UNIVERSITÀ DEGLI STUDI DI PADOVA

DIPARTIMENTO DI GEOSCIENZE

Bachelor Degree Thesis

Determination of microfracture pattern associated to pseudotachylytes (Gole Larghe Fault Zone, Italy)

22th July 2021

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Supervisor: Prof. Giulio di Toro

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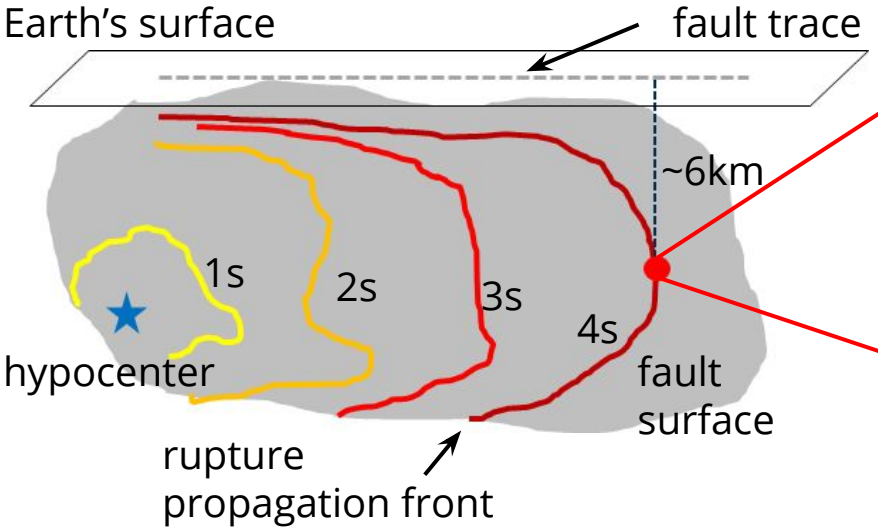
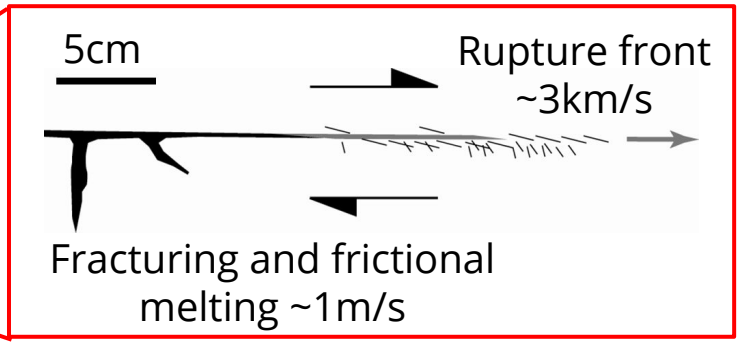
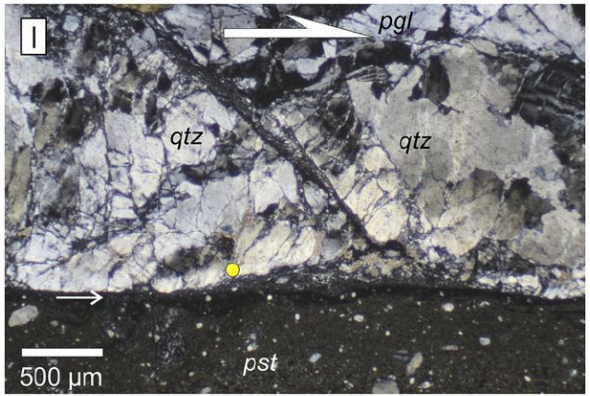
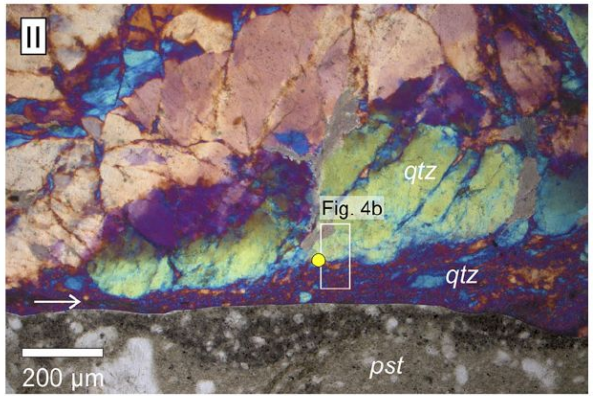
Motivations

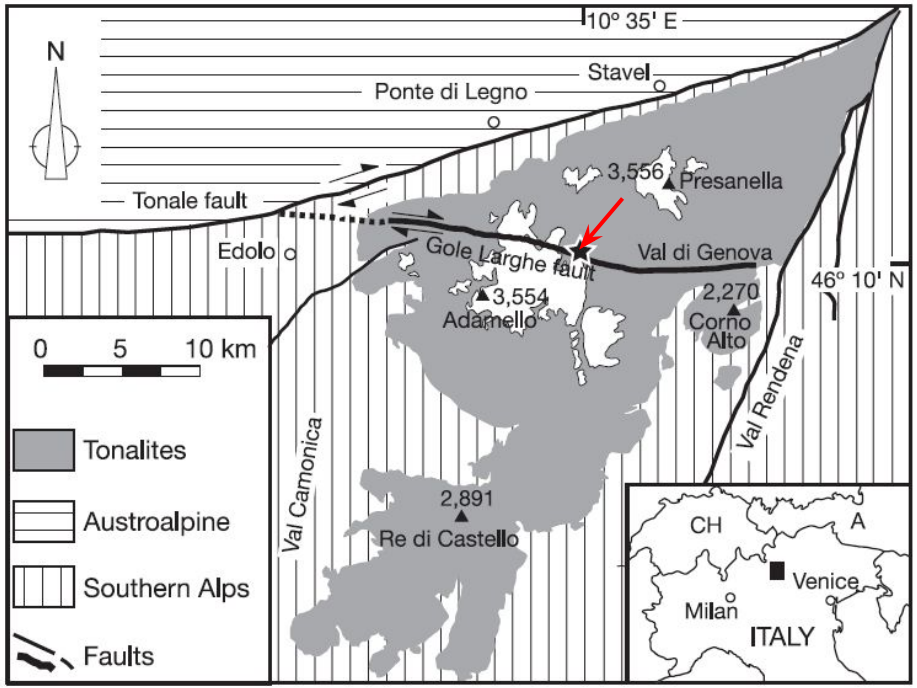


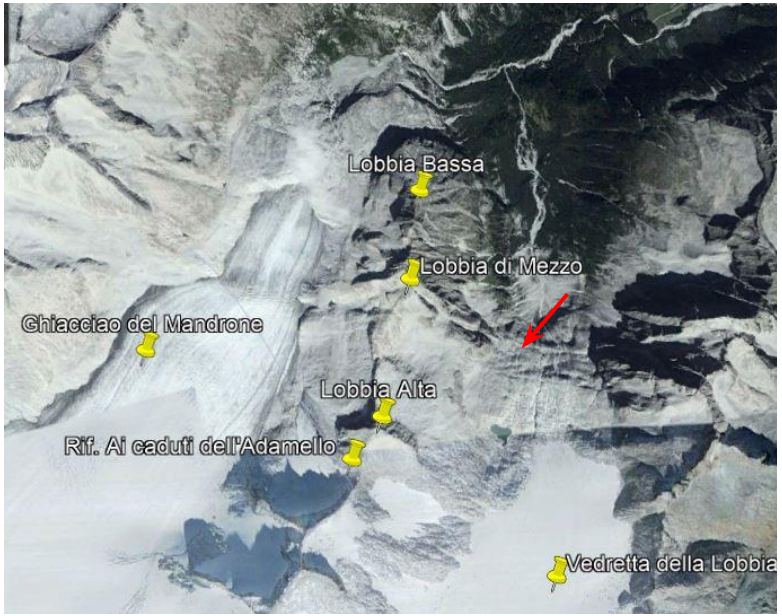






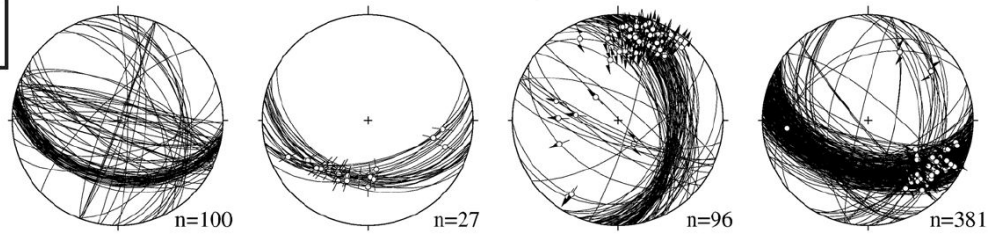
1. Geological setting



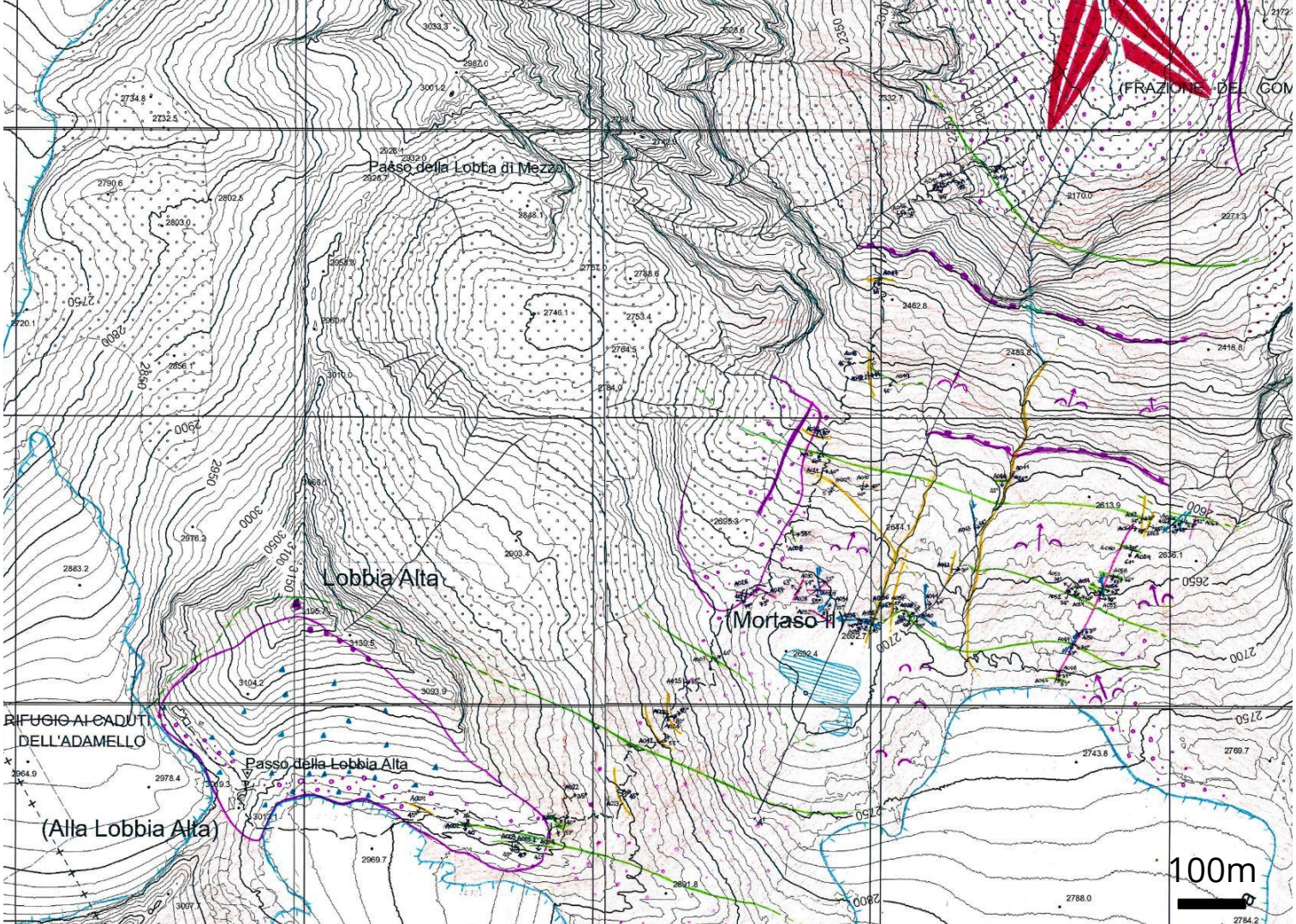


Emplacement conditions: p 0,25-0,35 GPa, T ~250°C, 9-11 km depth

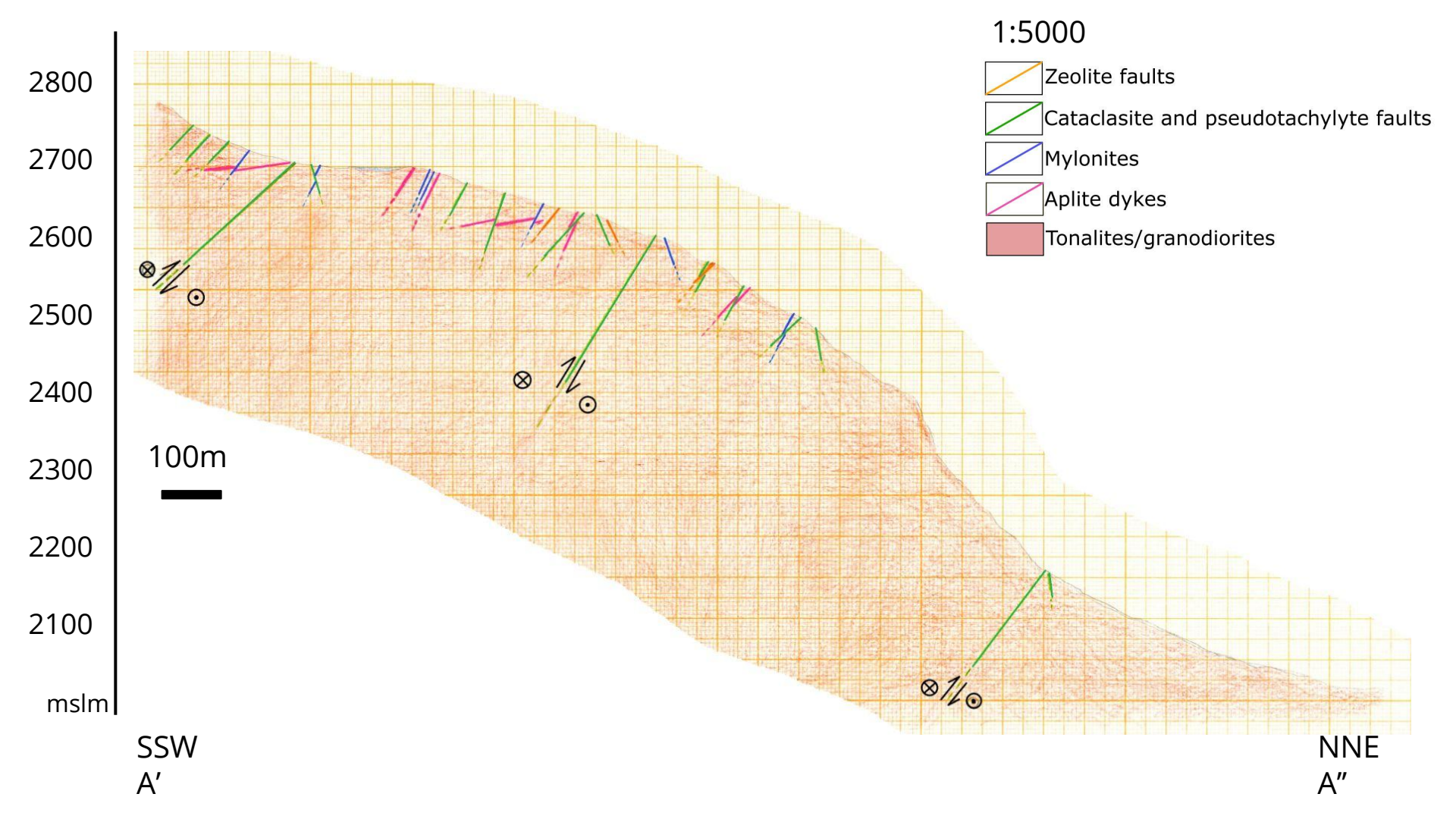
Estimated offset of the Gole Larghe Fault Zone: ~1 km



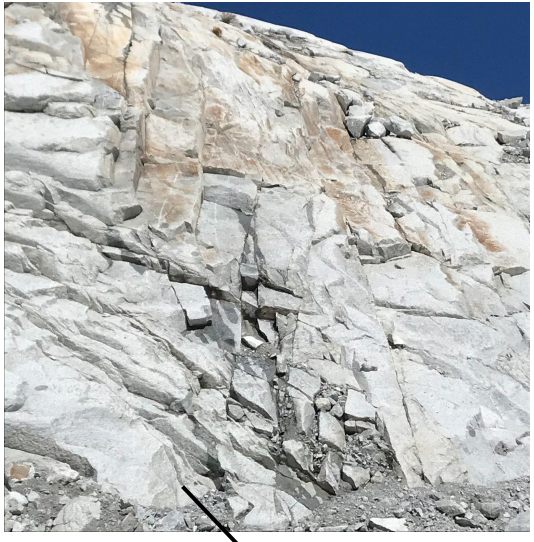
Joints Lineated joints Mylonites Faults


Passo della Lobia di Mezzo
Lobbia Alta
(Mortaso II)
RIFUGIO AI CADUTI
DELL'ADAMELLO
Passo della Lobbia Alta
(Alla Lobbia Alta)
100m

1:5000


1:5000
Zeolite faults
Cataclasite and pseudotachylyte faults
Mylonites
Aplite dykes
Tonalites/granodiorites
2800
2700
2600
2500
2400
2300
2200
2100
mslm
100m
SSW
A'
NNE
A"

2. Fieldwork, September 2020



Magmatic joints

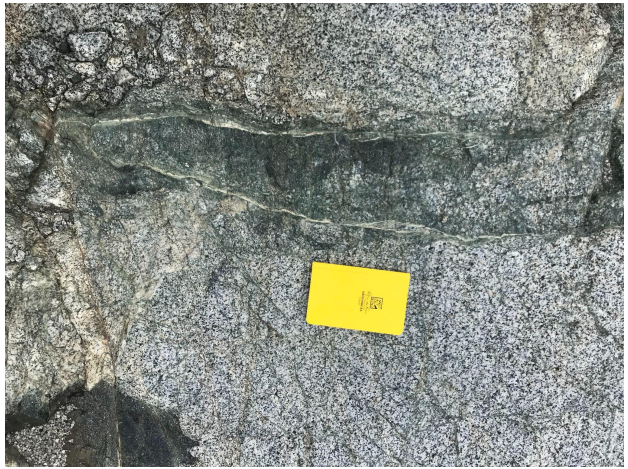
Cataclasites and pseudotachylytes fault

Mylonite

Zeolite fault

2. Fieldwork, September 2020

Aplite dyke cross-cutted by a pseudotachylyte



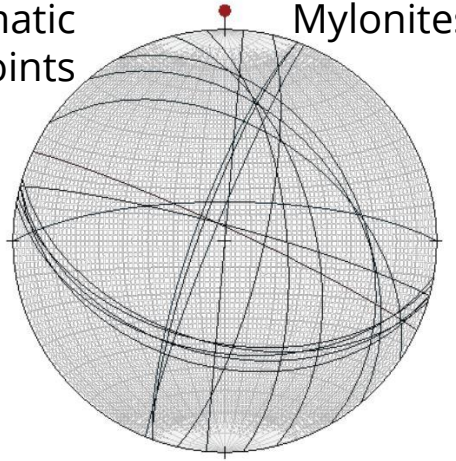
Cataclasite cutting an aplite dyke

Pseudotachylyte injected in a cataclasite

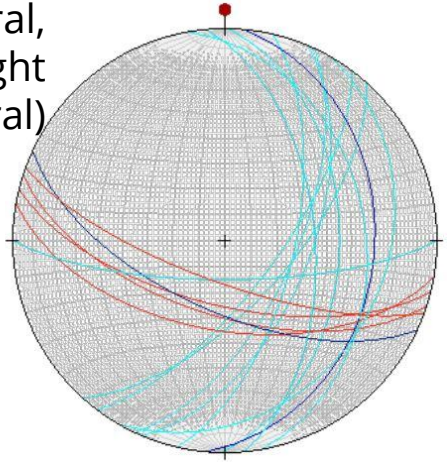
Xenolith dragged by a milonite

2. Fieldwork, September 2020

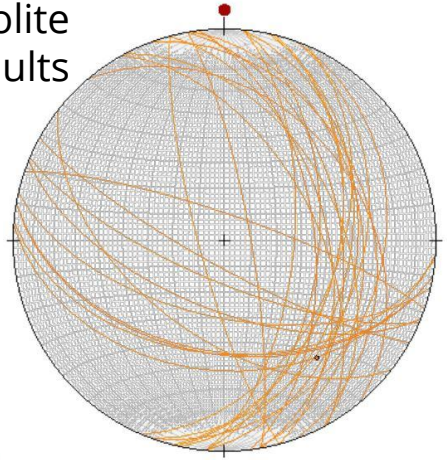
Magmatic joints



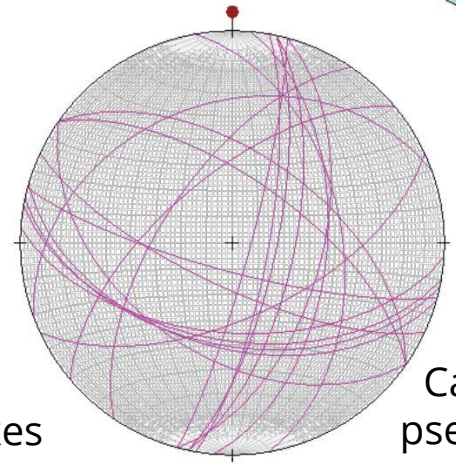
Mylonites (red dextral, light blue sinistral)



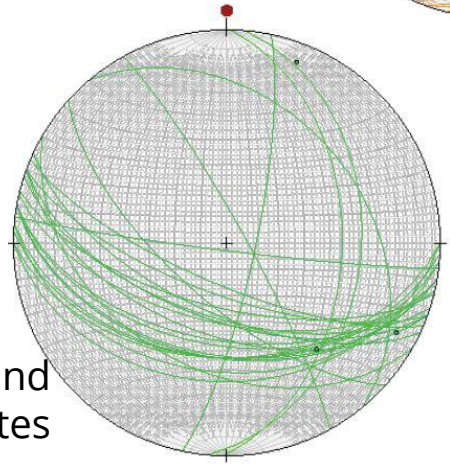
Zeolite faults



Total number of collected data: 158



Aplite dykes

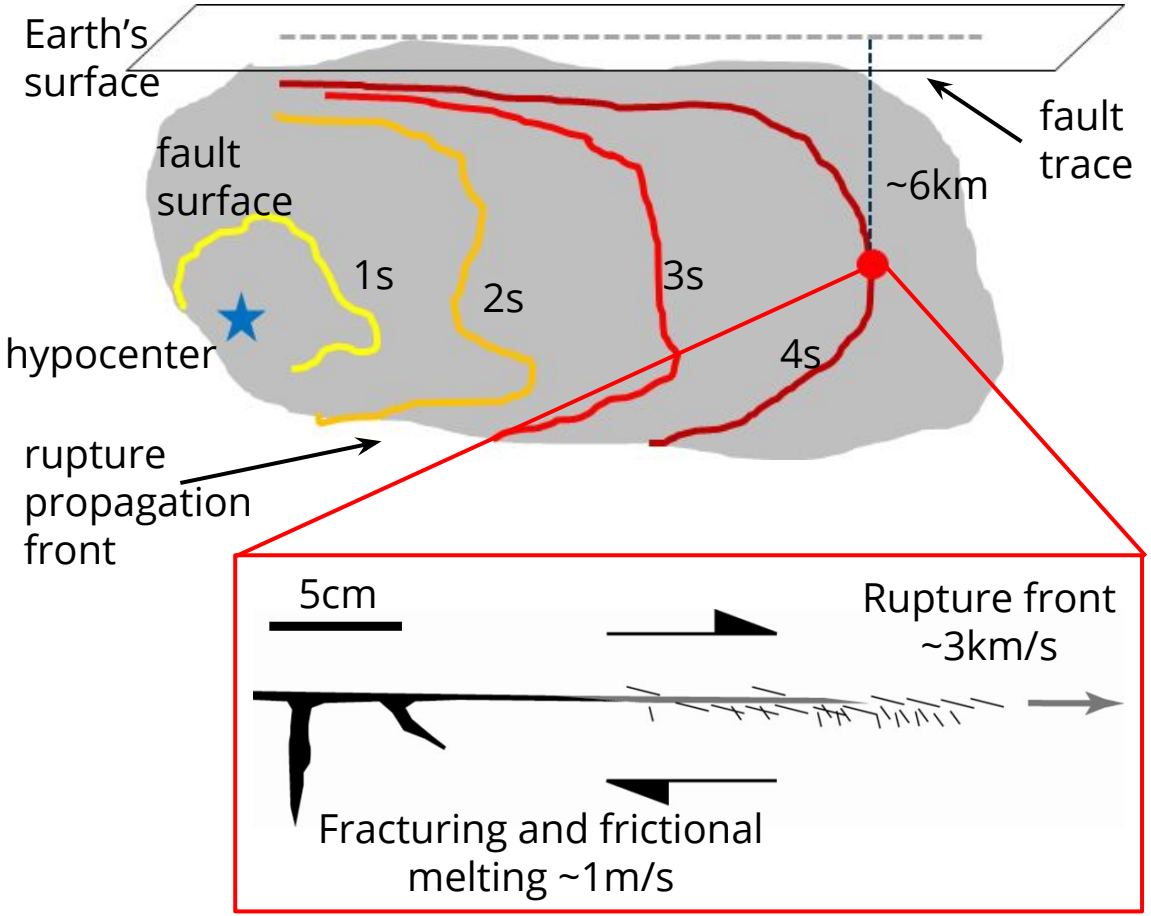


Cataclasites and pseudotachylytes

old

young

3. Earthquakes propagation



Energy budget of an earthquake (neglecting work against gravity):

$$E_{TOT}=E_{RAD}+Q+U_S \quad [J/m^2]$$

with:

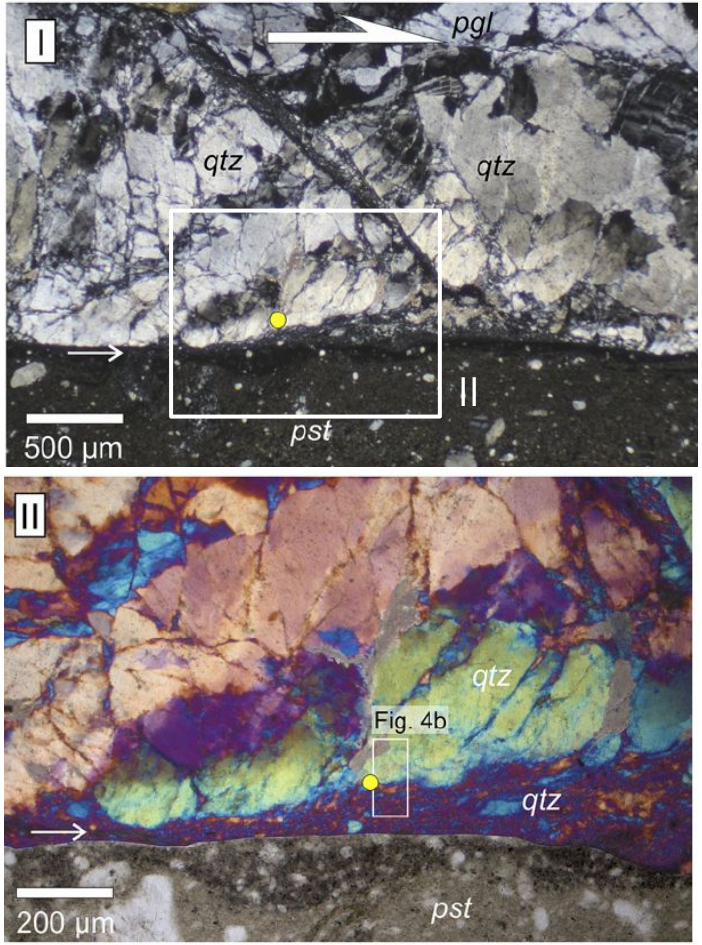
E_{TOT} total energy of an earthquake

E_{RAD} energy released in seismic waves

Q energy dissipated as frictional heat

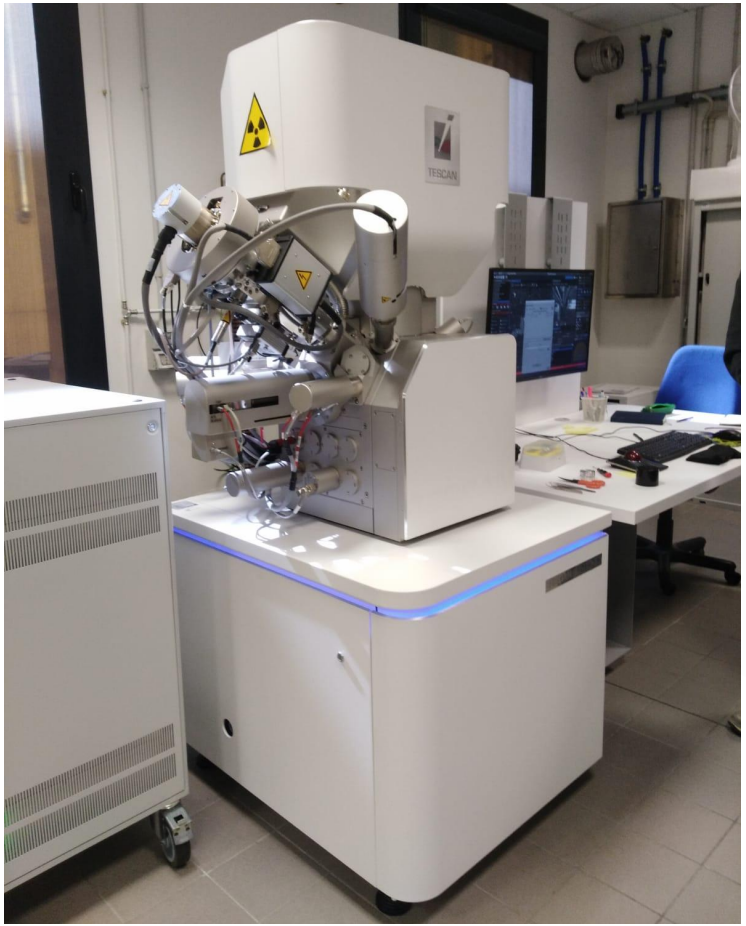
U_S energy dissipated in formation of new fractures

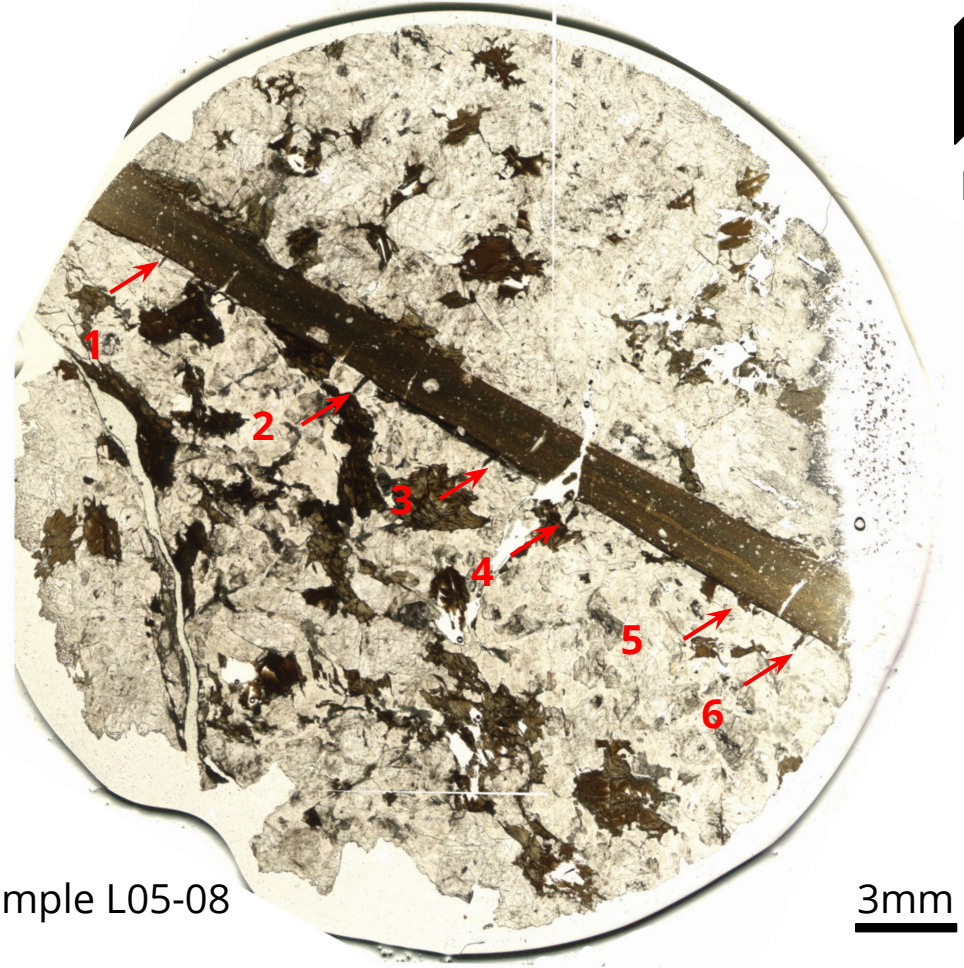
4. Pseudotachylytes and microfracture patterns



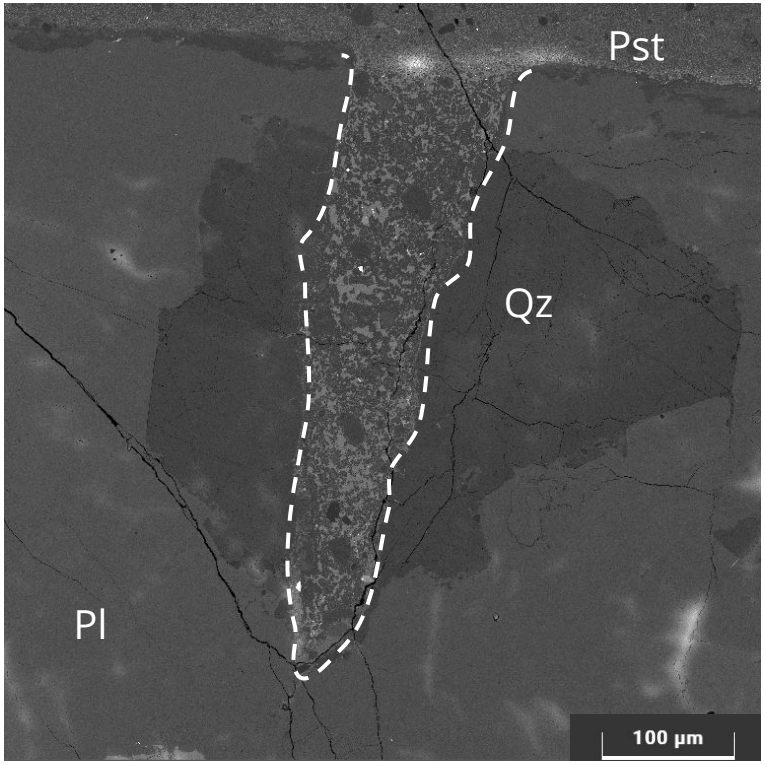
Optical microscope image (crossed nicols and with gypsum wedge) of a pseudotachylyte vein and associated micro- fractures

5. FESEM analysis

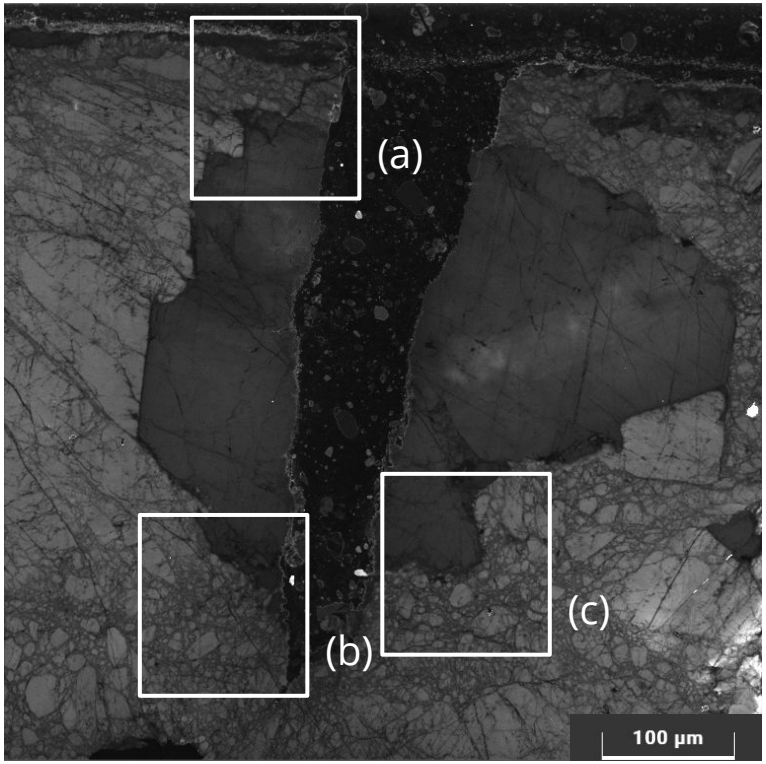




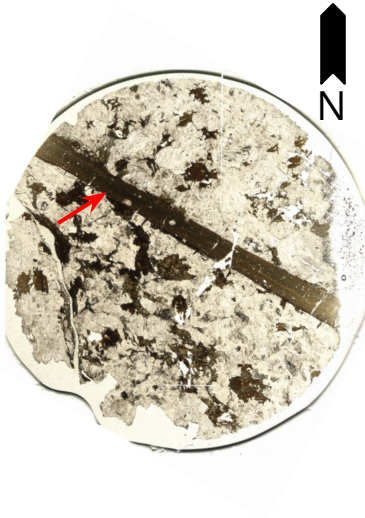
5. FESEM analysis



BSE image of injection vein n.2

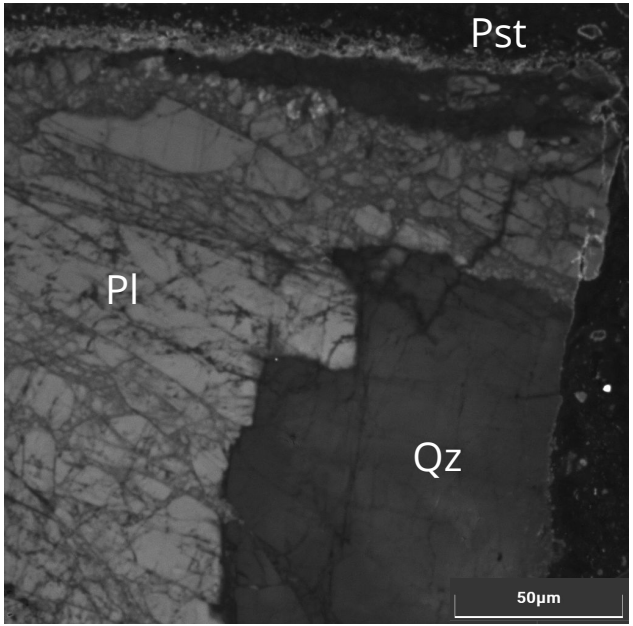


CL image of injection vein n.2

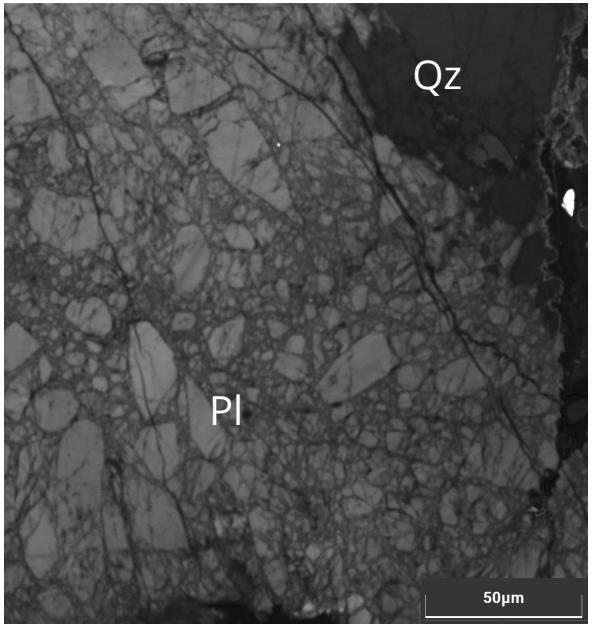


5. FESEM analysis

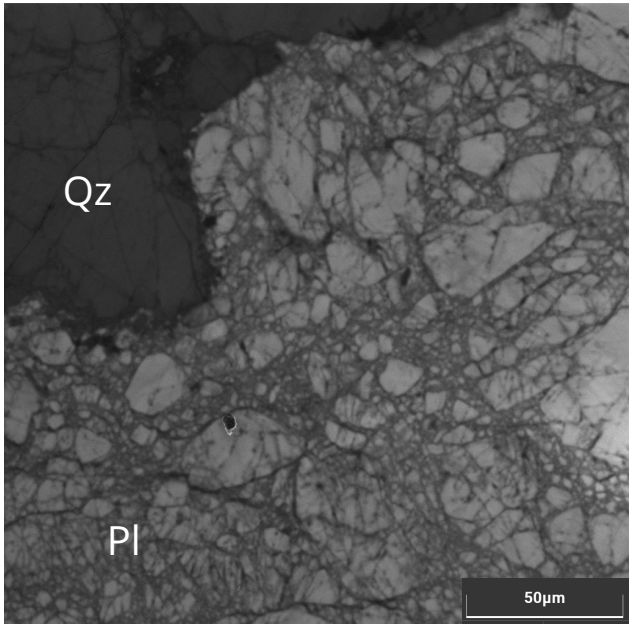
(a)



(b)

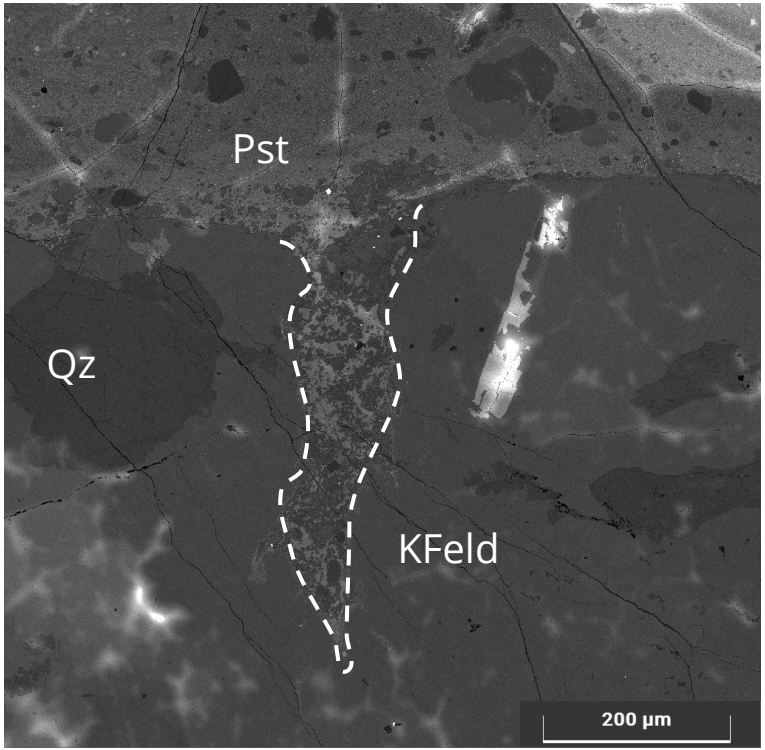


(c)

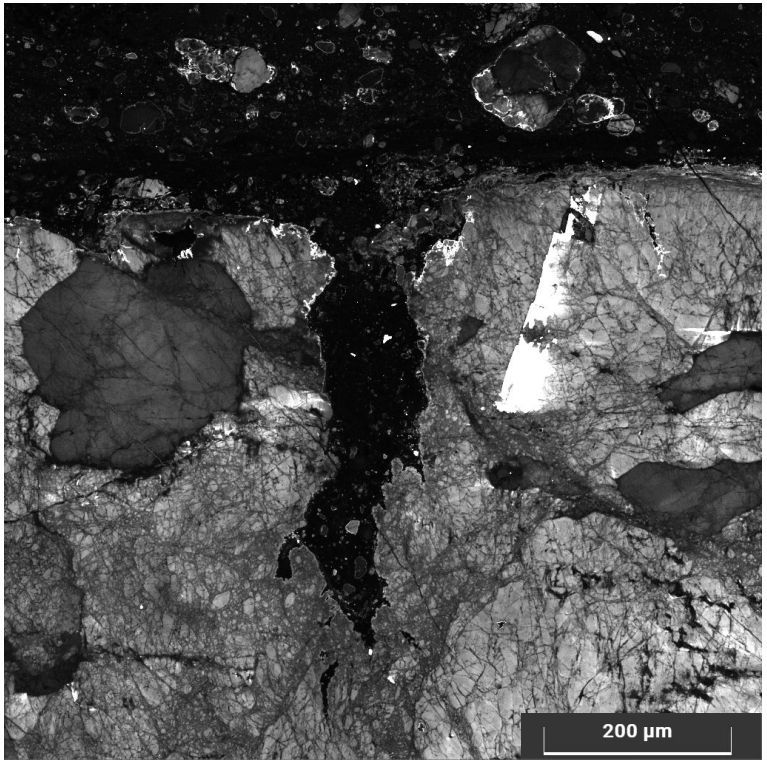


Details of the micro-fracture patterns in Pl crystals around injection vein n.2

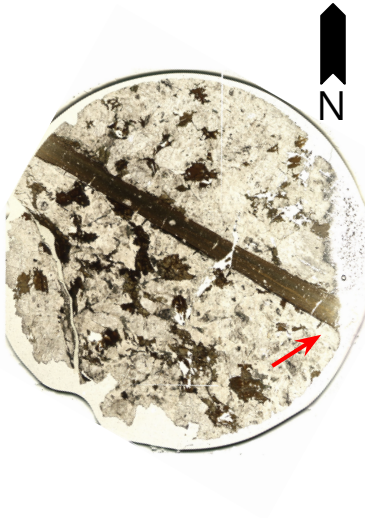
5. FESEM analysis



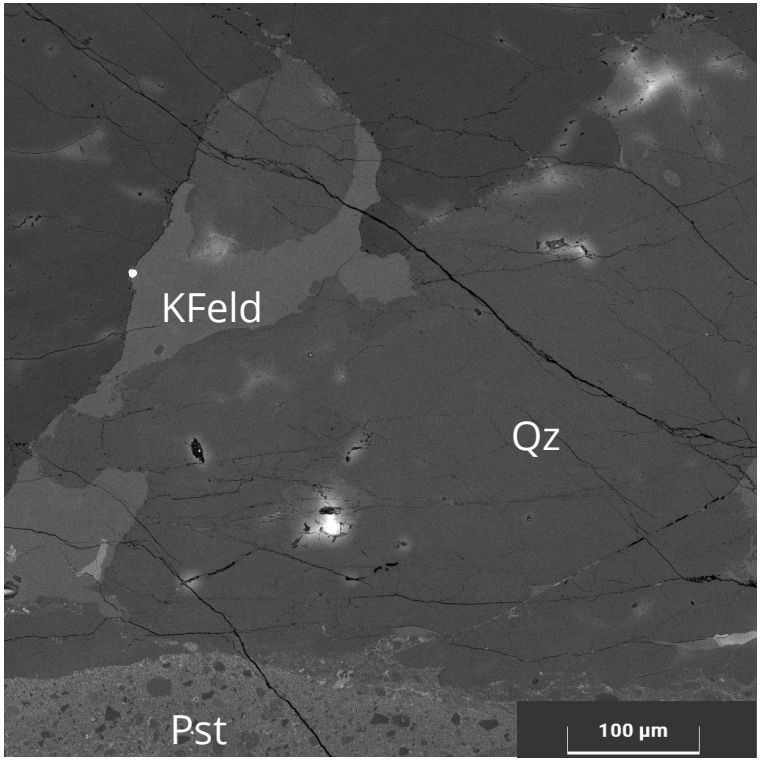
BSE image of injection vein n.6



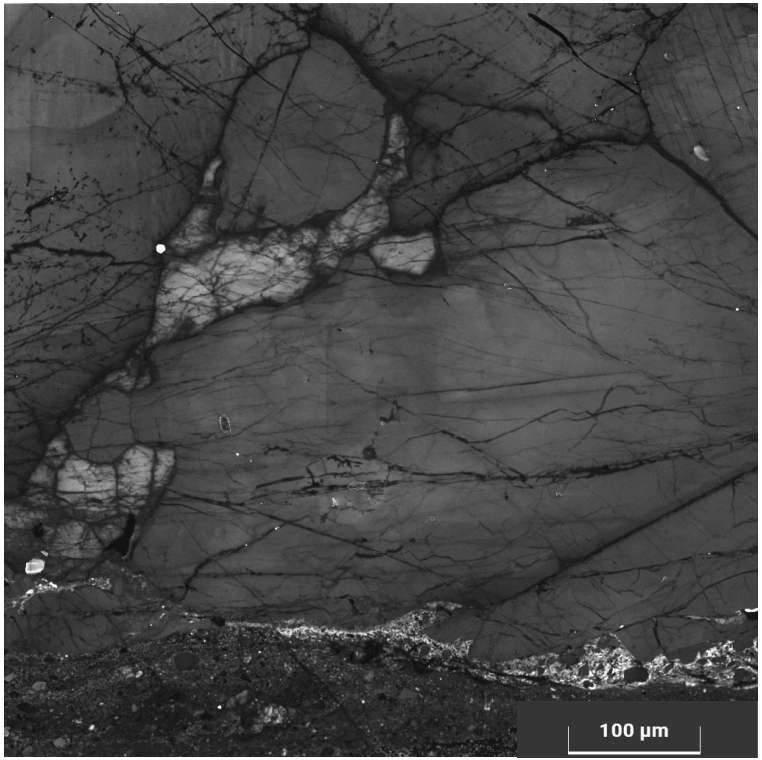
CL image of injection vein n.6



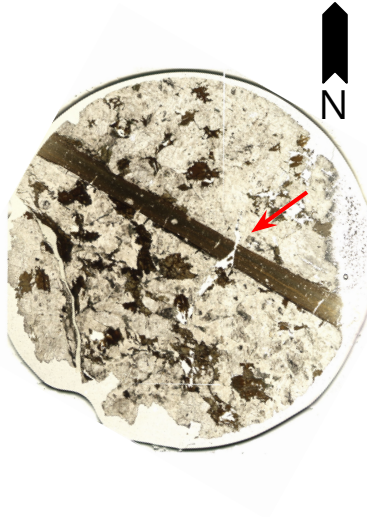
5. FESEM analysis



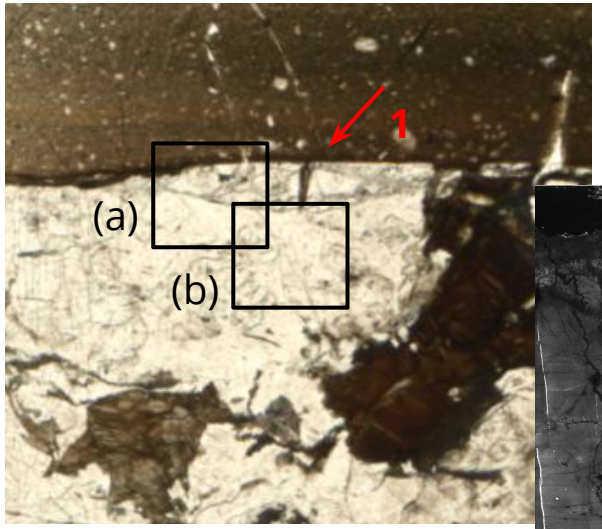
BSE image of the N wall, main vein

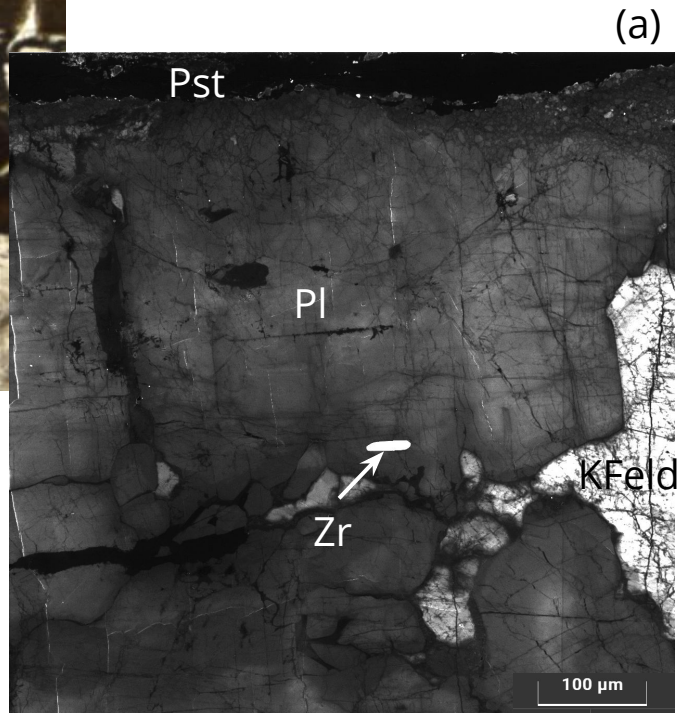


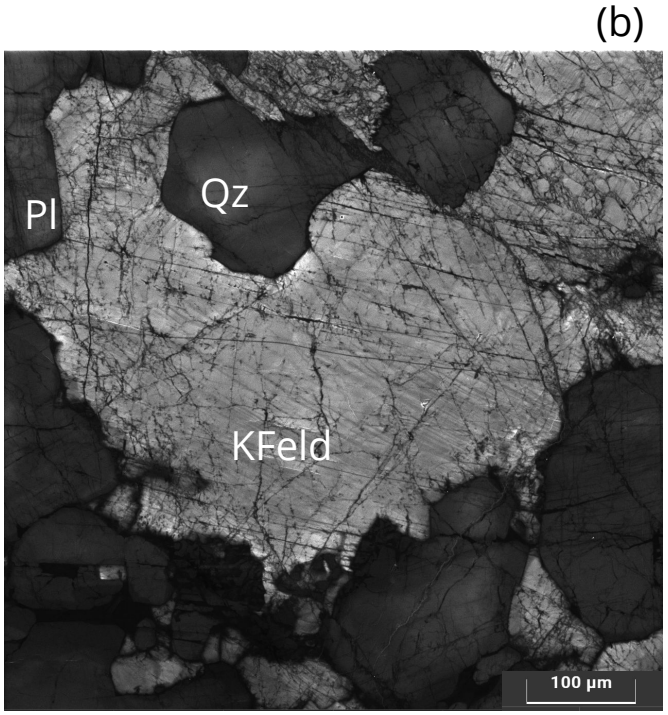
CL image of the N wall, main vein



5. FESEM analysis



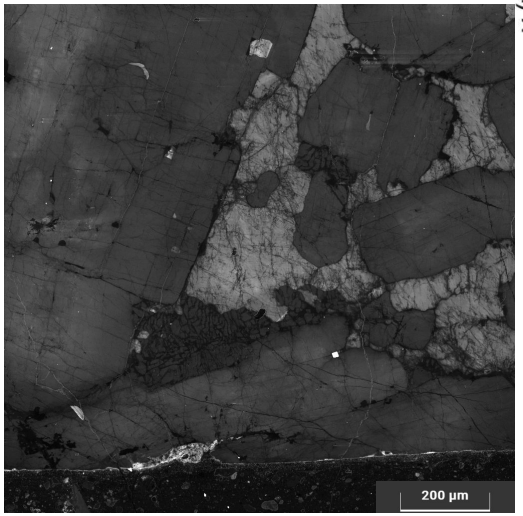


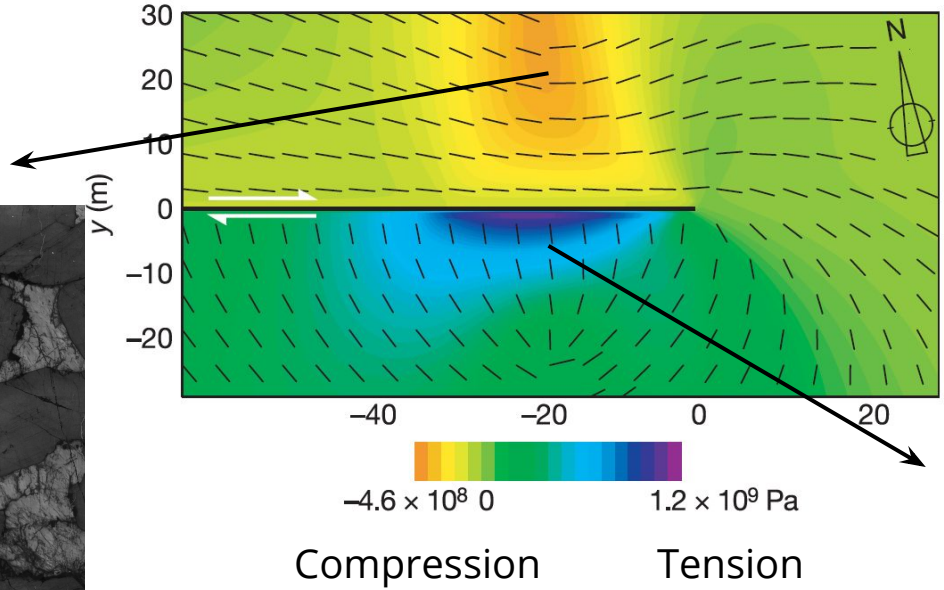


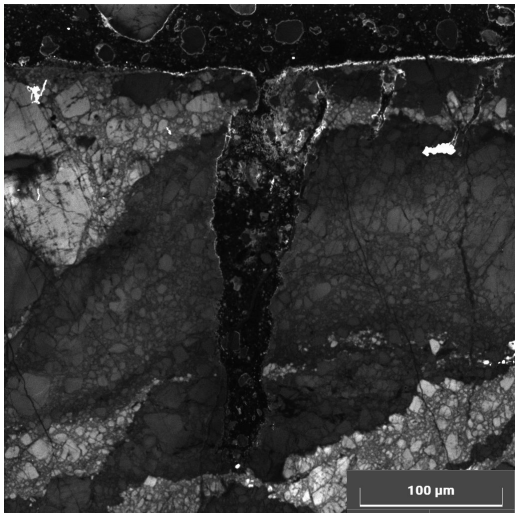
BSE and CL image of the host rock near injection vein n.1

5. FESEM analysis

Modelization of fracture propagation, representing an earthquake on a vertical dextral strike slip fault (back lines: maximum tension planes)







6. Conclusions

- The fieldwork was done in the Lobbie area, Adamello;
- There it's exposed the Gole Larghe Fault Zone, composed by several pseudotachylyte-bearing faults;
- Pseudotachylytes together with micro-fractures can give informations about the energy balance of an earthquake;
- From preliminar analysis with FESEM we note that the micro-fracture pattern is largely underestimated when analysed with traditional methods (optic microscope etc). These studies could give us more detailed information about this argument;
- The energy dissipated during a seismic event is much more than what considered until today in literature.


Thank you for your attention

Bibliography

G. Di Toro, *"Earthquake rupture dynamics frozen in exhumed ancient faults"*, Nature 436 (2005), 1009-1012.

G. di Toro and G. Pennacchioni, *"Fault plane processes and mesoscopic scale structure of a strong-type seismogenic fault in tonalites (Adamello batholith, Southern Alps)"*, Tectonophysics 402 (2005), 55-80.

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M. Bestmann, "Deformation and ultrafine dynamic recrystallization of quartz in pseudotachylyte-bearing brittle faults: a matter of a few seconds", Journal of Structural Geology 38 (2012), 21-38.

S. Smith, *"The structure of an exhumed intraplate seismogenic fault in crystalline basement"*, Tectonophysics 599 (2013), 29-44.

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