Granite facies enveloping the Mata da Rainha ore-forming system; insights into their composition and relation to the mineralizing events

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ERA-MIN2
RESEARCH & INNOVATION PROGRAMME ON RAW MATERIALS TO FOSTER CIRCULAR ECONOMY

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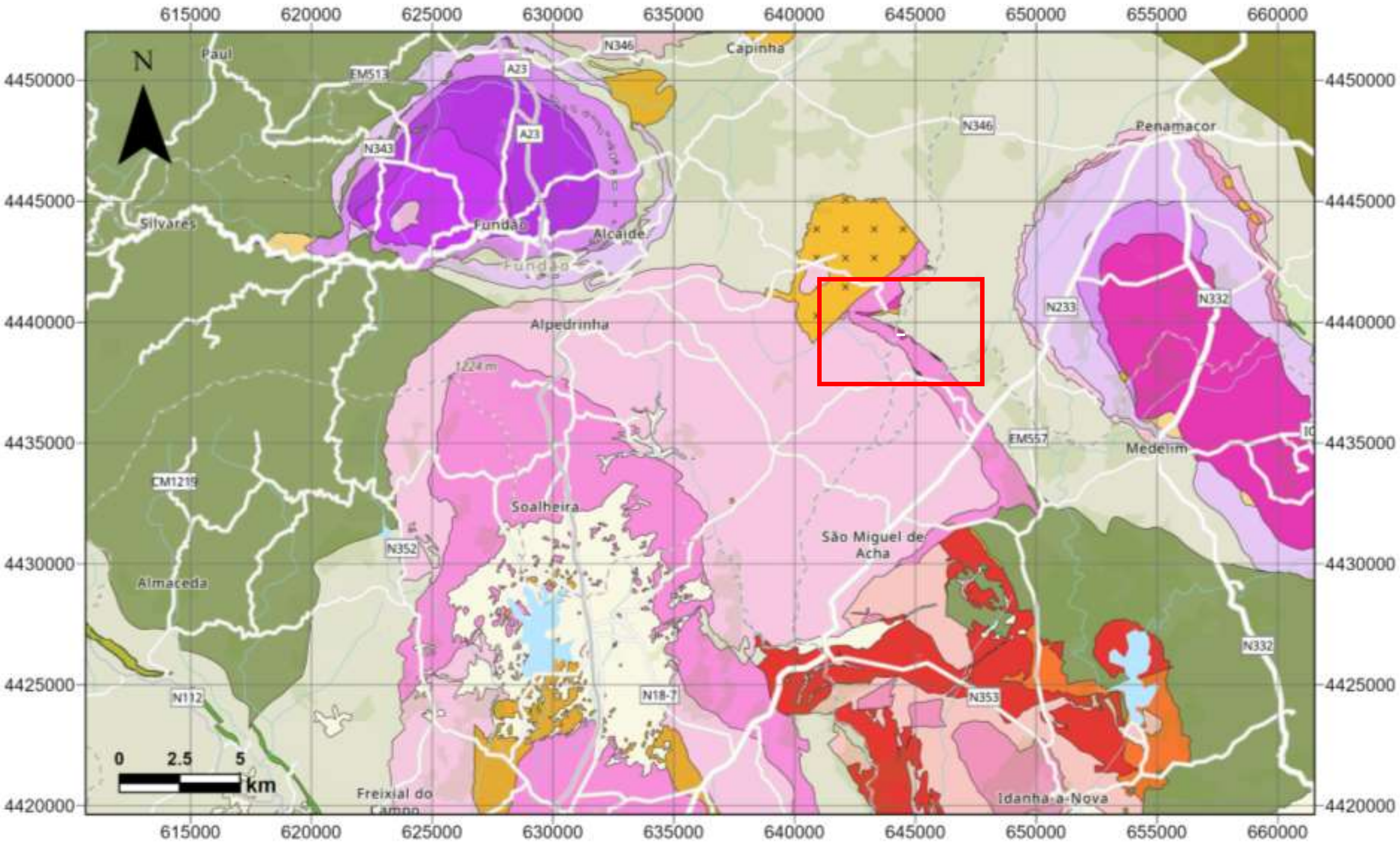
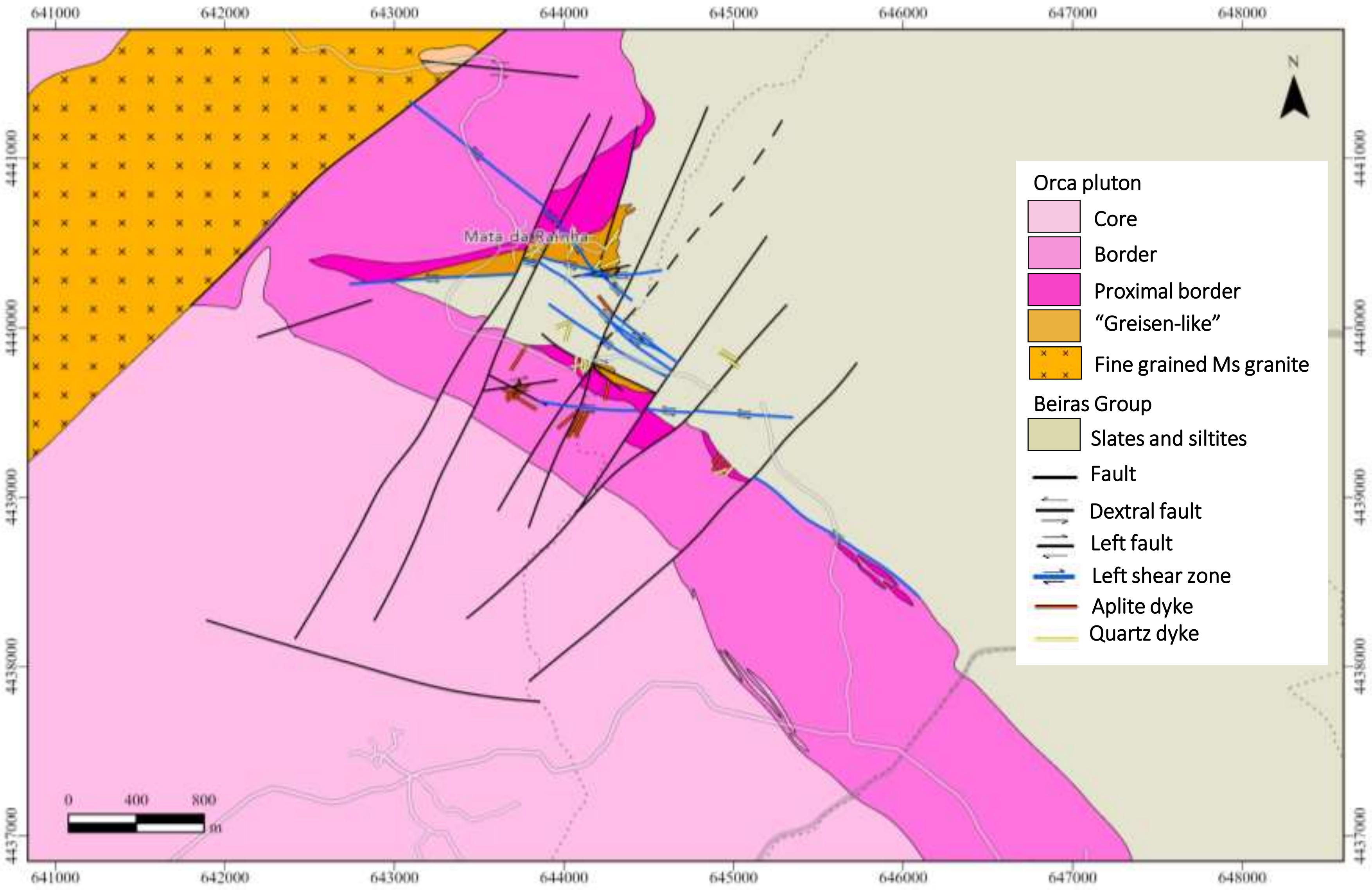
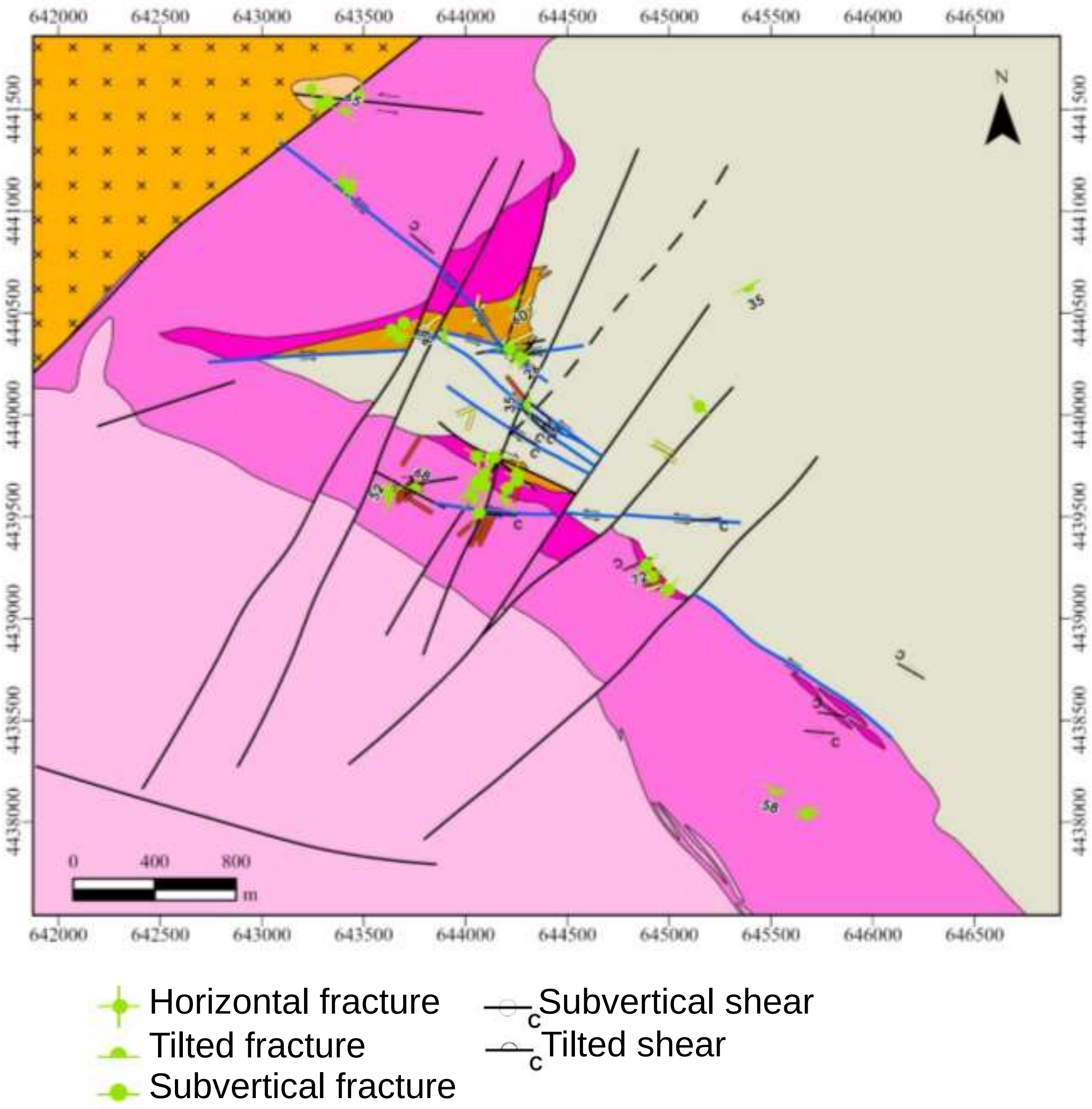
Mata da Rainha

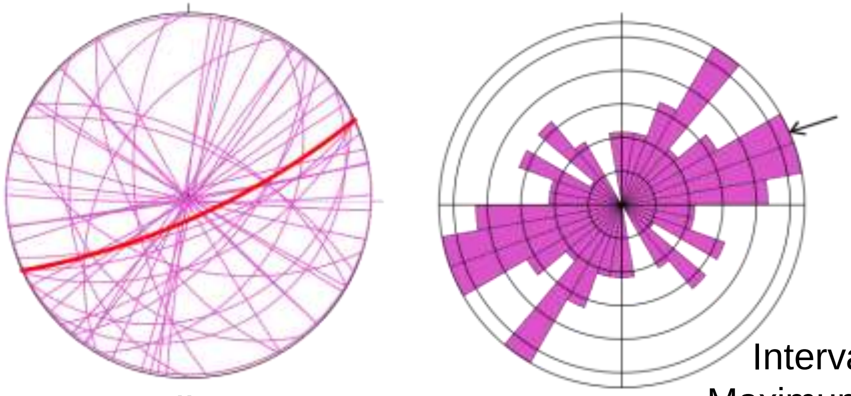


Geological Map





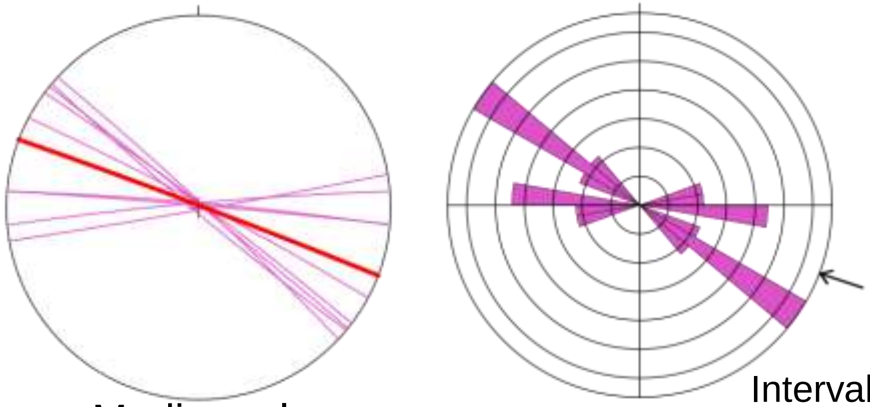
Fault zones and associated fractures n=46



Interval = 2%
Maximum = 10.9%

• Medium plane
Mean direction: 66º
11% of data: 30-40º and 60-80º

Left shear zones n=9

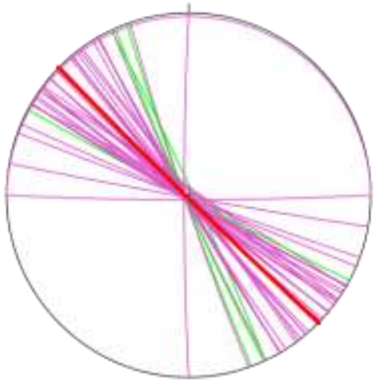


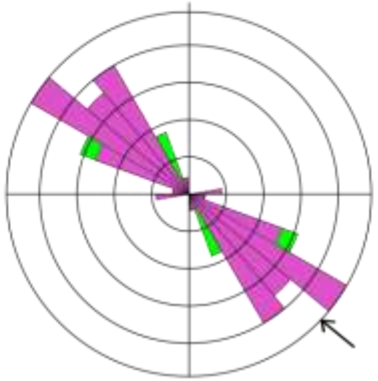
Interval = 5%
Maximum = 33.3%

• Medium plane
Mean direction = 111º
33% of data between 120º e 130º

Tectonic foliation in granites

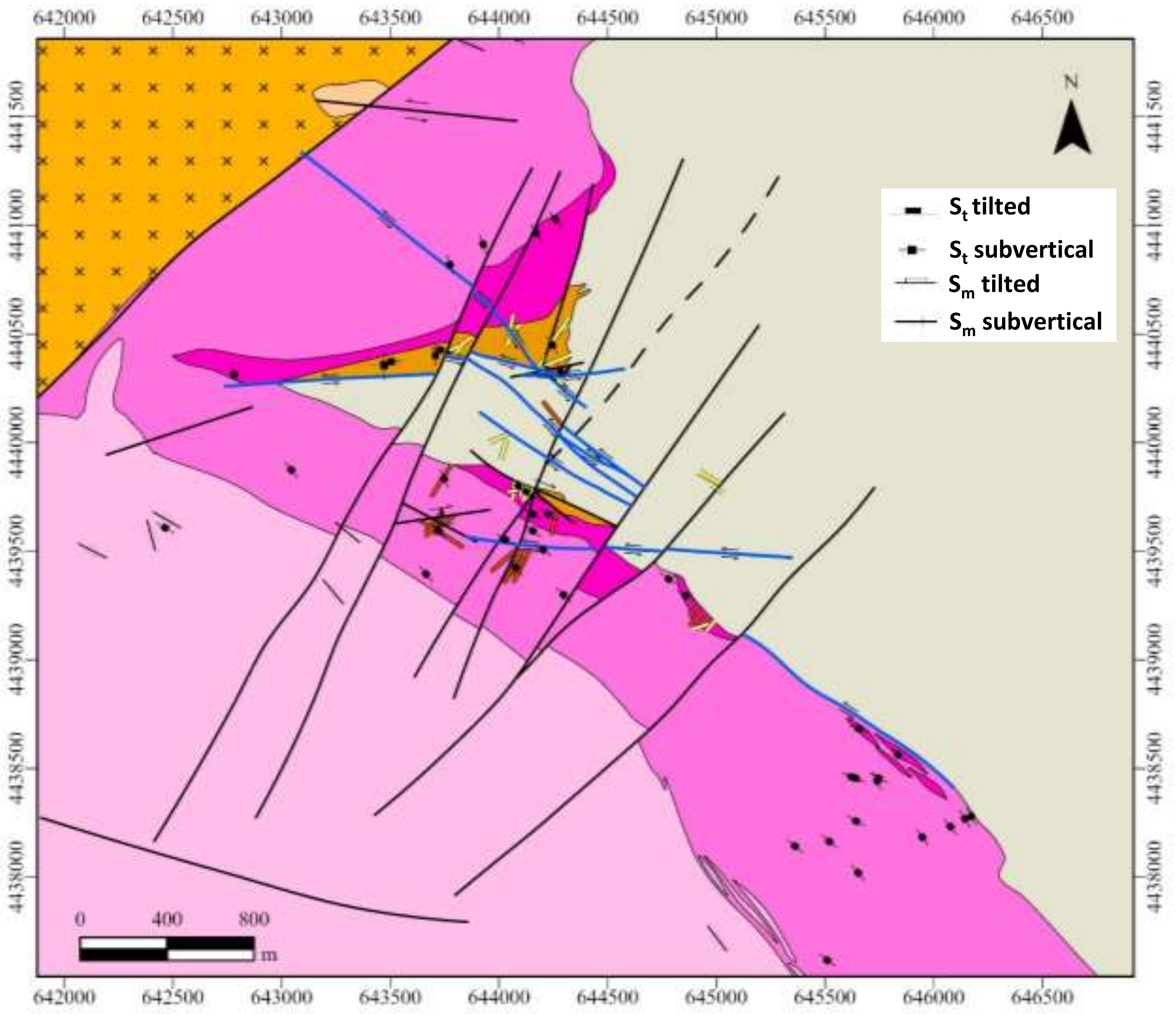
n=45 **Mean direction = 134º**



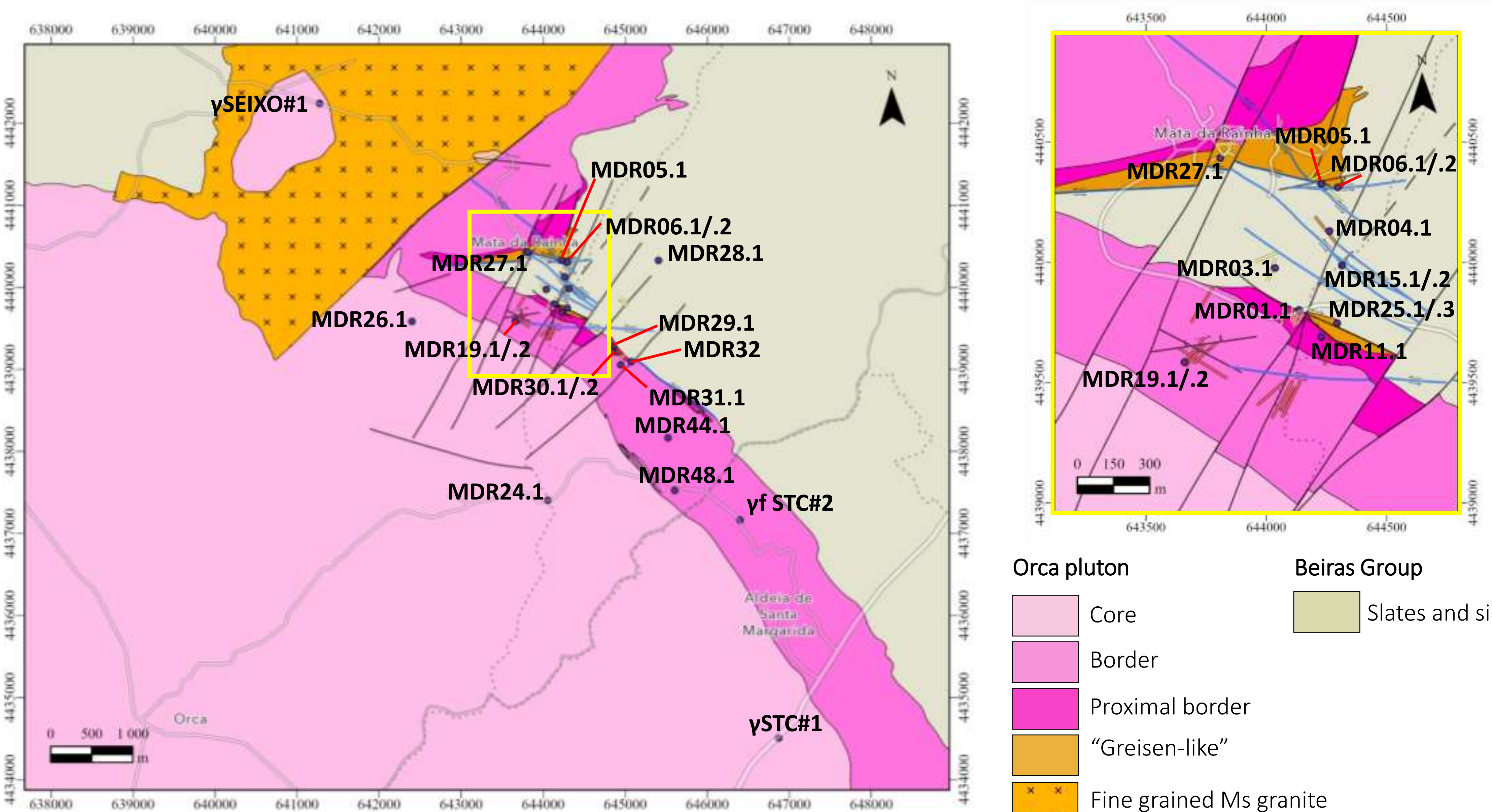


- Not associated with shear zone
- Associated with shear zone
- Mean plan

Interval = 5%
Maximum = 24.4%



Sampling



Orca pluton

- Core
- Border
- Proximal border
- "Greisen-like"
- Fine grained Ms granite

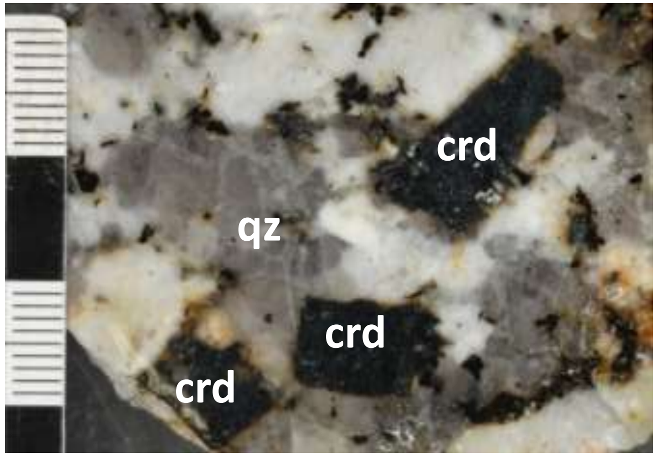
Beiras Group

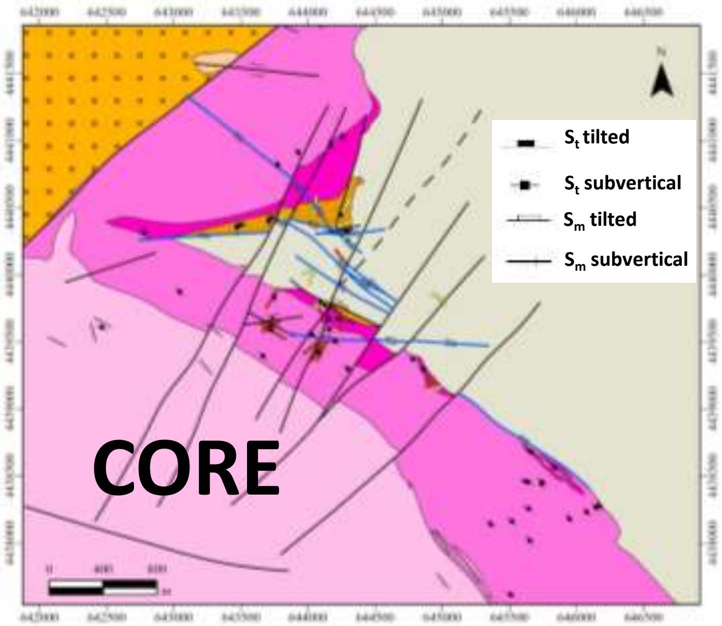
- Slates and siltites

Core Facies

plg + kfs + qz + bt + ms

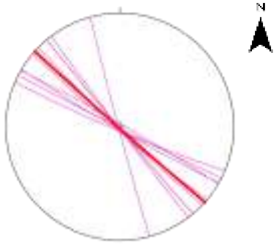
- 2-mica granite (**bt>ms**)
- **Porphyry texture**
- **Zoned plagioclase crystals**, some with 3-4 cm long; the longest dimension define a **magmatic flow** (↑Ab, *c*→*b*)
- **K-feldspar** (microcline); **perthites**
- Accessory minerals: apatite; zircon; monazite; Ti(-Fe) oxides
- Incipient biotite muscovitization

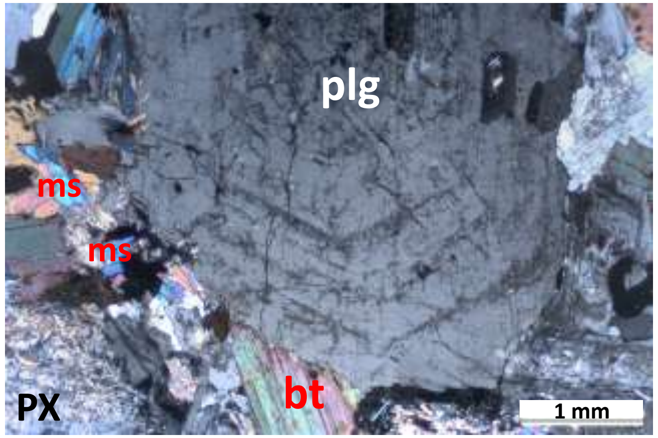




Magmatic flow n=10

Mean direction = 132º





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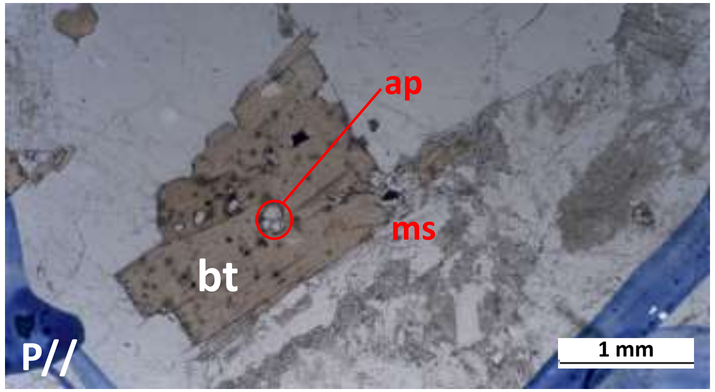
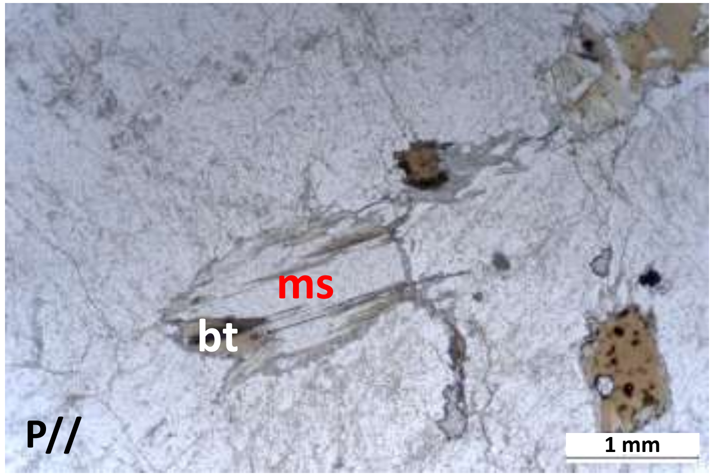
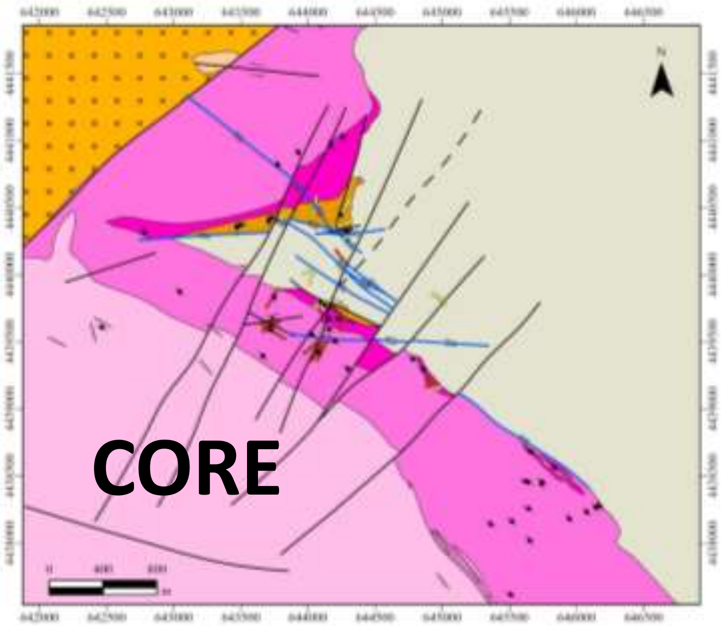
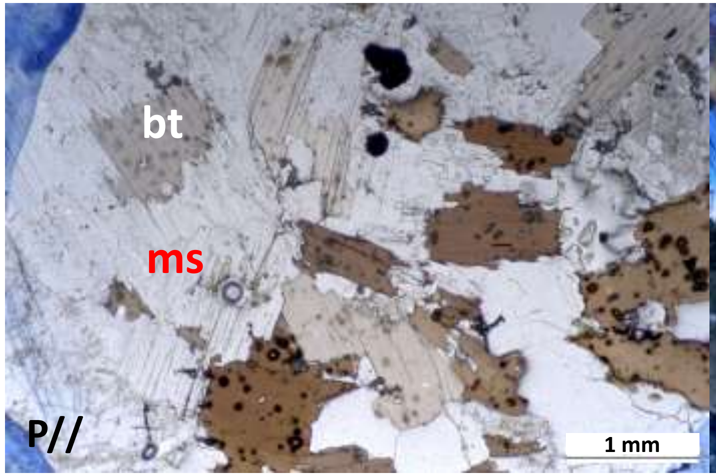
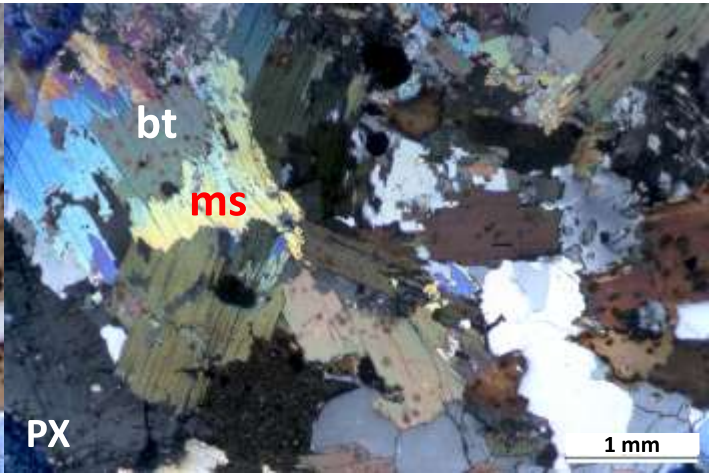




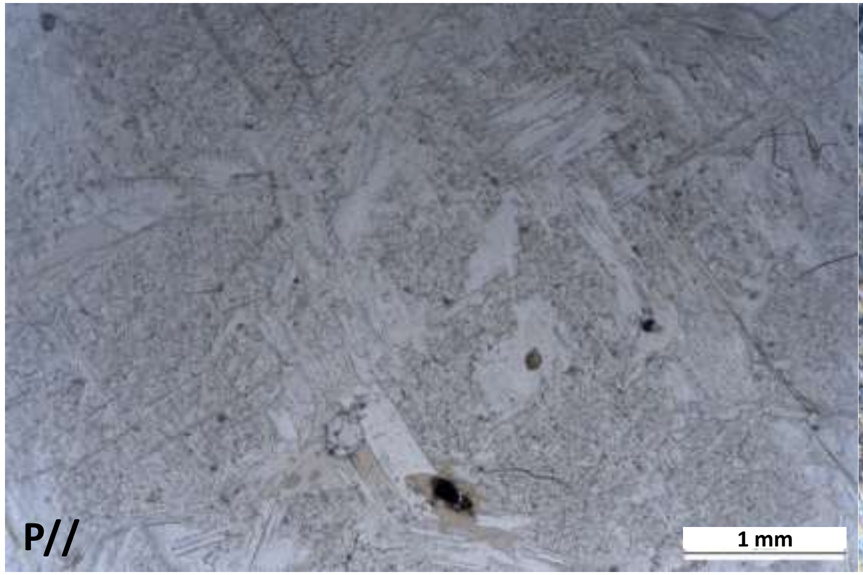


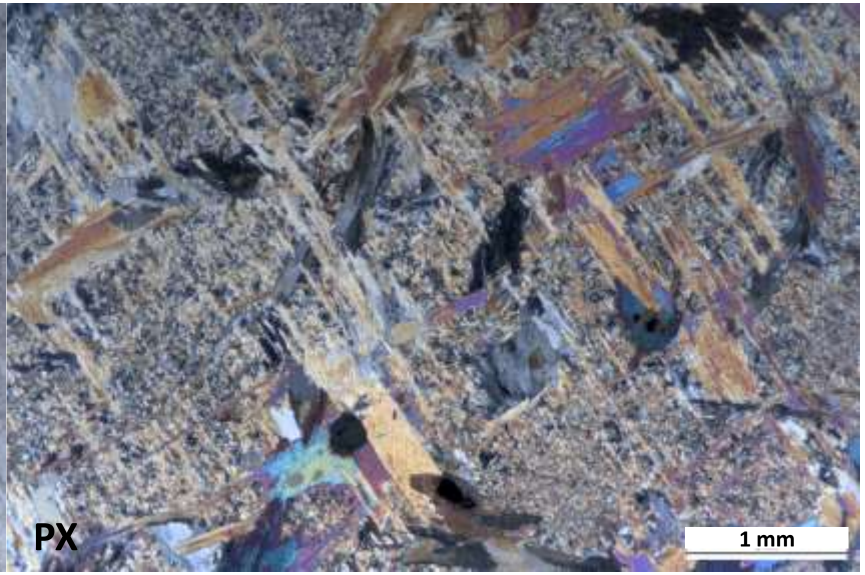


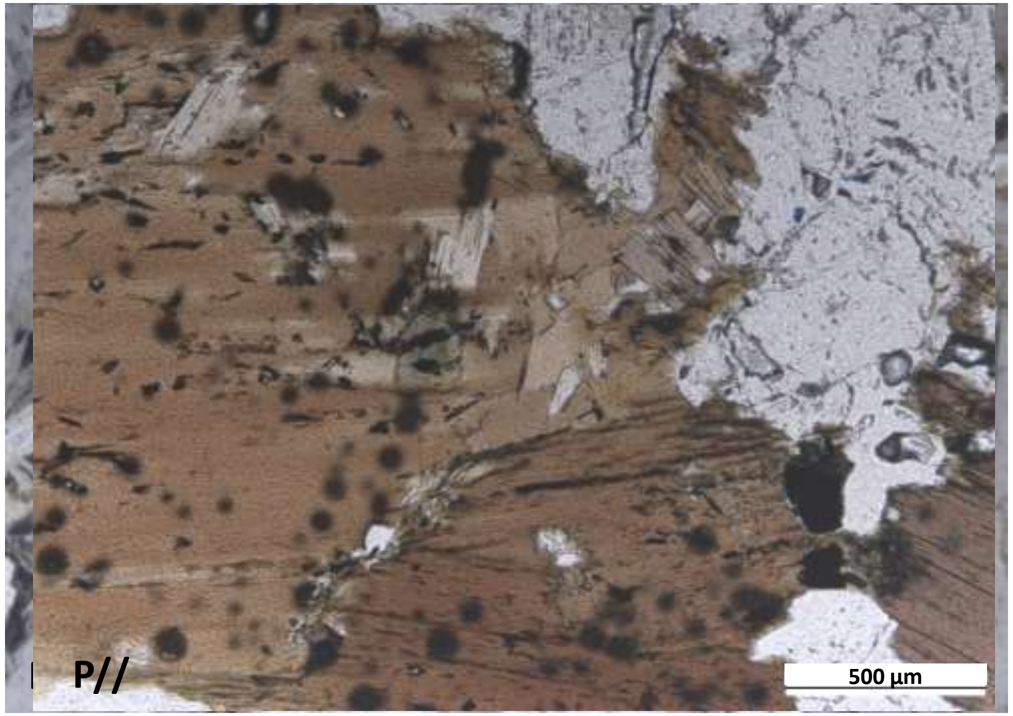


Core Facies

- The possible “cordierite” was completely altered to a **pseudomorph of ms ± qz with some biotite**
- In this alteration texture, there is a **cluster of fine tourmaline**



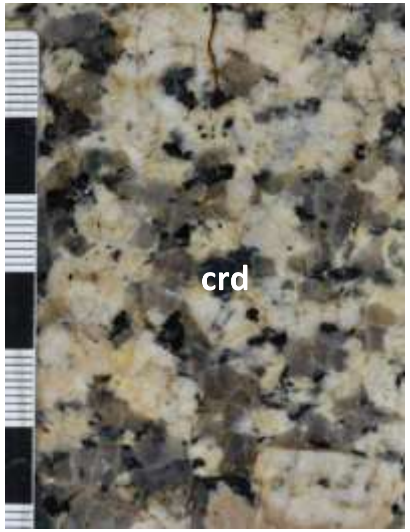


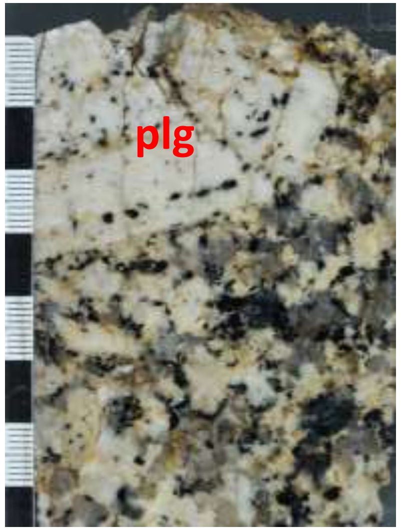


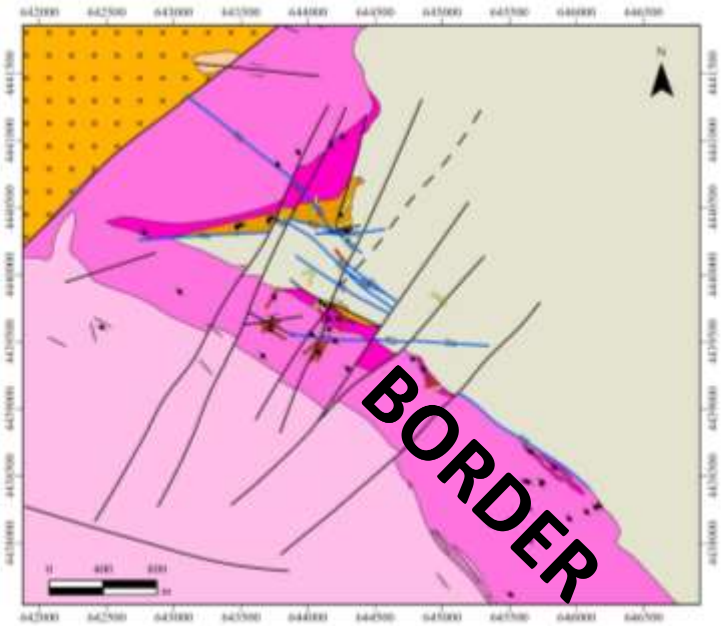
Border Facies

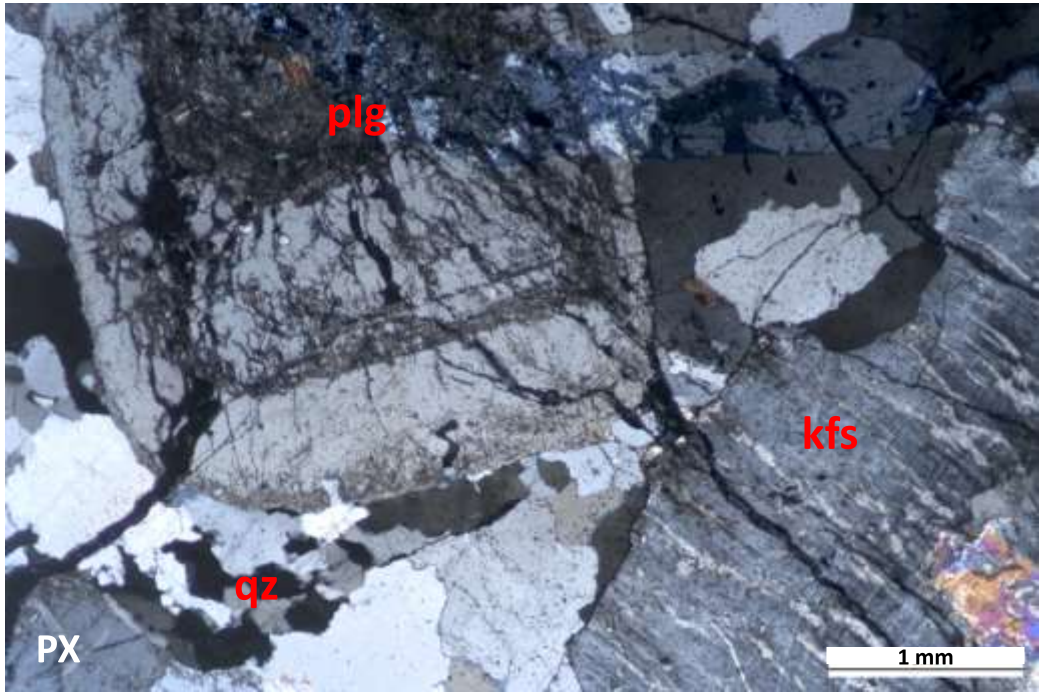
plg + kfs + qz + ms + bt ± chl

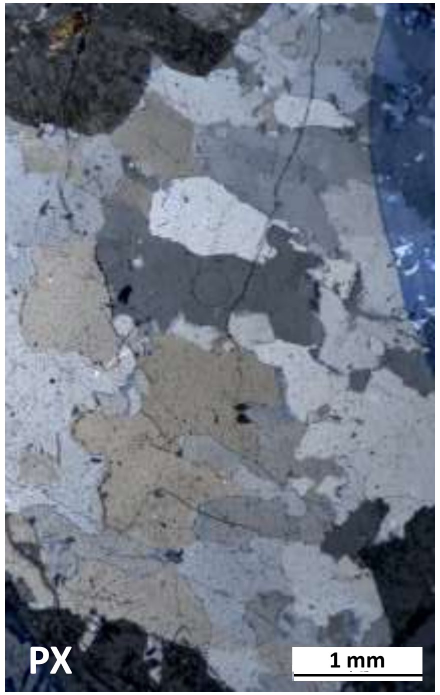
- 2-mica granite (**ms>bt**)
- **Porphyry tendency**
- **Qz: almost undeformed**; **slightly sutured boundaries**
- **Zoned plagioclase crystals** (↑Ab, *c*→ *b*); shows **twinning, sericitic alteration and fractures; corrosion gulfs**
- **K-feldspar; perthites**
- Abundant biotite muscovitization
- Accessory minerals: apatite; zircon; monazite; Ti(-Fe) oxides; xenotime
- Pseudomorph still present
- More abundant and larger tourmaline than in the core facies











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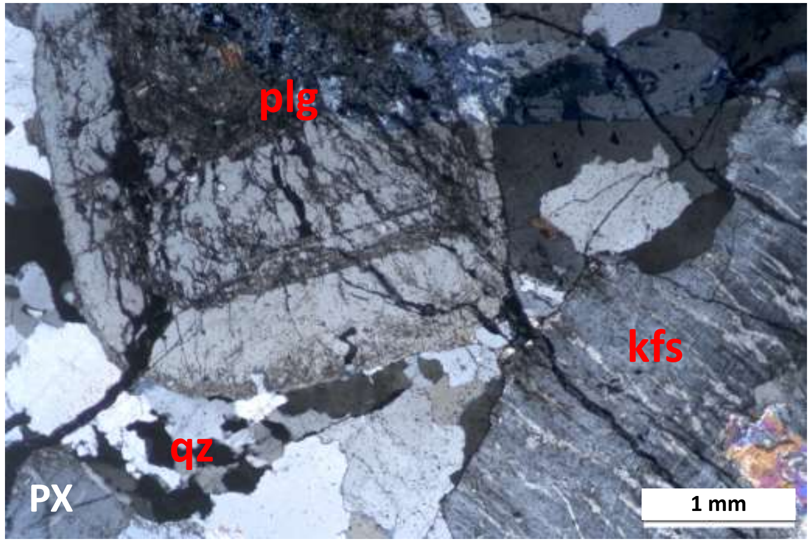

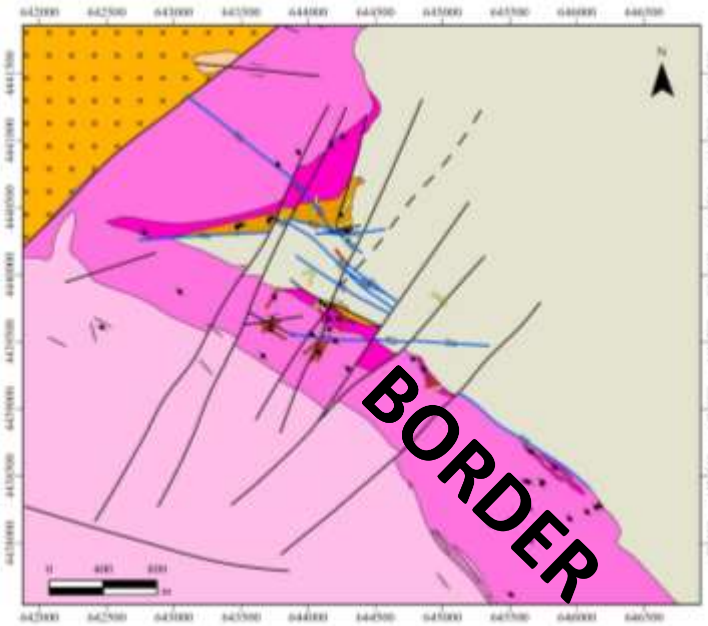

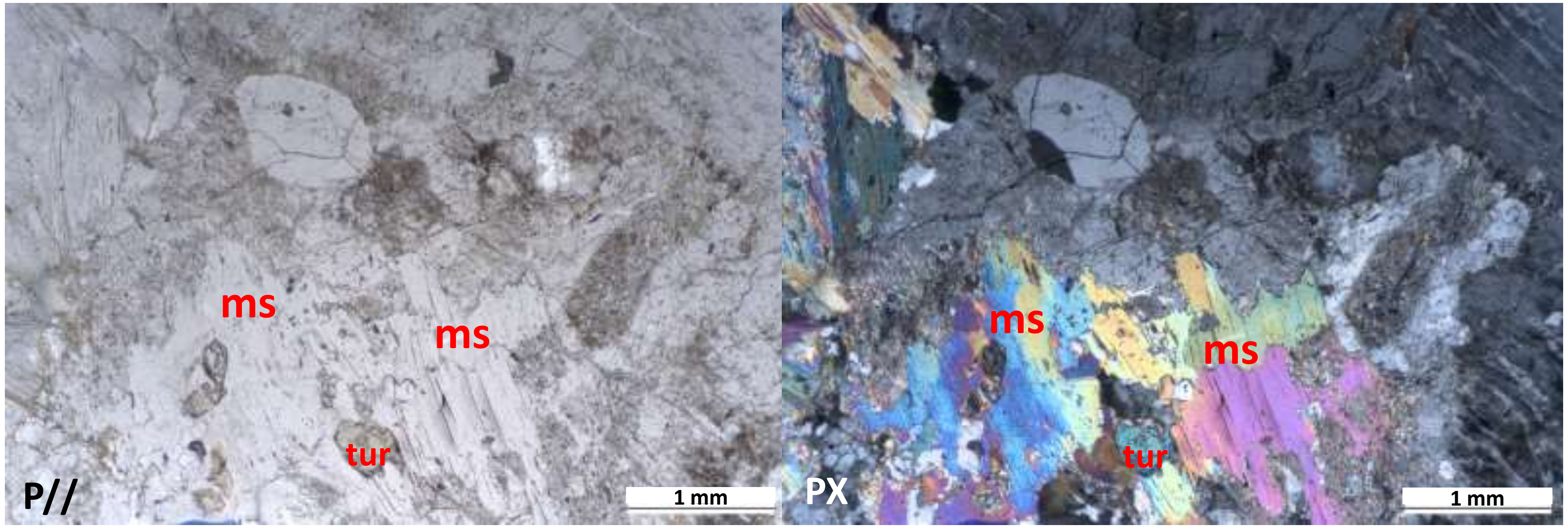

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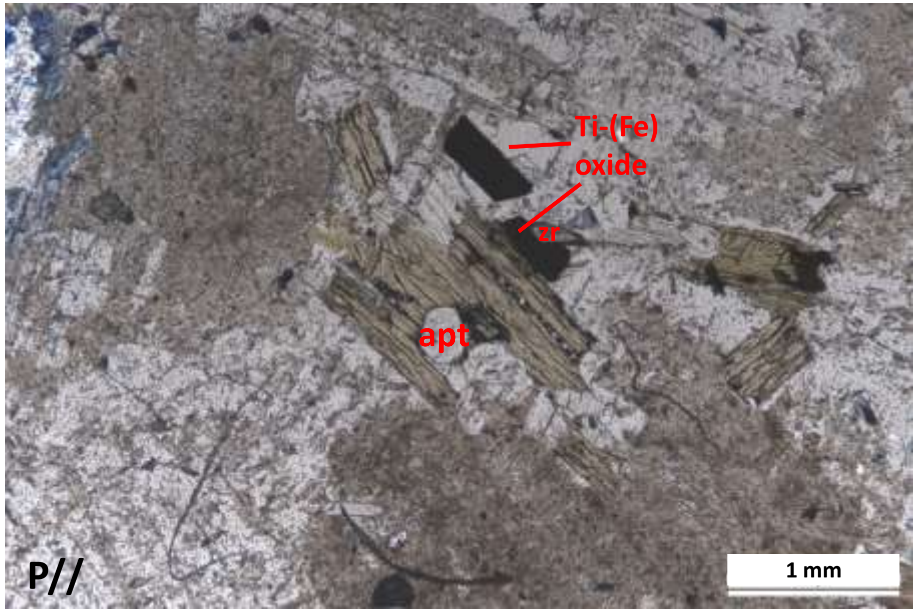
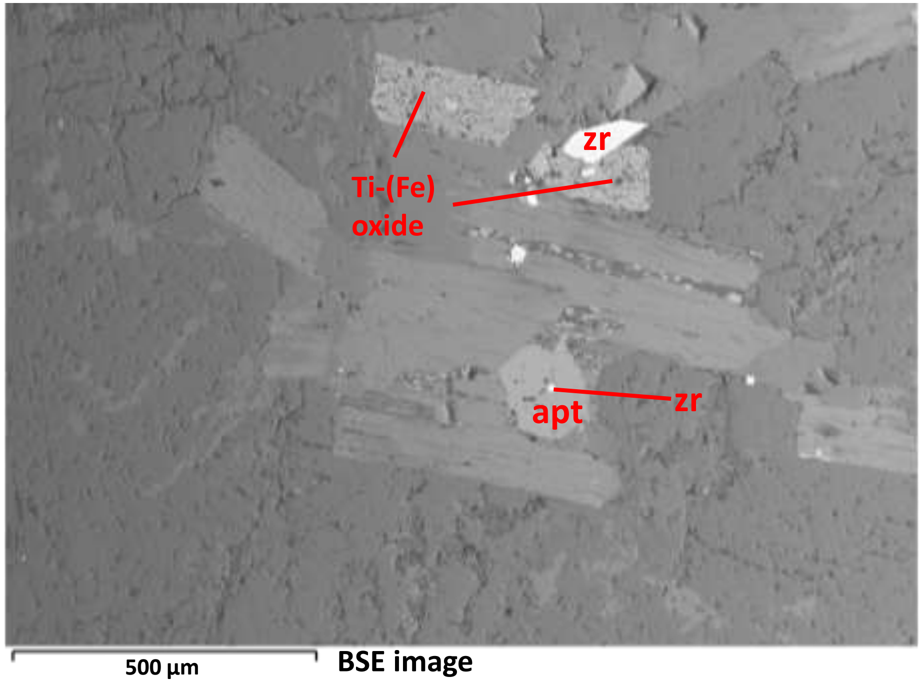
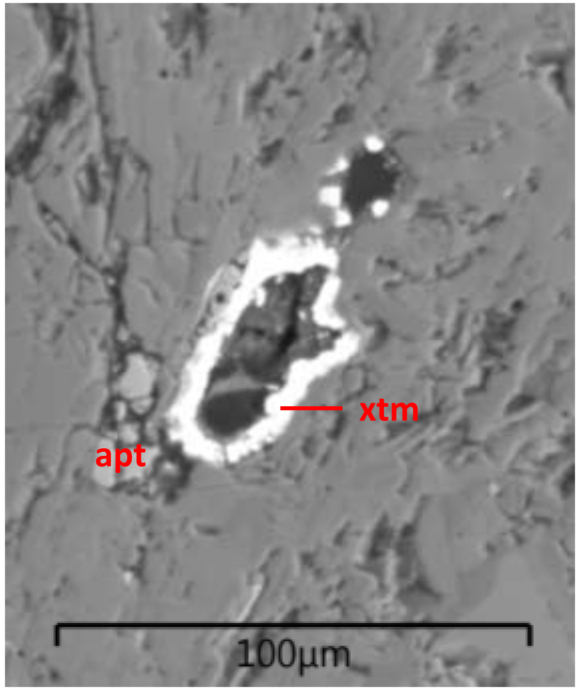




BSE image



BSE image

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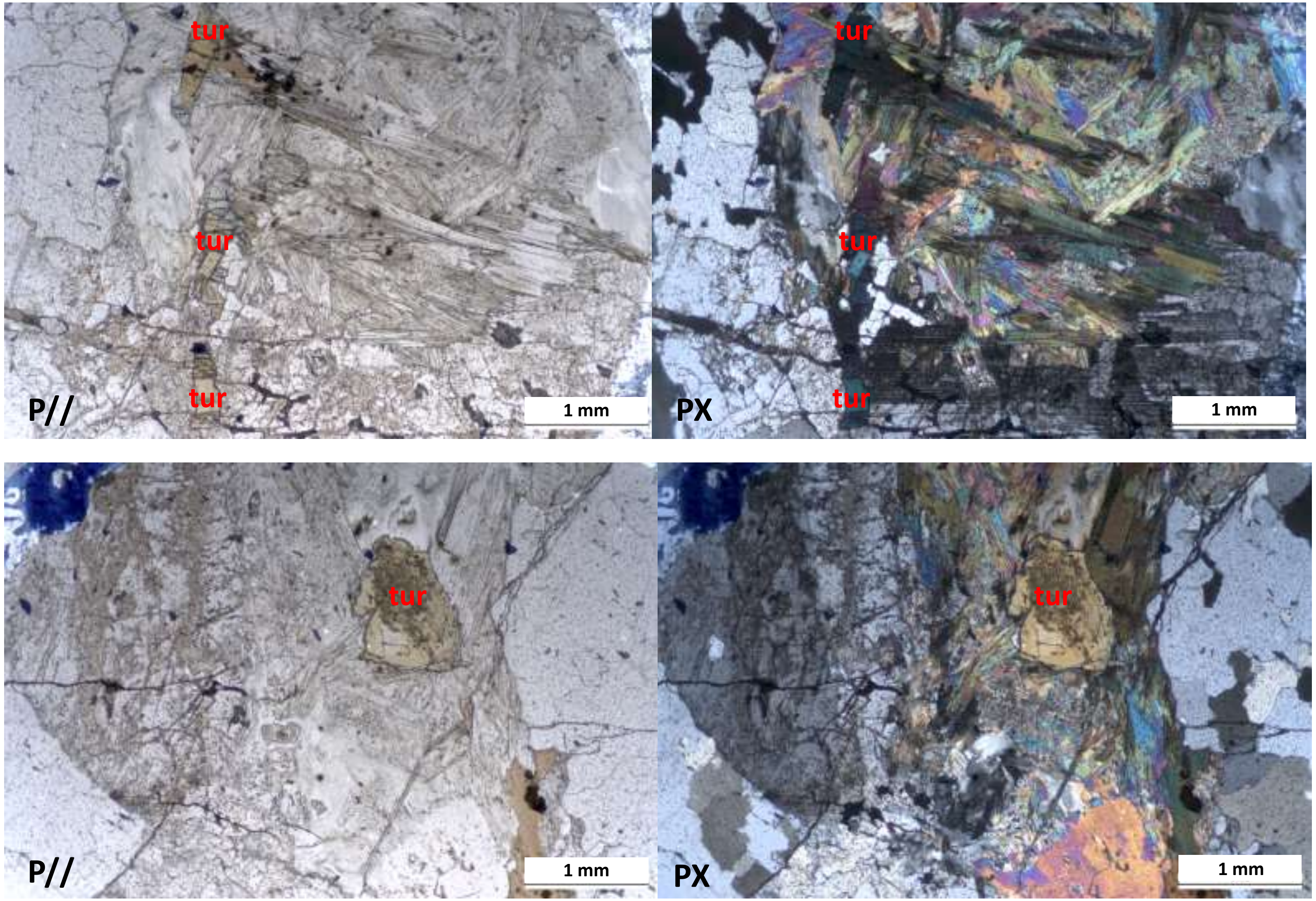
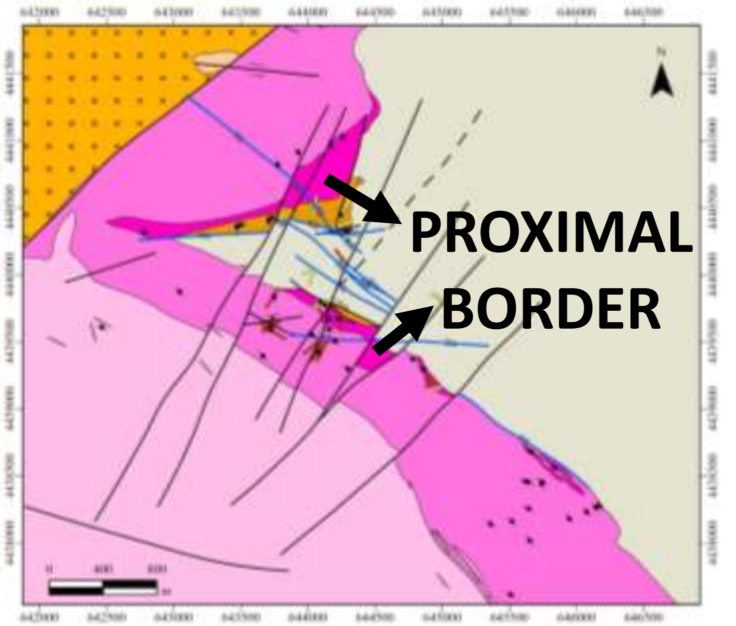
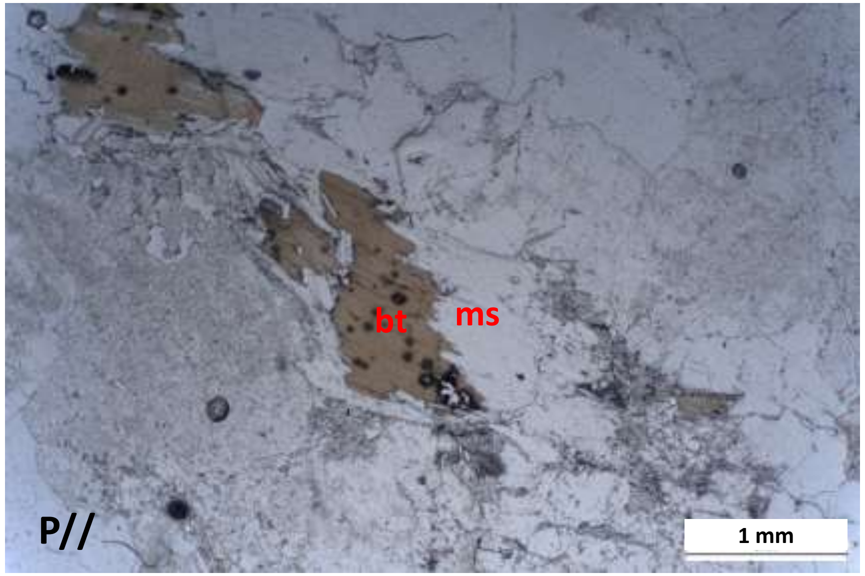


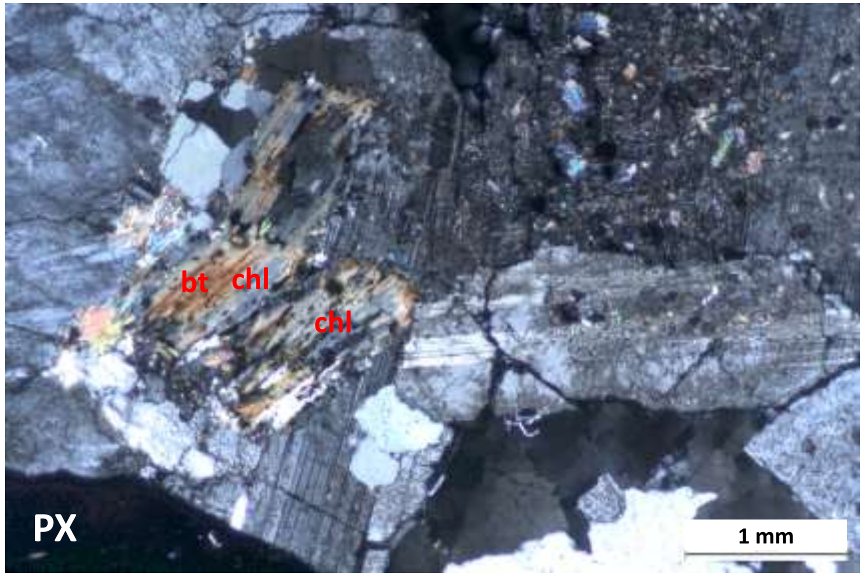
Proximal Border Facies

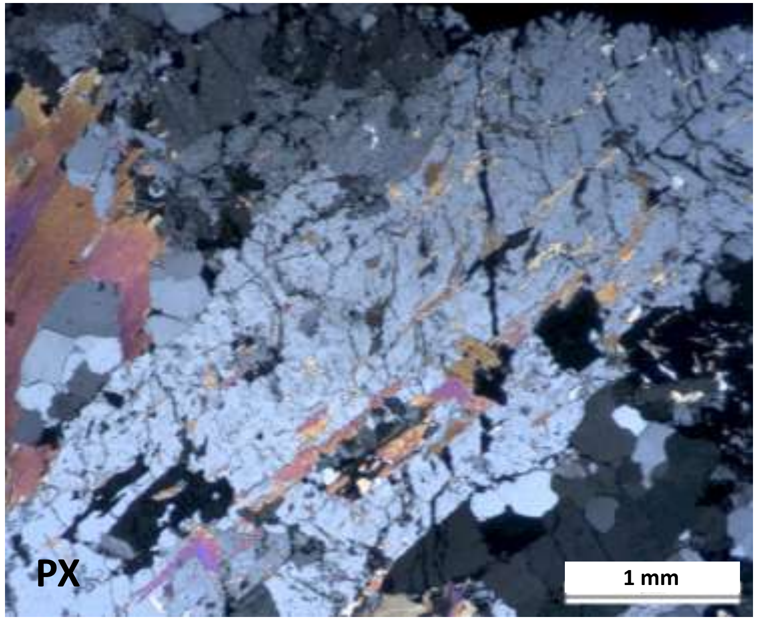
plg + kfs + qz + ms ± bt ± chl ± tur

- **Ms>>Bt>Chl**
- **Biotite muscovitization and chloritization**
- **Plg (mechanical twinning), strong hydrolysis**
- Qz: strong wavy extinction and sutured boundaries; sub-granulation in samples close to shear zones
- K-feldspar; perthites
- Inter- and intragranular fractures filled with ms
- Late silicification; qz ± ms fractures and veinlets









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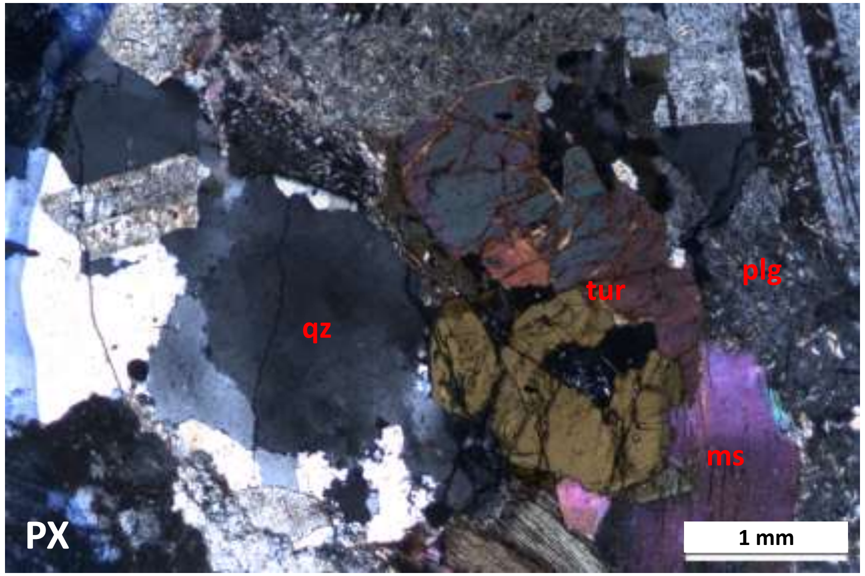
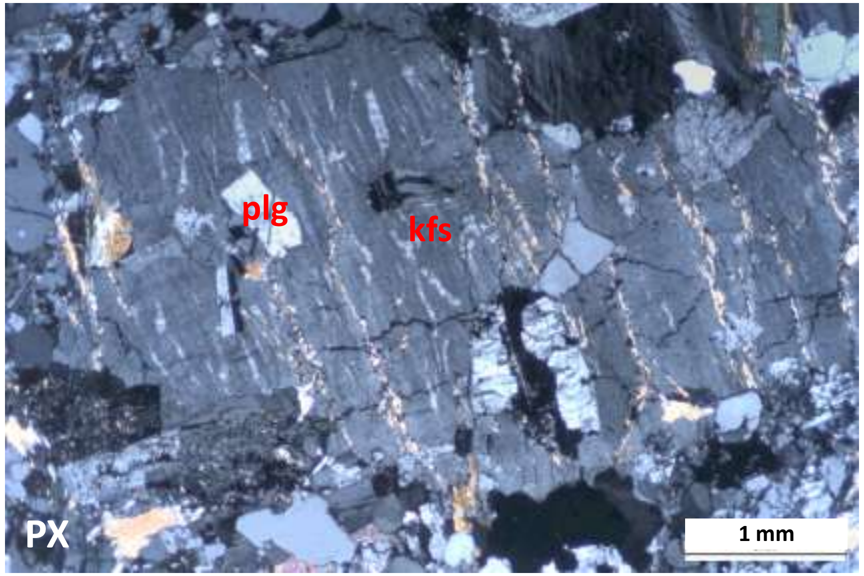
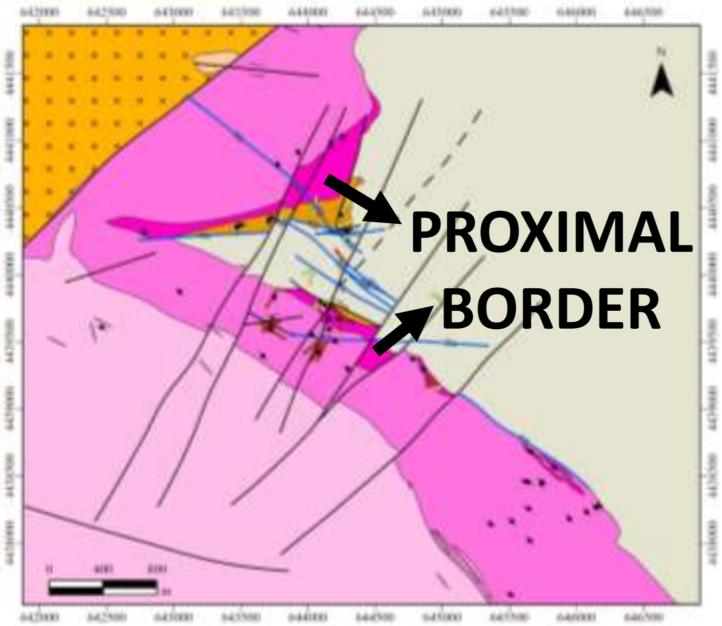


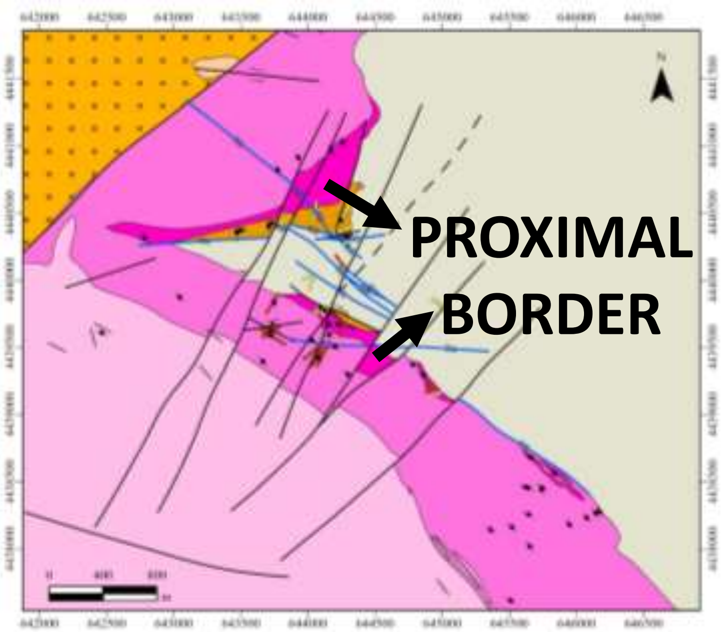


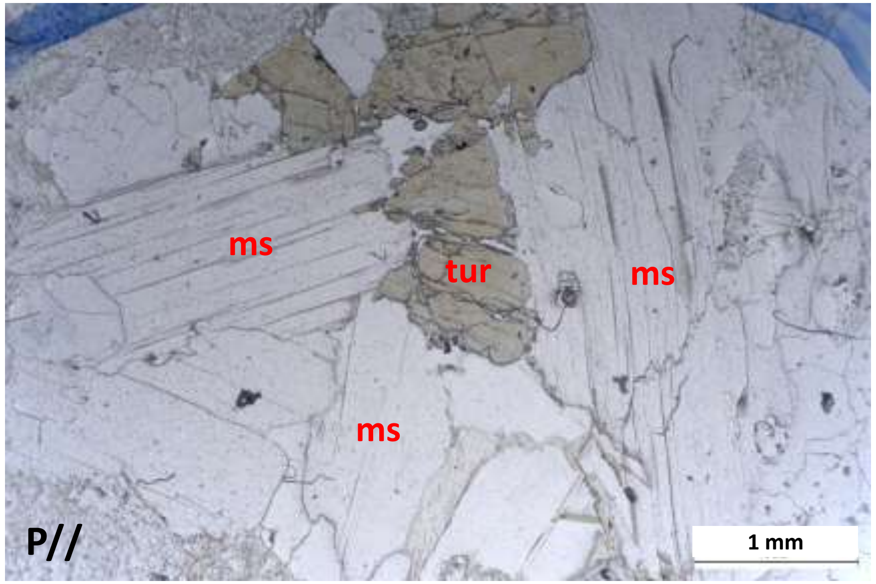


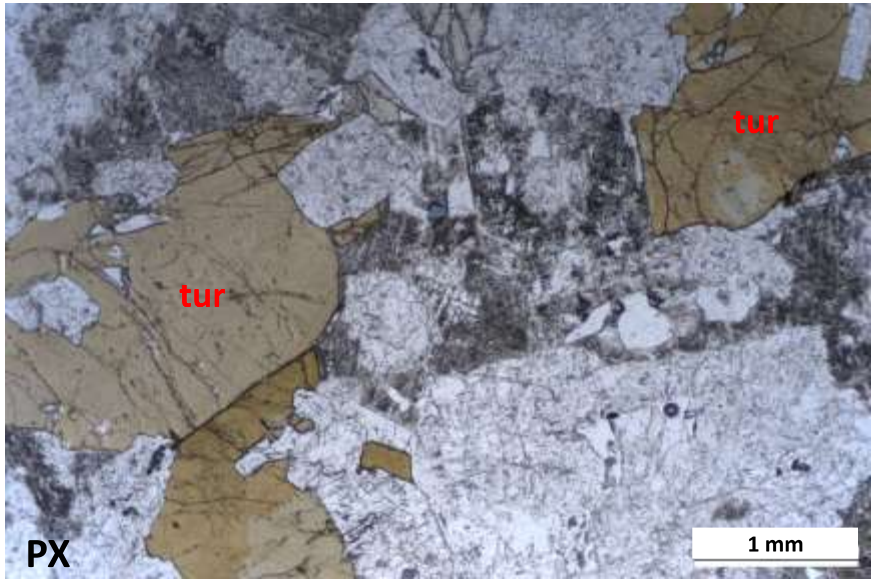
Proximal Border Facies

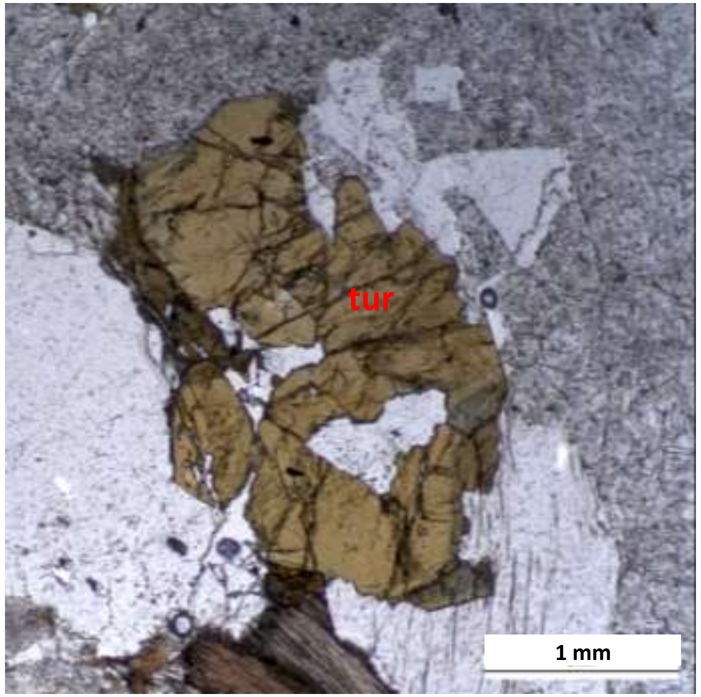
plg + kfs + qz + ms ± bt ± chl ± tur

- **Close to aplitic-pegmatite bodies: can also show porphyry texture; ↑ tur; 2 types of tourmaline: anhedral/corroded vs. euhedral/regular rims**
- Accessory minerals: apatite, zircon, Ti(-Fe) oxides, monazite-(Ce); xenotime









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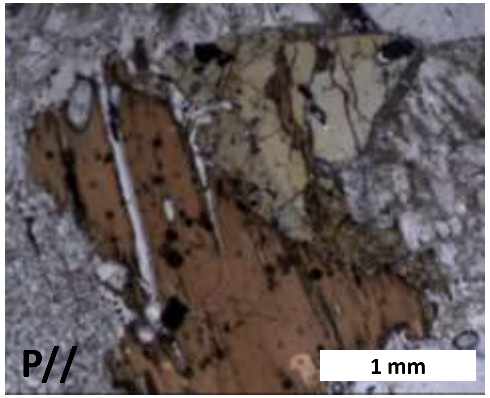
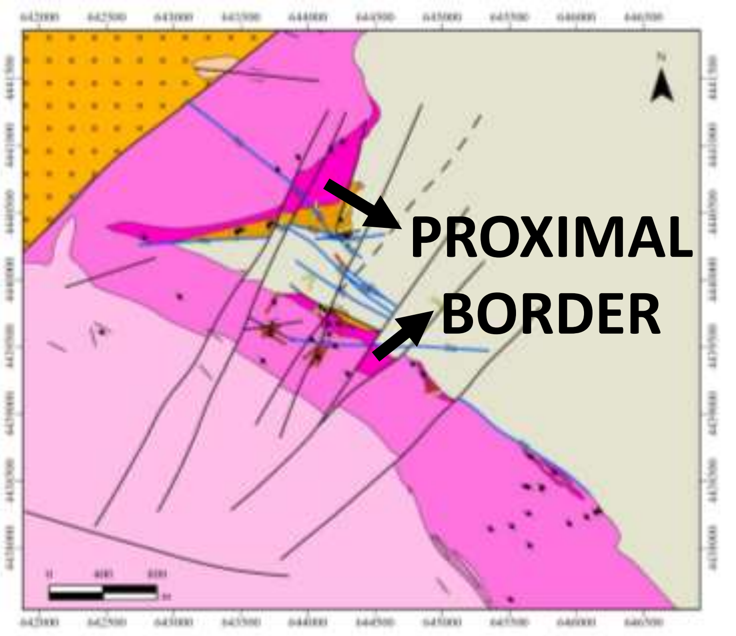
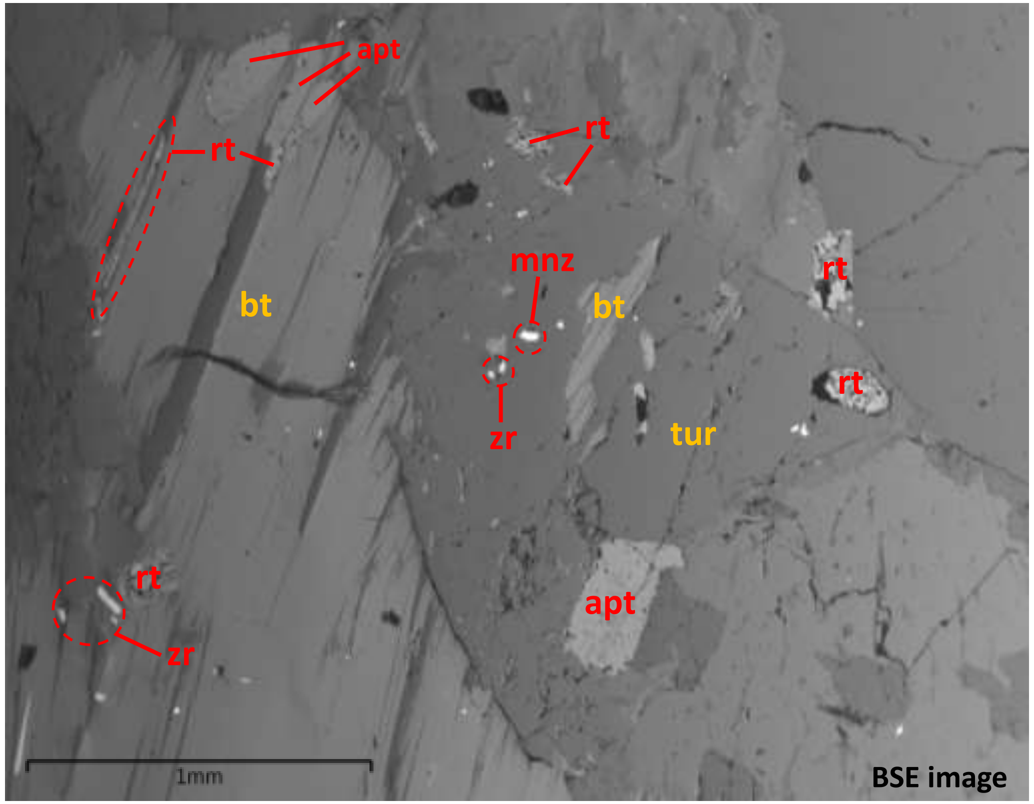
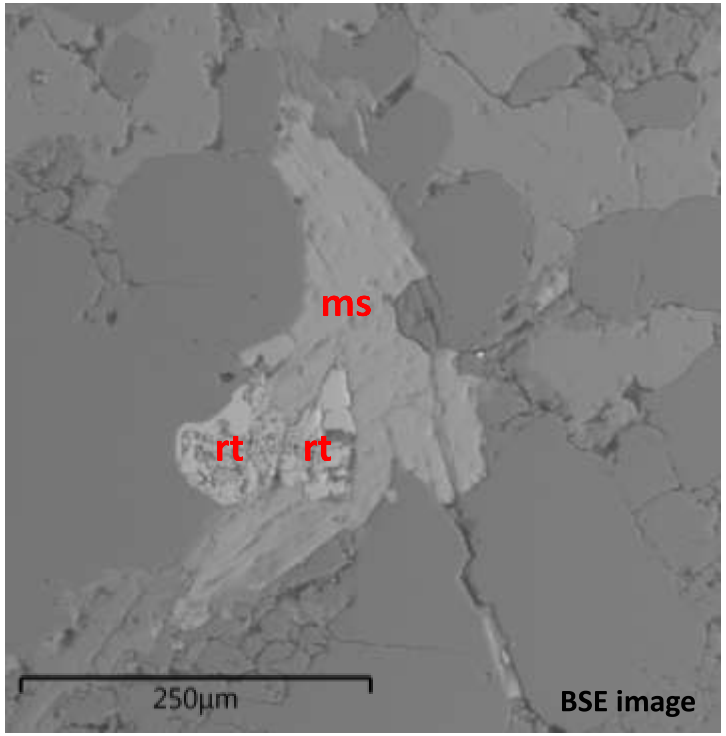






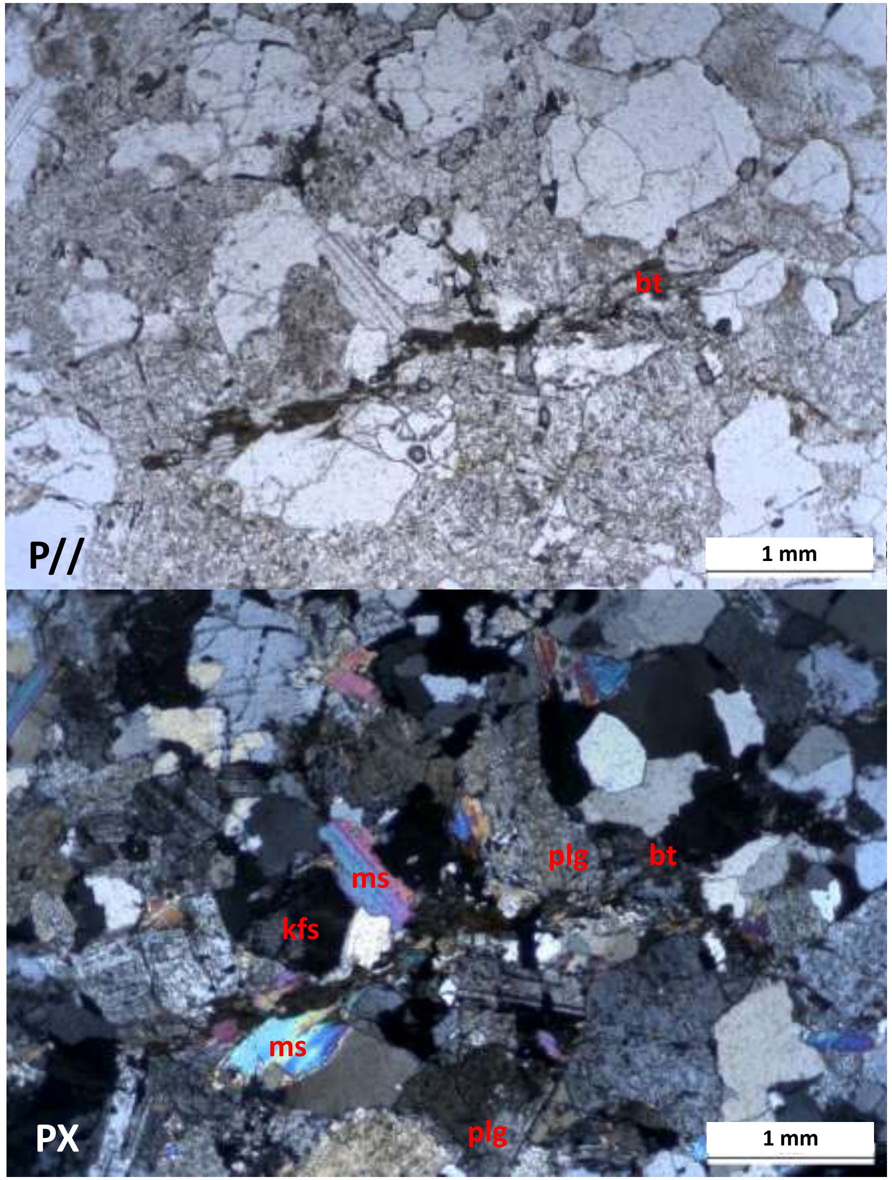


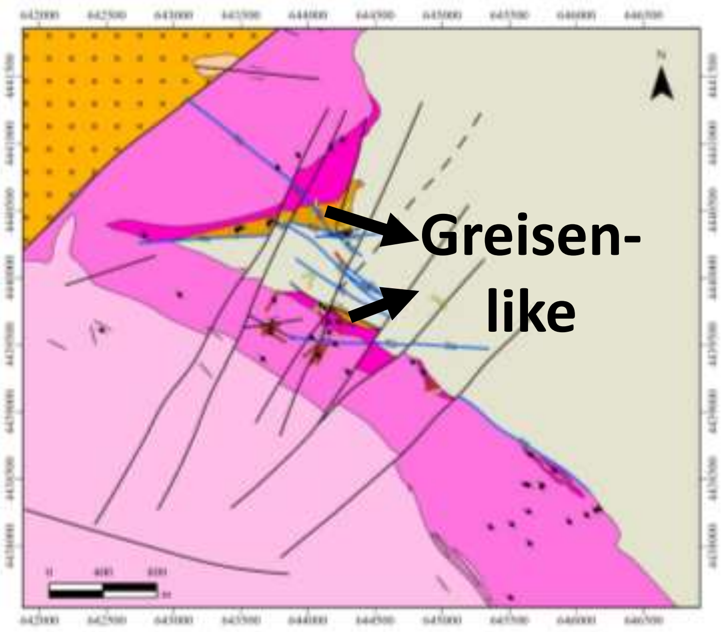
“Greisen-like” facies

❖ **4 samples**

MDR25.3

- Bt remains + plg + kfs + ms
- Qz with wavy extinction





“Greisen-like” facies

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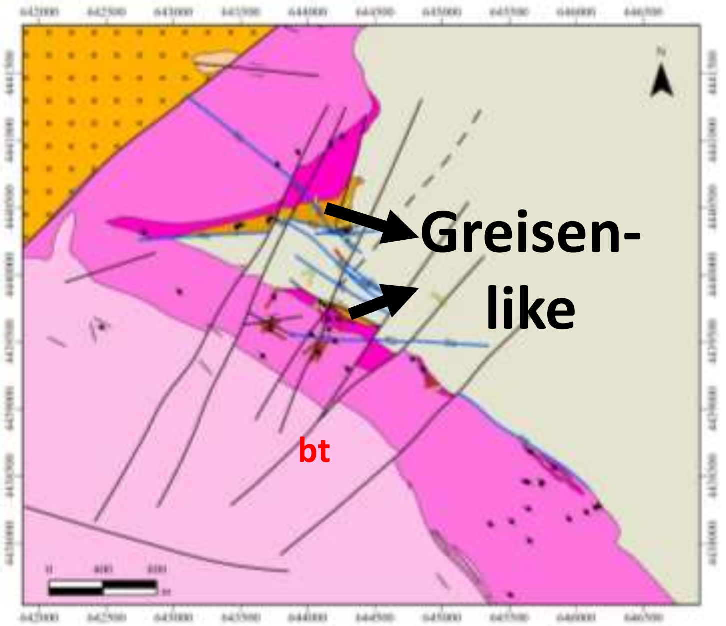
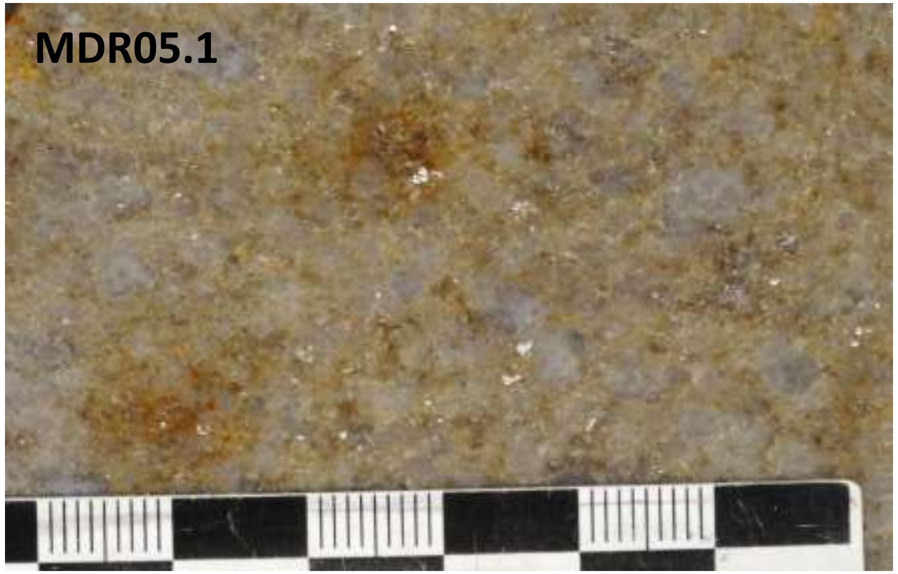
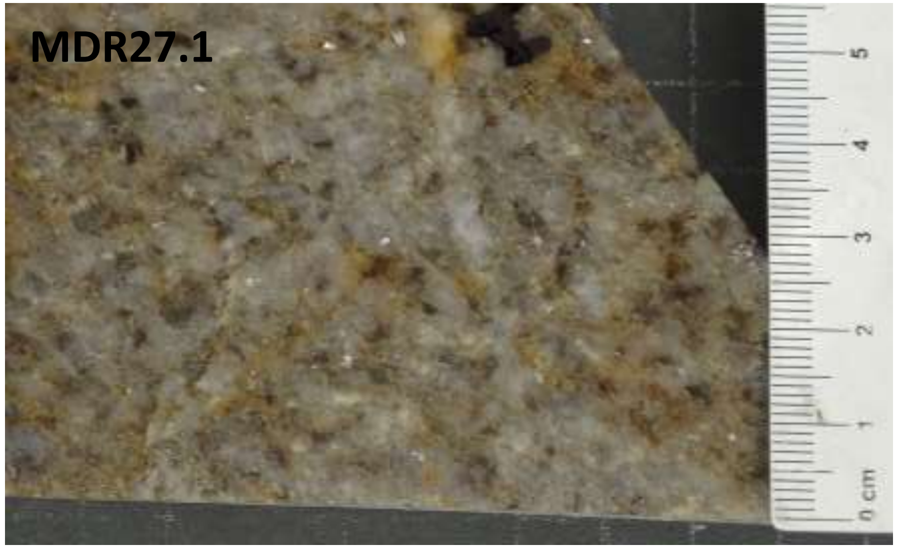
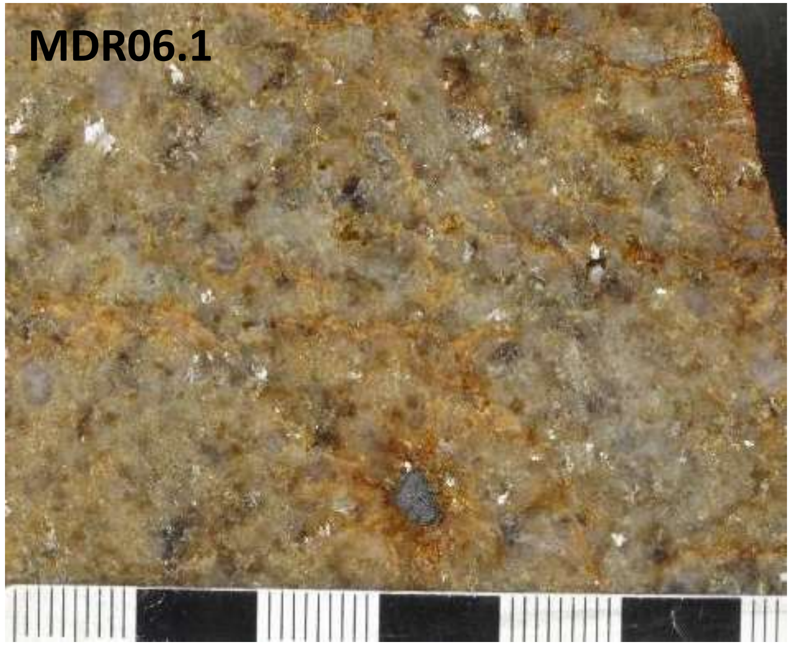
<u>MDR05.1</u>, <u>MDR 27.1, MDR06.1</u>
- Bt remains
- Don’t have feldspars
- Intense muscovitization
- Subgranulation of qz
- Accessory minerals: apatite, zircon, arsenopyrite, xenotime









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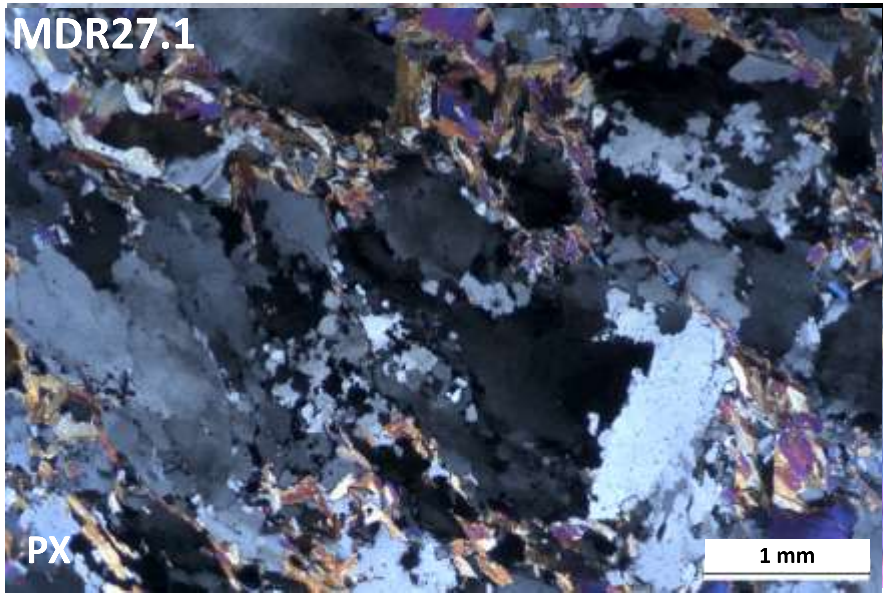
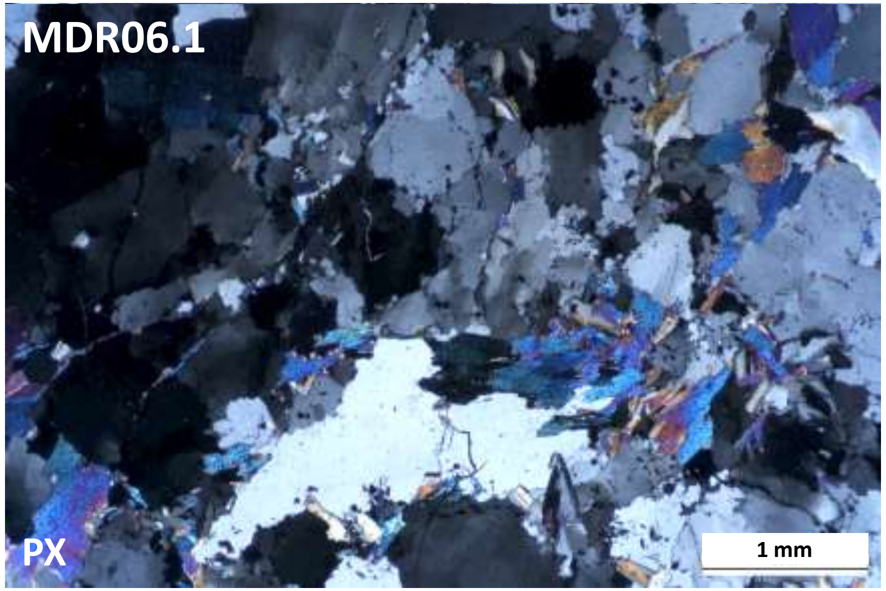
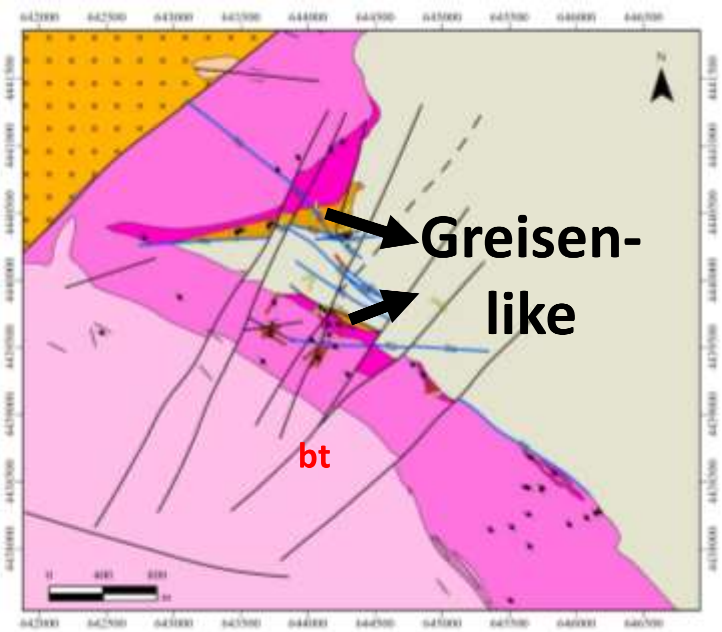
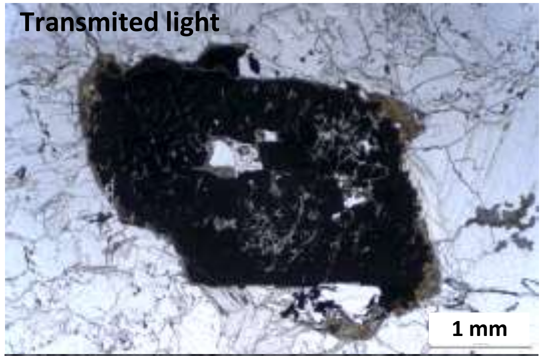
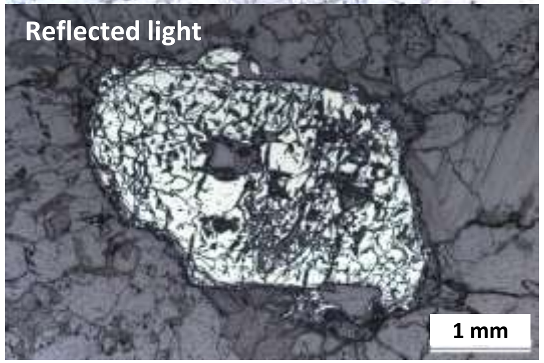
Leucogranite







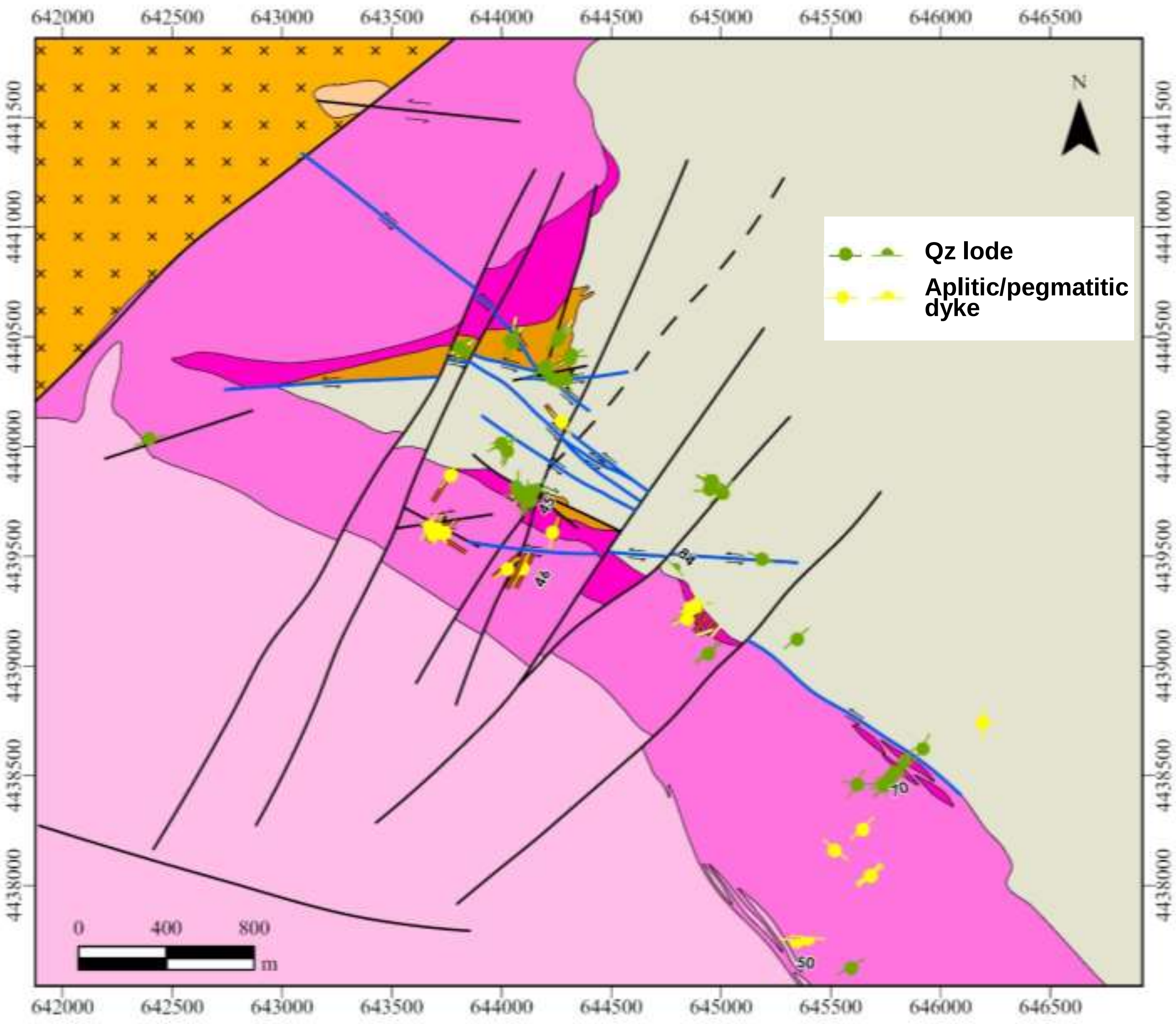




Dykes

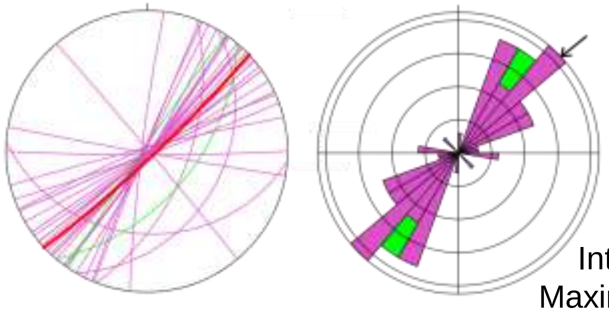
4 types:
1. Aplites
2. Qz-tur
3. Qz
4. Microgranite

Aplites and Qz/Qz-tur dykes
- Located at the pluton border and in metassediments
- Aplites are mostly confined to the border facies
- Spatial overlapping with shear and fault zones



Dykes

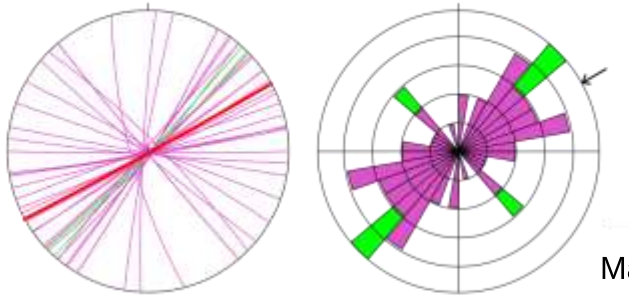
Quartz-tourmaline n=33



Mean direction = 47º
- Qz with abundant tur
- Qz with rare tur
- Medium plane

Interval = 5%
Maximum = 21.2%

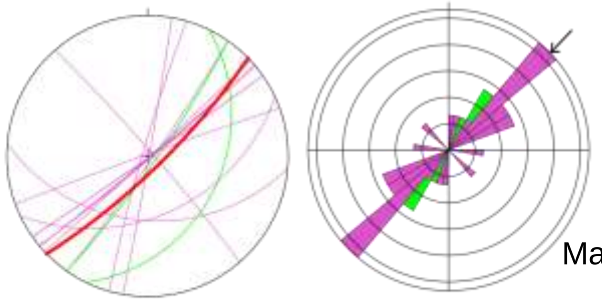
Quartz without tourmaline n=34



Mean direction = 61º
- Milky qz
- Grey qz
- Medium plane

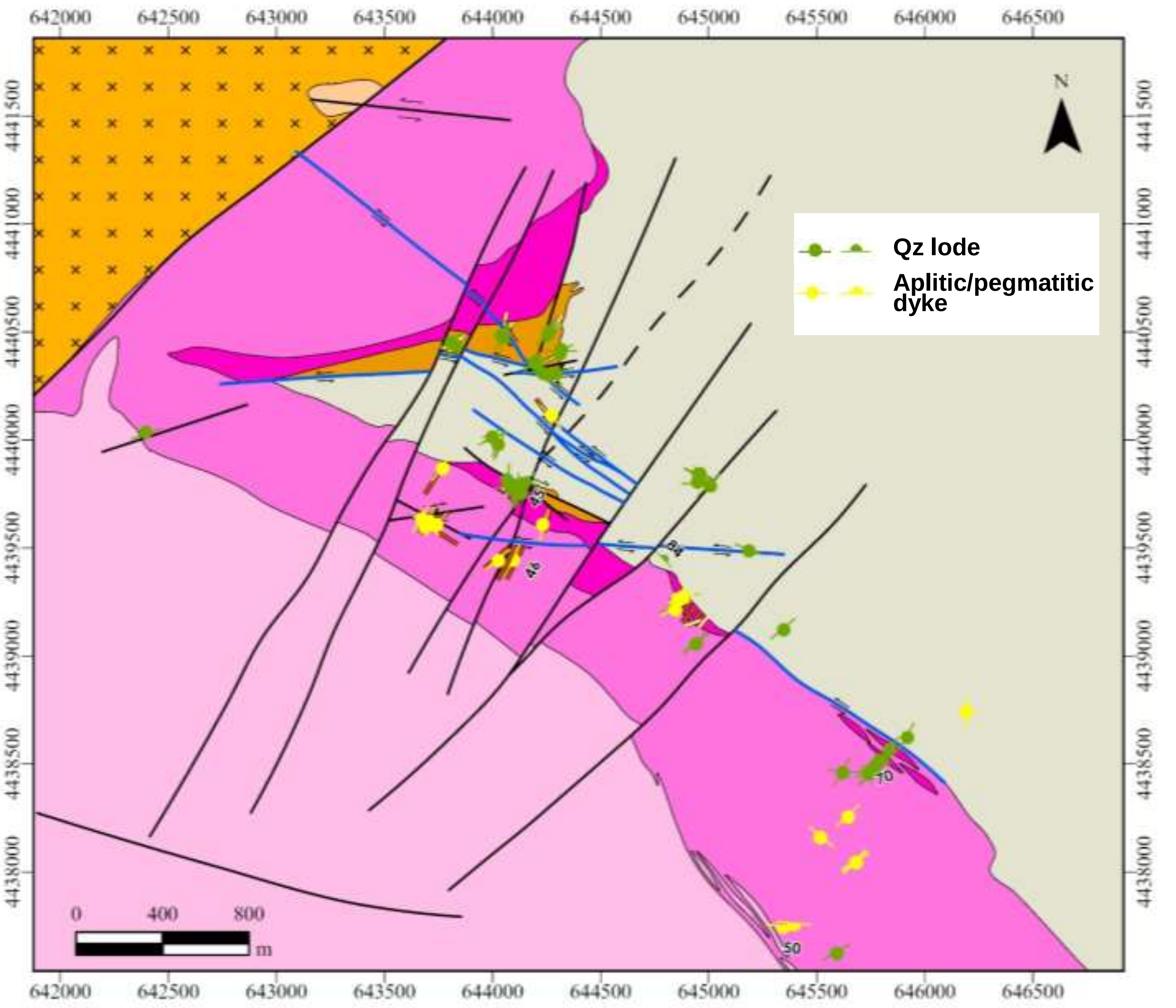
Interval = 3%
Maximum = 14.7%

Aplite n=33



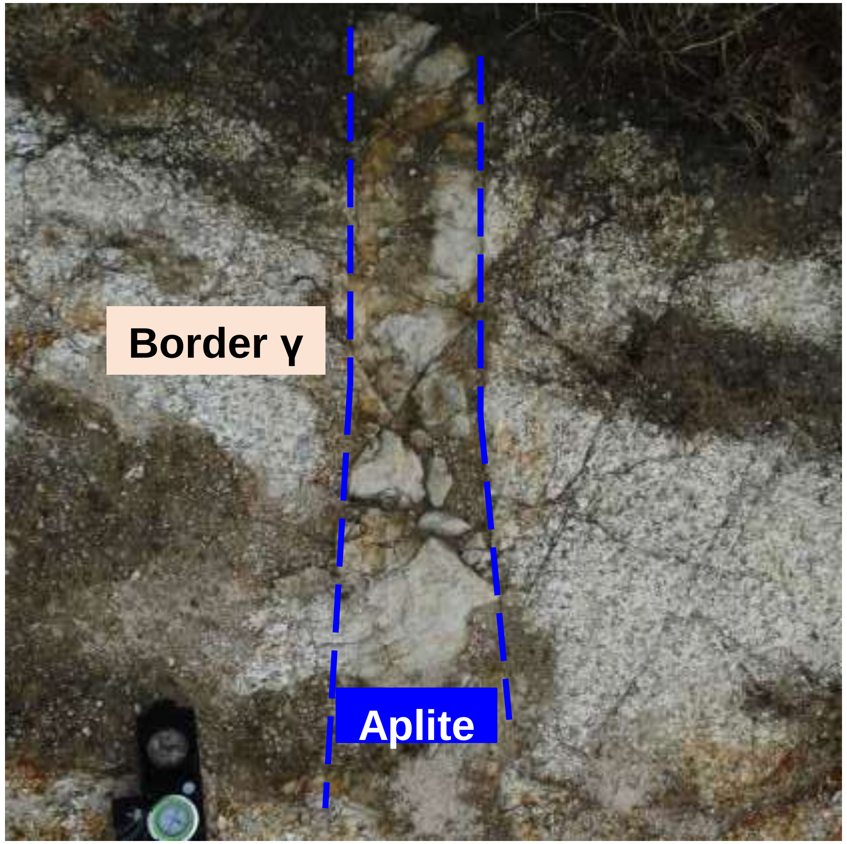
Mean direction = 46º
- Aplite
- Aplite-pegmatite
- Medium plane

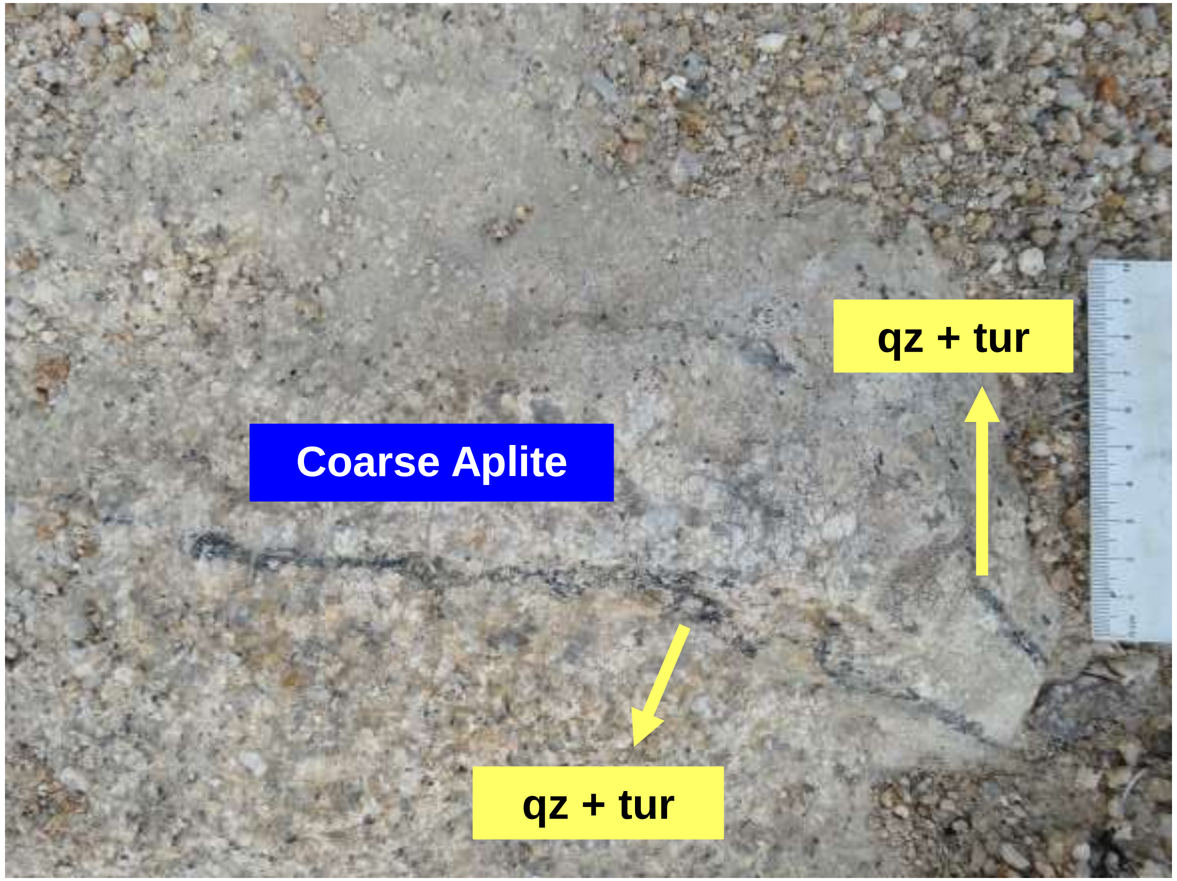
Interval = 5%
Maximum = 26.7%

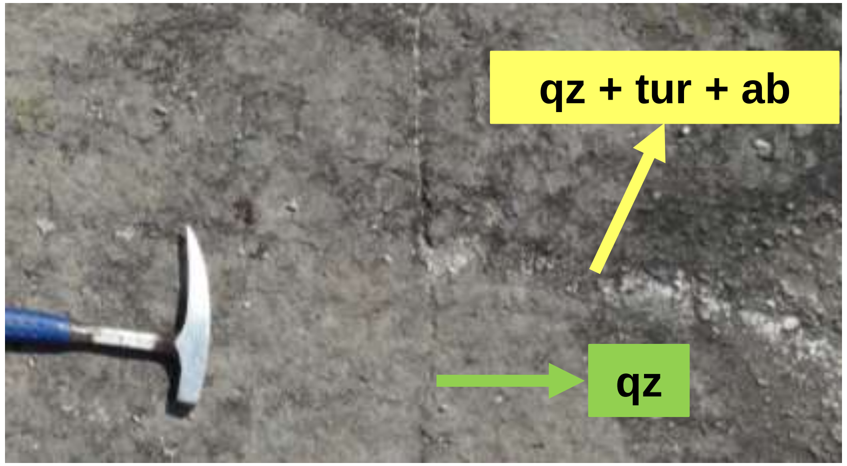


Dykes - Field relationships

- Aplite dykes are hosted in granites (mostly border facies)
- Aplite dykes are cut by qz + tur veins
- Qz+tur veins are cut by qz (mineralized?) infillings







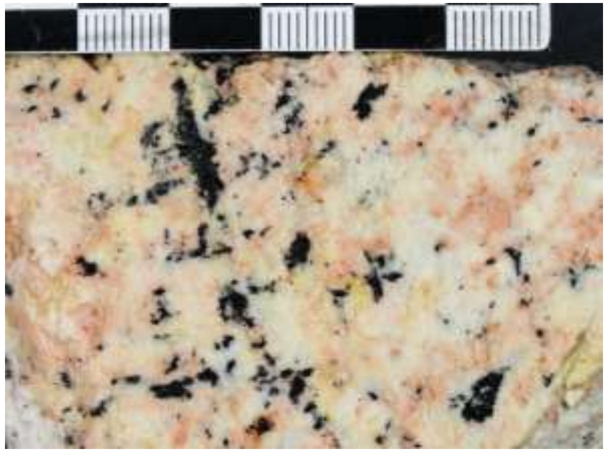
Dykes - Aplites

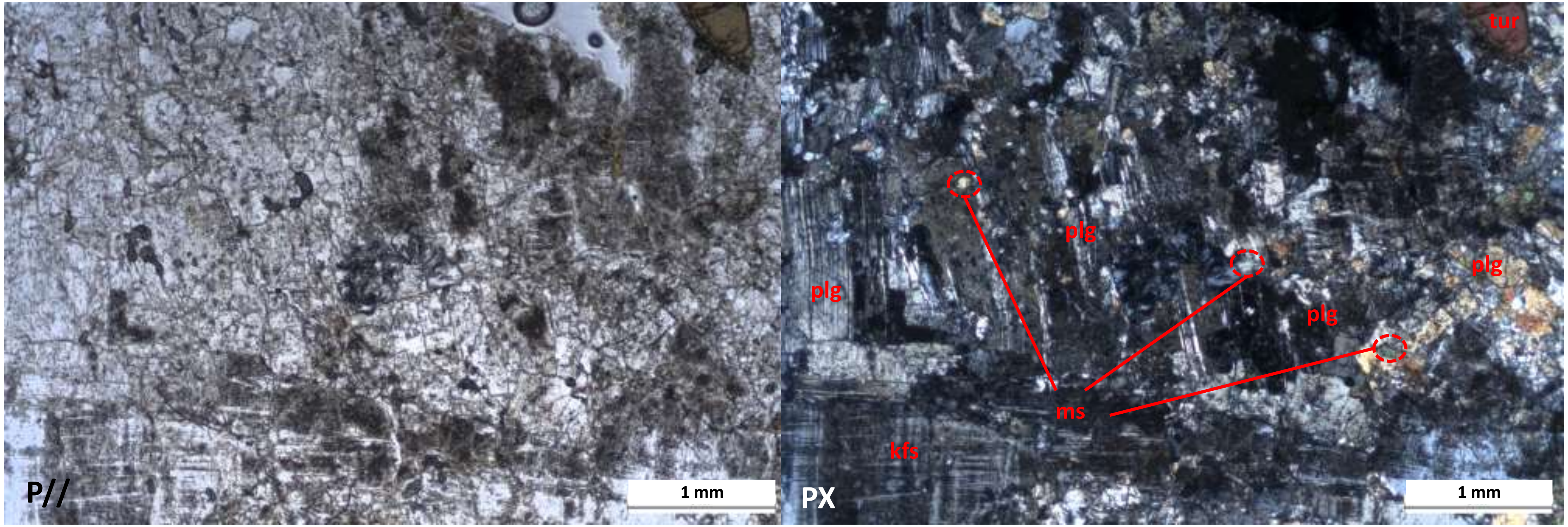
❖ **2 types** of aplite dykes based on the **grain size and mineralogical composition**

Type 1

kfs + plg + tur + qz

- Strongly weathered
- Hydrolysed plg (mechanical twinning)
- Kfs (microcline)
- Tiny ms (<200 µm) as inclusions in plg
- Highly fractured tourmaline
- Accessory minerals: ms; apt





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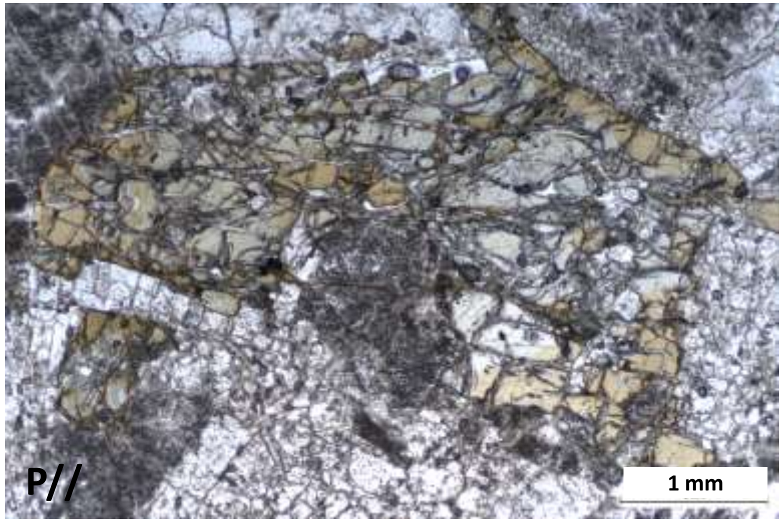
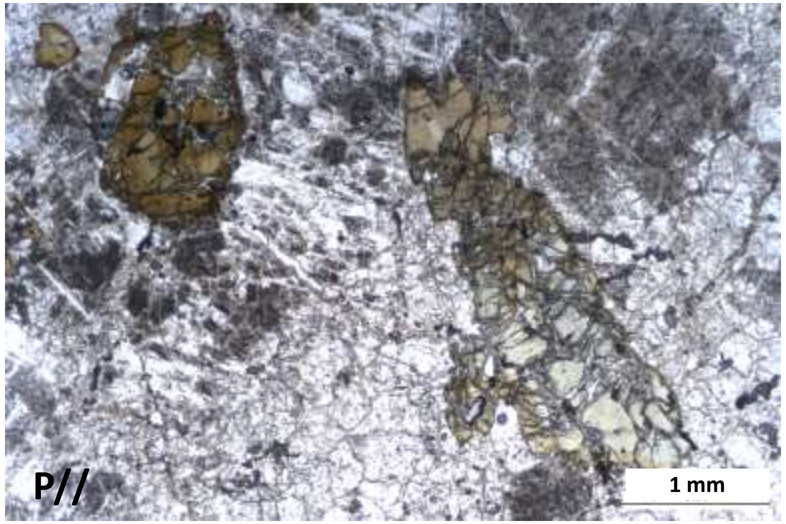
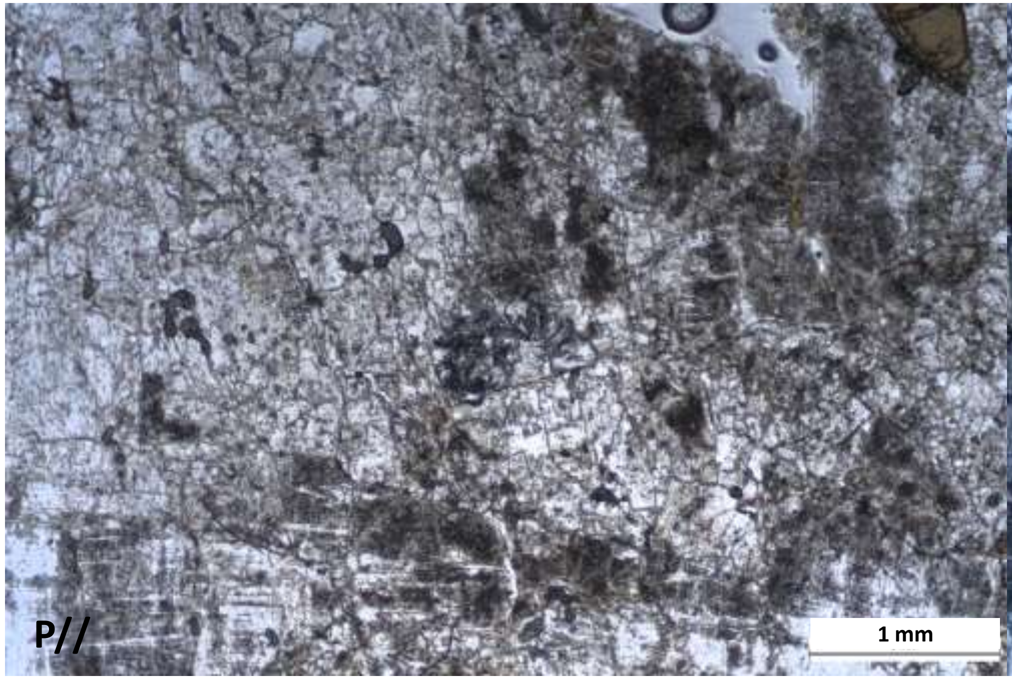




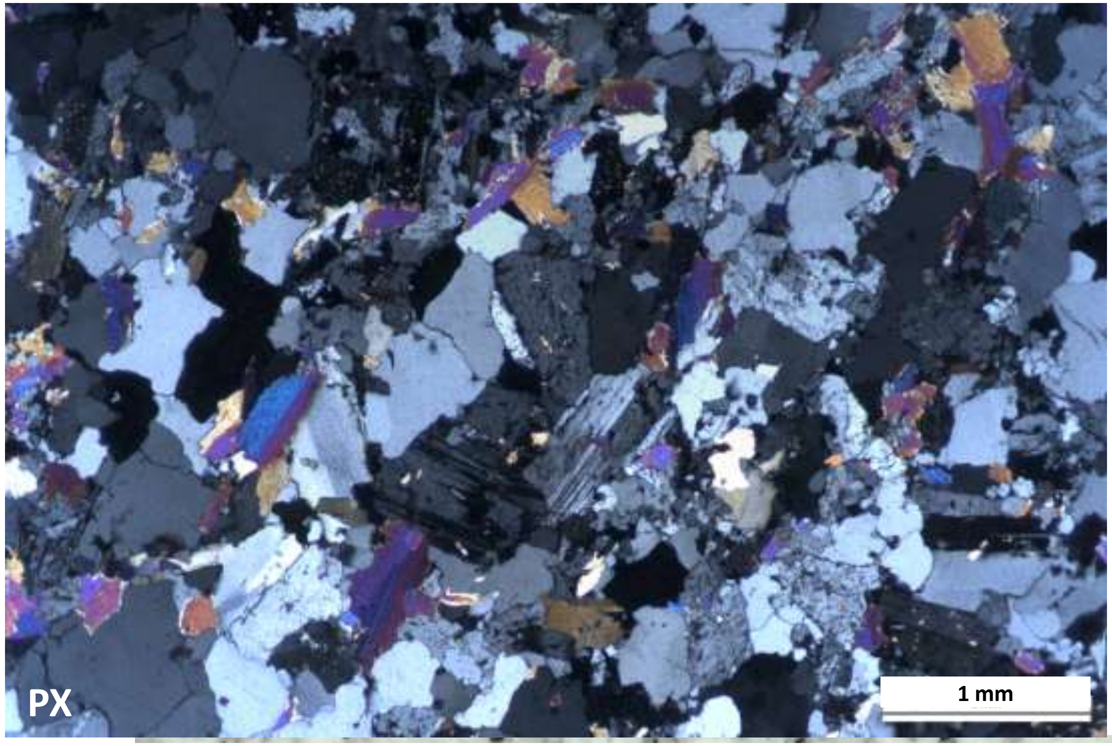


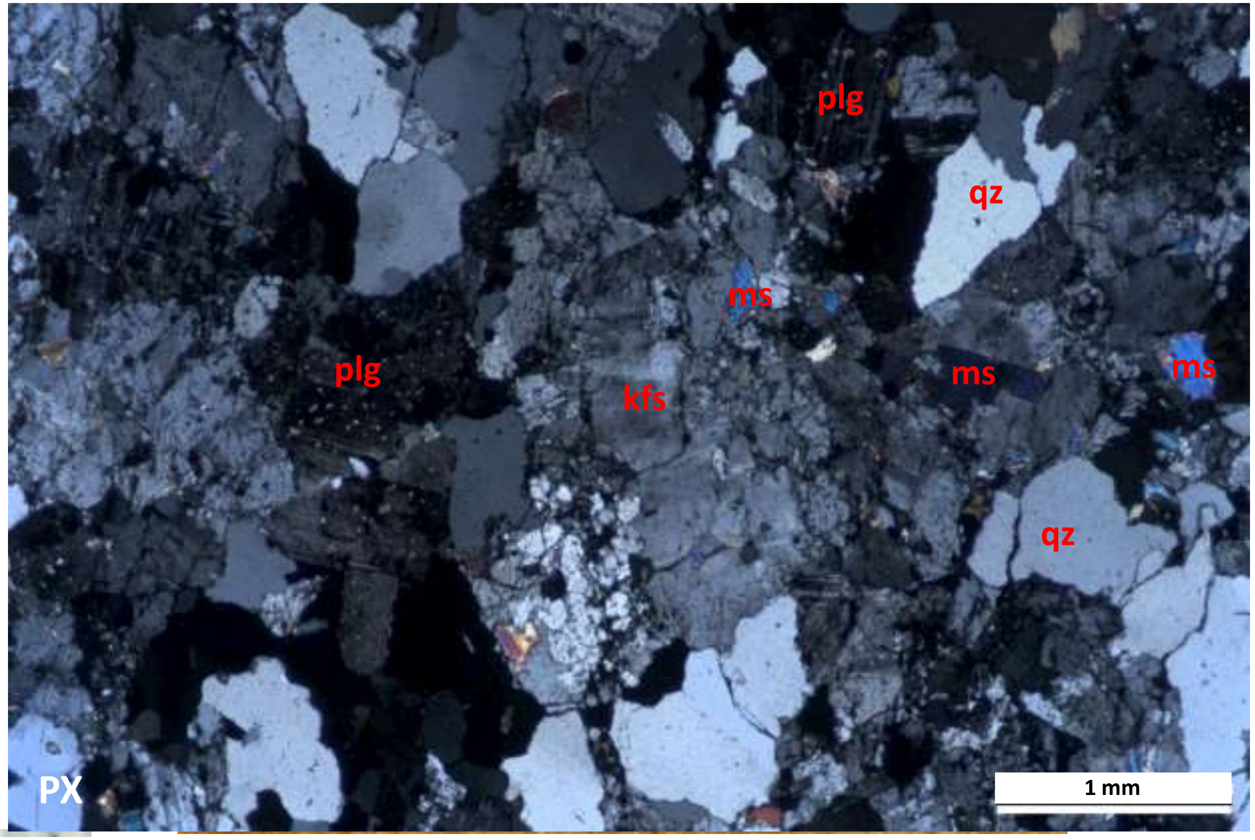
Dykes - Aplites

Type 2

plg + kfs + qz + tur + ms

- **Plag (mechanical twinning) > kfs; strongly altered and fractured**
- **Qz: wavy extinction, irregular boundaries; also present in late fractures**
- Large sized ms along with tur in contact with qz veins
- Tur: corroded; disseminated





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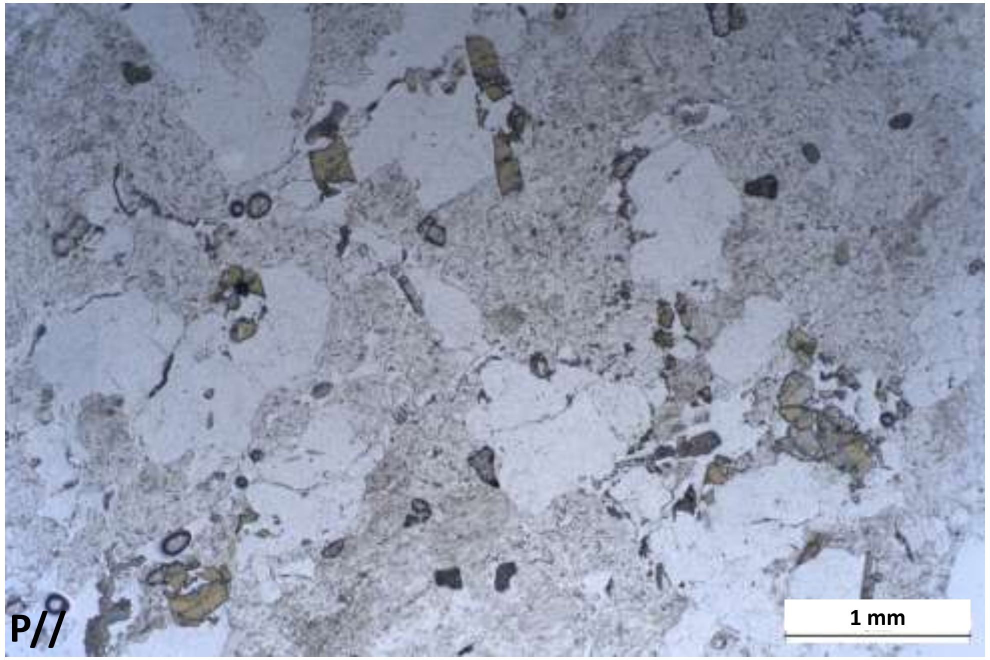
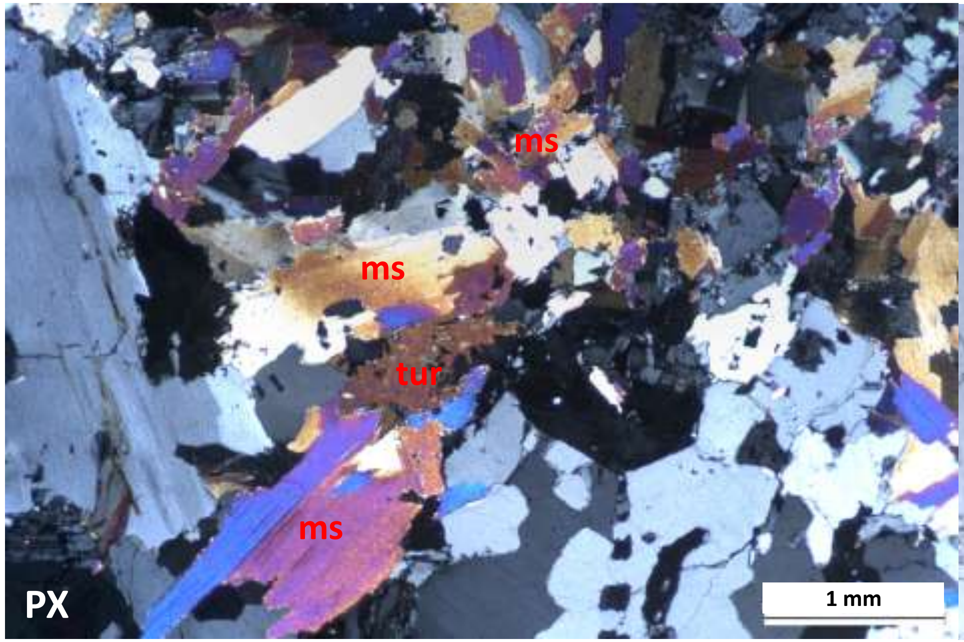
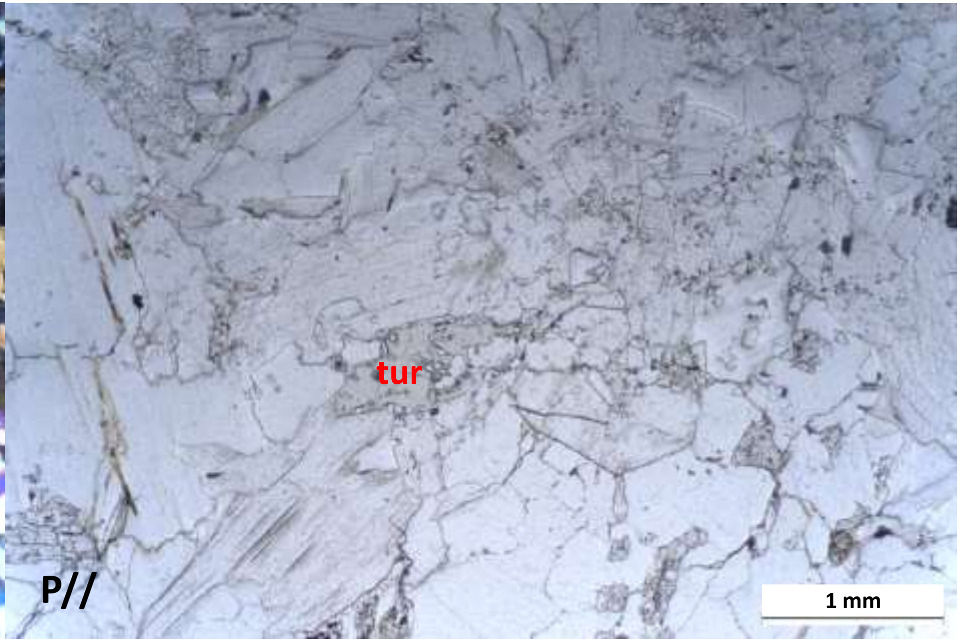


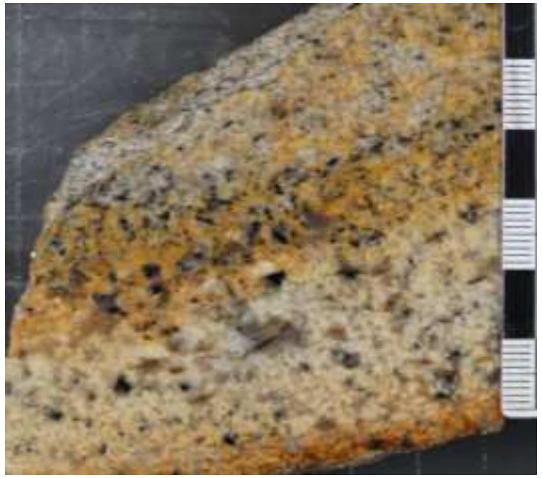


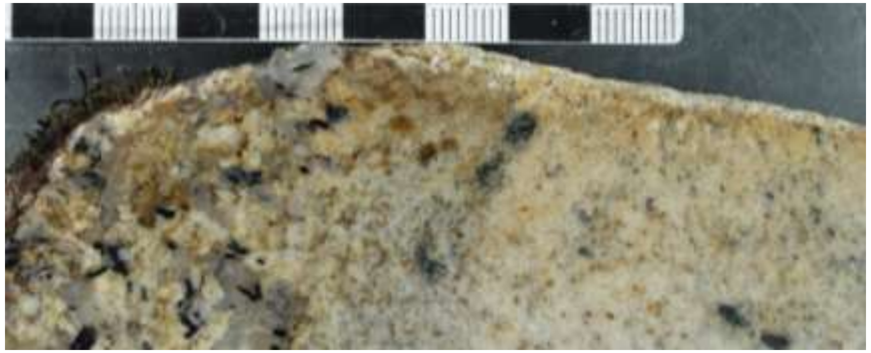


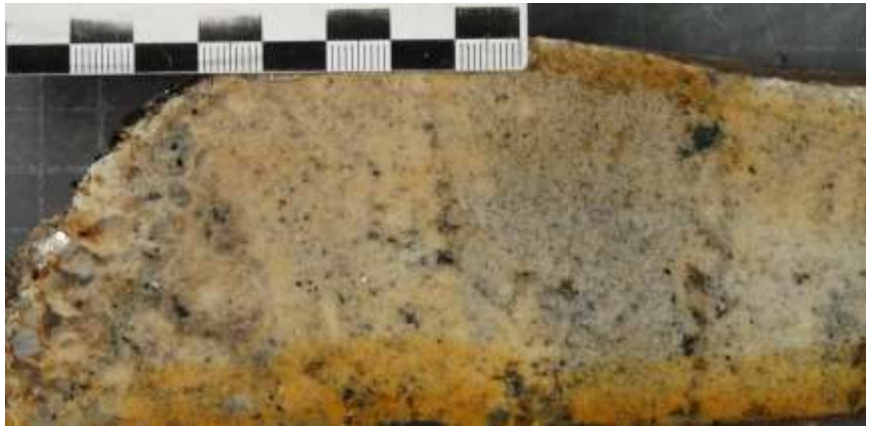
Dykes – Microgranites

plg + kfs + qz + ms + bt ± chl

- **Heterogeneous grain size; locally transitioning to a coarse-grained (pegmatitic) texture**
- Bt muscovitization
- Hydrolysed plg (occasionally mechanically twinned)
- Qz: wavy extinction; sutured boundaries
- Zoned plg and kfs with perthites in the pegmatitic zones
- Incipient ms fabrics in fine-grained domains
- Local enrichments in bt +qz + ms







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- **Incipient ms fabrics** in **fine-grained domains**
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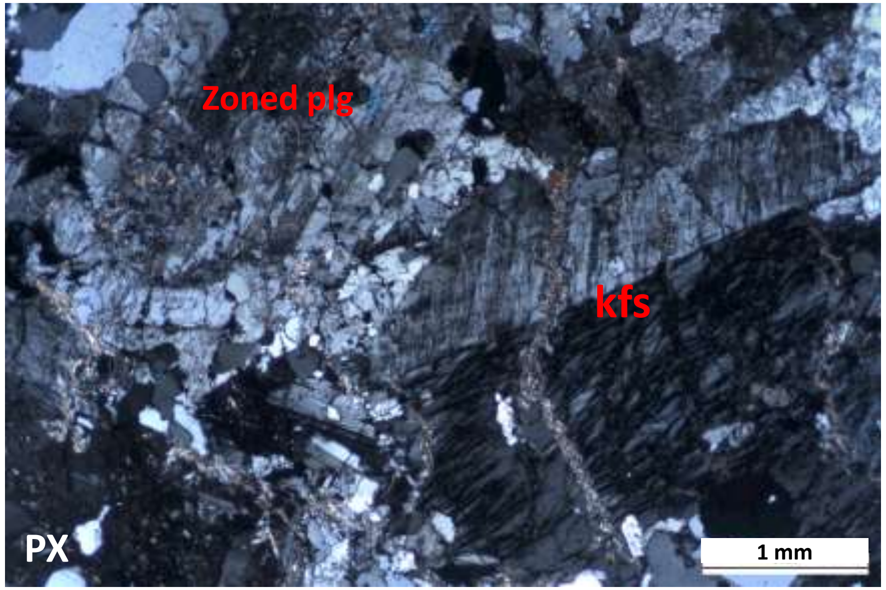

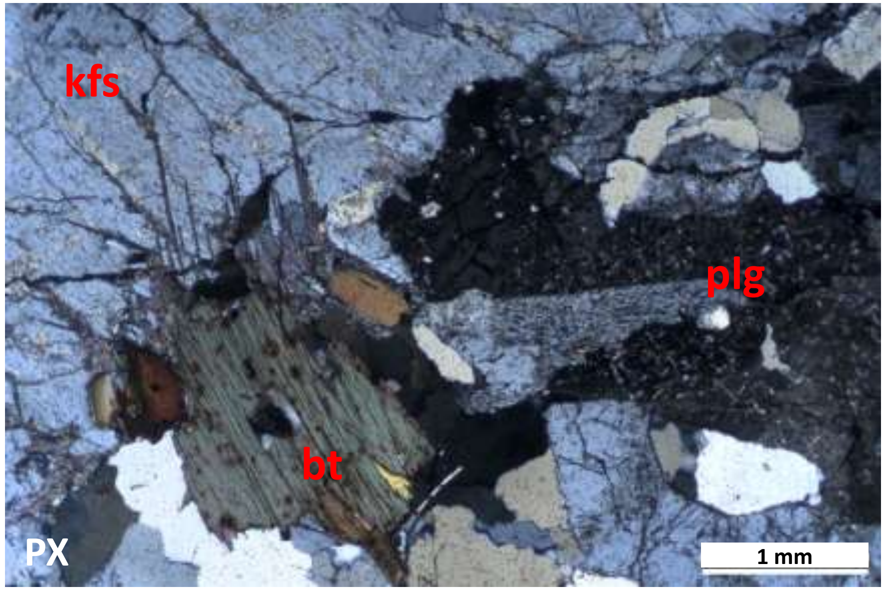

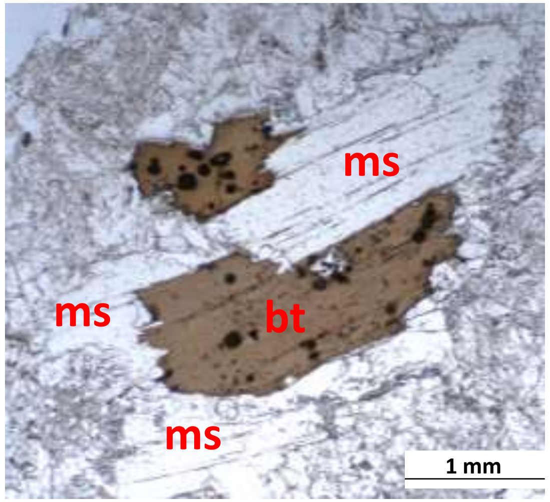

Dykes – Microgranites

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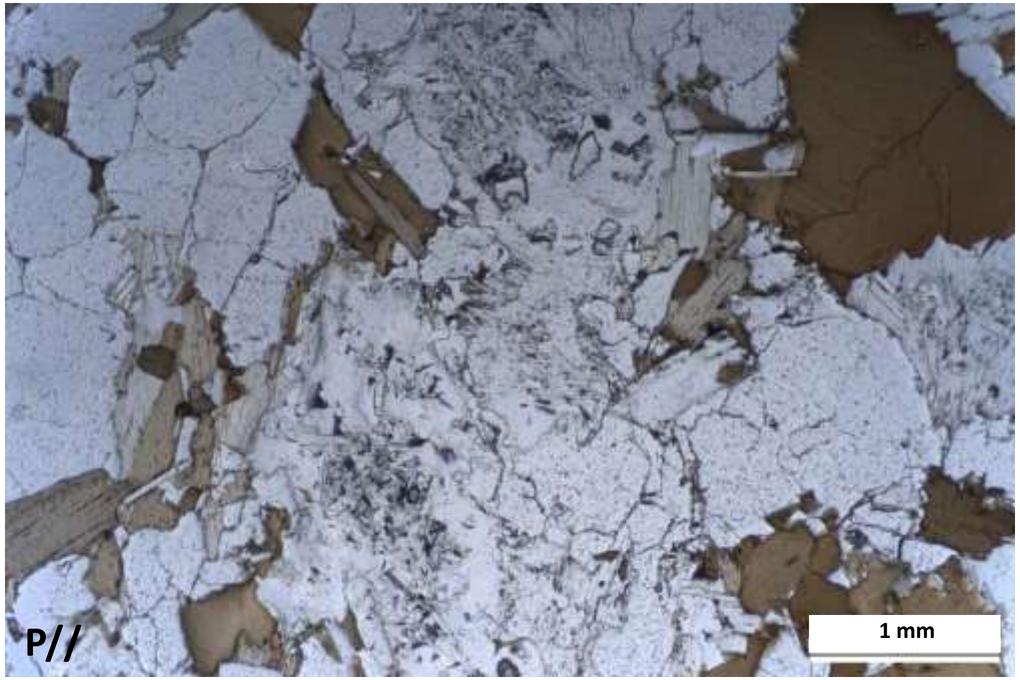
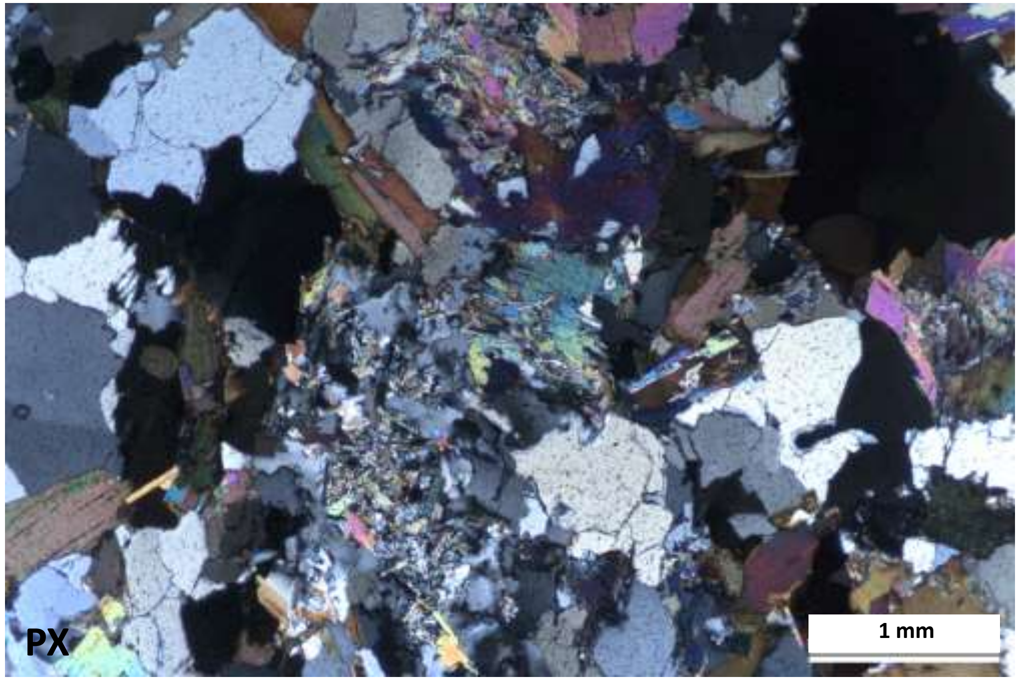
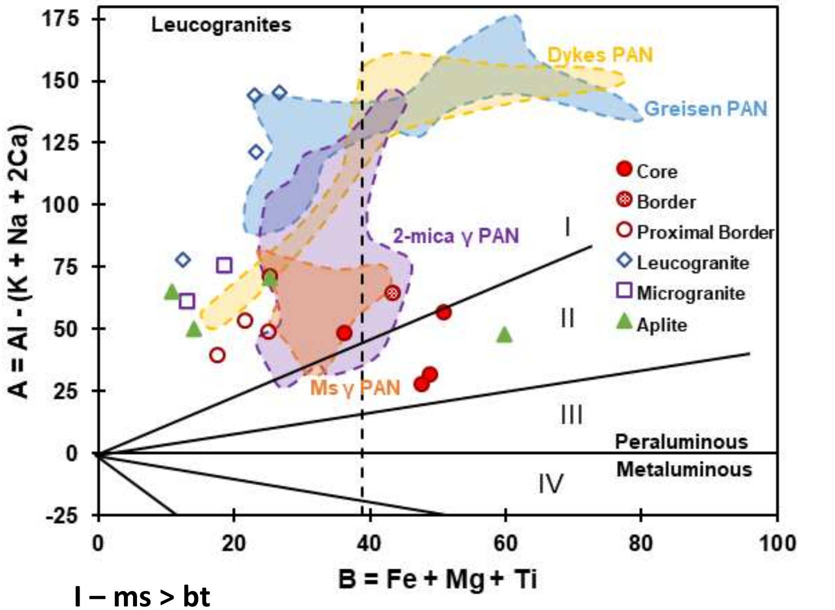
- **Local enrichments in bt + qz + ms**

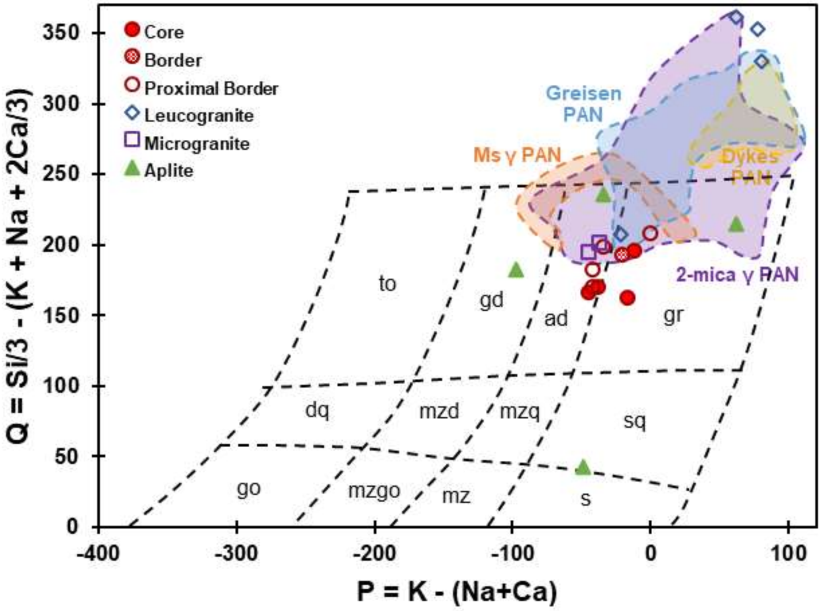


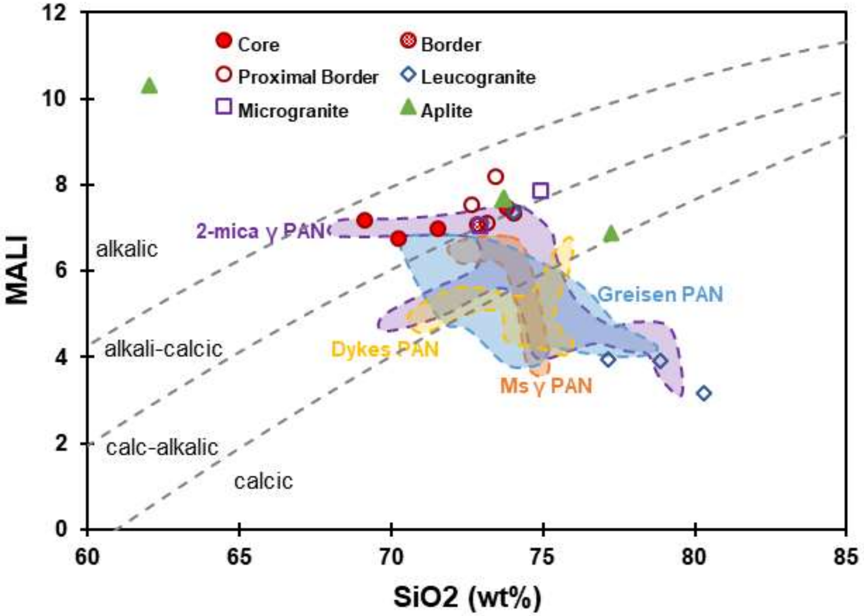


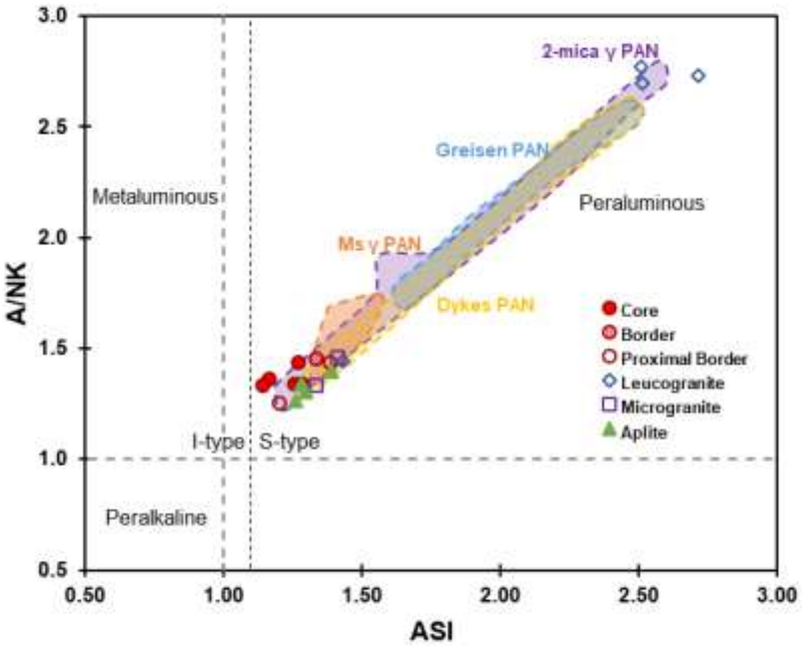
Geochemistry



I – ms > bt
II – bt > ms

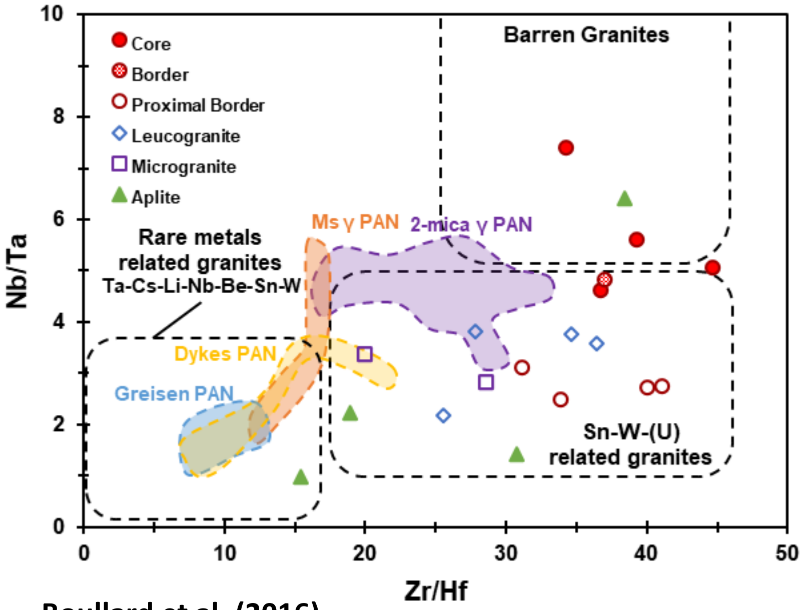




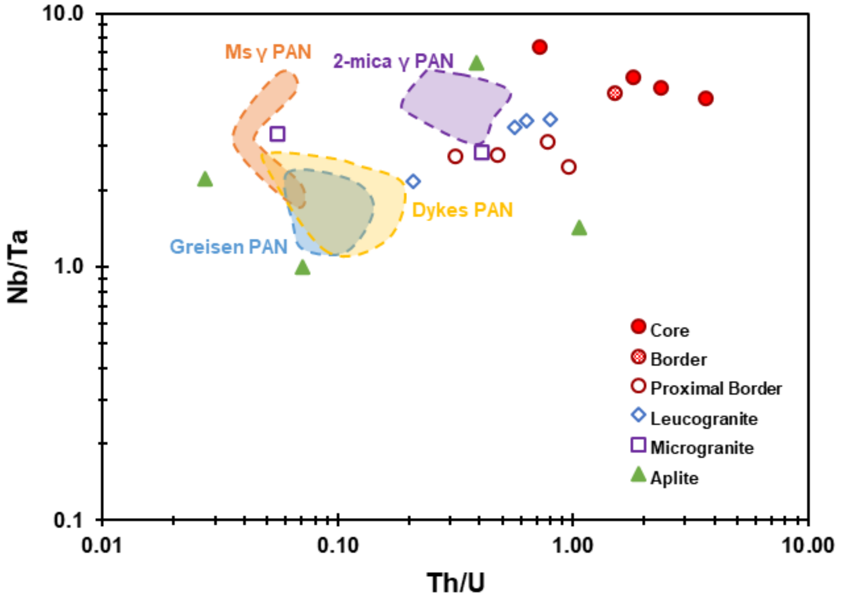


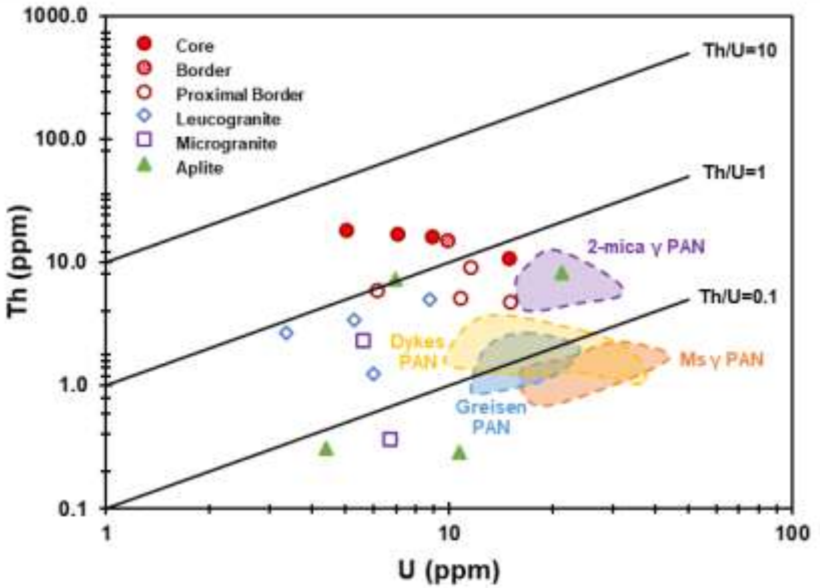
- Peraluminous S-type rocks
- Evolving trend well defined
- 2 groups of leucogranites (expected vs. anomalous behaviour)
- Compositions range from adamellite to granite
- Prevalent alkali-calcic series, tending towards calc-alkalic series
- Leucogranites as the most differentiated facies
- Comparing to Panasqueira granites, Mata da Rainha is less evolved

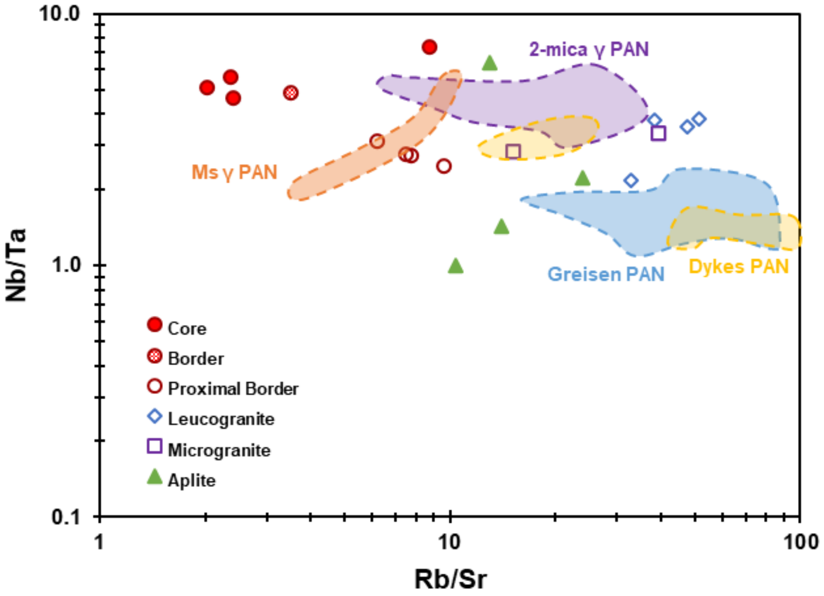
Panasqueira analysis from Marignac et al. (2020)

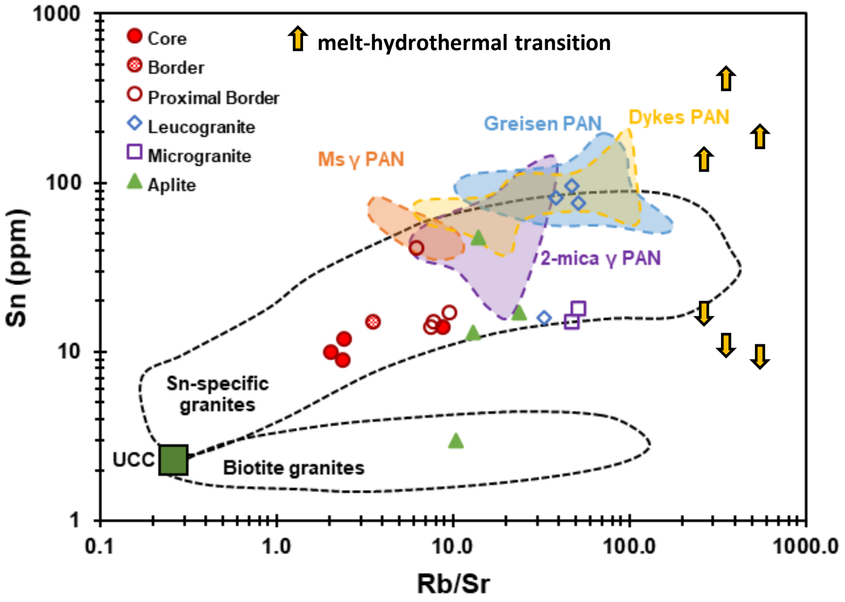


Boullard et al. (2016)





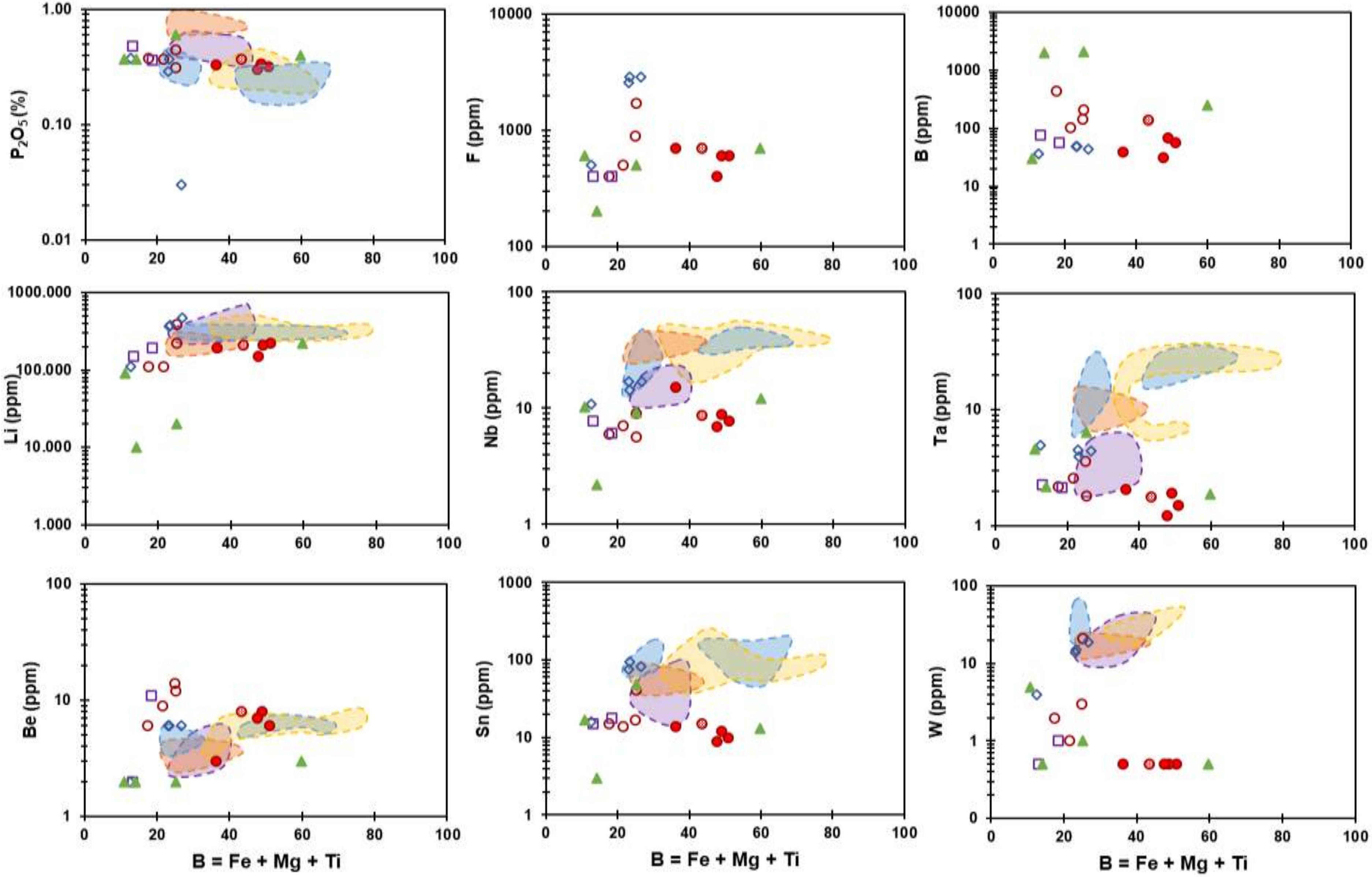




Romer & Pichavant (2020)

- Core facies in the barren granites field, whereas the more differentiated facies plot in the Sn-W- (U) related granites field
- Nb/Ta decreasing → strongly affected by hydrothermal processes (Nb/Ta<5)

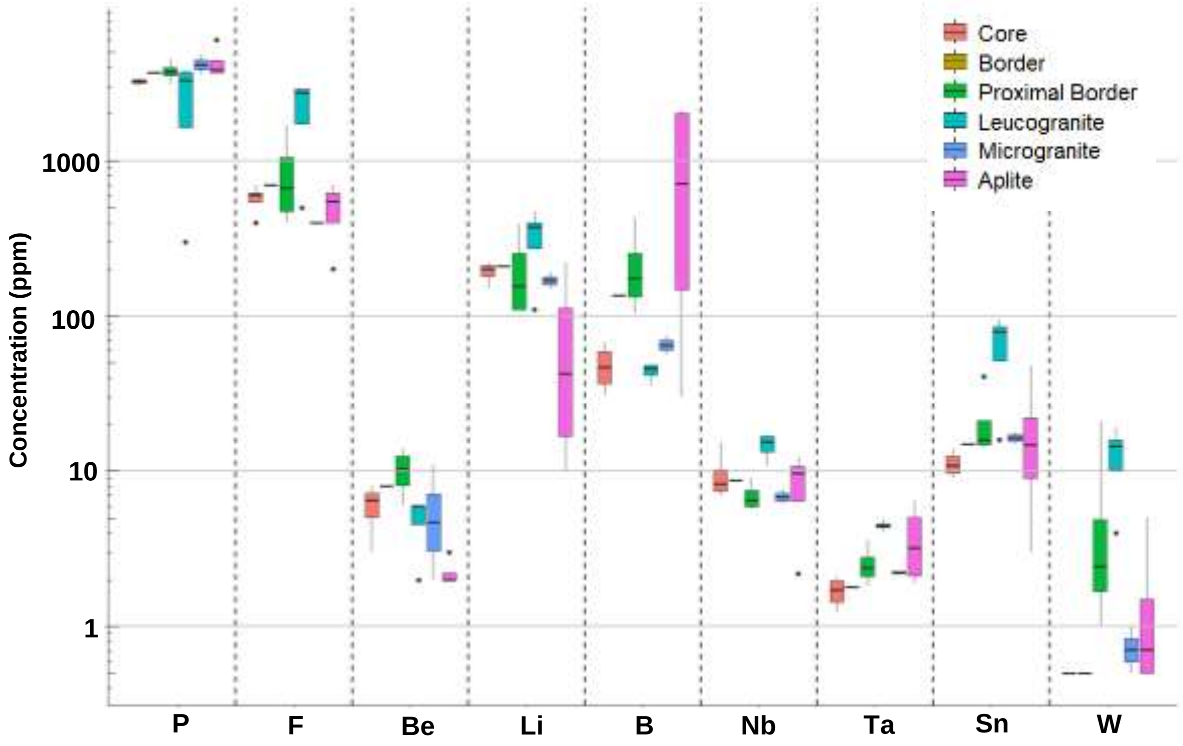
Panasqueira analysis from Marignac et al. (2020)



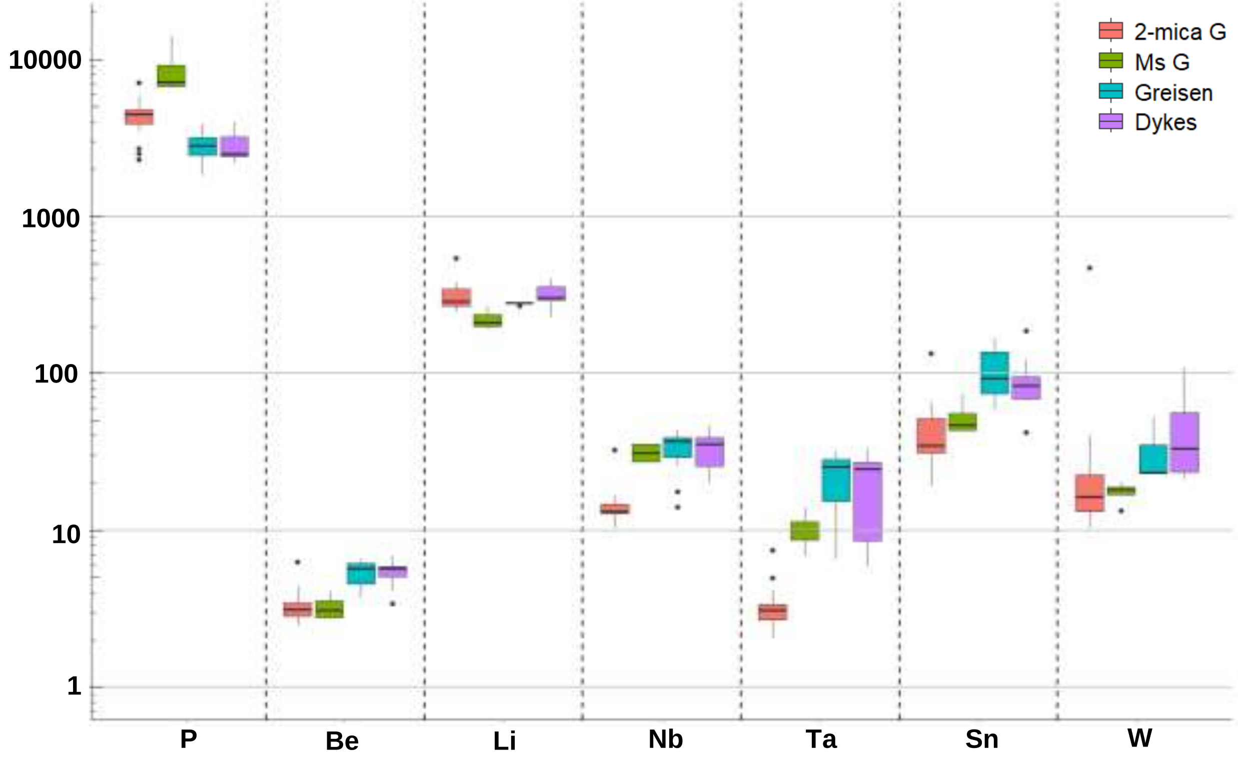
Panasqueira analysis from Marignac et al. (2020)

- Mata da Rainha has high values of F and B; higher F in leucogranites and proximal border facies; higher B in proximal border facies and aplites
- P and Li from Mata da Rainha are in the value range of Panasqueira
- In general, Nb, Ta, Sn and W values from Panasqueira are higher than in Mata da Rainha
- The P, Nb, Be, Sn and W contents in leucogranites from Mata da Rainha are similar to those displayed by the Panasqueira greisen

Mata da Rainha



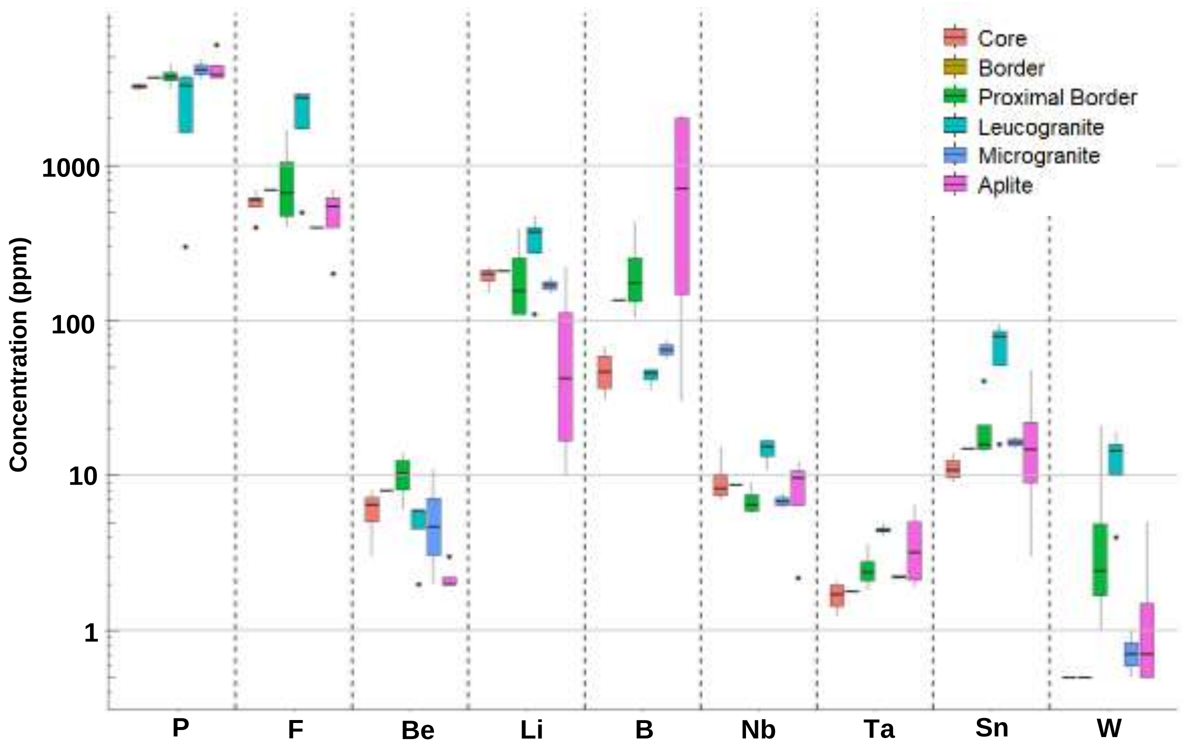
Panasqueira



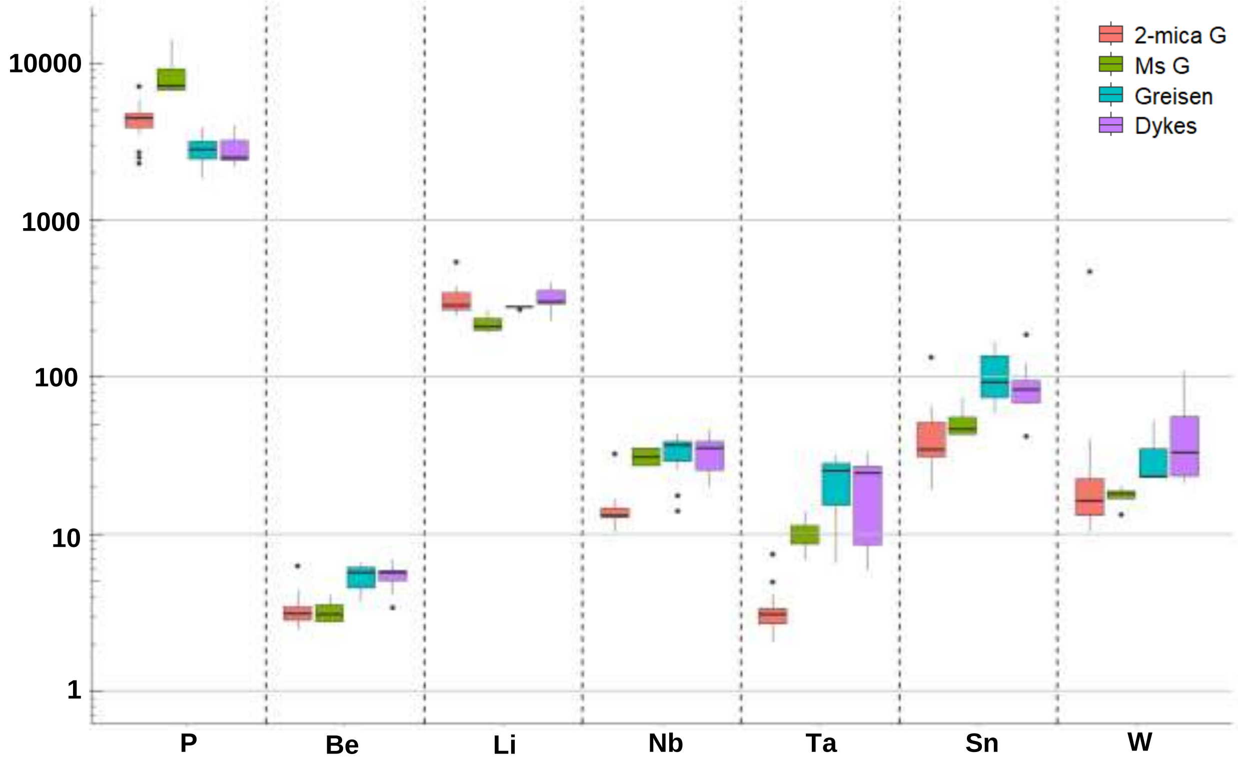
Mata da Rainha

- Higher values of P in the proximal border and leucogranite facies
- Leucogranite facies has the highest values of F, Li, Nb, Ta, Sn and W
- In general, aplites have a wide range of elemental concentration values
- Aplites show also higher values of B, followed by granites forming proximal border

Mata da Rainha



Panasqueira



Mata da Rainha vs. Panasqueira

- P values in Panasqueira granites are much higher than those in Mata da Rainha
- Be slightly lower in Panasqueira
- Li values in granite facies from Panasqueira and Mata da Rainha are in the same range
- Nb, Ta, Sn and W are higher in Panasqueira granites

Granite facies enveloping the Mata da Rainha ore-forming system; insights into their composition and relation to the mineralizing events

- There are clear mineralogical and textural evidence of HT-metasomatism and subsequent hydrothermal alteration
- Muscovitization and tourmalinization present in all the granite facies, more significantly in the pluton border
- Increasing deformation observed mostly in the pluton's outer, including dykes
- The most evolved facies (leucogranite, "greisen-like" facies) has the highest values of F, Li, Nb, Ta, Sn and W, although below those typifying the Panasqueira granites (Nb, Ta, Sn and W)
- The highest B values correspond to aplites, followed by the proximal border facies
- Aplites do not carry significant amounts of disseminated cassiterite

https://mostmeg.rd.ciencias.ulisboa.pt/

Thank you for your attention!

Modified metasediment adjoining the "greisen-like" facies (Mata da Rainha)