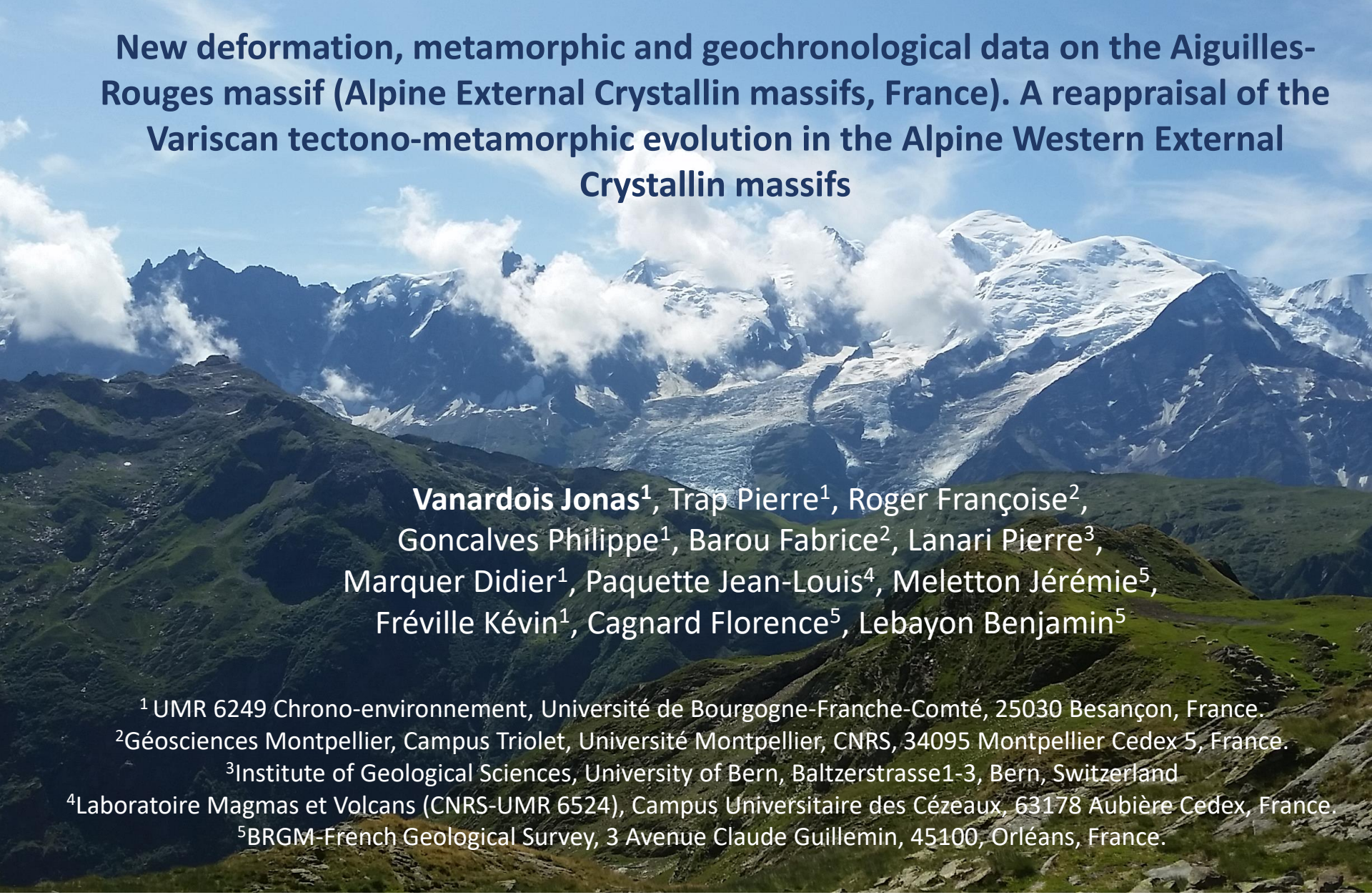
New deformation, metamorphic and geochronological data on the Aiguilles-Rouges massif (Alpine External Crystallin massifs, France). A reappraisal of the Variscan tectono-metamorphic evolution in the Alpine Western External Crystallin massifs



Vanardois Jonas[1], Trap Pierre[1], Roger Françoise[2], Goncalves Philippe[1], Barou Fabrice[2], Lanari Pierre[3], Marquer Didier[1], Paquette Jean-Louis[4], Meletton Jérémie[5], Fréville Kévin[1], Cagnard Florence[5], Lebayon Benjamin[5]

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[2]Géosciences Montpellier, Campus Triolet, Université Montpellier, CNRS, 34095 Montpellier Cedex 5, France.
[3]Institute of Geological Sciences, University of Bern, Baltzerstrasse1-3, Bern, Switzerland
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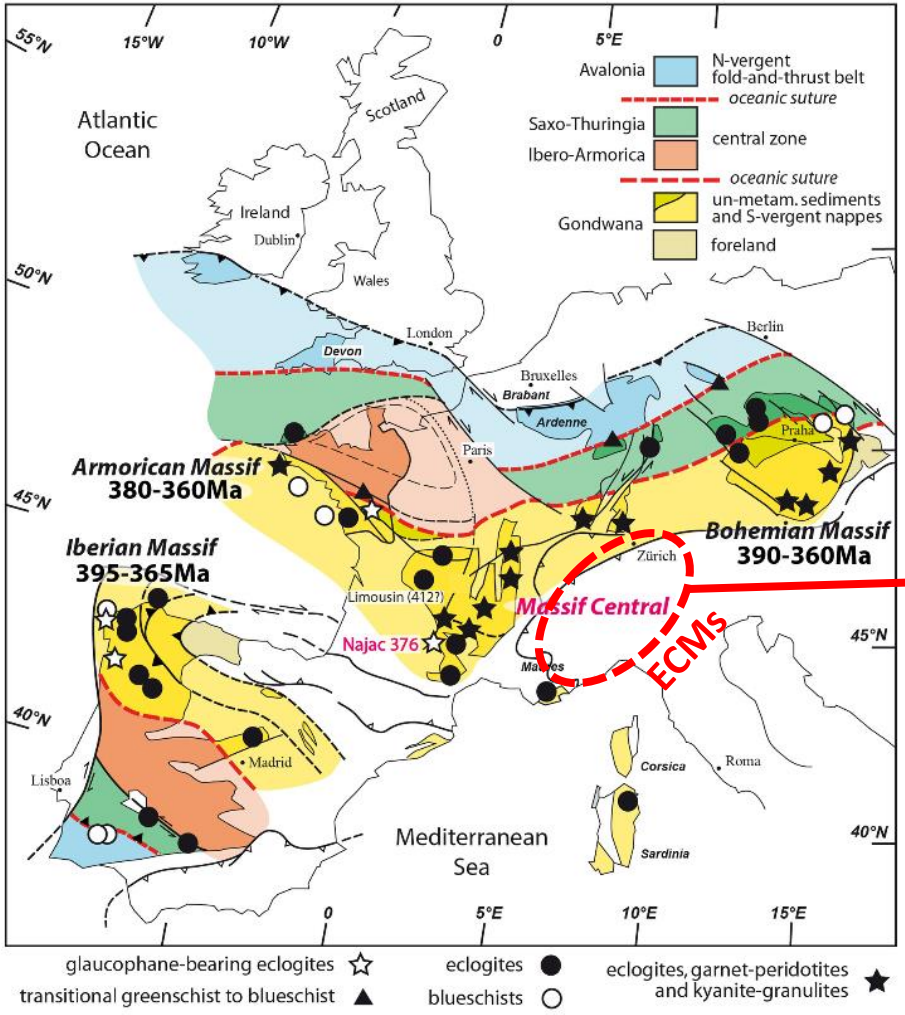
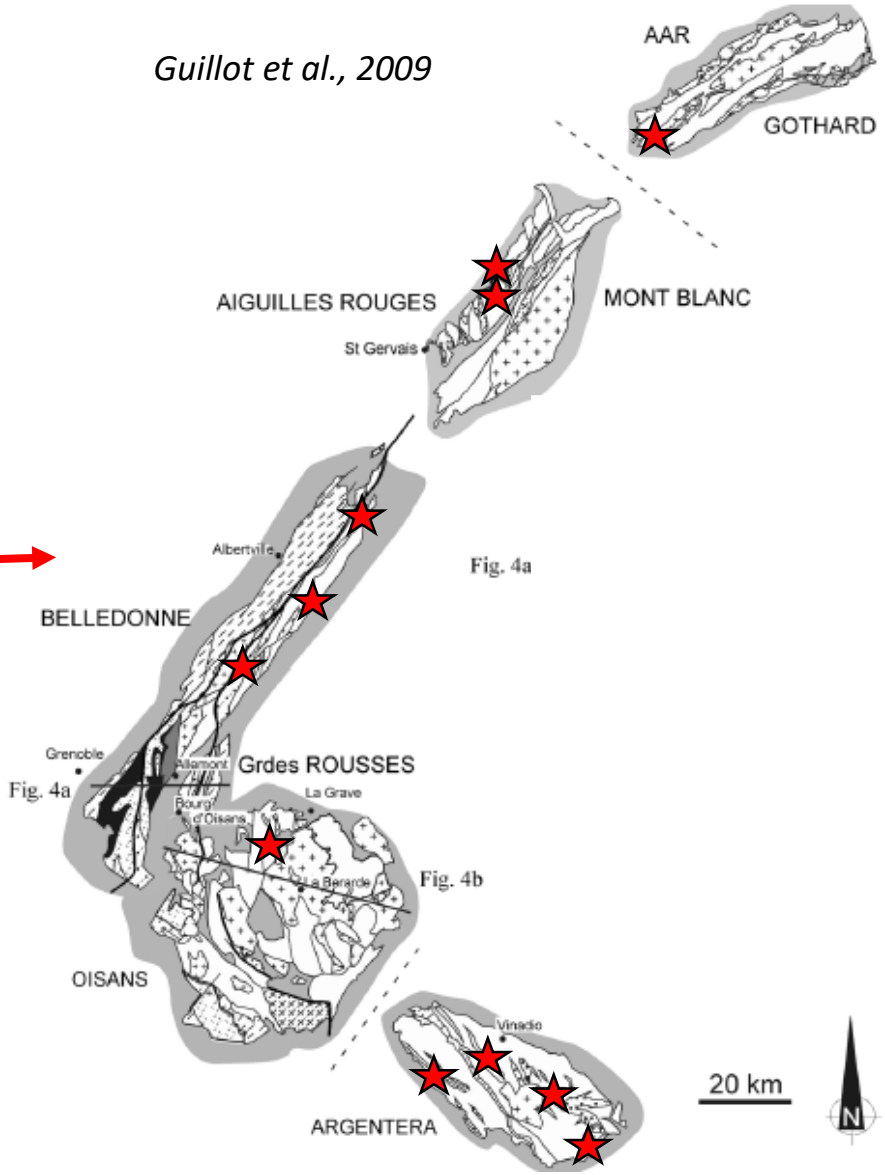
[5]BRGM-French Geological Survey, 3 Avenue Claude Guillemin, 45100, Orléans, France.



Lotout et al., 2018

Guillot et al., 2009

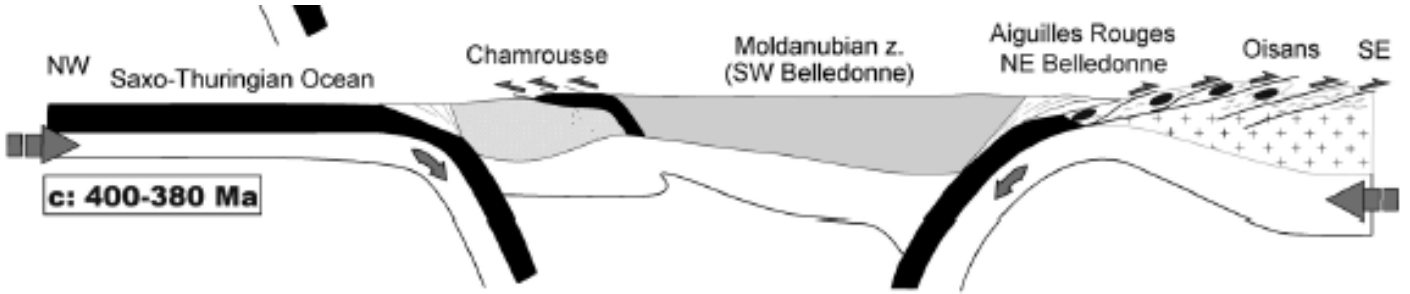


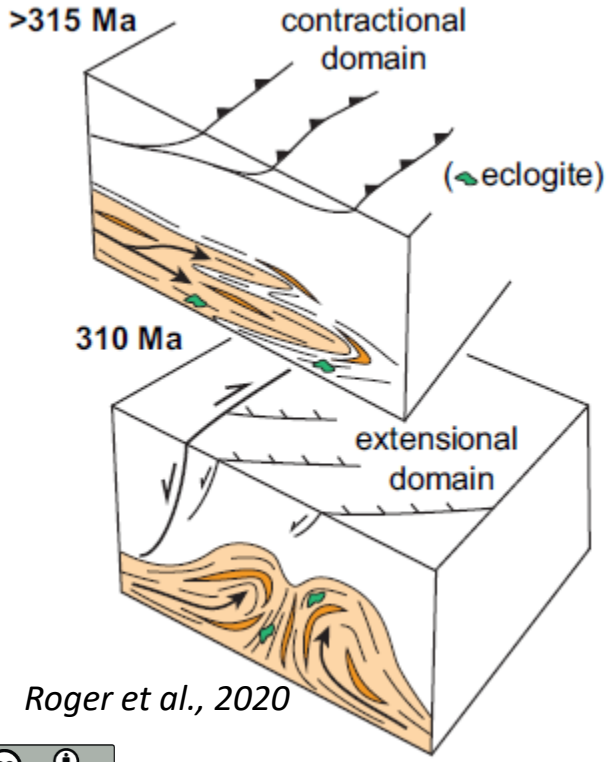
Numerous eclogitic occurrences throught the whole Variscan belt and also in the ECMs.

Geodynamical scenarii :

Guillot & Ménot., 2009

- **Subduction zone** already proposed in the ECMs *(Guillot & Ménot., 2009; Jouffray et al., 2020).*



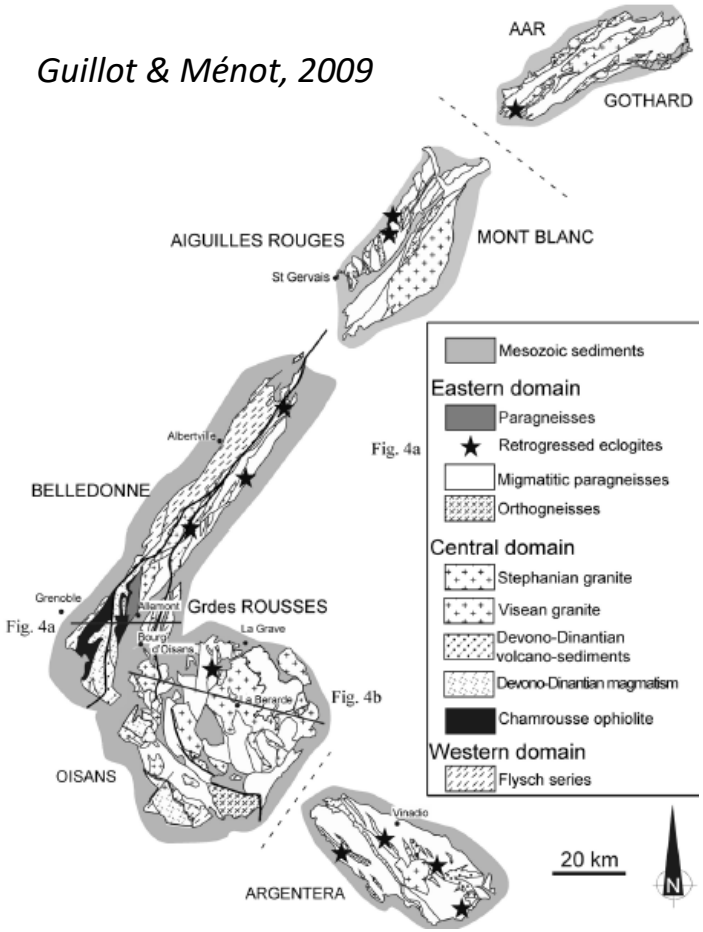


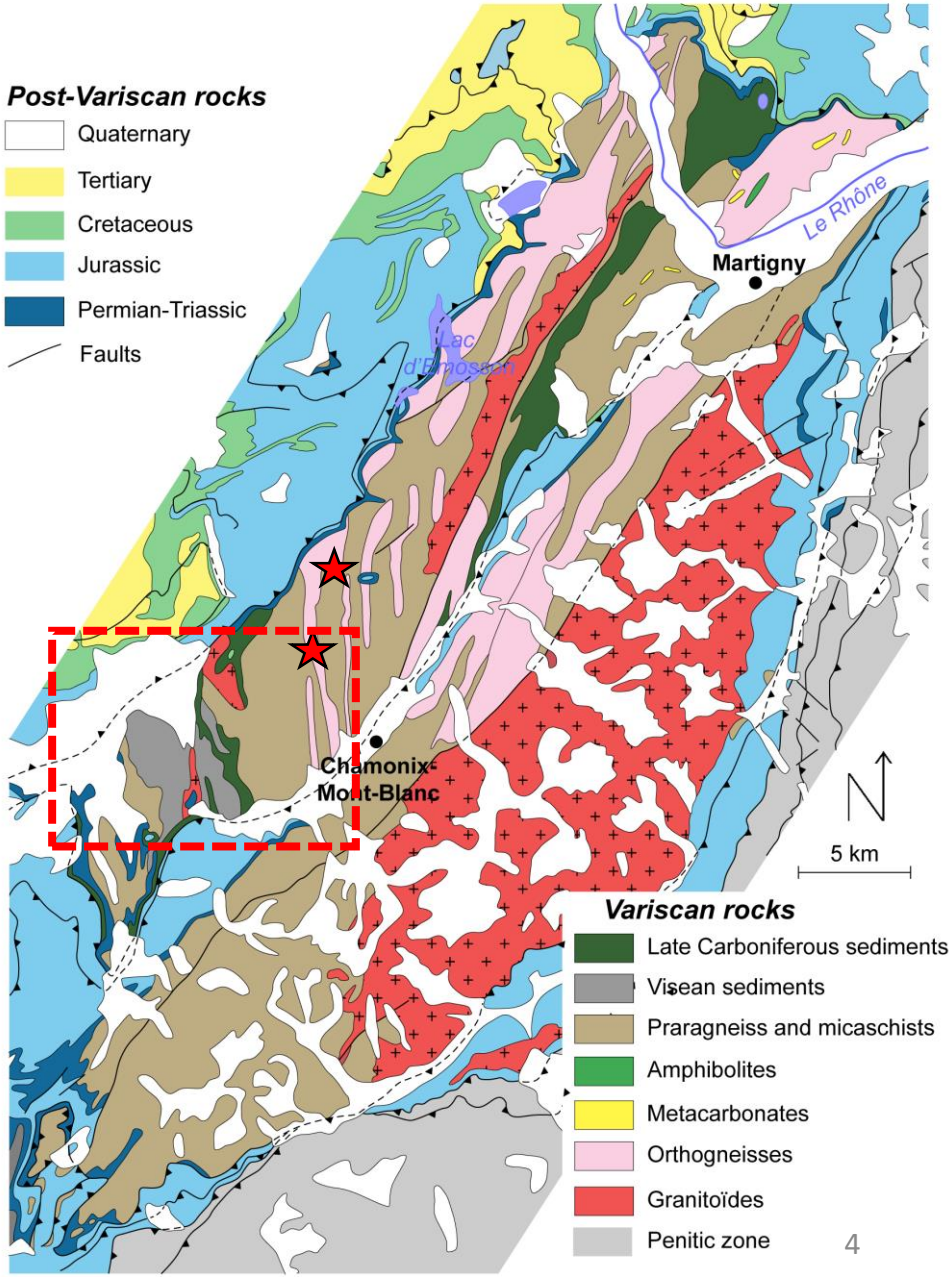
Roger et al., 2020

- **Pieces of crustal root of an orogenic plateau** as in the Montagne Noire *(Whitney et al., 2015; Roger et al., 2020)*

- **Overpressure phenomenum**

Guillot & Ménot, 2009





Structural analysis of the SW part of the Aiguilles-Rouges massif (ARM) and **thermobarometric modeling** of the Lac Cornu eclogites.

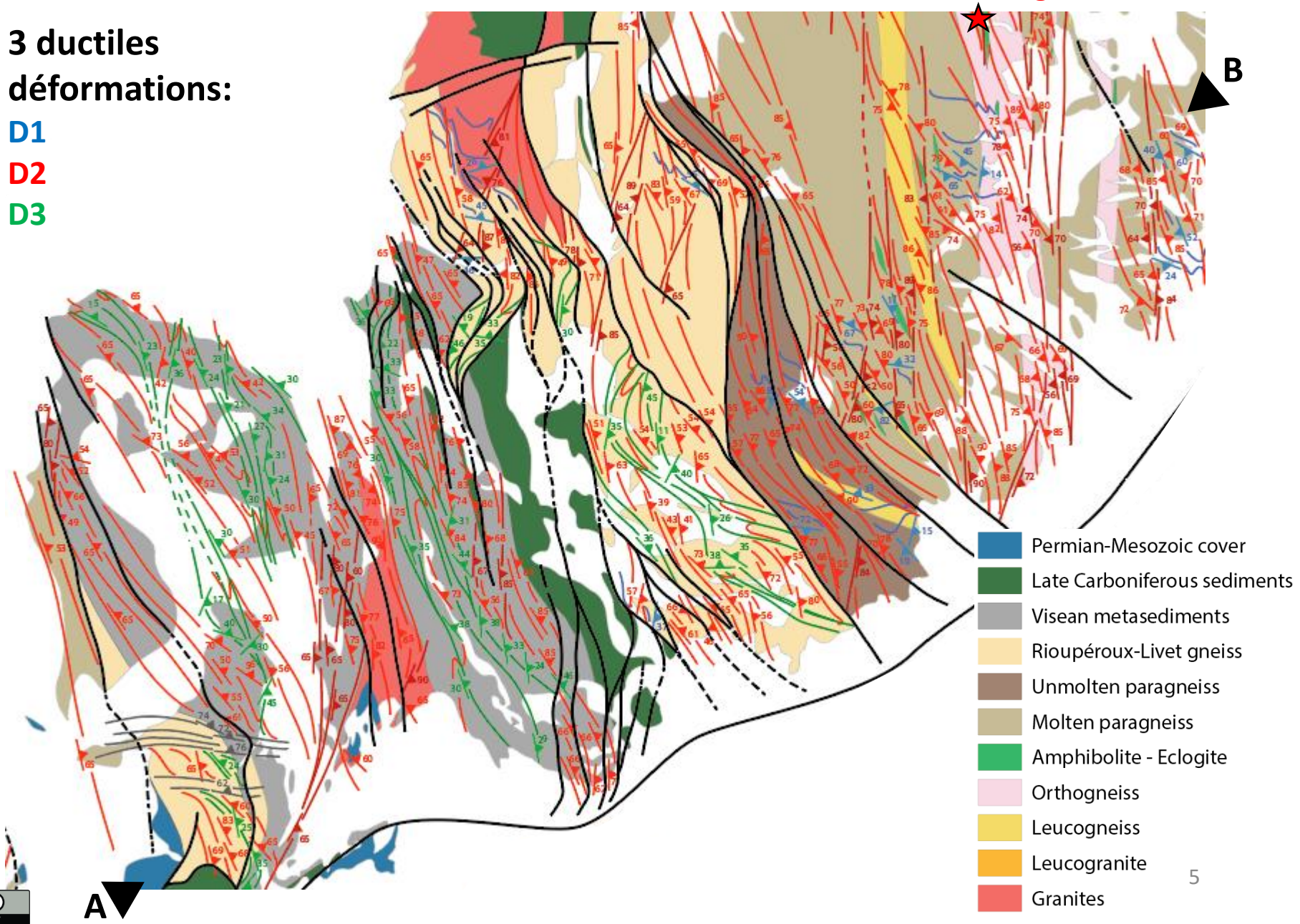
3 ductiles déformations:

D1

D2

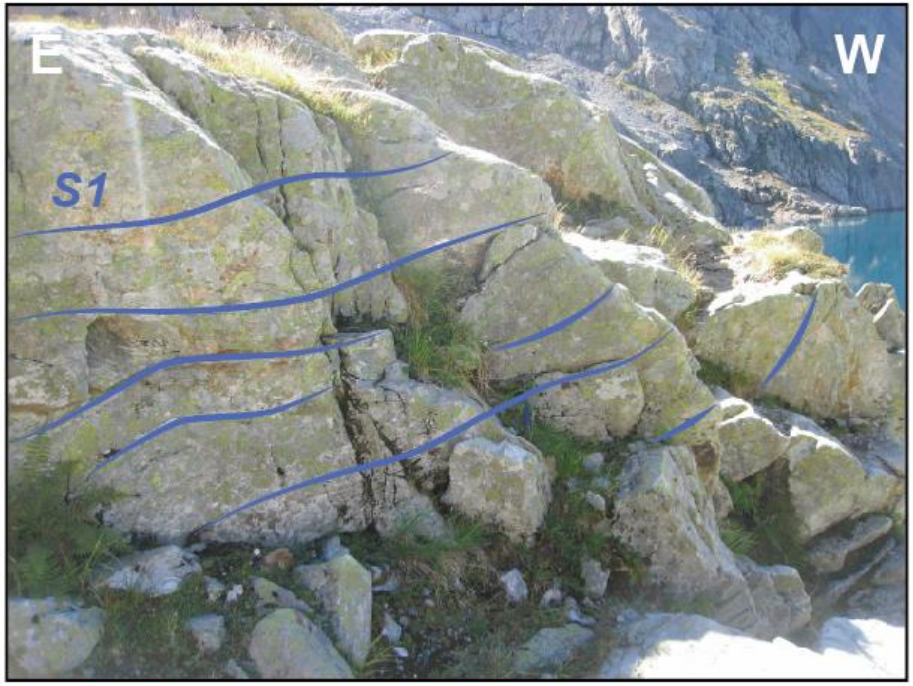
D3

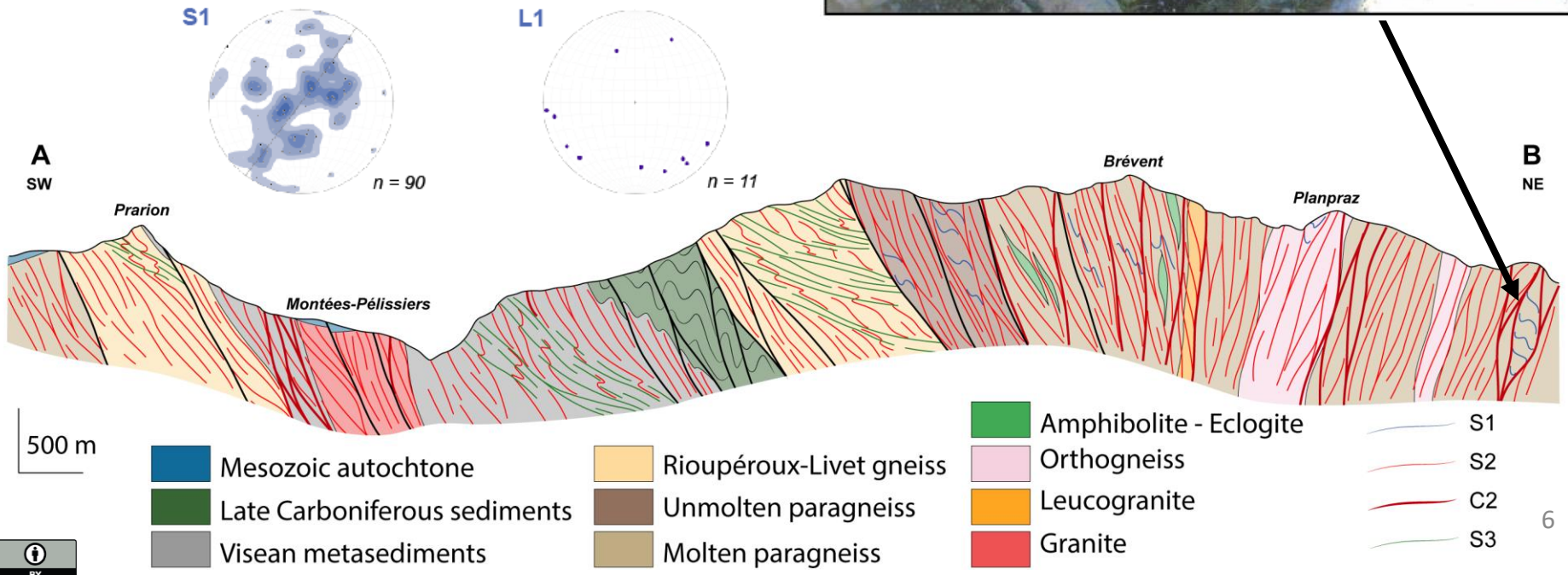
Lac Cornu eclogites



D1

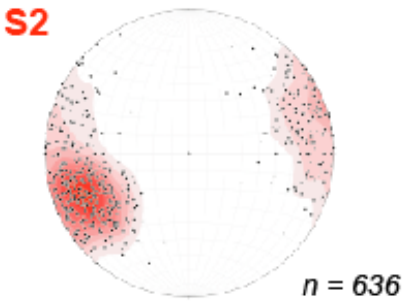
- D1 is a relictual deformation, observed in low-D2 strain domains.
- D1 forms a sub-horizontal S1 foliation slightly deeping toward the SW.
- S1 is present in the whole gneissic basement and is missing in the suprastructural Carboniferous (presumed) sediments.
- Mineral or stretching lineations L1 have been observed but D1 kinematic remains uncertain.

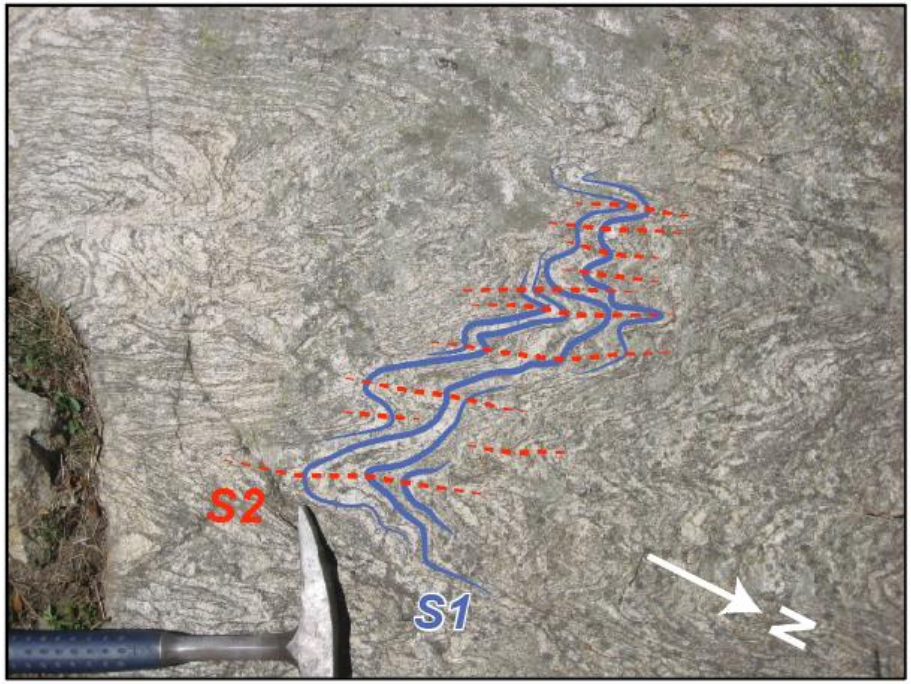


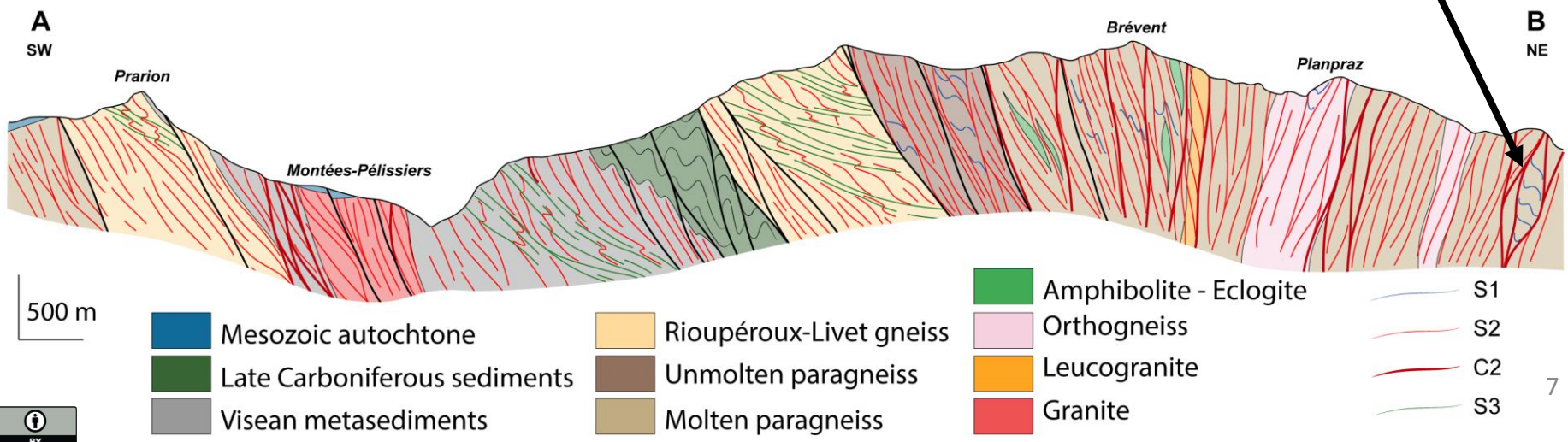


D2

- D2 is the most pervasive deformation of the massif.
- D2 folds S1 and forms a sub-vertical S2 foliation oriented N160.

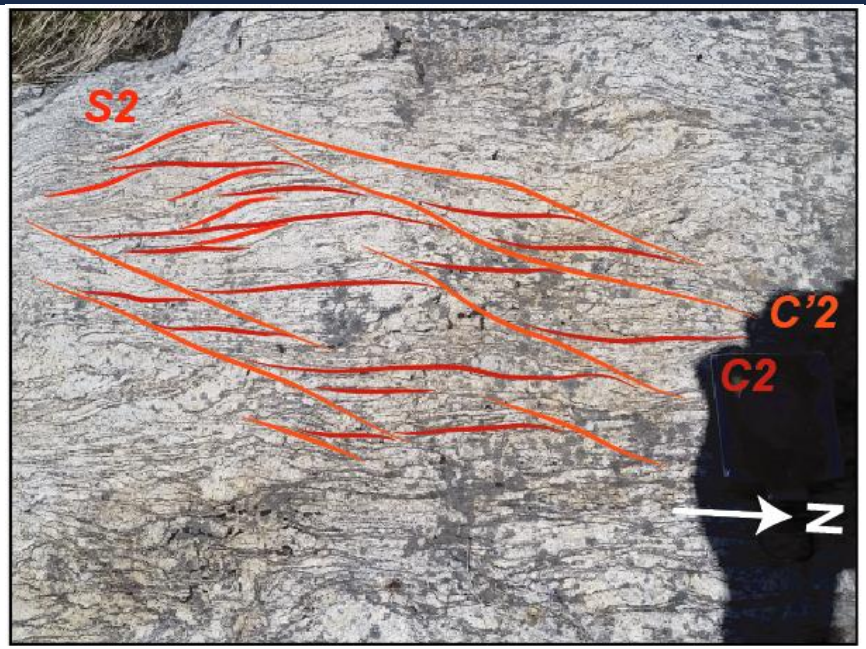


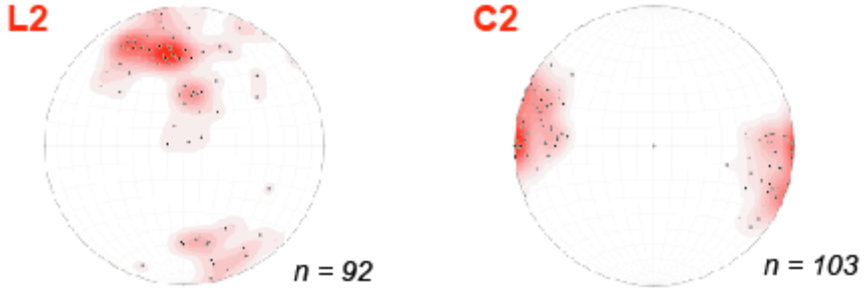


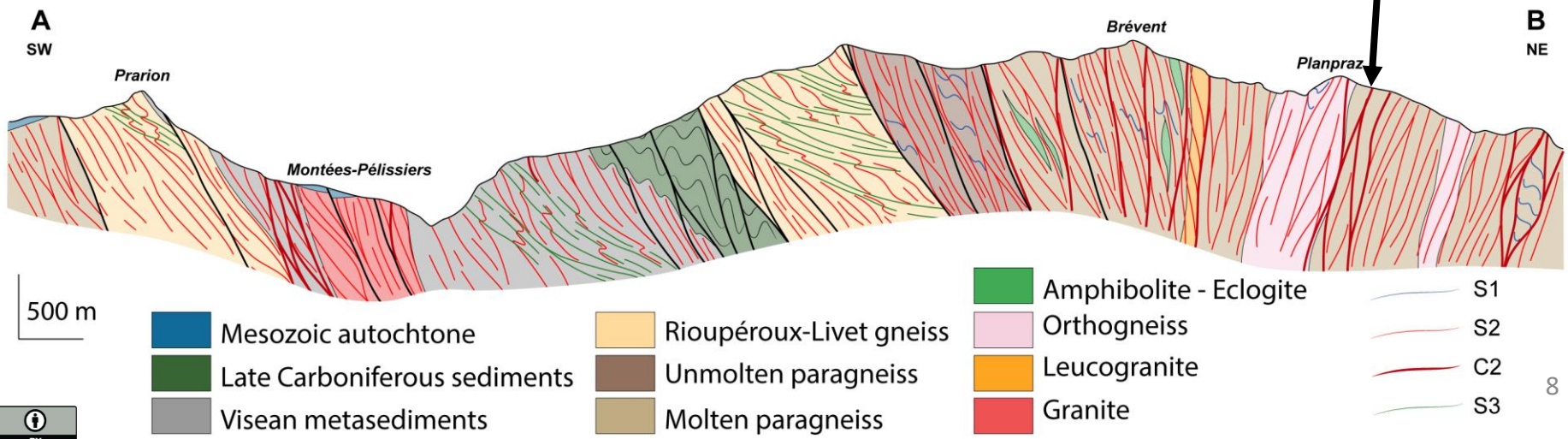


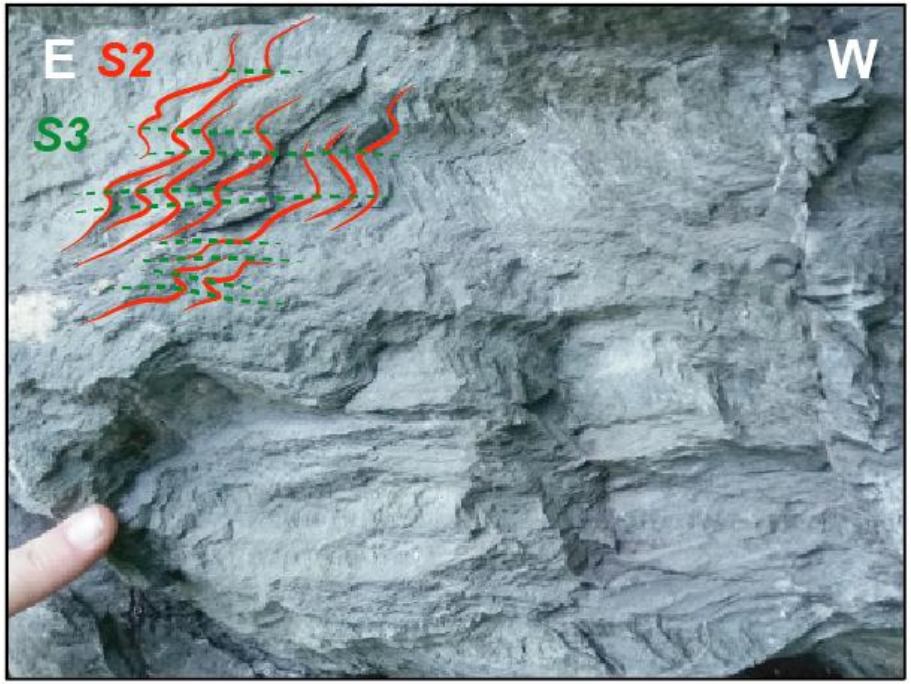
D2

- S2 holds a weakly to moderately plunging mineral and stretching L2 lineations along which dextral shearing is conspicuous.
- Shear strain increases towards the NE with a anastomosed network of centimetric to decametric shear zones arranged in a S-C-C' pattern (S2 N160, C2 N10 and C'2 N30).



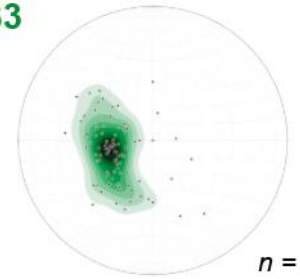


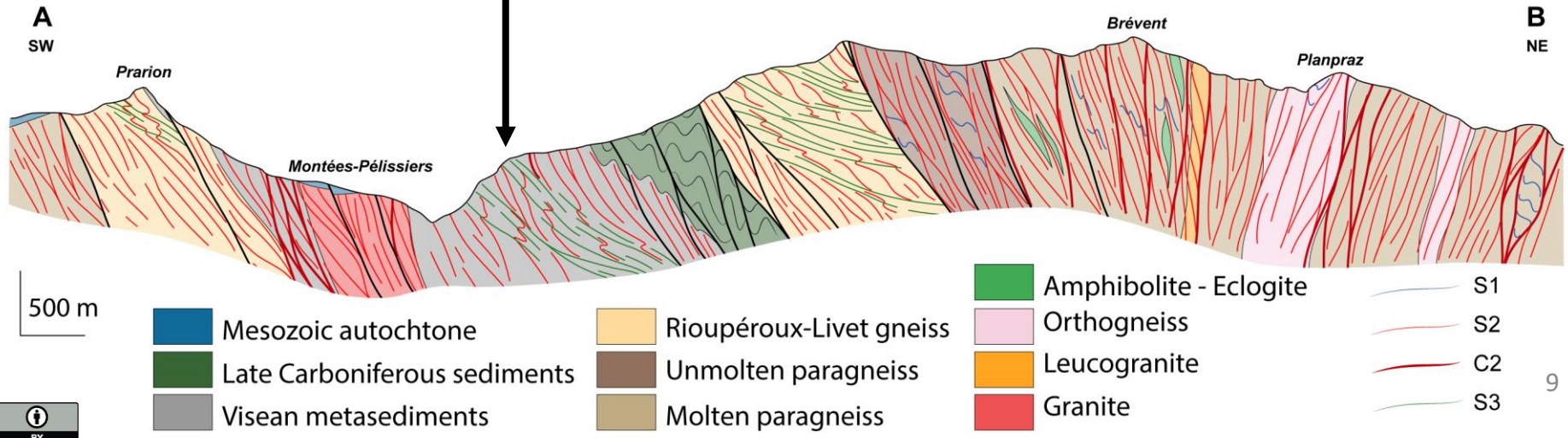




D3

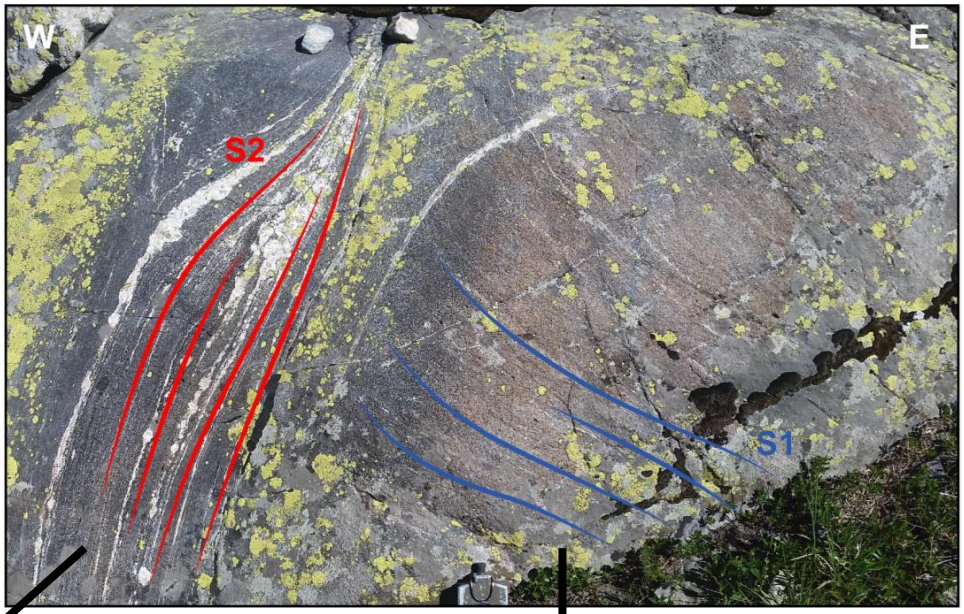
- D3 forms meter to decameter localized domains where D2 is reworked by open tight F3 folds with a sub-horizontal S3 cleavage.
- D3 is only present in the Lower-Carboniferous sediments and in the "Riouperoux Livet" type gneisses.
- L3 mineral and stretching lineations are gently dipping towards the NW or the SE. D3 Kinematics remains unknown.

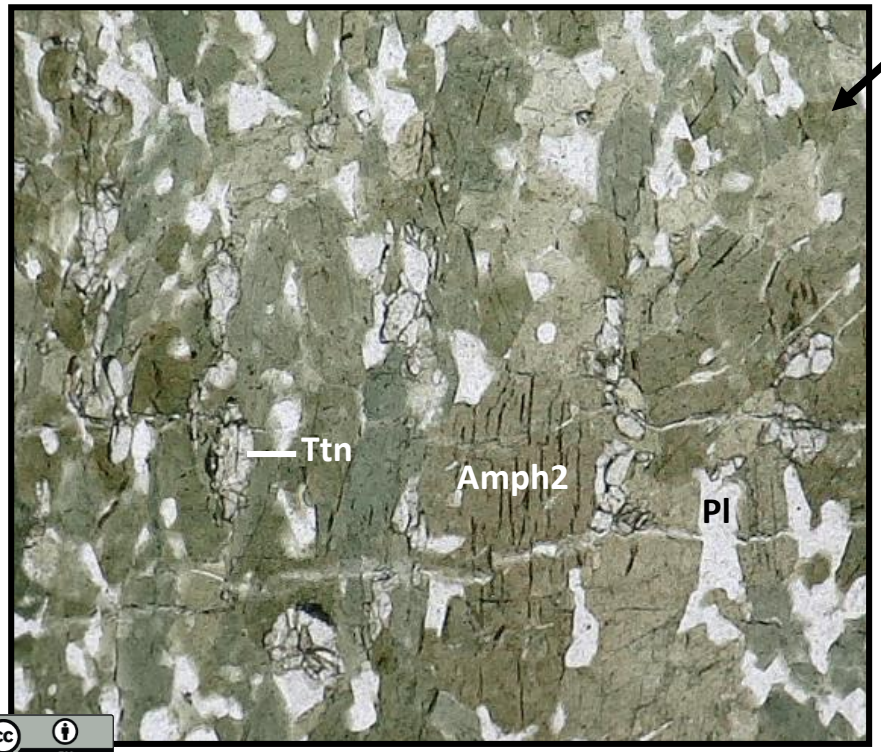


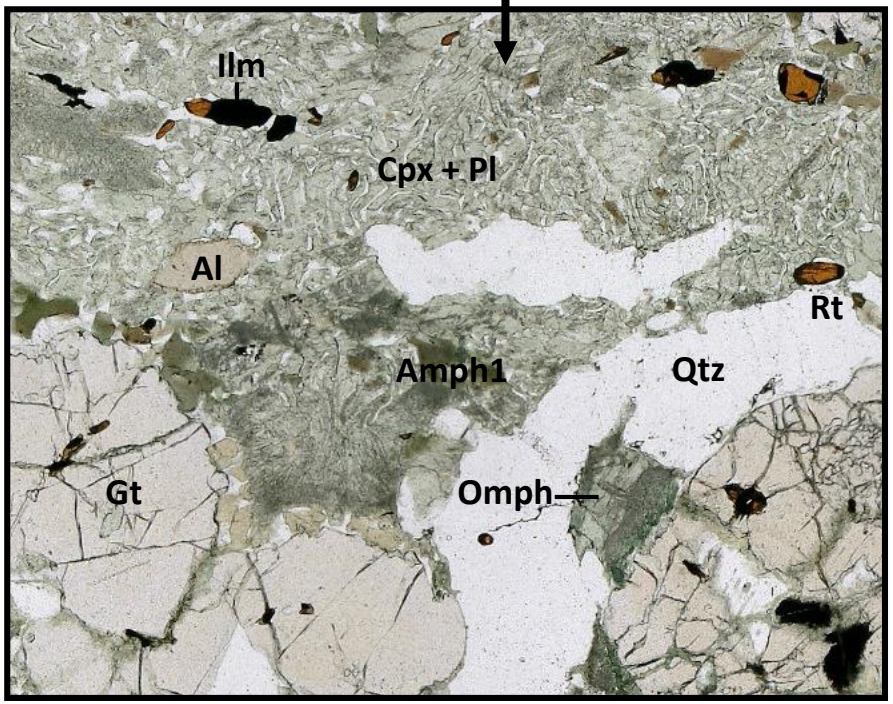


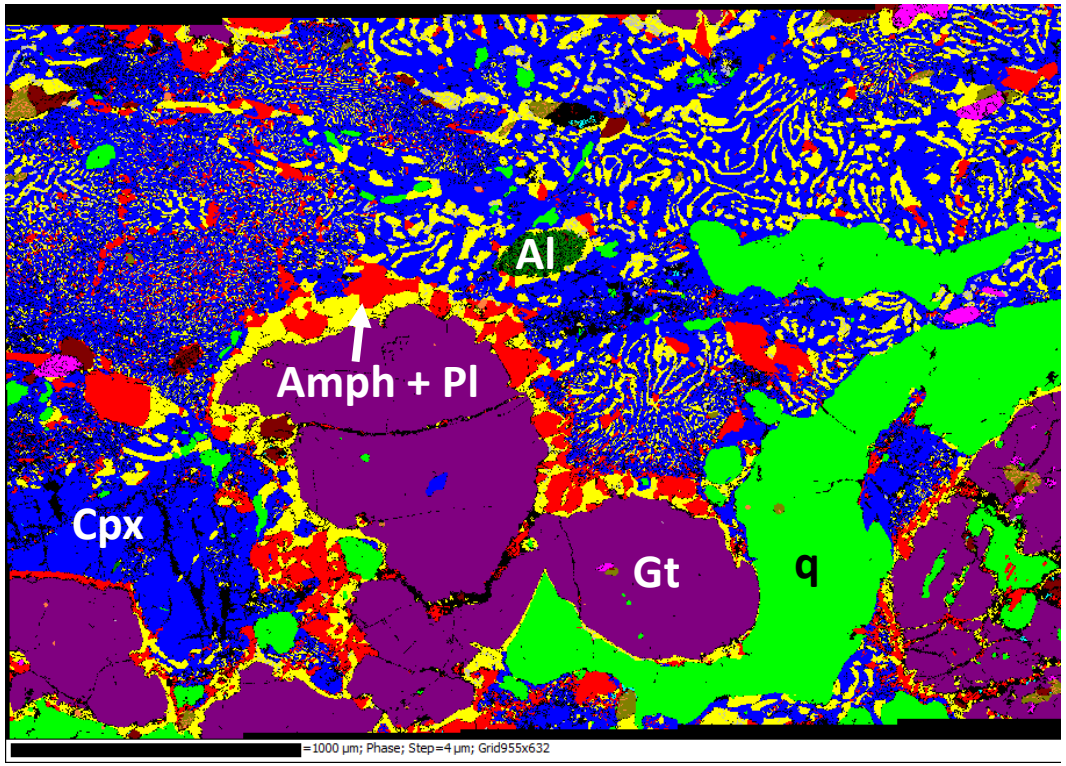
Cornu Lake eclogites

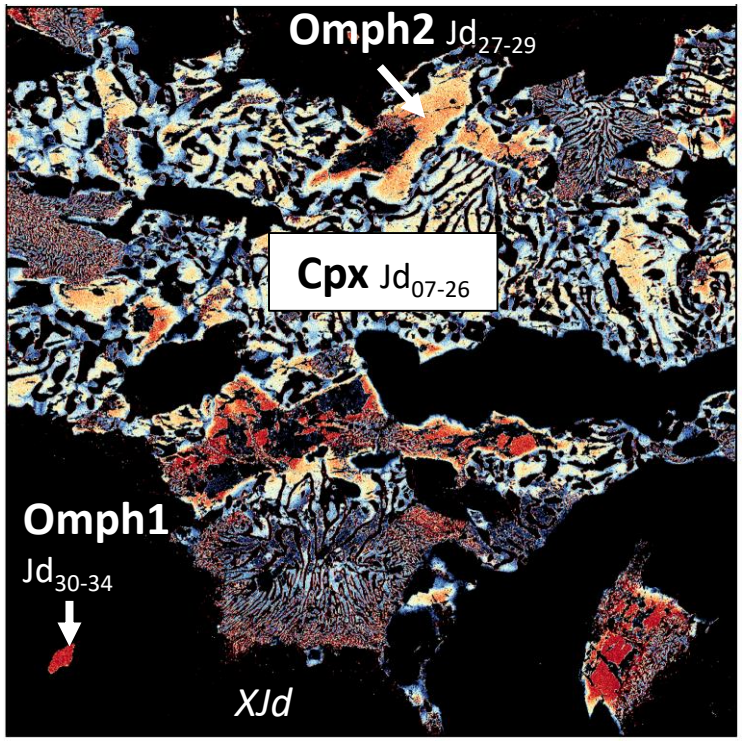
Retrogression from Eclogitic facies to low-T° amphibolitic facies

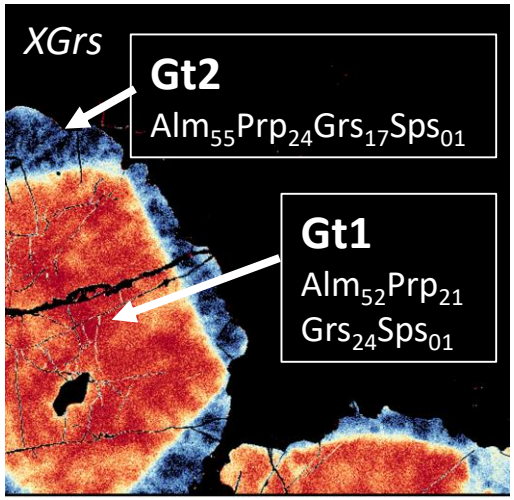


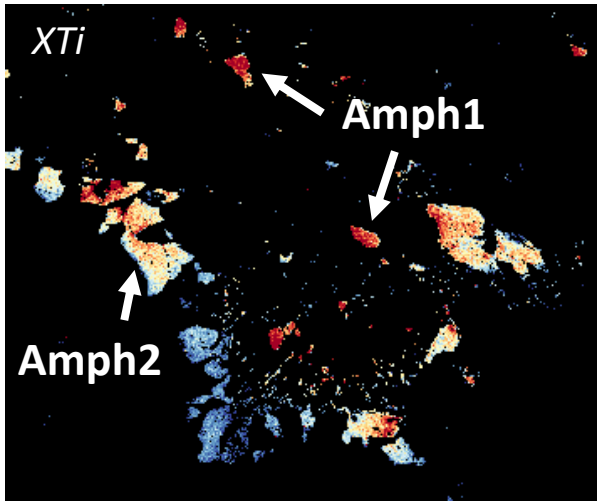










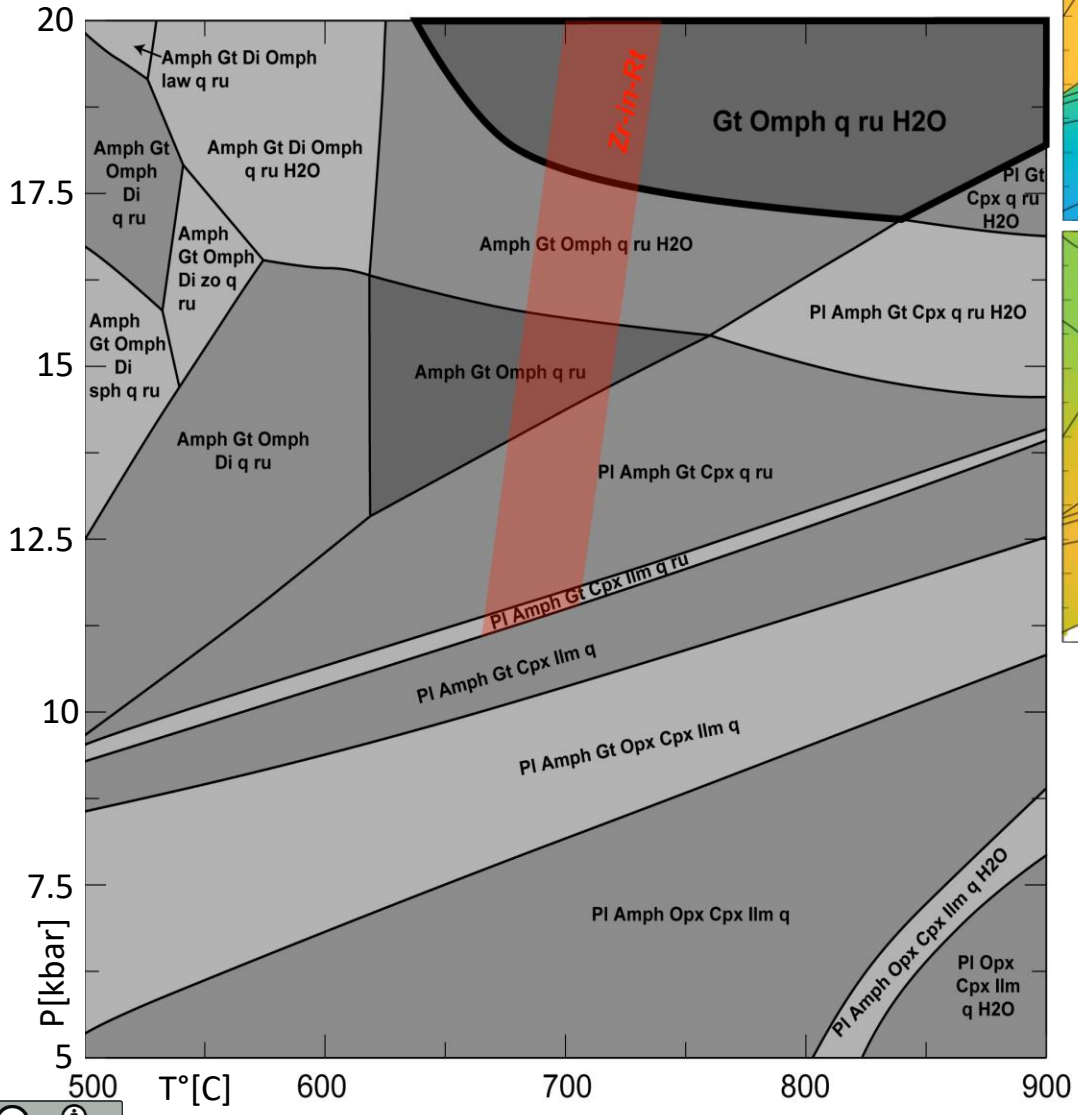


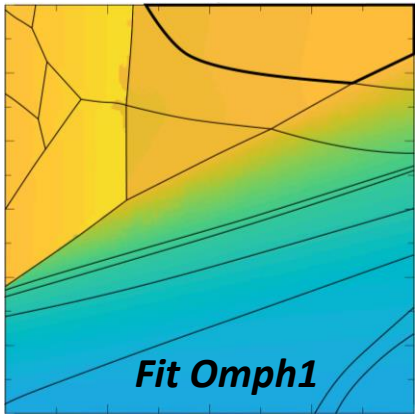
3 main parageneses :

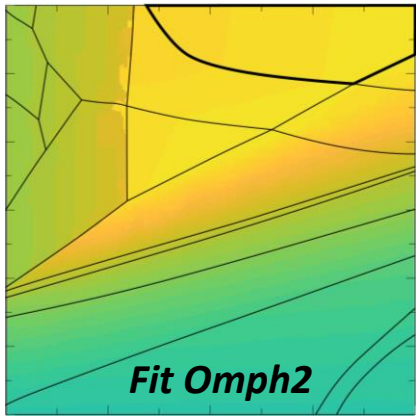
- Gt1 + Omph + Qtz + Rt + Al
- Gt2 + Sympl(Cpx + Pl = breakdown Omph) + Amph1 + Qtz + Rt/Ilm
- Amph2 + Pl (Breakdown Gt) + Ttn

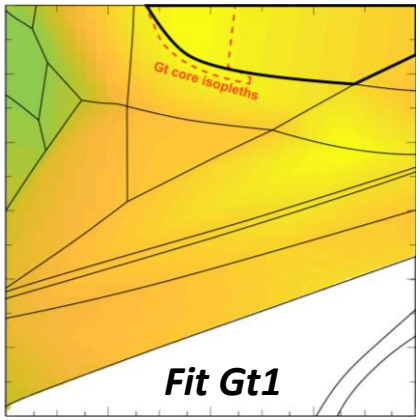
- **HP paragenesis**
  Gt1 + Omph + q + ru

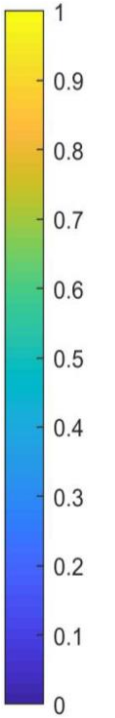
NCFMASHTO







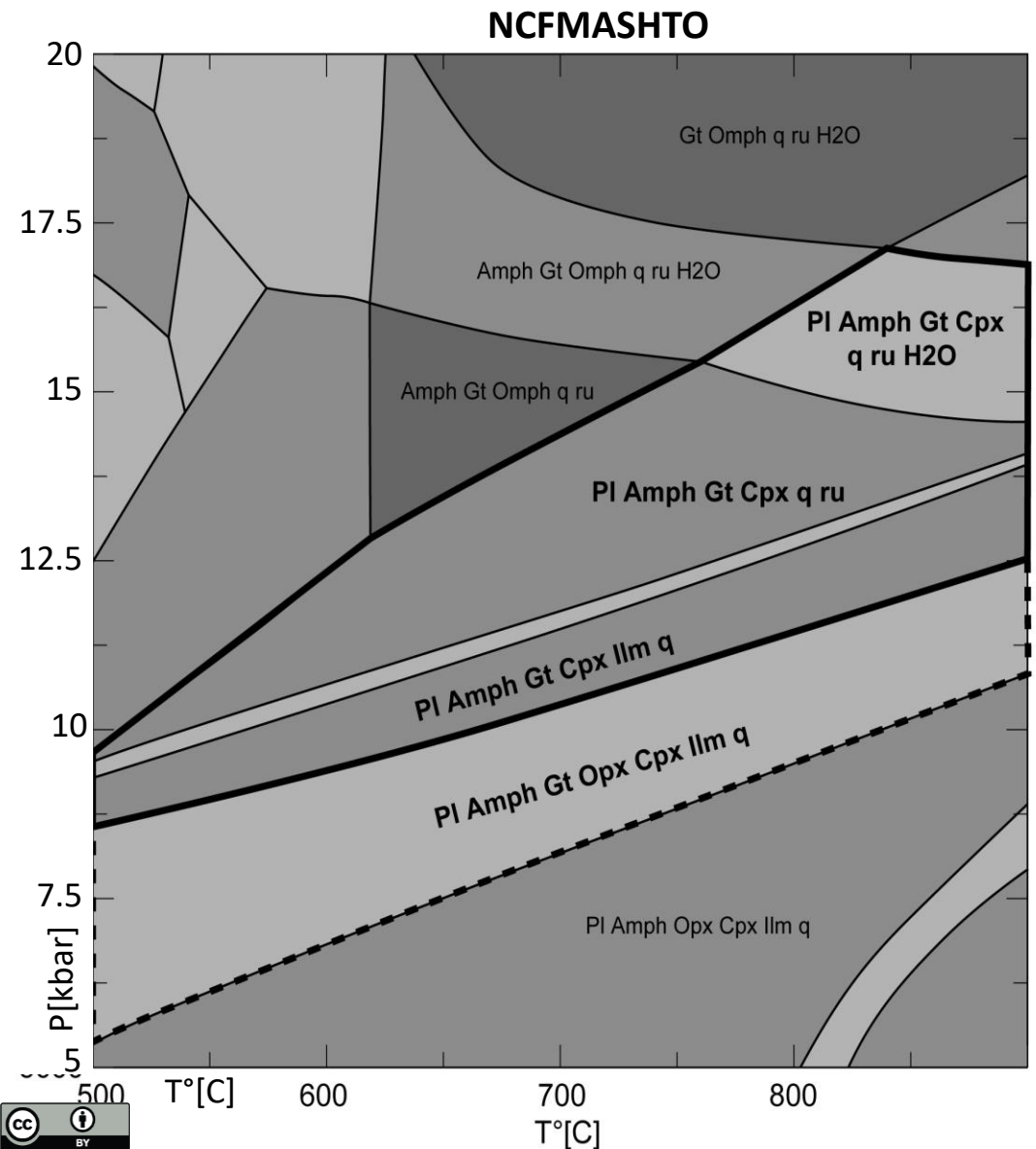


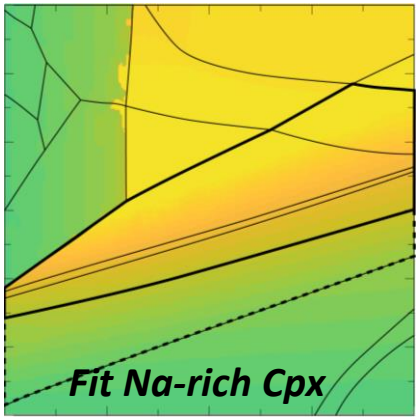


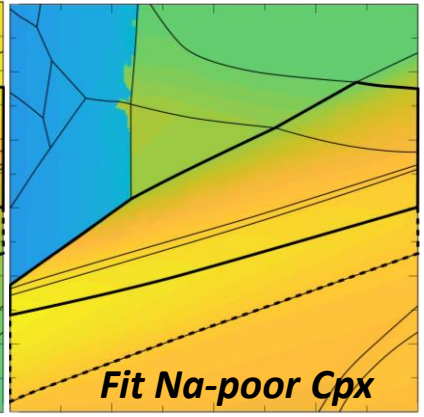
P peak at ca. 700°C and 17.5 kbar (minimum, no upper limit)
Omph1 is prograde (below 630°C)

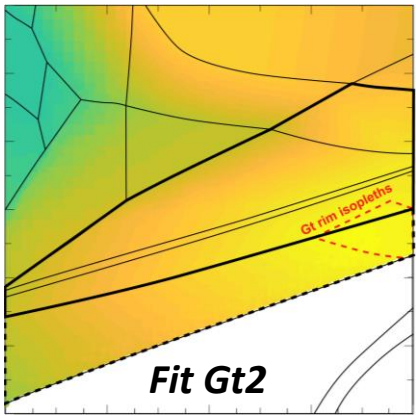
- **HT paragenesis**

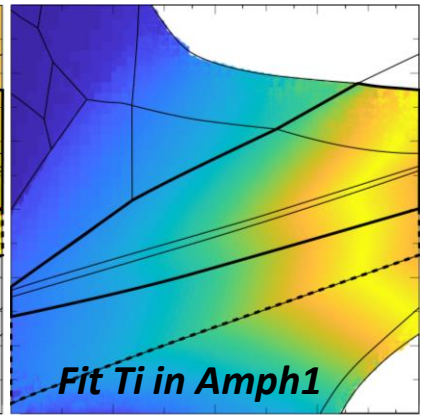
Gt2 + Sympl(Cpx + Pl) + Amph1 + q + ru/Ilm (+ Opx)

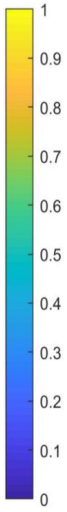












Evolution from ca. **875°C at 17 kbar** (Amph1 and Na-rich Cpx) to ca. **825°C and 12kbar** (Grt2, Na-poor Cpx)

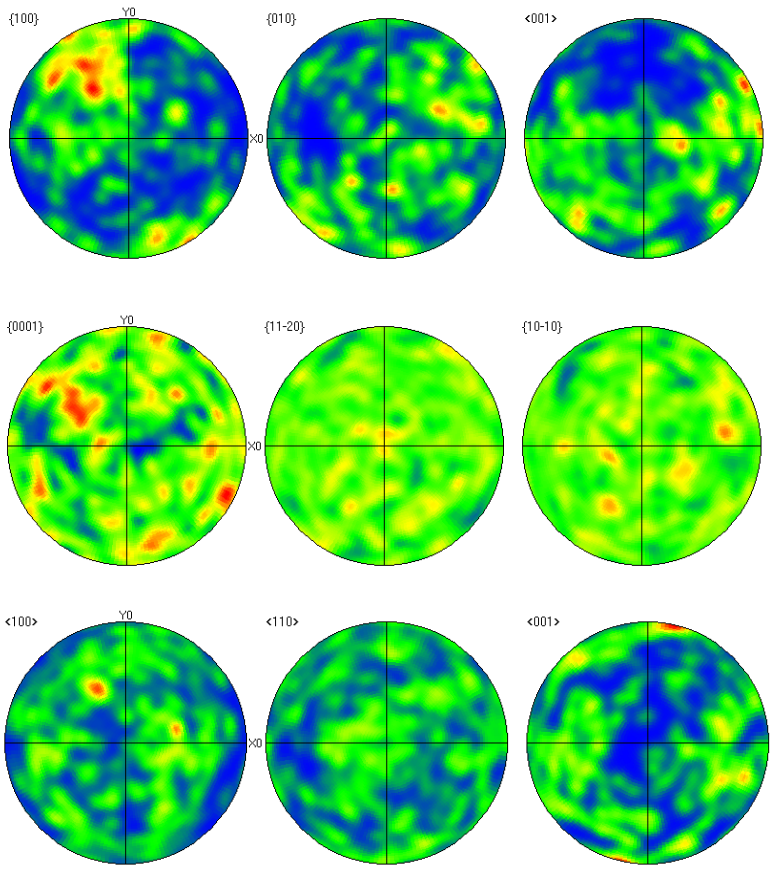
Gt inclusions (Omph1, q, ru)

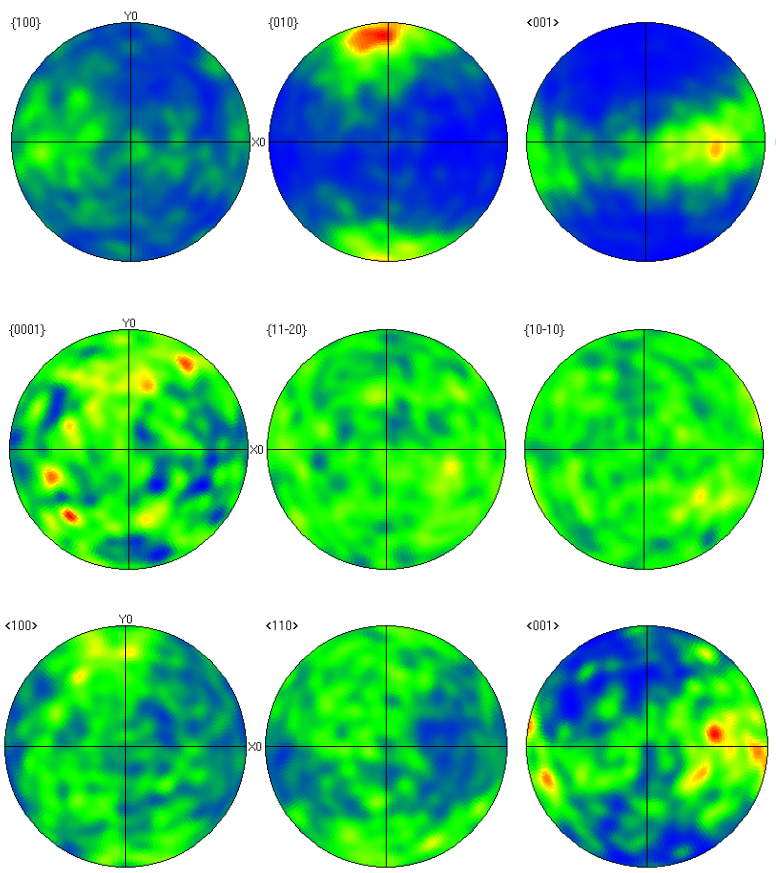
Matrix minerals (Omph2, Cpx, q, ru)

Cpx

q

ru





S1

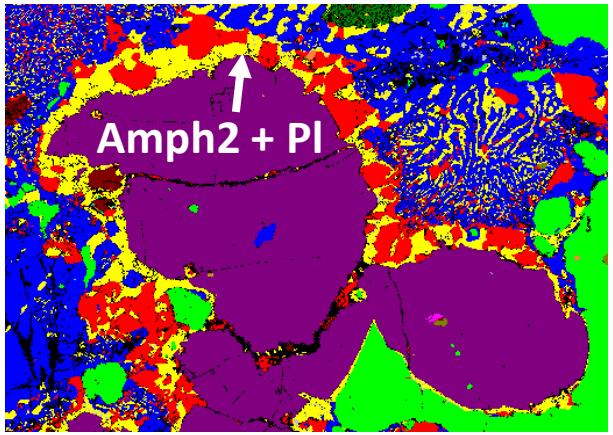
➡ Inclusions in Gt1 do not mark the S1

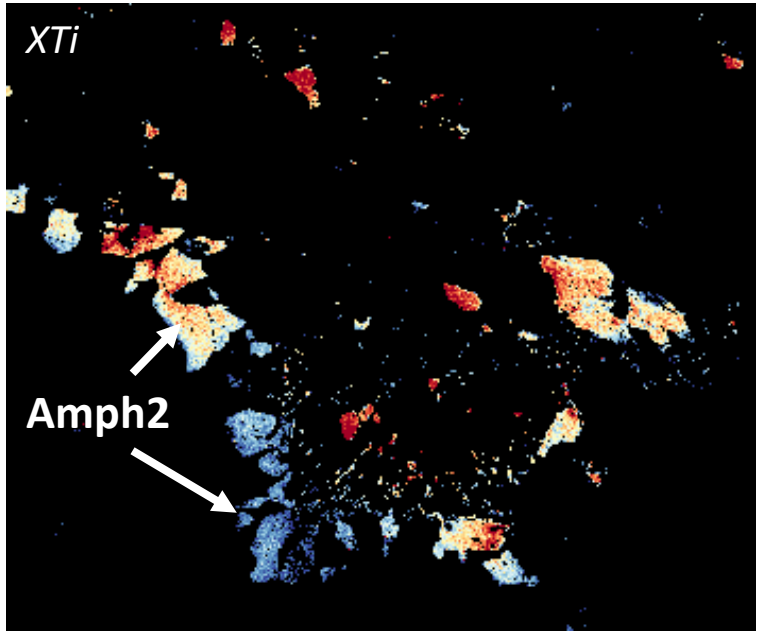
➡ Mnx (mostly Cpx and ru) in the matrix mark the S1

➡ Rutiles are syn-HP peak, so **D1 is post-HP**
Cpx from symplectites crystallized oriented in S1, so **D1 is syn-HT**

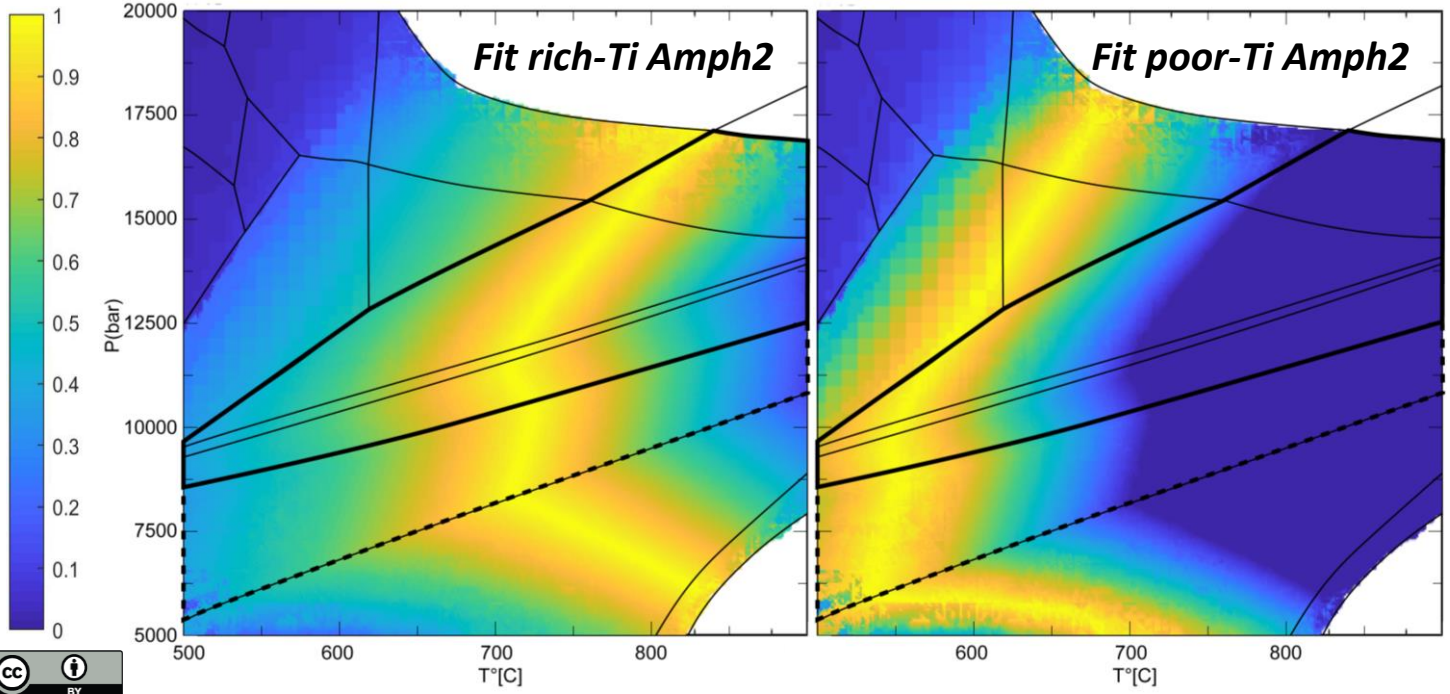
- **retrogressed paragenesis**

Pl + Amph2 (Gt Breakdown) + Ttn

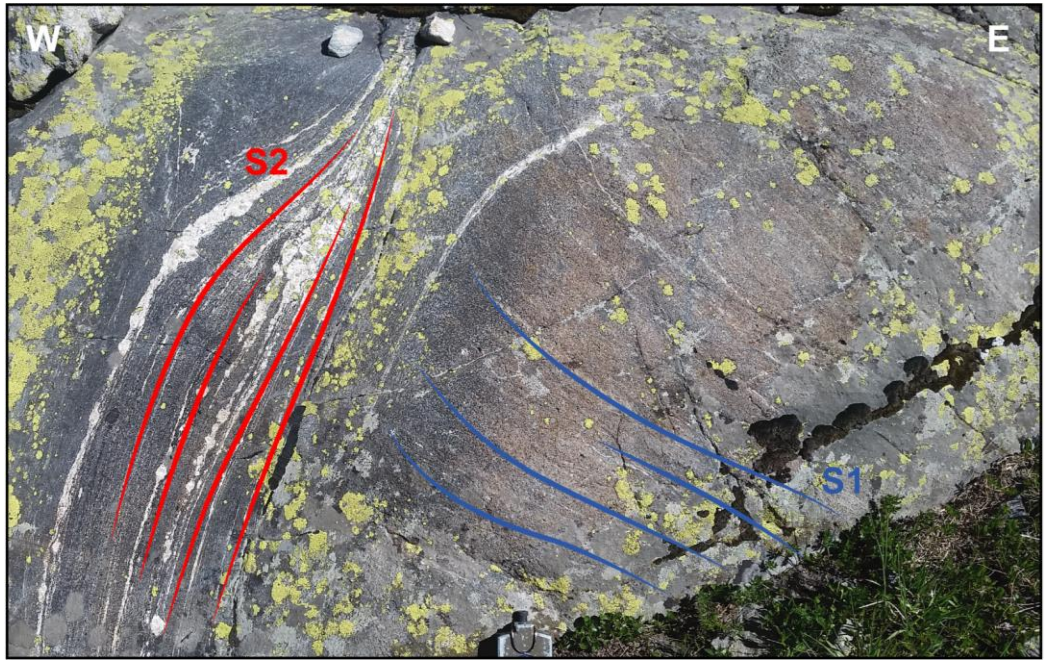


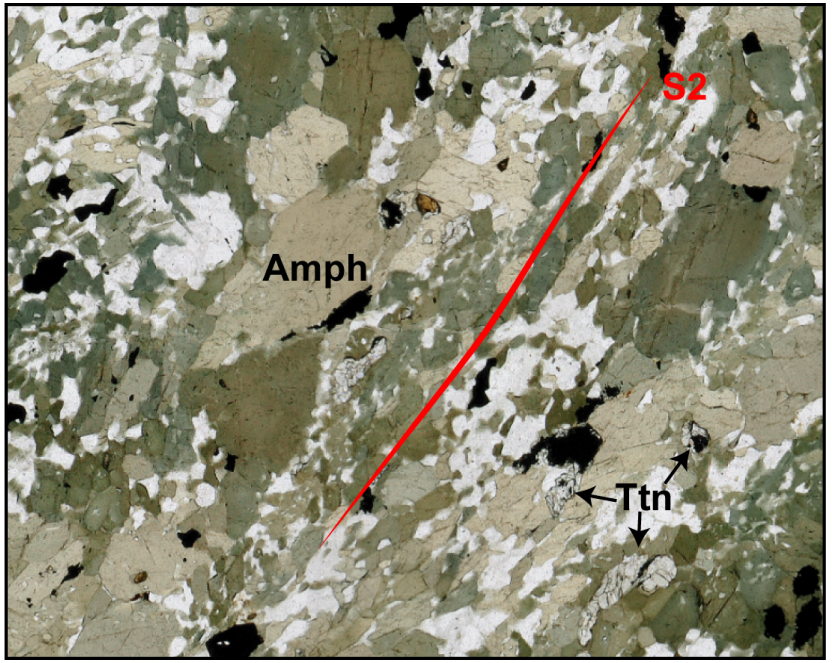


Evolution from rich to poor-Ti Amph2

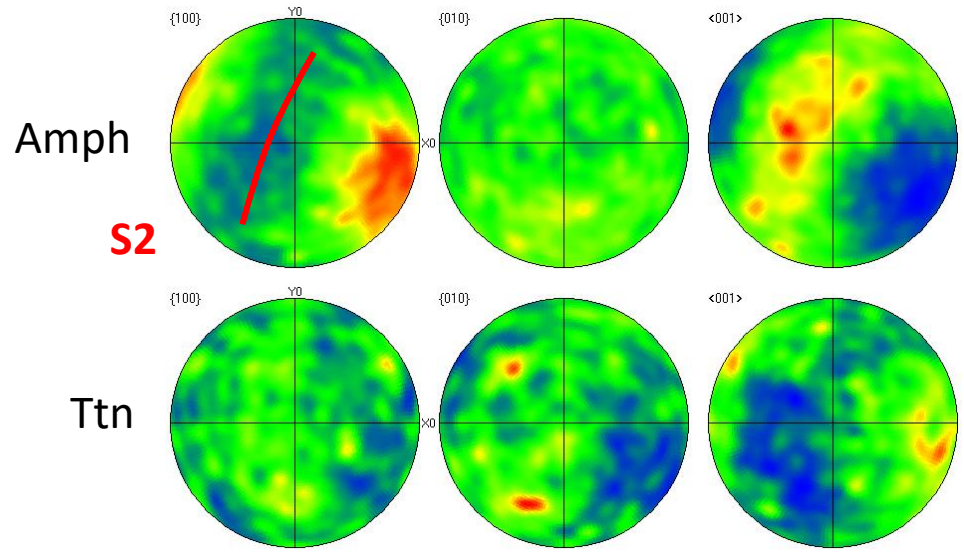


Temperatures between ca. **710°C to 550 °C** for the garnet corona

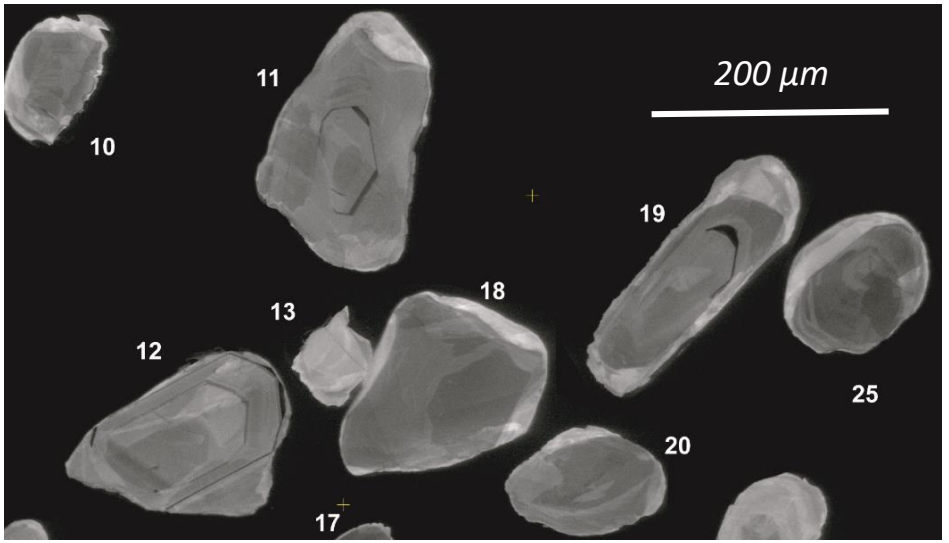




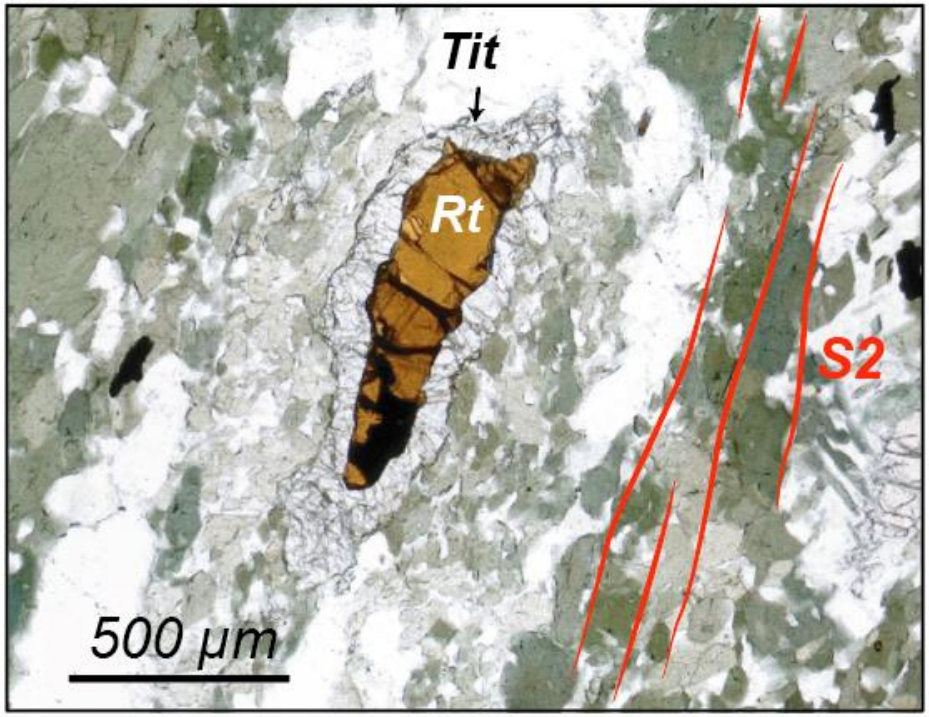
Amph + Pl + Ttn retromorphose is syn D2



Several samples are ready to be analysed by LA-ICPMS in order to constrain the tectonic, magmatic and metamorphic evolution of the ARM, such as rutiles, zircons and titanites from Cornu Lake eclogites.



Zircons from Cornu Lake eclogites



Rutile and Titanites from Cornu Lake retrogressed eclogites

Unfortunately, the dating session has been cancelled because of the Covid-19 .

Results in July !!!

Age of HP metamorphism:

- 395 ± 2 Ma proposed by Paquette et al. (1989) on eclogite from Belledonne massif.
- Ages at ca. 340 Ma on eclogites from ARM (Bussy et al., 2011), Belledone and Pelvoux massifs (Jacob et al., 2020), Argentera massif (Rubatto et al., 2010)

→ age at ca. **340 Ma** seems more robust (⚠ age at 340 Ma on an Amph from retrogressed eclogite by Jouffray et al., 2020)

Age of HT metamorphism and D1:

- Coeval with Pormenaz granite (332± 2 Ma) and T° peak of metamorphism dated at 327 ± 2 Ma in micaschists (Bussy et al., 2000)

→ age between ca. **325-335 Ma**

Age of D2 dextral shearing:

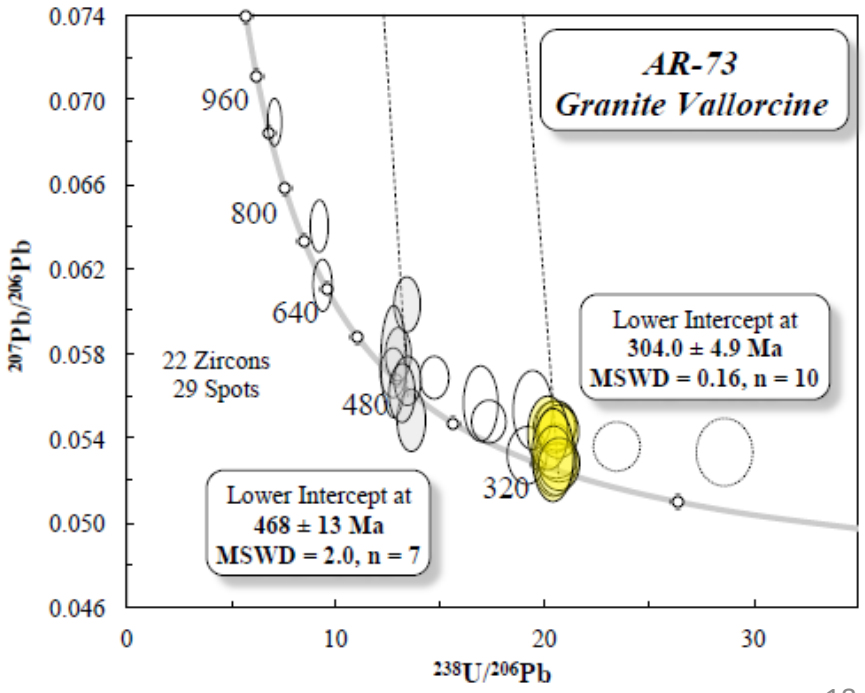
- Generally interpreted as coeval with Montées-Pélissiers granite (331 ± 2 Ma; Bussy et al., 2000) and with Vallorcine granite (ca. 305 Ma; Bussy et al., 2000 and this study)

→ age between ca. **305-330 Ma**

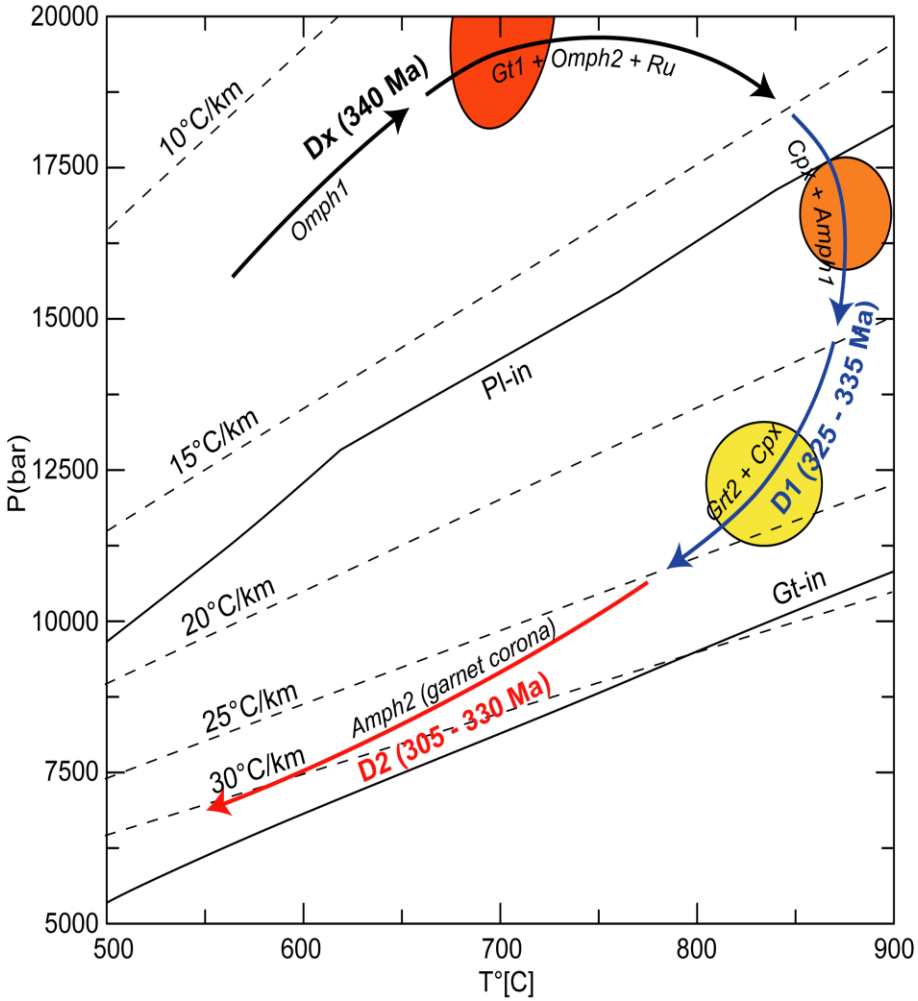
Age of D3:

- Continuum of partial melting from D1 to D3

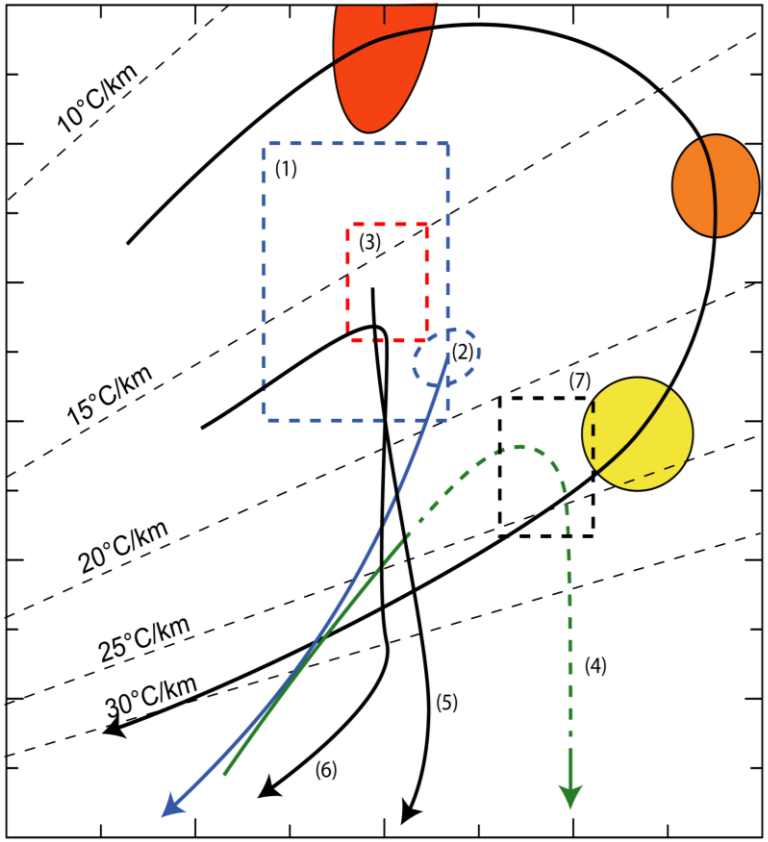
→ **After 305 Ma ?**



P-T-t-D evolution of the Cornu Lake eclogite from the ARM



Comparison with others P-T estimations in the ECMs.



*Argentera: (1) Jouffray et al., 2020; Ferrando et al., 2008; Belledonne: (3) Jacob et al., 2020; Oisans: (4) Fréville, 2016; **ARM**: (5) Schulz and von Raumer, 1993; (6) Schulz and von Raumer, 2011; (7) Liégeois and Duchesne, 1981.*

Fast tectonic evolution from the HP metamorphism and D2 dextral shearing.
T and P higher than others studies of the ECMS.

High pressure origin ?

- D2 dextral shearing occurs in the whole Variscan belt in a mature thick crust and is considered as late-orogenic evolution (e.g. Ballèvre et al., 2018)
- Time span between the HP metamorphism and the beginning of D2 shearing (≈ 10 Ma) is too short for the subduction scenario in the ECMs (Jouffray et al., 2020; Rubatto et al., 2010; Guillot et al., 2009)

→ HP metamorphism is interpreted as equilibrated lower crust exhumed thanks to vertical shear zones (D2) (Jacob et al., 2020; Whitney et al., 2015).

Possible evolution of the ARM and of the ECMs

- Dx nappe stacking until 340 Ma (Fréville, 2016) with HP metamorphism in the lower crust
- D1 thermal relaxation (peak of T) and lateral flow (335-325 Ma)
- D2 dextral shearing along with lateral flow (330 -305 Ma) → exhumation of the lower crust
- D3 crustal thinning related to orogenic collapse ? (305 - ? Ma)

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