Compositions of mylonites and pseudotachylites in lower crustal rocks (Premosello, Ivrea Zone)

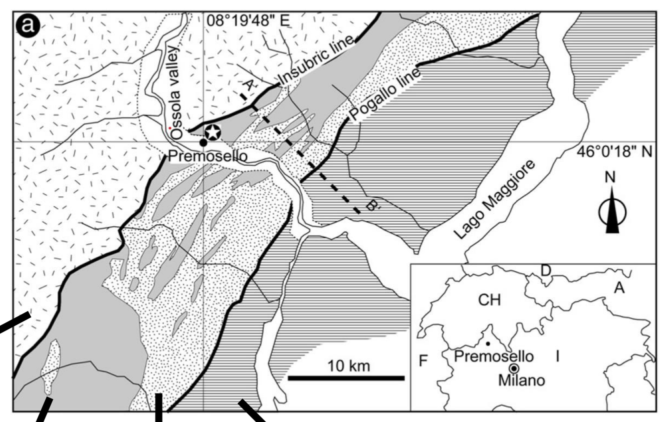
Alina Hofer, Jörg Hermann, Francesca Piccoli

Institute of Geology, University of Bern, Baltzerstrasse 1+3, 3012 Bern, Switzerland

1. Introduction

The Ivrea Zone in the Italian southern Alps is a slice of pre-Alpine continental lower crust and sub-continental mantle that was tectonically exhumed during the Alpine orogeny. It is a unique place to study a part of the Earth that is otherwise not accessible and to improve our understanding of the lower crust and the crust mantle transition zone.

The purpose of this study is to characterise composition and deformation structures of the lower continental crust using samples collected at the village of Premosello.



Alpine metamorphic units

Mafic and ultramafic rocks

Paragneiss

Serie dei Laghi

Map from Pittarello et al. 2012

2. Research questions

- How do bulk compositions of the rocks compare to those of the mylonites and pseudotachylites?
- Are fine-grained mylonites and pseudotachylites representative of the bulk composition, or was there a fractionation of the minerals, main elements and trace elements during the deformation?

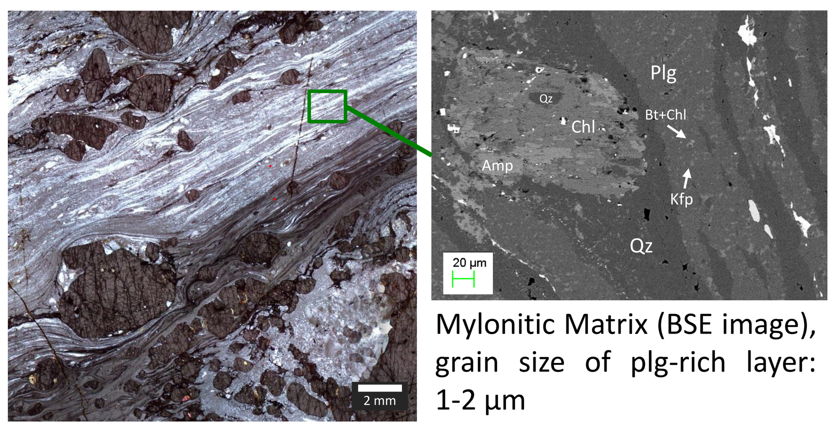
3. Methods

- Light microscopy
- Scanning Electron Microscopy
- Bulk rock and microbulk analysis (spot size 100 µm) in different parts of the mylonites and pseudotachylites with LA-ICP-MS

4. Results

Rock types:

Metapelite



Felsic mylonite (XP light)

● Red dots: size of laser ablation pits

Mylonitic Matrix (BSE image), grain size of plg-rich layer: 1-2 µm

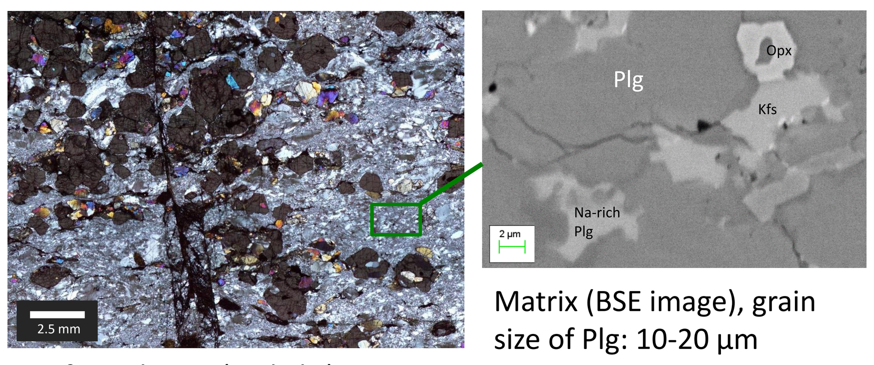
At the microscopic scale and in the hand sample, garnets porphyroclasts occur in fine-grained mylonite with light and dark bands.

BSE image: Alternation of quartz and plagioclase - K-feldspar - biotite - chlorite bands.

Light and dark bands that are visible at larger scale consist of the same minerals.

Pseudotachylites are also present in the metapelites.

Metamafic sediment



Mafic mylonite (XP light)

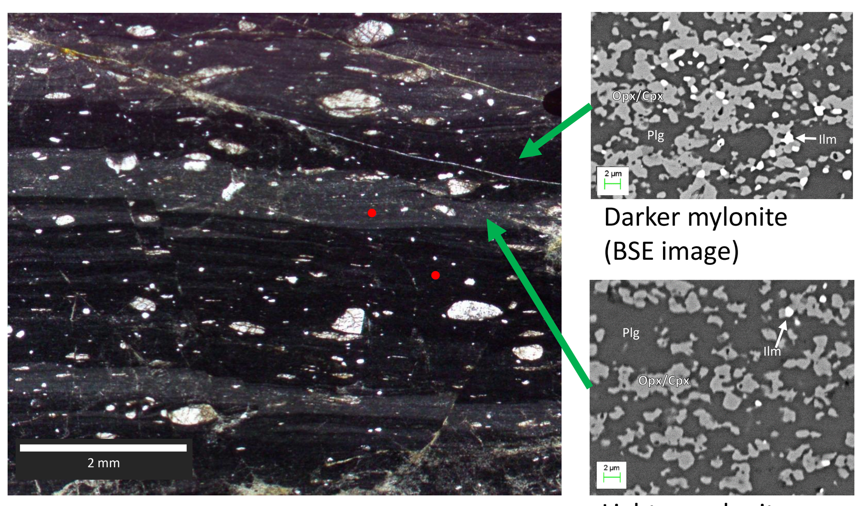
Matrix (BSE image), grain size of Plg: 10-20 µm

Main minerals: Garnet, plagioclase, clino- and orthopyroxene

Matrix: Mainly plagioclase with rare K-feldspar and pyroxene.

The bulk composition falls between that of metapelite and metagabbro.

Metagabbro

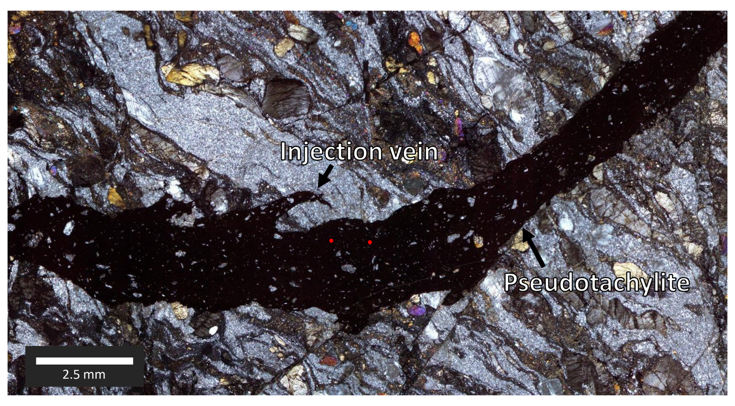


Mylonitic metagabbro (XP light)

● Red dots: size of laser ablation pits

Darker mylonite (BSE image)

Lighter mylonite (BSE image)



Metagabbro with pseudotachylite and injection veins (XP light)

● Red dots: size of laser ablation pits

Mylonitic metagabbro: Pyroxene grains in a very fine-grained mylonitic matrix with an alternation of lighter and darker mylonites.

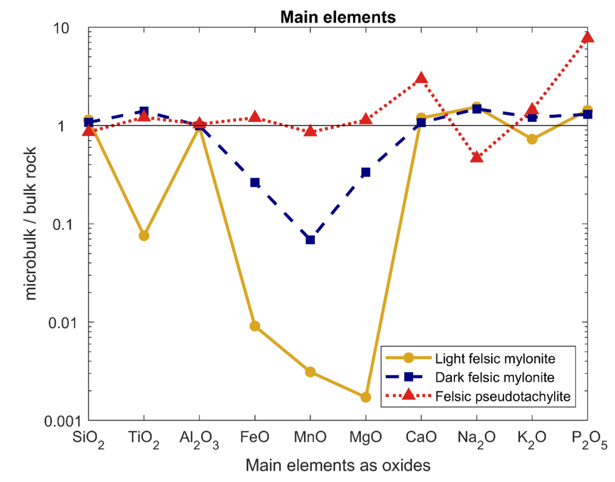
Metagabbro with pseudotachylite: Mylonite with a larger grain size and pseudotachylites cross-cut the foliation of the mylonite.

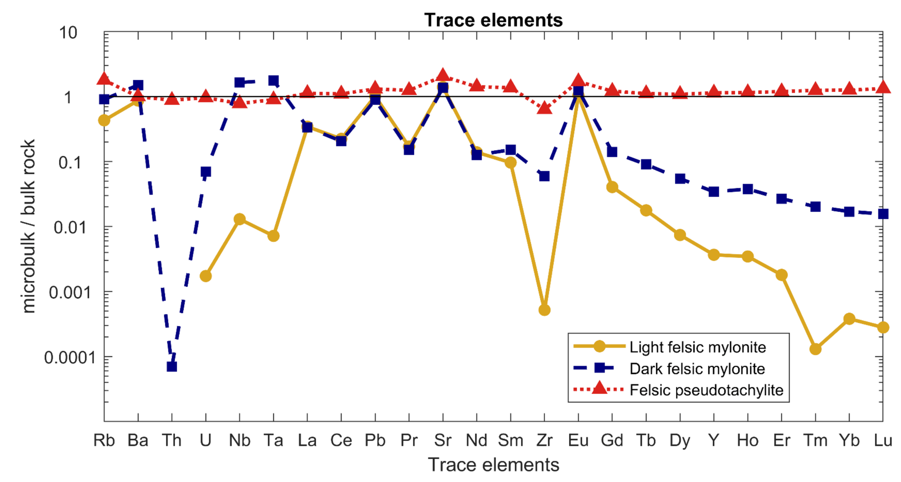
Felsic rocks

The data is normalised to the bulk rock of metapelite.

● Red dots in the images on the left represent the sizes of the laser ablation pits (100 µm) in the sample.

The light felsic mylonite exhibits the strongest fractionation and the pseudotachylite the least. The pseudotachylite is a good approximation of the bulk rock, because the fast deformation prevented mineral fractionation. In the mylonites, plagioclase and quartz are preferentially deformed while garnet and zircon are more resistant.

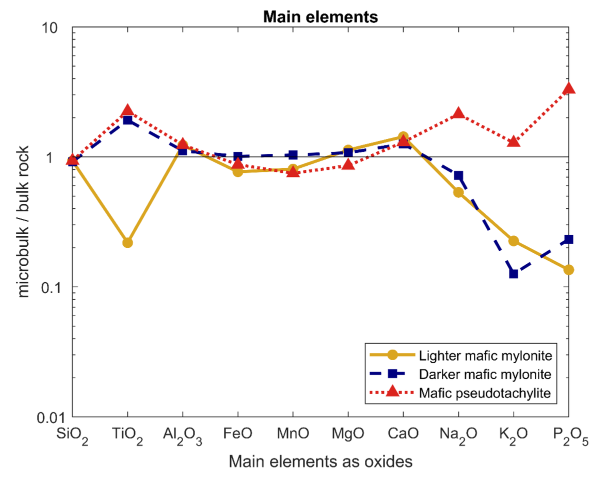


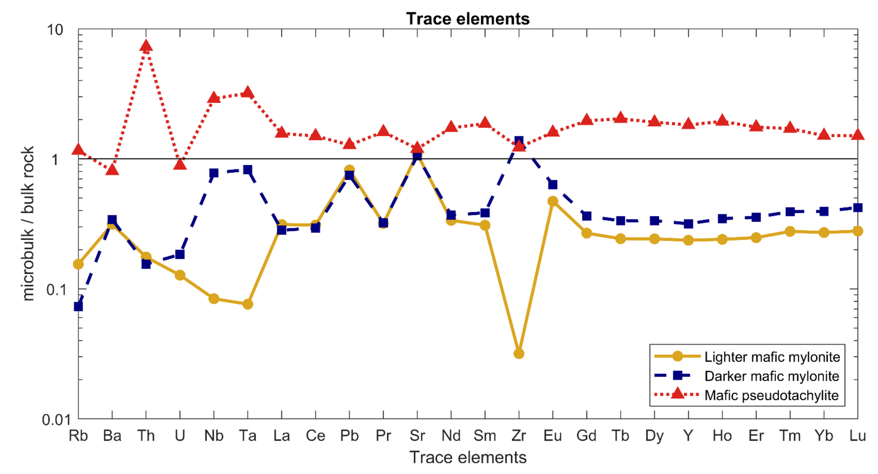


Mafic rocks

The data is normalised to the bulk rock of metagabbro.

Again, the lighter mafic mylonite exhibits the strongest fractionation and the pseudotachylite the least. The lower HREE show that pyroxene is residual, whereas plagioclase is preferentially deformed in the mylonites.





Bulk rock analysis

	SiO_2	Al_2O_3	FeO	MgO	CaO	Na_2O	K_2O	TiO_2	LOI	Total
Metapelite	67.42	14.29	7.46	2.66	2.16	3.26	1.92	0.63	0.06	99.84
Metamafic sediment	49.44	16.69	15.39	5.46	8.75	1.69	0.41	1.57	0.08	99.47
Mylonitic metagabbro	53.27	17.47	10.86	6.78	7.98	1.89	0.28	0.91	0.32	99.76
Metagabbro with pseudotachylite	51.45	15.08	10.23	11.18	9.34	0.76	0.14	0.24	1.39	99.82

Quantitative bulk rock analysis of main element oxides in wt.%

5. Conclusions

- The pseudotachylites are a result of very fast deformation with no mineral fractionation.
- Slower deformation, which lead to the formation of mylonites, caused preferential deformation of felsic minerals and therefore a fractionation in the composition.
- There is also a distinction between the lighter and darker bands, with the darker bands also including Fe-Ti-oxides. This suggests that the deformation of different coloured bands occurred at different rates, which can be quantified using microbulk compositions.

References

Pittarello, Lidia & Pennacchioni, Giorgio & Di Toro, Giulio. (2012). Amphibolite-facies pseudotachylytes in Premosello metagabbro and felsic mylonites (Ivrea Zone, Italy). Tectonophysics. 580. 43–57. 10.1016/j.tecto.2012.08.001.