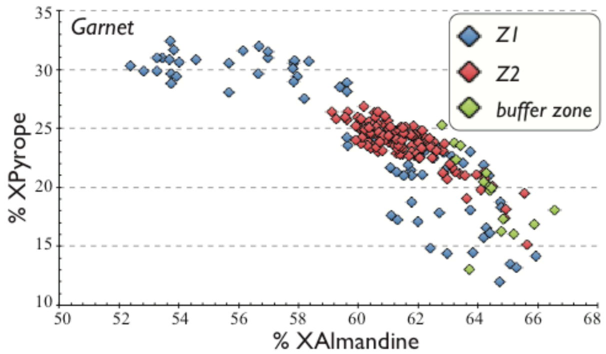

Fig. 6: garnet Xalm vs. Xprp plot (EPMA analyses)

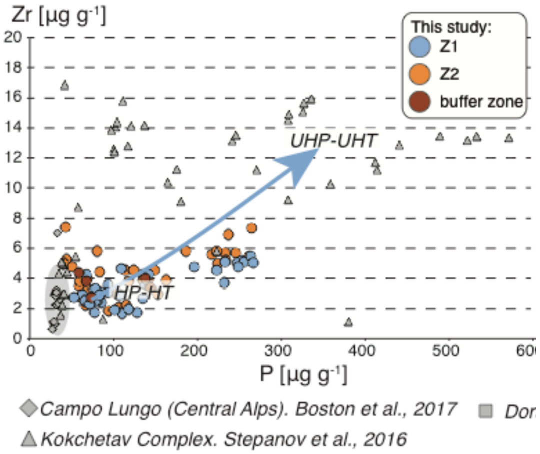

Fig. 7:. P vs. Zr plot (LA-ICP-MS)

Major elements in garnet don't show zoning, though concentration change significantly between different grains (Figs. 2, 6) –> diffusion at HT in presence of not-interconnected melt

Trace element mapping (Fig. 5) allowed distinguishing between core-mantle and rim –> **all garnets grew at eclogite facies conditions**

Not shown here

+ key trace element in garnet (P, Ti, Zr, Na) (Fig. 7)
+ Zr-in-rutile thermometry
+ metamorphic zircons
+ thermodynamic simulations

P-T path reconstruction

P-T path and implications for HP rocks exhumation along a subduction channel

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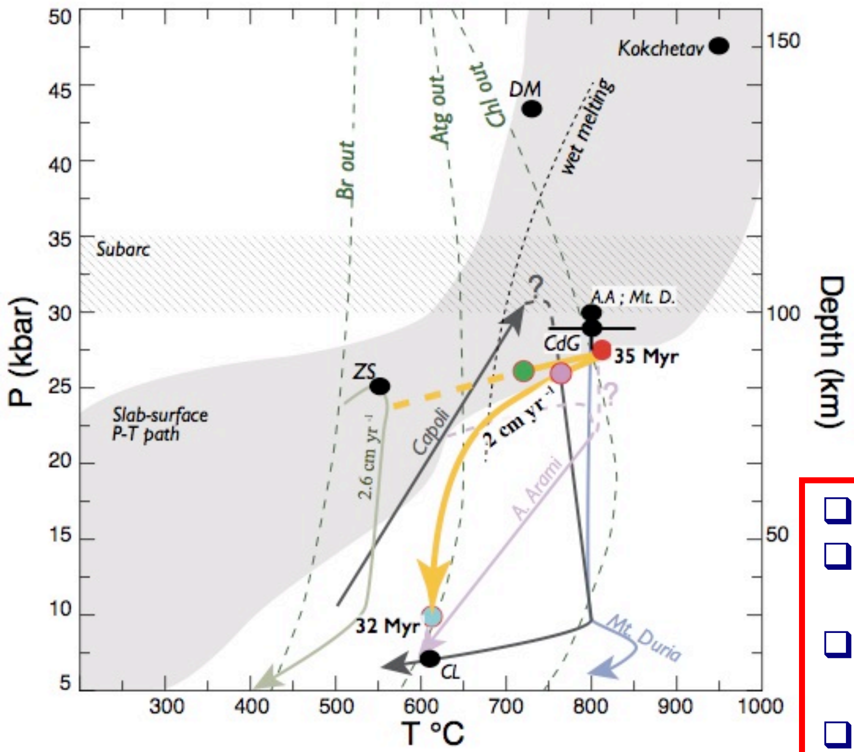

CdG Cima di Gagnone, AA Alpe Arami, Mt D Monte Duria, ZS zermatt saas, DM Dora Maira

Reconstructed history:

- Prograde path
  - -450 ppm Zr in Rutile
- Flushed melting (zircon metamorphic rim) → Ultramafic rocks are the fluid source for wet melting (chl-out reaction liberates fluids that infiltrate the metapelite)
- Peak conditions: T>800°C; 2.75 GPa :
  - -Phengite with TiO_2 1.5 wt% , Si 3.25 p.f.u.
  - -Garnet with XPyrope of >30%
  - -Zr, P and HREE enrichment in Garnet
- Rapid isobaric cooling:
  - -Phengite with Si 3.35 p.f.u., TiO_2 < 1wt%
  - -Preservation of chemical gradients and garnet zoning
- Barrovian re-equilibration: 10 Kbars; 625°C
  - 15 vol% Garnet
  - 30 vol% Phengite3 with low Si, low Ti
  - 30 vol% Plagioclase
  - 200 ppm Zr in Rutile

KEY FINDINGS

- ❑ Peak conditions are followed by isobaric cooling
- ❑ Metapelites and ultramafic rocks from Cima di Gagnone share a common prograde - peak - exhumation path
- ❑ Important implications for the exhumation of dense rocks such as garnet metaperidotite
- ❑ Need of in-situ, micro-analytical approach to recognize local equilibrium