Squeezed Under the Sheet: White Mica Records High Tectonic Stresses Within a Decollement Thrust

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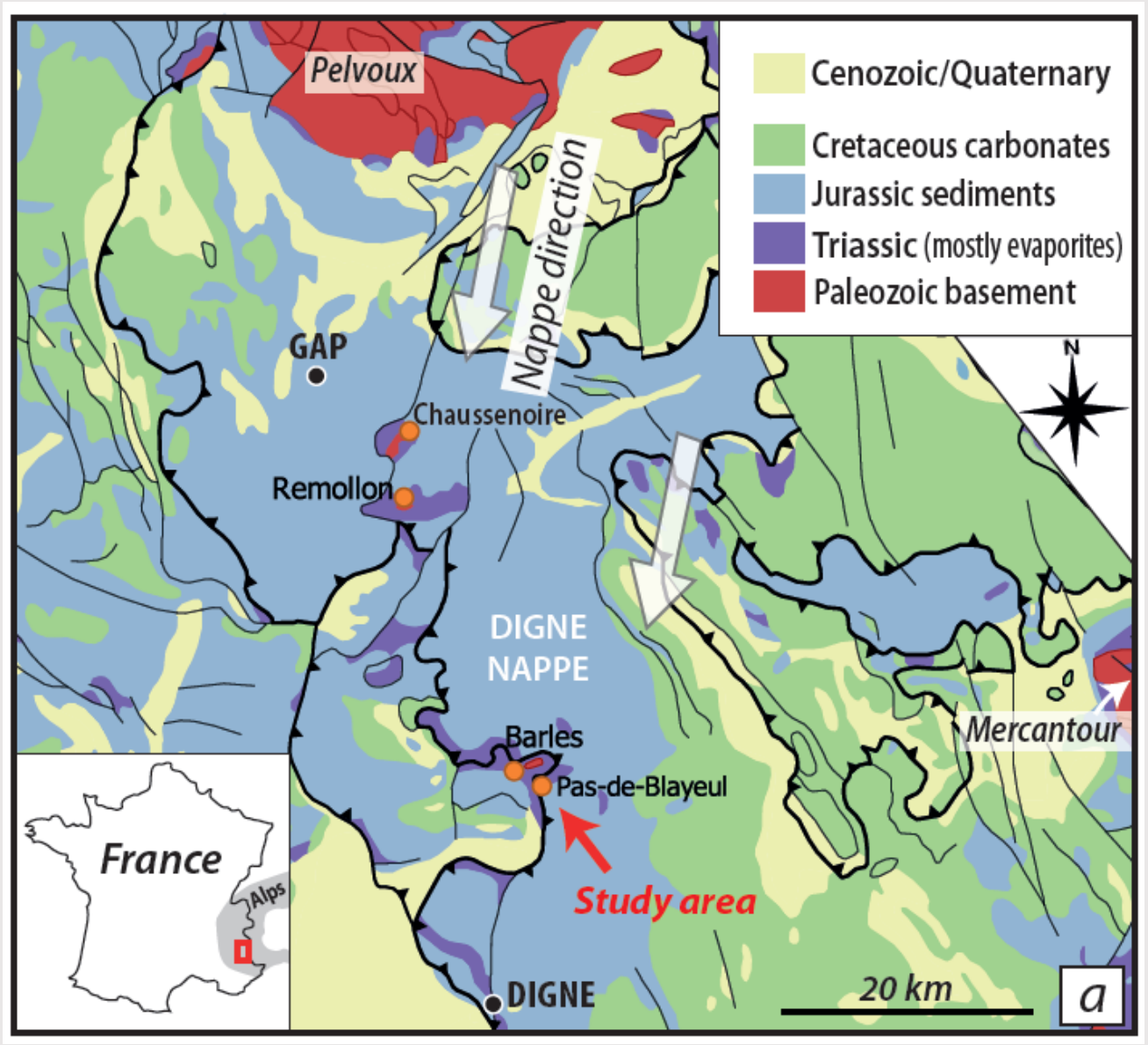
Decollement thrusts that host evaporites are expected to be very “weak”, thus promoting the transport of thrust sheets over large distances in foreland basins. This statement is in apparent contradiction with the numerous examples of micro-seismicity and seismicity along decollements in active fold-and-thrust belts.

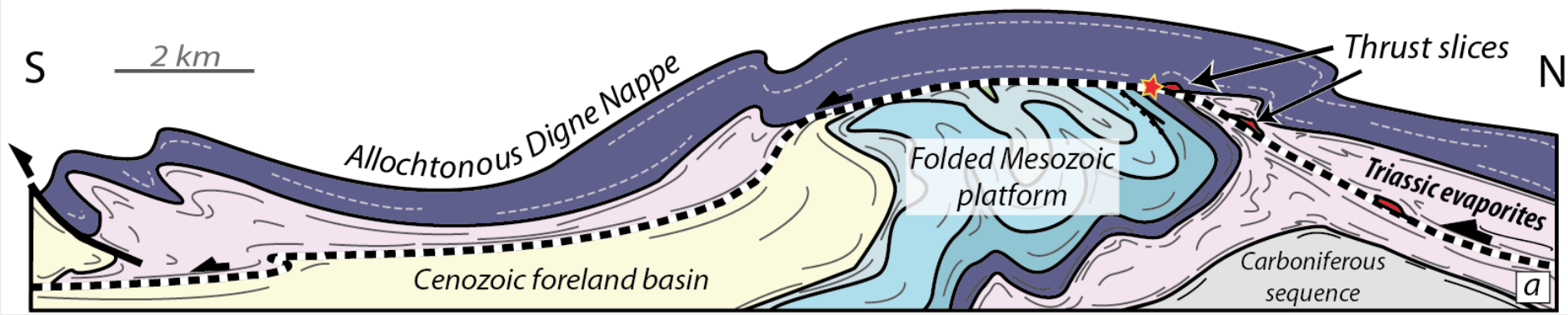
We study here a fossil thrust zone from the base of the Digne nappe (SE France) where exotic thrust slices formed by brecciated Paleozoic basement micaschists are observed within the Mio-Pliocene decollement. White mica grains in these micaschists show thin high-Si (high pressure) rims, that may be explained by strain accumulation in the thrust slices at the base of the moving nappe.



The study area in SW French Alps.

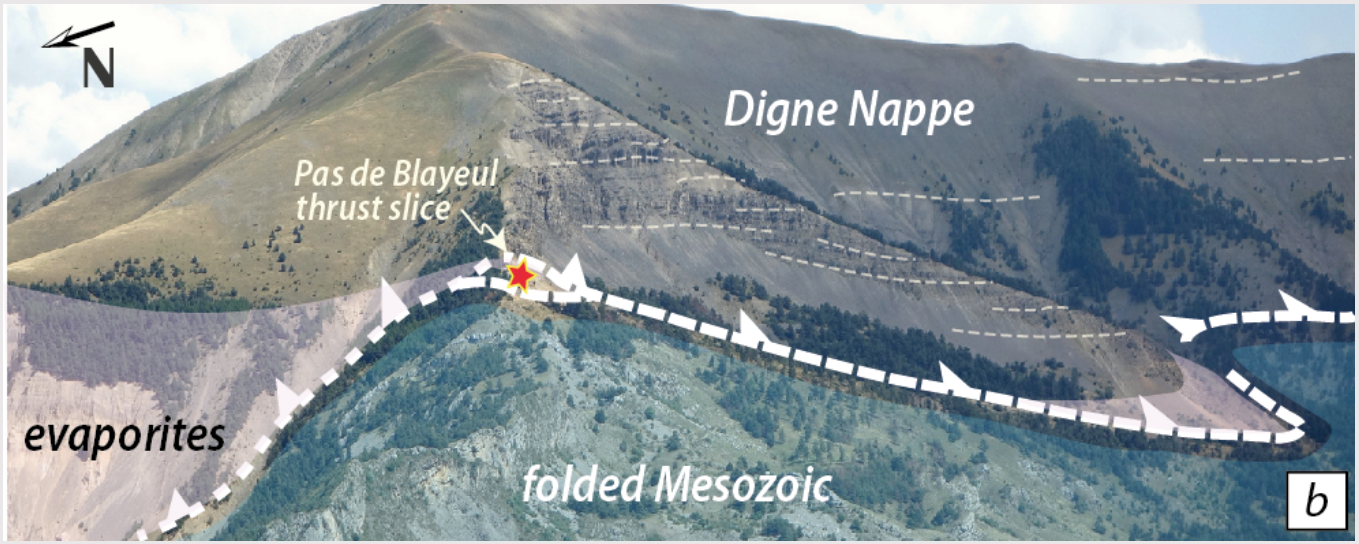
Red arrow points to Pas-de-Blayeul, where thrust slice micaschist samples were collected.

Map also shows the localities of Remollon and Chaussenoire, where basement samples were collected for comparison



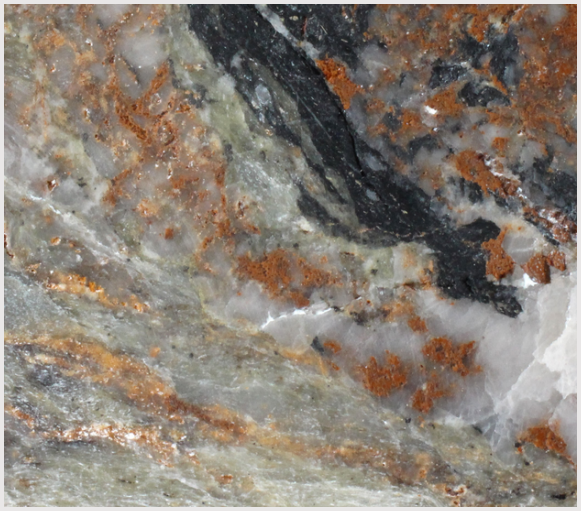
Simplified cross-section (modified after Gidon and Pairis (1992) showing the structural relationships between the underlying folded Mesozoic sequence and the Digne thrust nappe. The location of expected thrust slices is shown in red and the star locates the position of the studied sliver

Panorama of the Pas-de-Blayeul area showing the position of the thrust slice with respect to surrounding units.



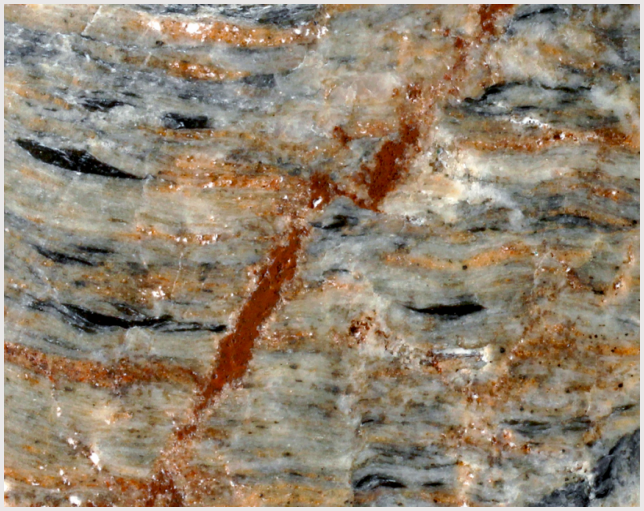
Field pictures from Pas-de-Blayeul:

Brecciated micaschists with abundant quartz and (Fe)carbonate veins



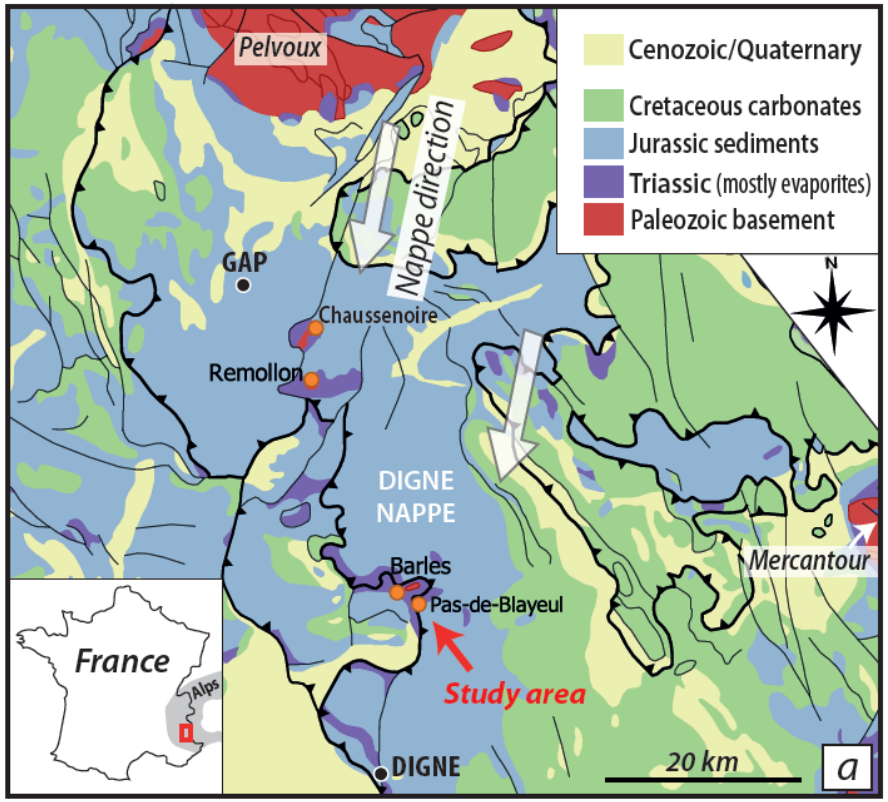
1 cm

Pas-de-Blayeul



Pas-de-Blayeul

Remollon-Chaussenoire dome

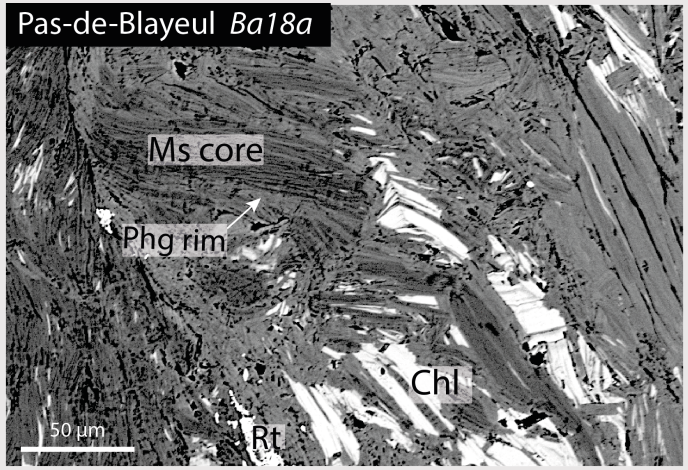


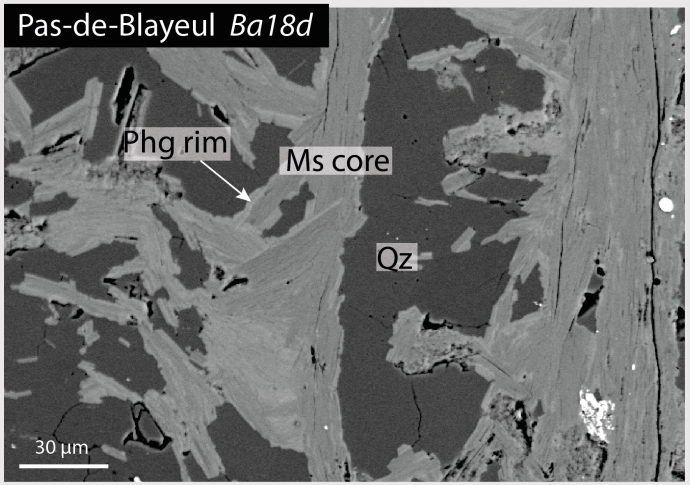
On hand specimen scale Pas-de-Blayeul (thrust slice) and Remollon-Chaussenoire (in place basement) samples are remarkably similar:

Alternating white mica (+/- organic matter) and quartz+albite layers with abundant veining

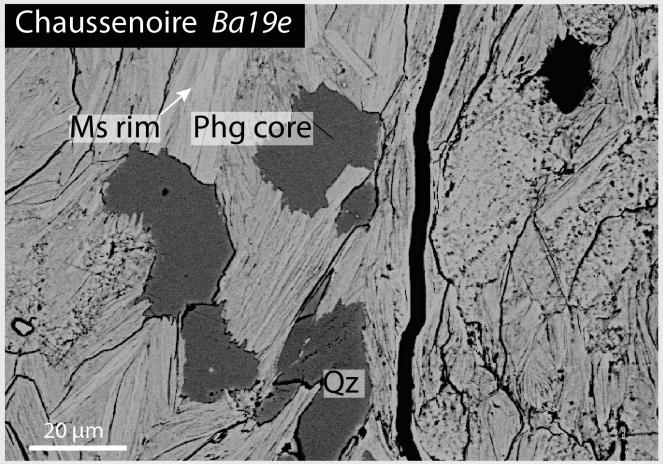
Scanning Electron Microscope

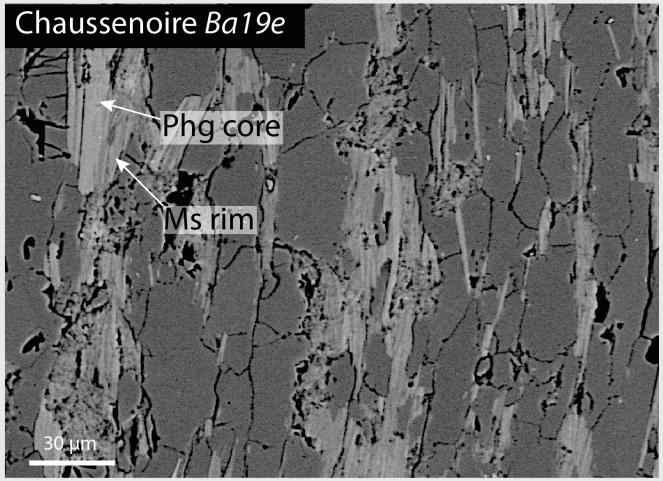
Pas-de-Blayeul thrust sliver





Remollon-Chaussenoire dome



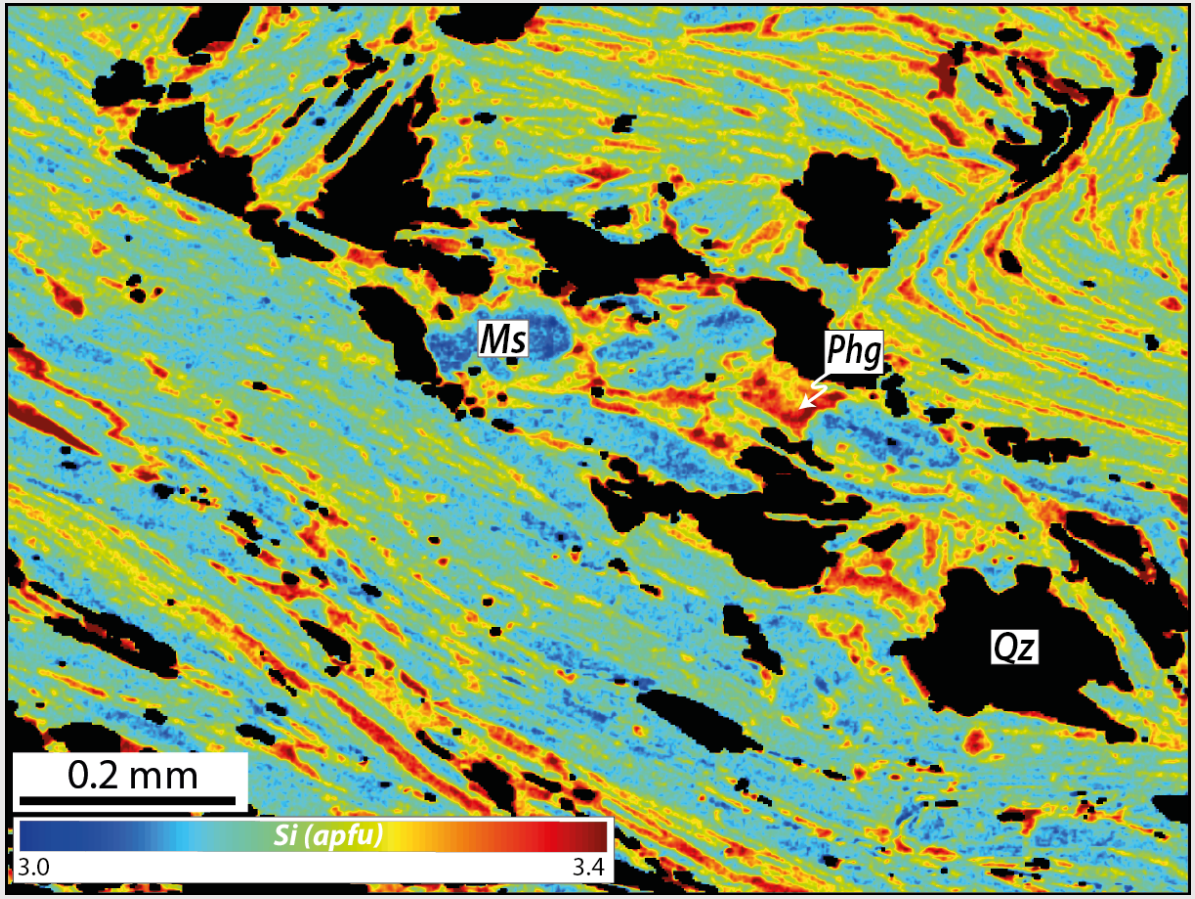


Mica grains in Pas-de-Blayeul samples show muscovitic (ms) cores and phengitic, high-Si rims (phg), possibly recording a late rise in pressure

The tendency in Remollon samples seems inverse, and is chemically less pronounced

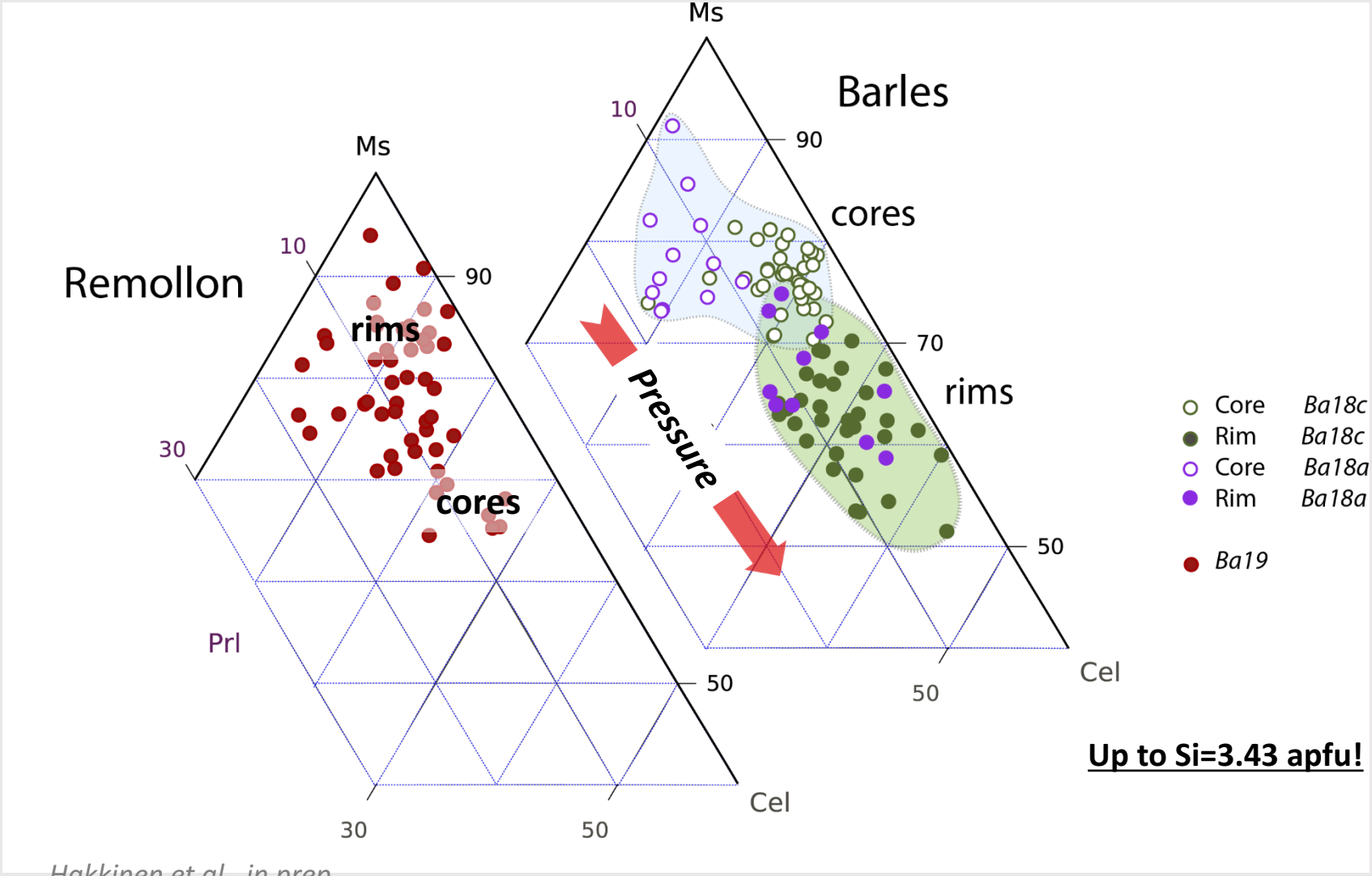
Electron Probe X-ray mapping

Pas-de-Blayeul thrust sliver



Chemical map for Si content in white mica
(atoms per formula unit, calculated for 11 oxygens)

White mica chemistry



Hakkinen et al., in prep.

Pressure-temperature constraints?

- **Barles decollement thrust**:

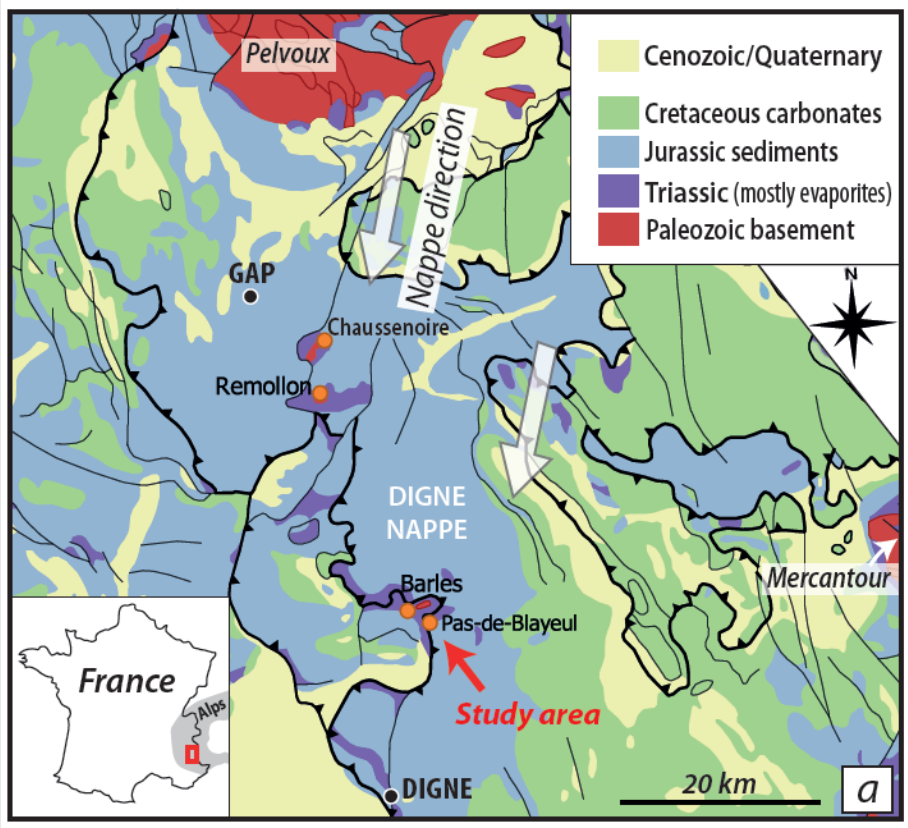
  Variscan metamorphism = 520°C +/- 40°C (RSCM)

  Alpine event = 5km of overburden (mostly limestones) >> **P = 1.3 kbar**

  5km @ 30°/km *(Pottel & Trullenque, 2012)* >> **T = 150-200°C**

- **Remollon**: P unknown, T 480 +/- 40°C

- **Pelvoux**: 150-250°C / 2-3 kbar *(Pottel & Trullenque, 2012)*



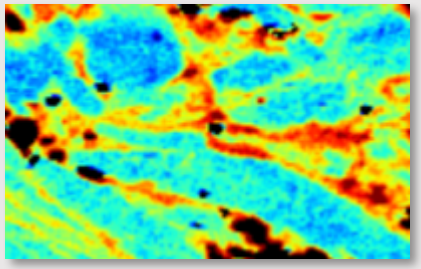
Estimating the pressure recorded by Barles thrust slice

- 5km of overburden (mostly limestones) = 1.3 kbar
- Total pressure recorded by phengitic rims = at least, **5-10 kbar**

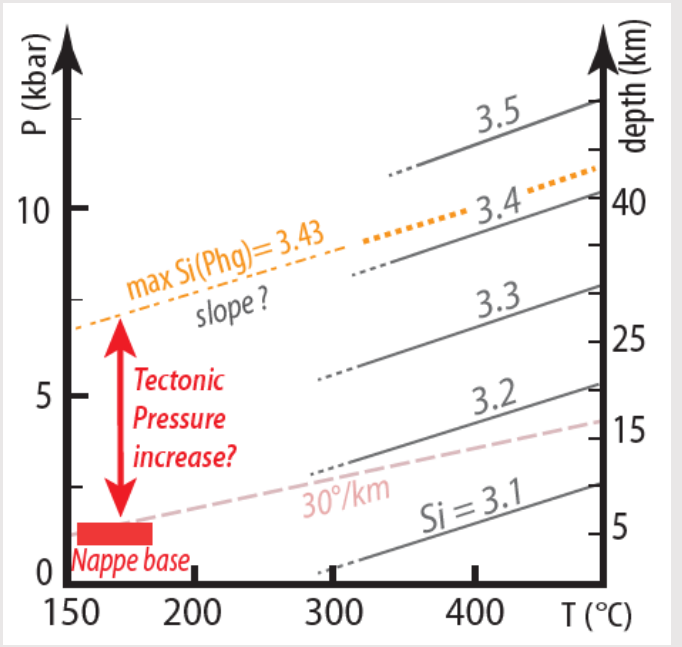
Deviatoric pressure = Total pressure – overburden load

➢ at least 5 kbar (500 MPa) of deviatoric stresses??

Disequilibrium-driven mineral zoning!

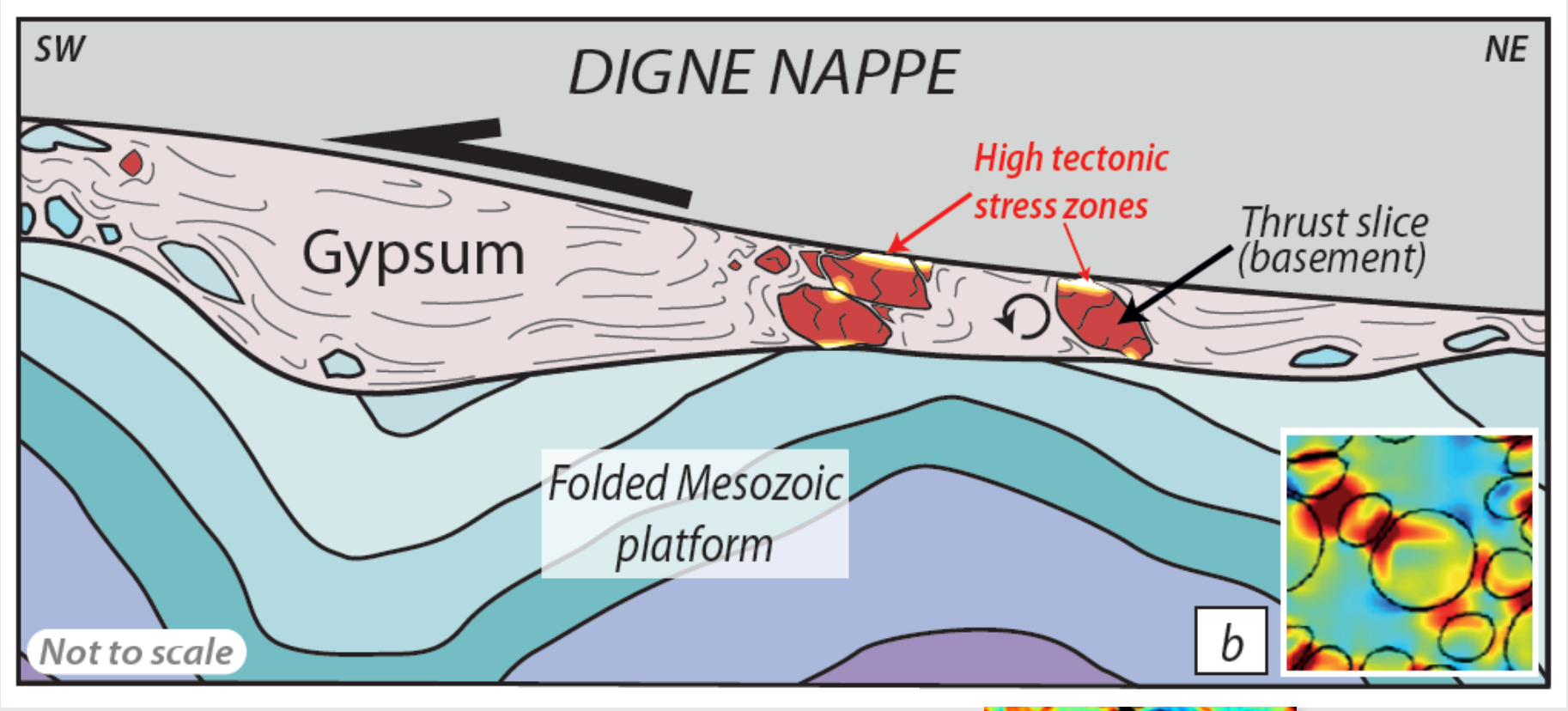


Up to Si=3.43 apfu



A model to explain the microstructures

Hakkinen et al., in prep.



- *High deviatoric stresses (-up to 0.5 GPa?-) can be reached during indentation of rigid blocks*