ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

MIGMATITE
A complex mixture of rocks

(or "Why ancient greek is important")

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summary

- Migmatite and the lower crust
- What are migmatites are
- Examples from the Ivrea basement in the Biella area (with Marco Palmieri)
- Epilogue

there was melt in the lower crust

The Palaeozoic (French Variscides)

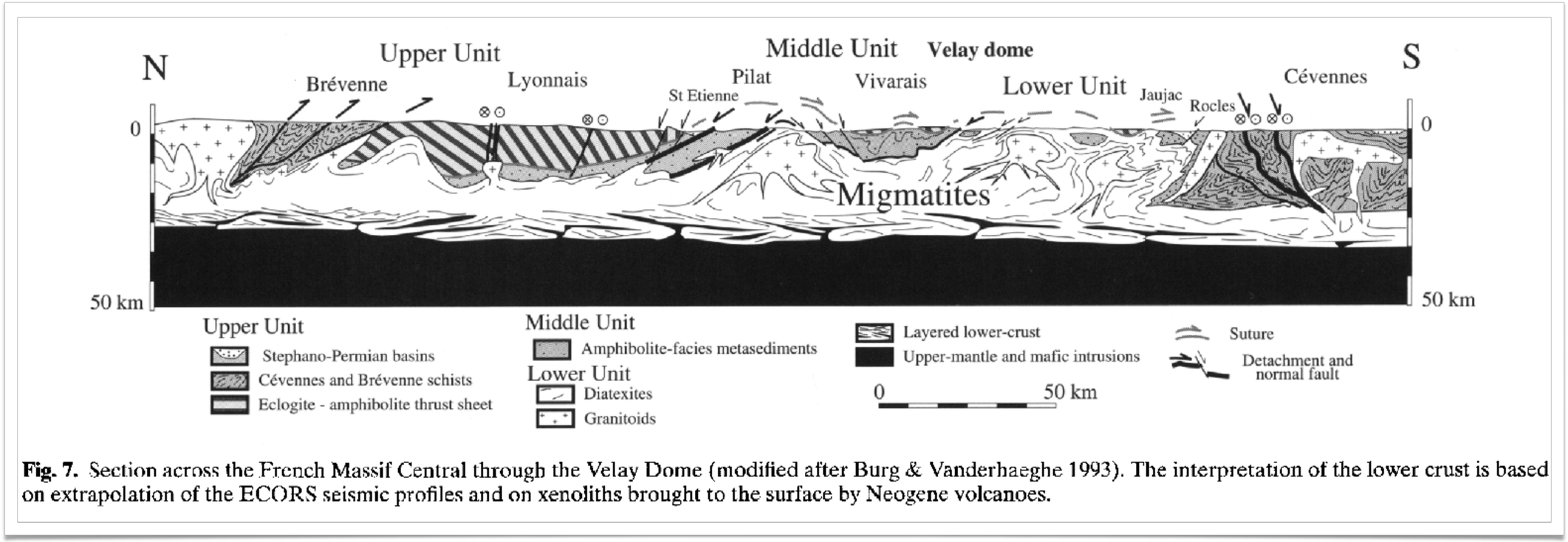

Fig. 7. Section across the French Massif Central through the Velay Dome (modified after Burg & Vanderhaeghe 1993). The interpretation of the lower crust is based on extrapolation of the ECORS seismic profiles and on xenoliths brought to the surface by Neogene volcanoes.

Vanderhaeghe et al. 1999

there was melt in the lower crust

The Mesozoic Canadian Cordillera

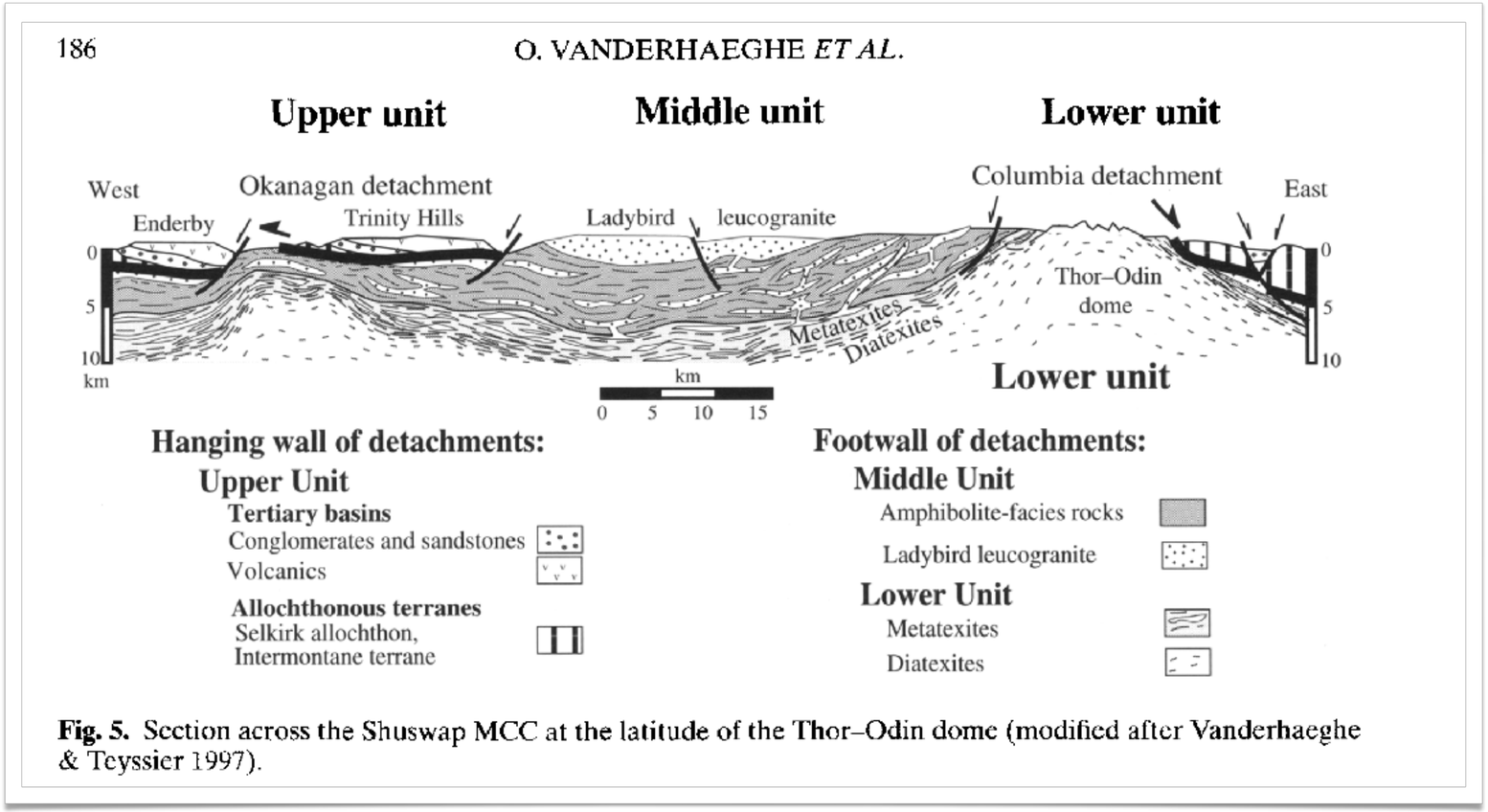

Fig. 5. Section across the Shuswap MCC at the latitude of the Thor–Odin dome (modified after Vanderhaeghe & Teyssier 1997).

Vanderhaeghe et al. 1999

there *is* melt in the lower crust

CONSEQUENCES

1) Reduction of crust strength
2) Lateral flow of crust
3) Imposing limits on mountains elevation
    - Implication on climate!

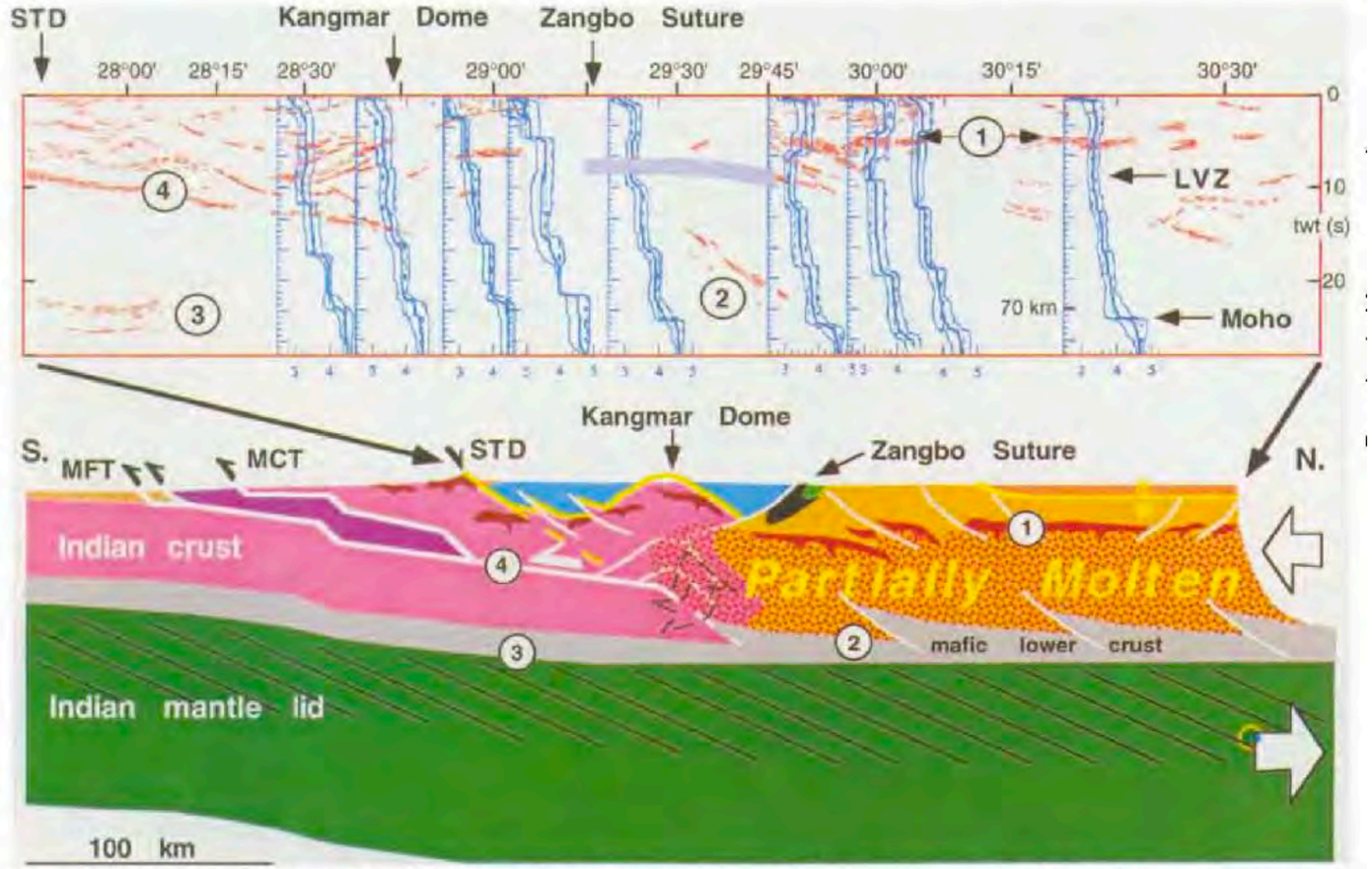

Fig. 2. (**Top**) Composite of selected INDEPTH geophysical observations along the Yadong-Gulu rift in southern Tibet; red, composite north-south CMP profile described in (*6*); blue, one-dimensional shear-wave velocity profiles derived from broadband earthquake data (*7*); blue stipple, wide-angle reflection observed in CMP data gap beneath and just north of the Zangbo suture; LVZ, midcrustal low-velocity zone evident in shear-wave velocity profiles north of the Zangbo suture. (**Bottom**) Interpretive lithosphere-scale cross-section of the Himalayan collision zone (see text). MFT, Main Frontal thrust; MCT, Main Central thrust; STD, South Tibetan detachment system. Numbers refer to features discussed in text.

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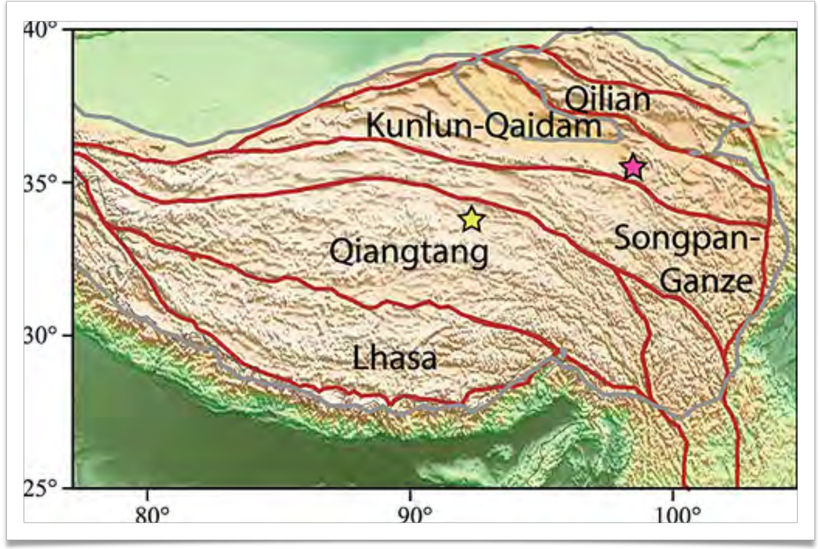
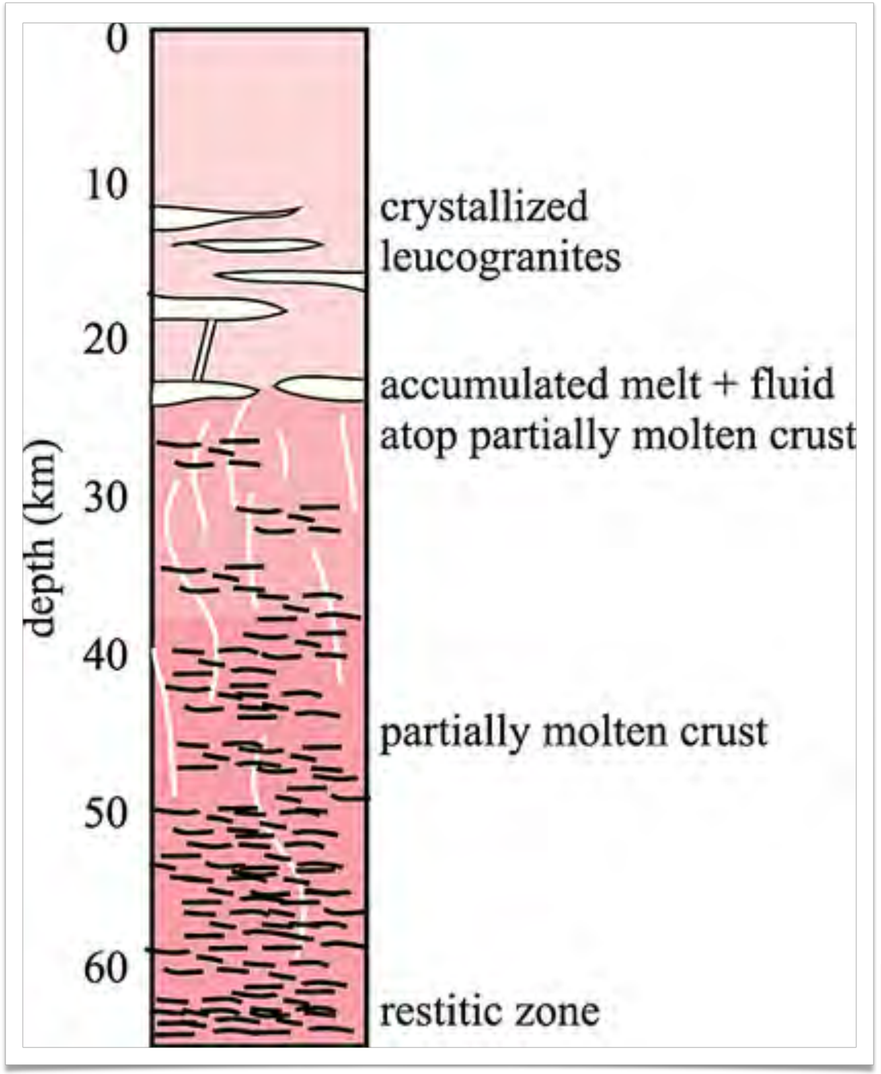
Nelson et al. SCIENCE 1996

migmatite-granite connection

Partially melted, mica-bearing crust in Central Tibet





Hacker et al. (2014)
Scaillet&Searle (2006)

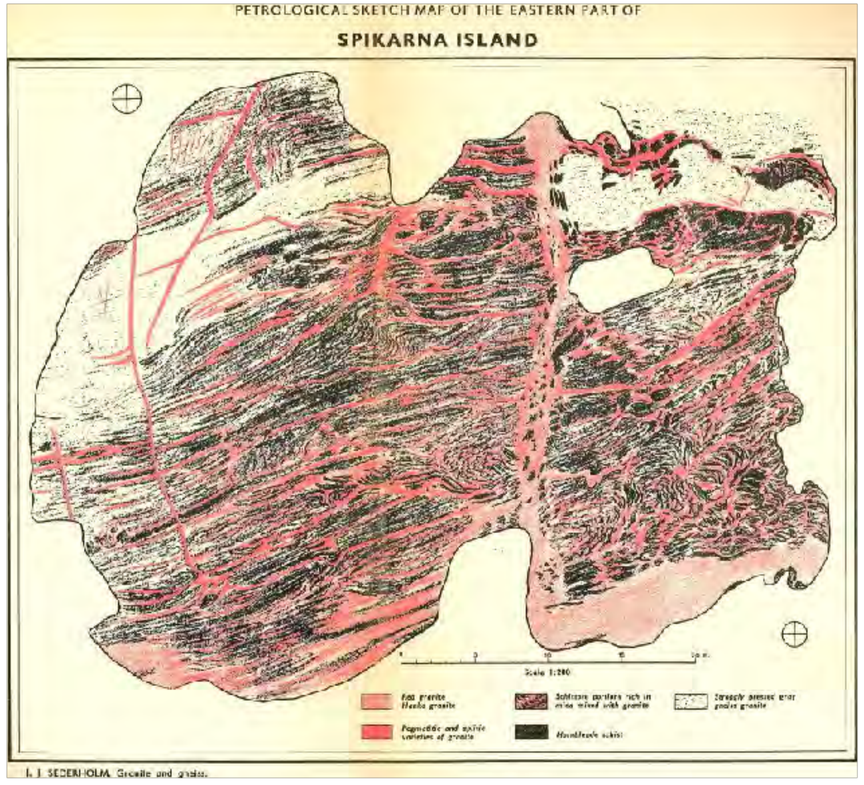
The mid crust intruded by granites

The lower crust is a mixture of
i) partially melted rocks
ii) Melt-depleted rocks (restite)
iii) Unmelted rocks

The specific state depends on *P-T-X*-fluid content

milestones in migmatites

1907 (Sederholm)



*"The bedrock consists of a diffuse **mixture** of different granitic and gneissose rocks*
(...)
Spikarna are localities where the mixed rocks can be studied particularly well.
(...)
Within these zones the rock is intersected by a dense network of veins consisting of a granite, partly pegmatic and aplitic and partly medium-grained, pink in colour
(...)

Mixture

MIGMA

MIGMATITE

milestones in migmatites

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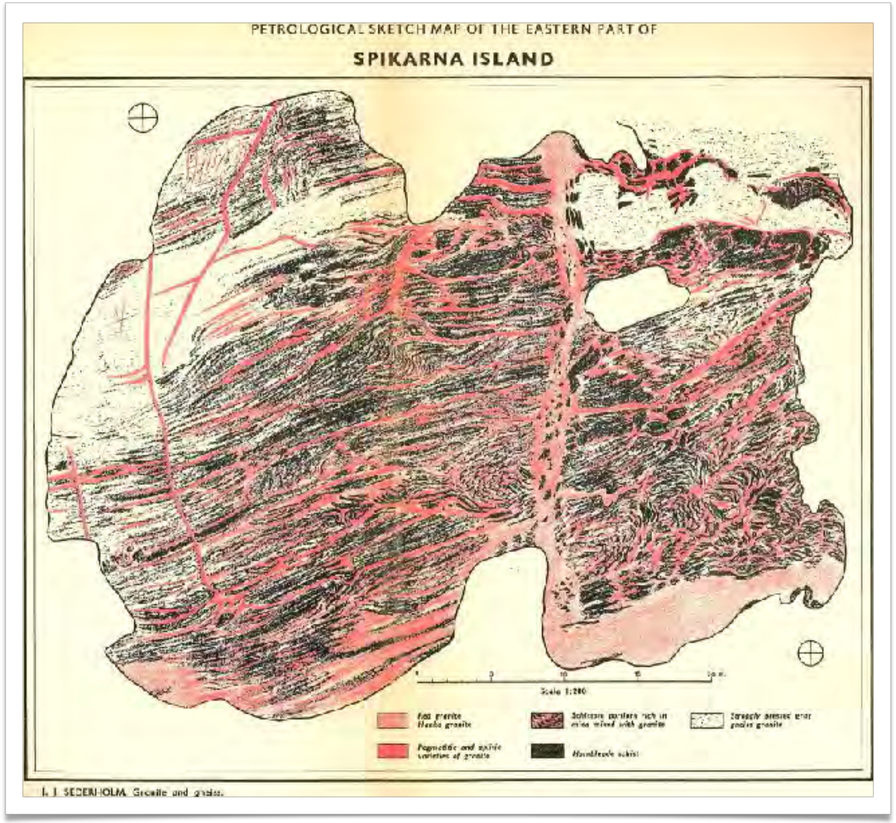
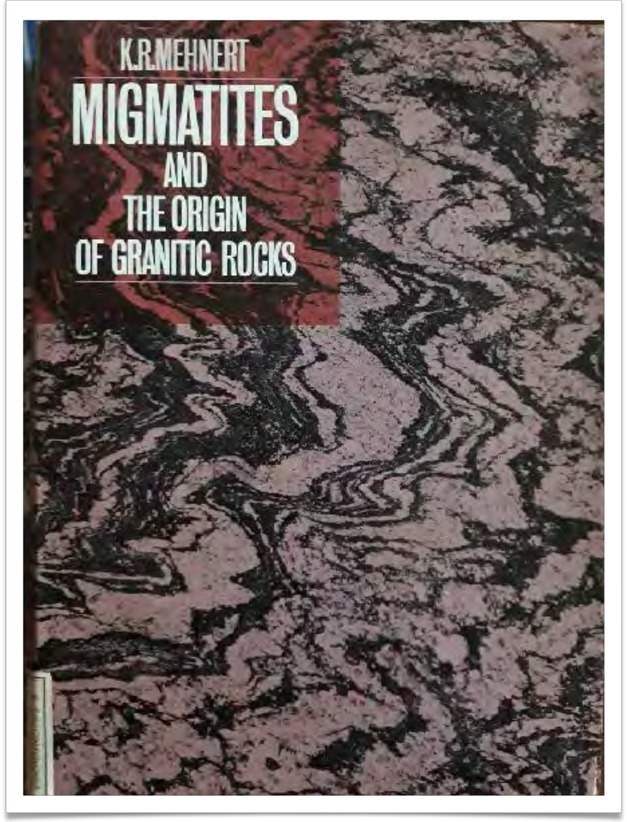


1968 (Mehnert)



milestones in migmatites

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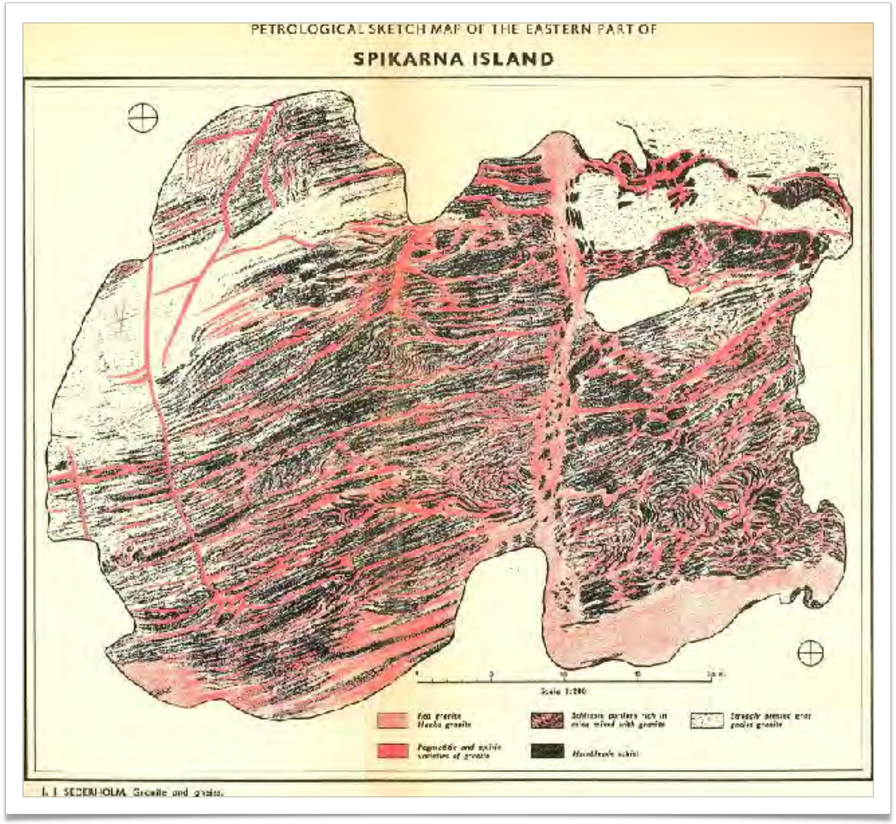
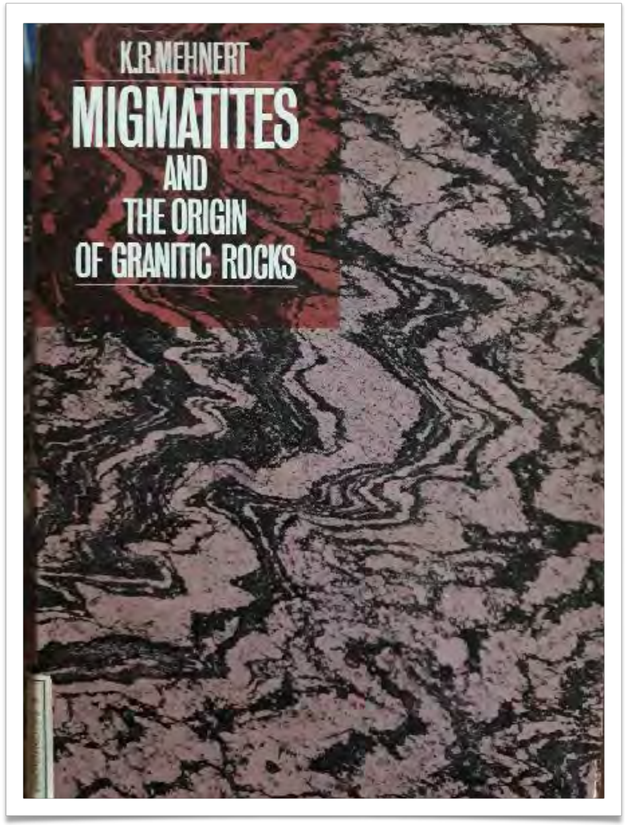
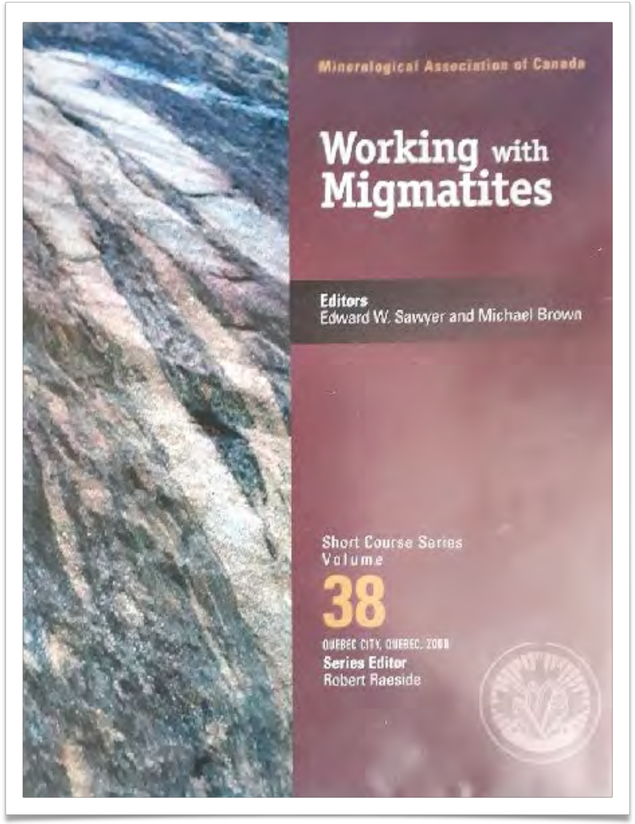


1968 (Mehnert)



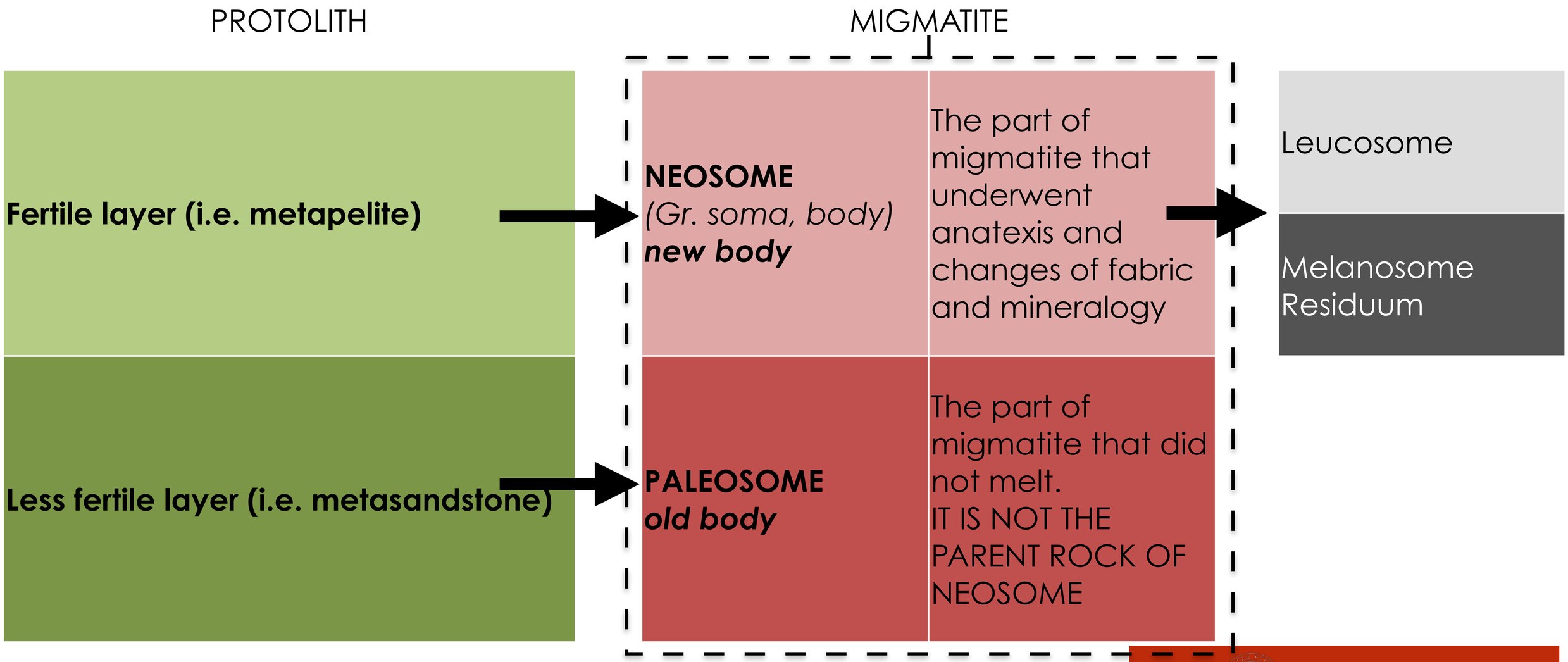
2008 (Sawyer, Brown)



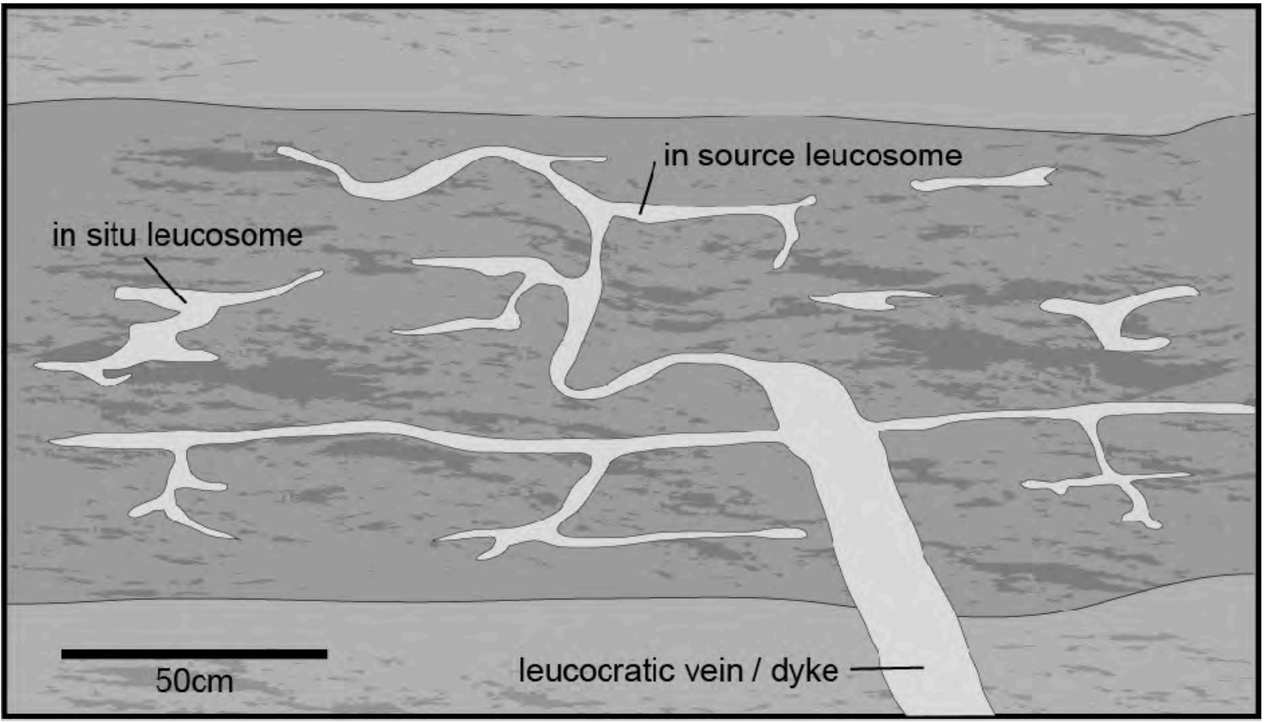
migmatites are

- Rocks from medium to high grade metamorphic areas
- At least some part of the migmatite is formed by partial melting (T > 650°C)
- Fabric is heterogeneous at all scale
  - Mehnert's book, **13** *descriptive* terms
  - Sawyer, Brown, c. **20** *genetically-based* terms

the fundamental parts of a migmatite

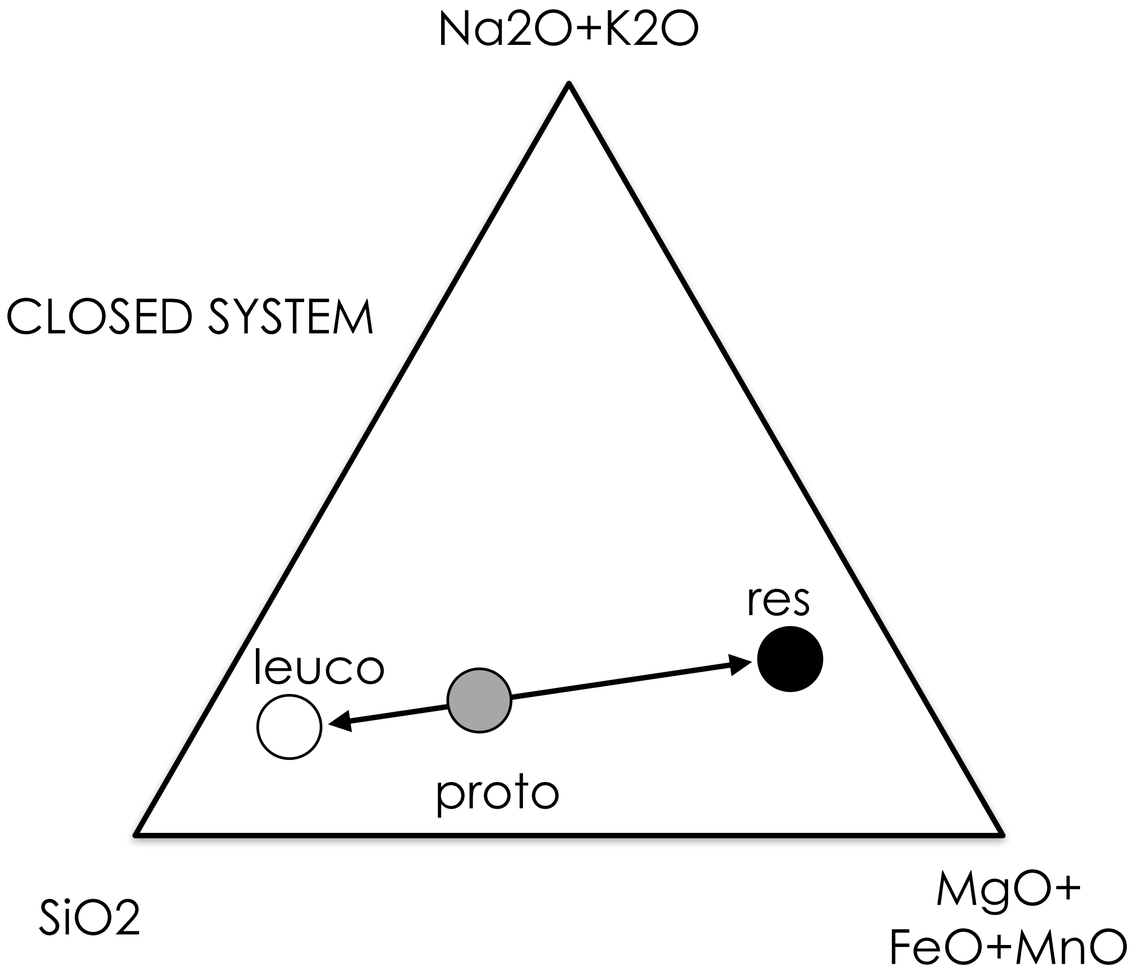


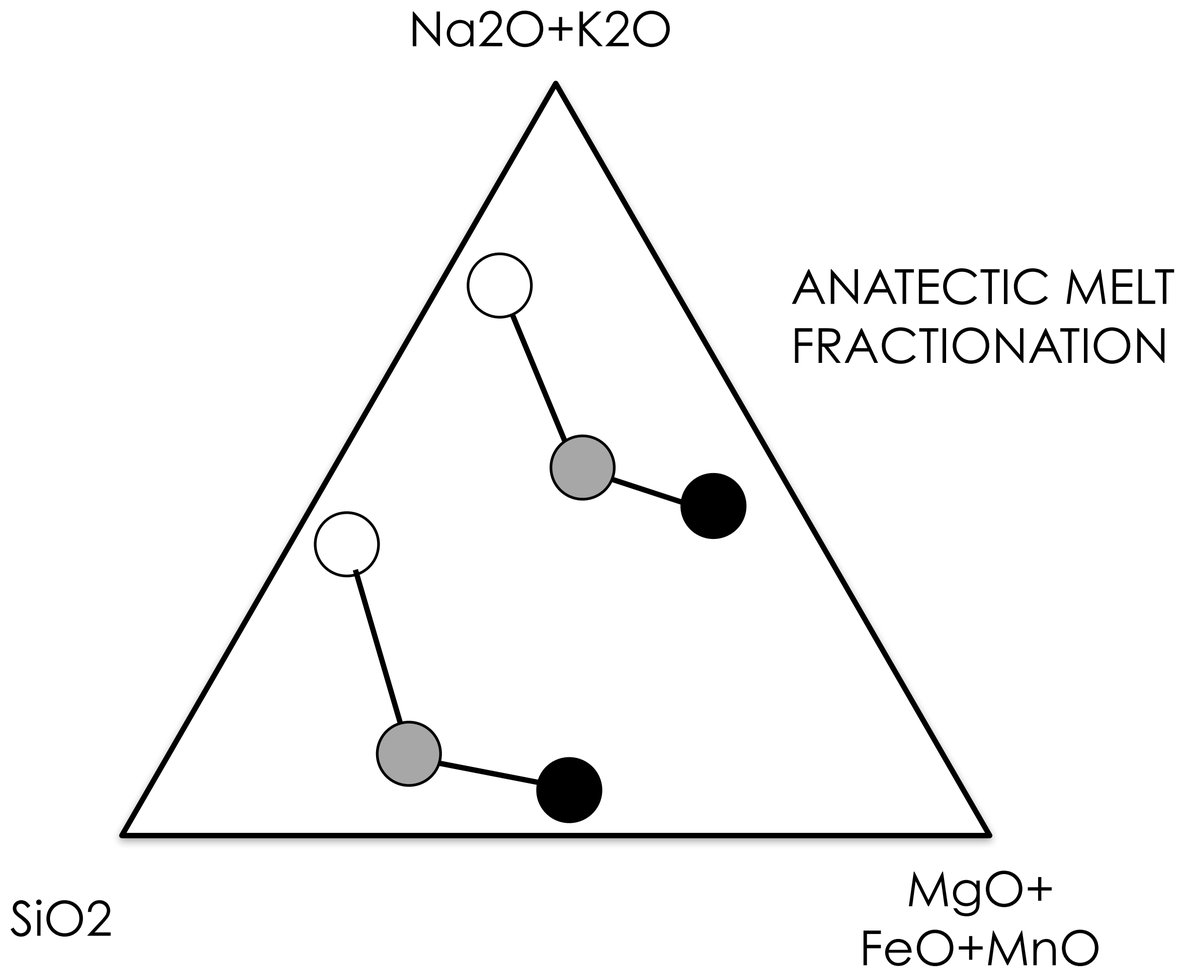
leucosome



Redrawn after Sawyer, 2008

leucosome may, or may not, represent anatectic melt composition

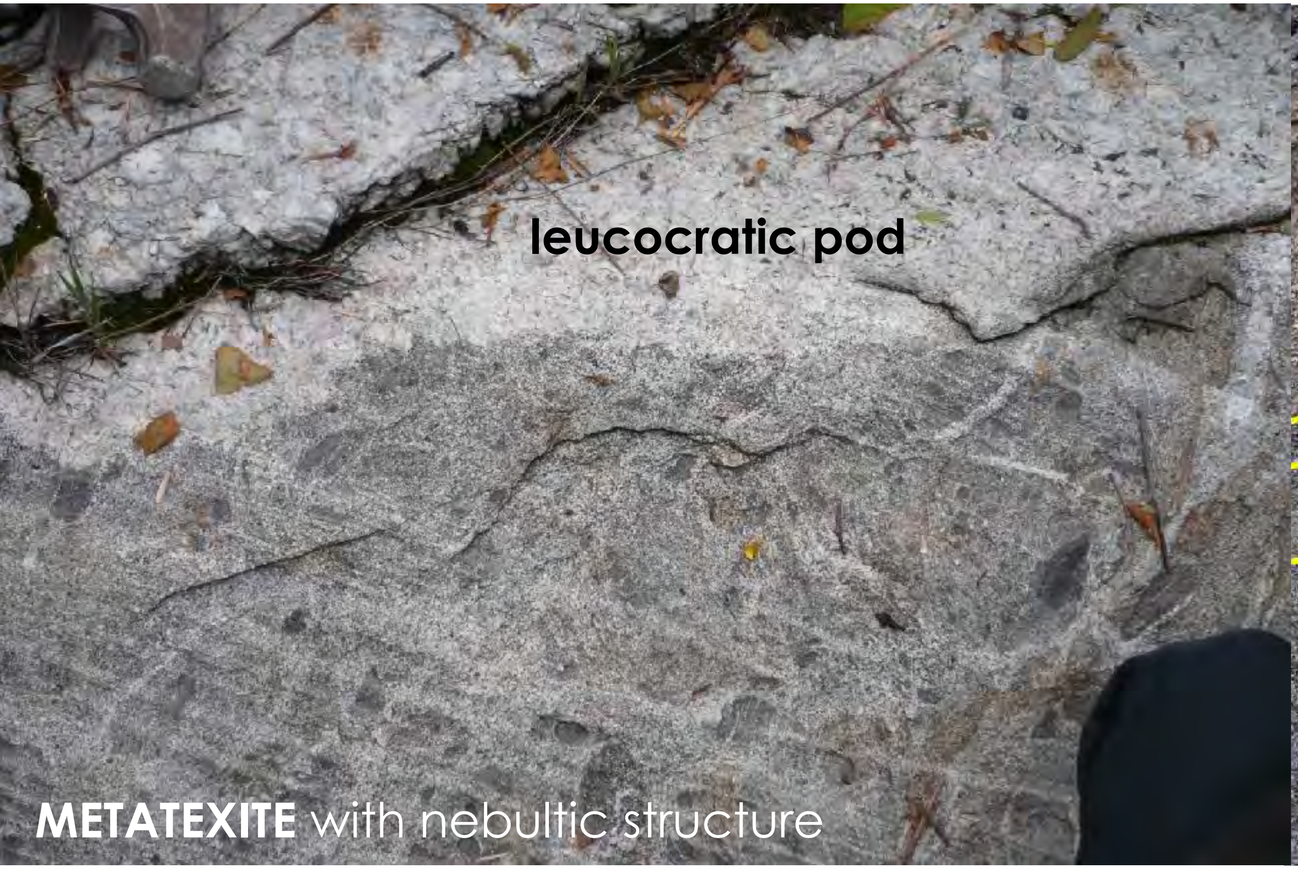


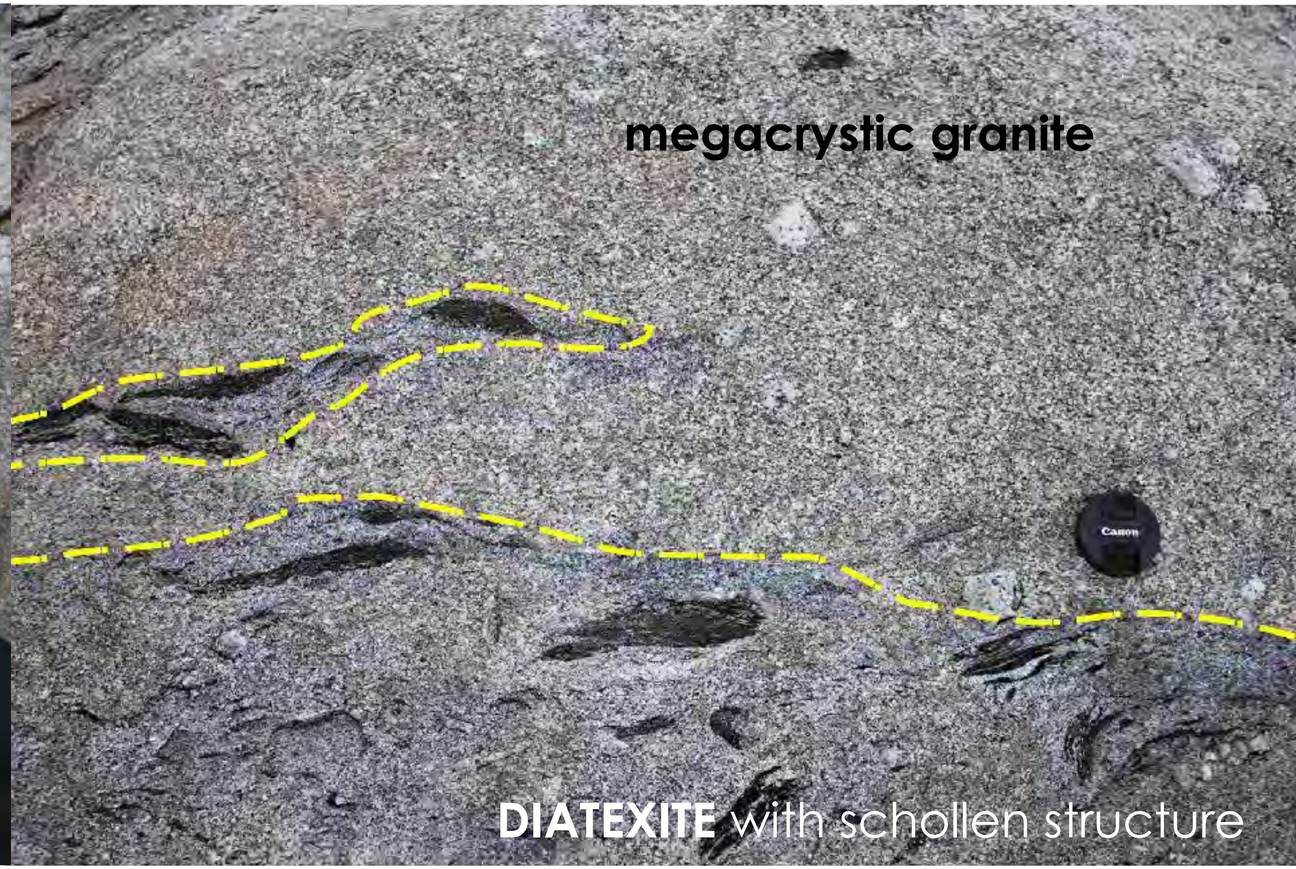


Modified from Kriegsman 2001

two end-member morphologies

Modified from http://users.monash.edu.au/~weinberg/Pages/KI2014/50pct/IMG_5630.JPG

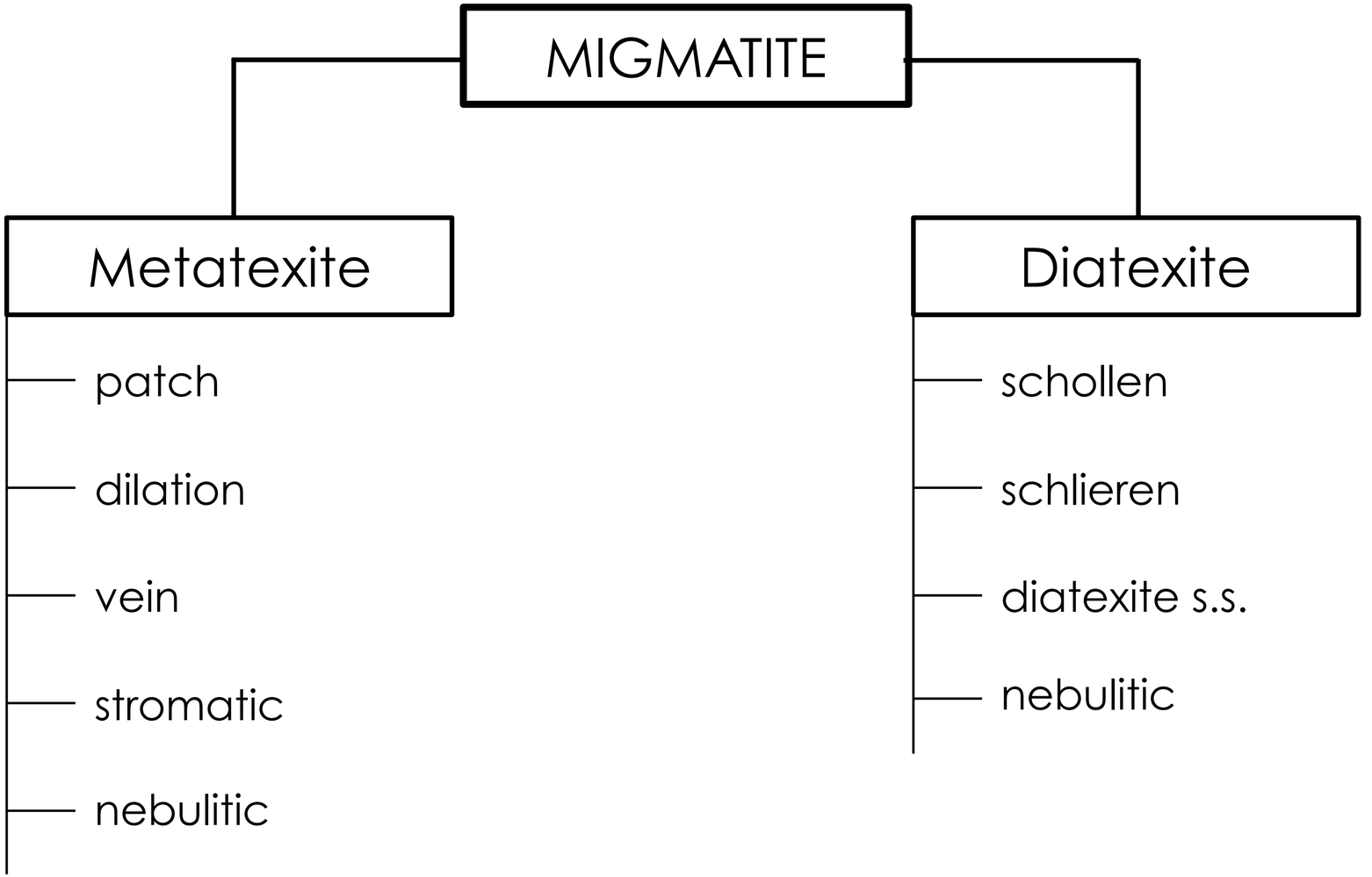




Metatexite *= migmatite containing evident pre-migmatization layering, foliation or banding, which survived partial melting (Brown, 1973).*

Diatexite *= migmatite in which the pre-migmatization structures are destroyed (Brown, 1973)*

main structures



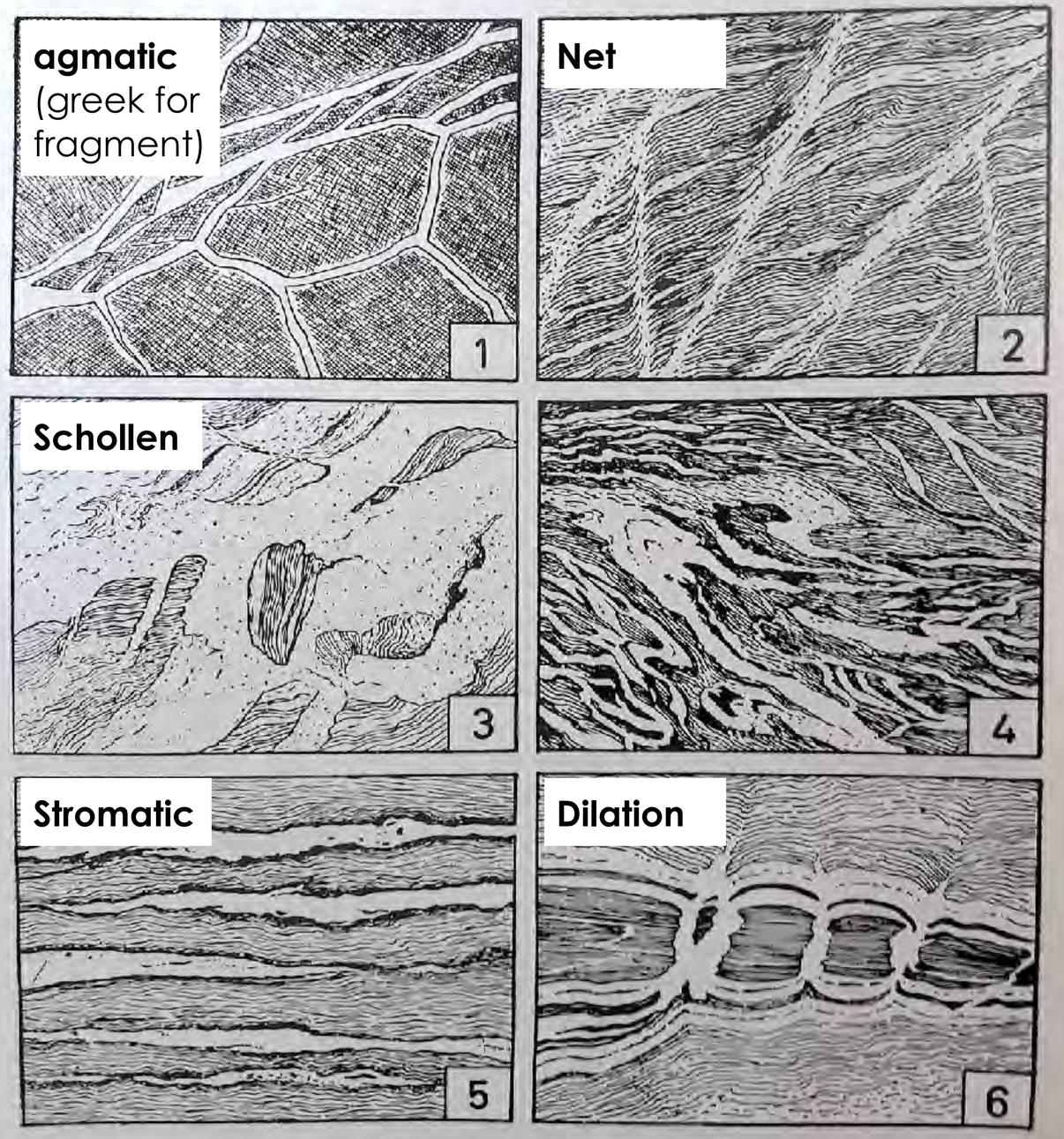


Fig. 1a. Summary of typical migmatite structures.
1. Agmatic (breccia) structure.
2. Diktyonitic structure.

Mehnert, 1968

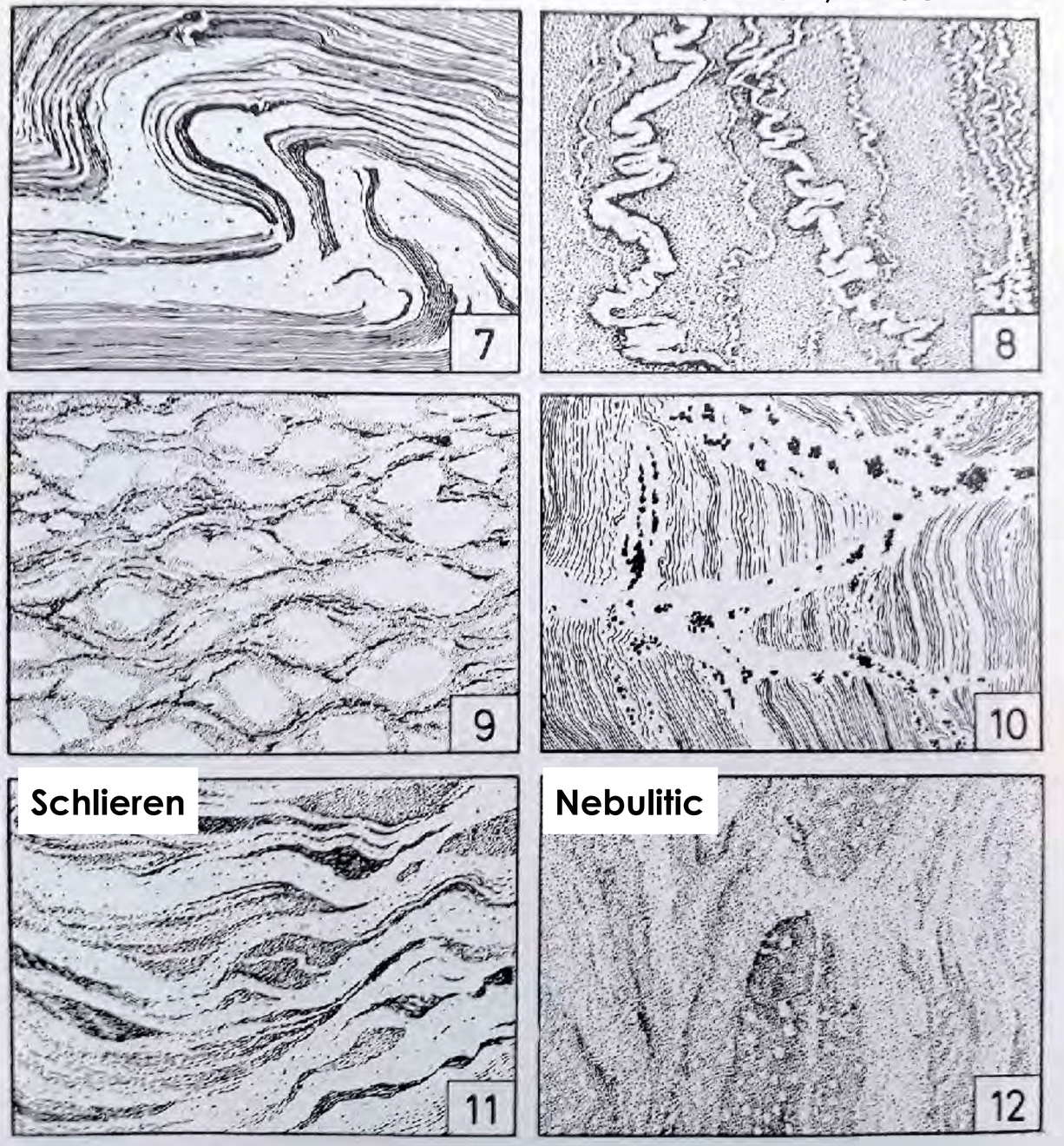
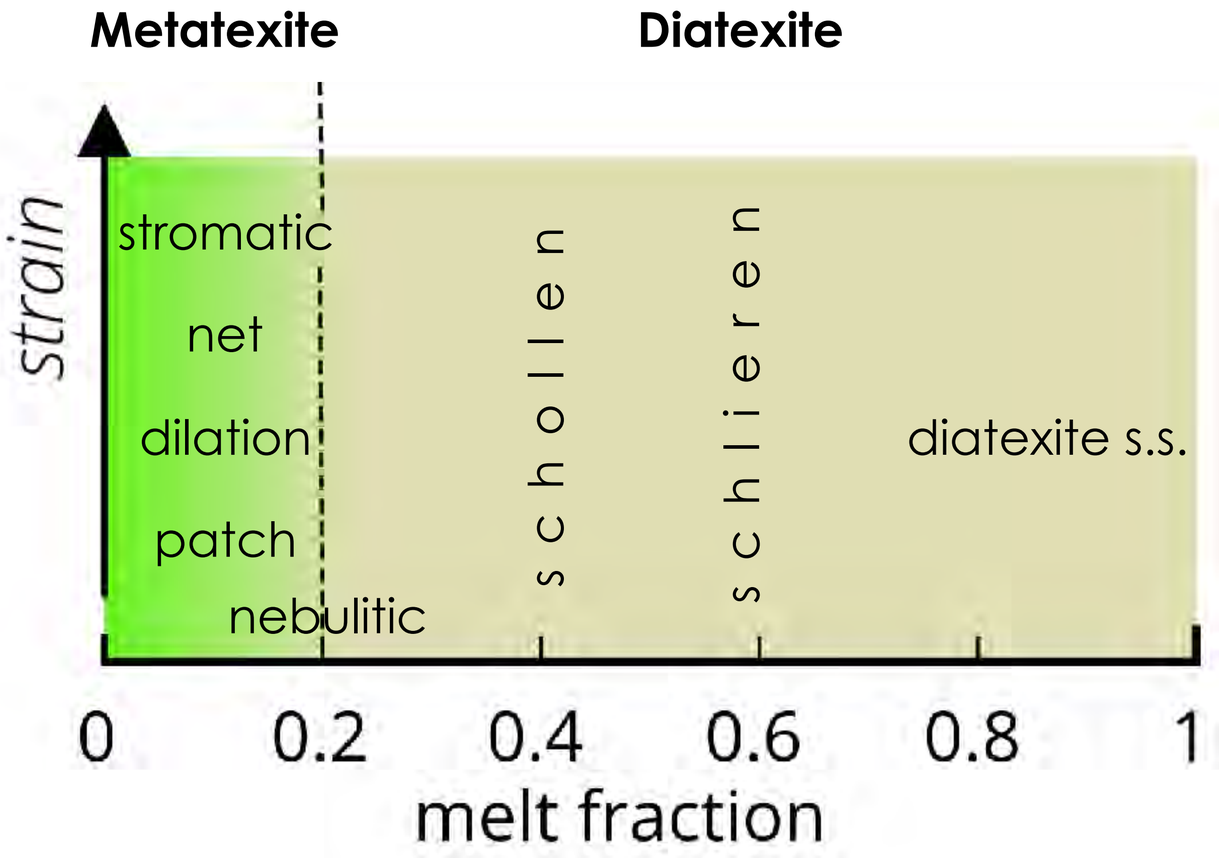


Fig. 1b. Summary of typical migmatite structures.
7. Folded

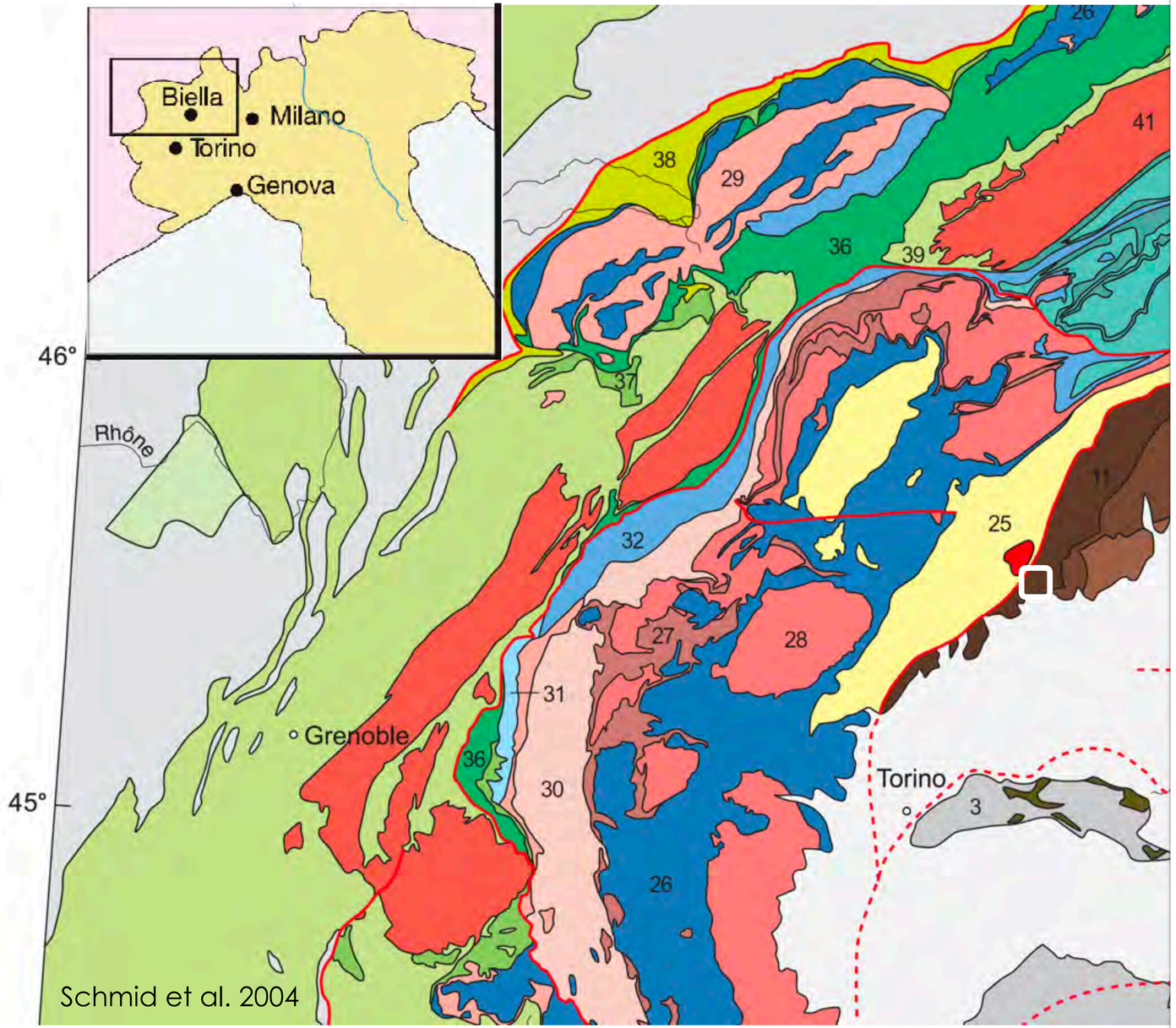
from field to inference



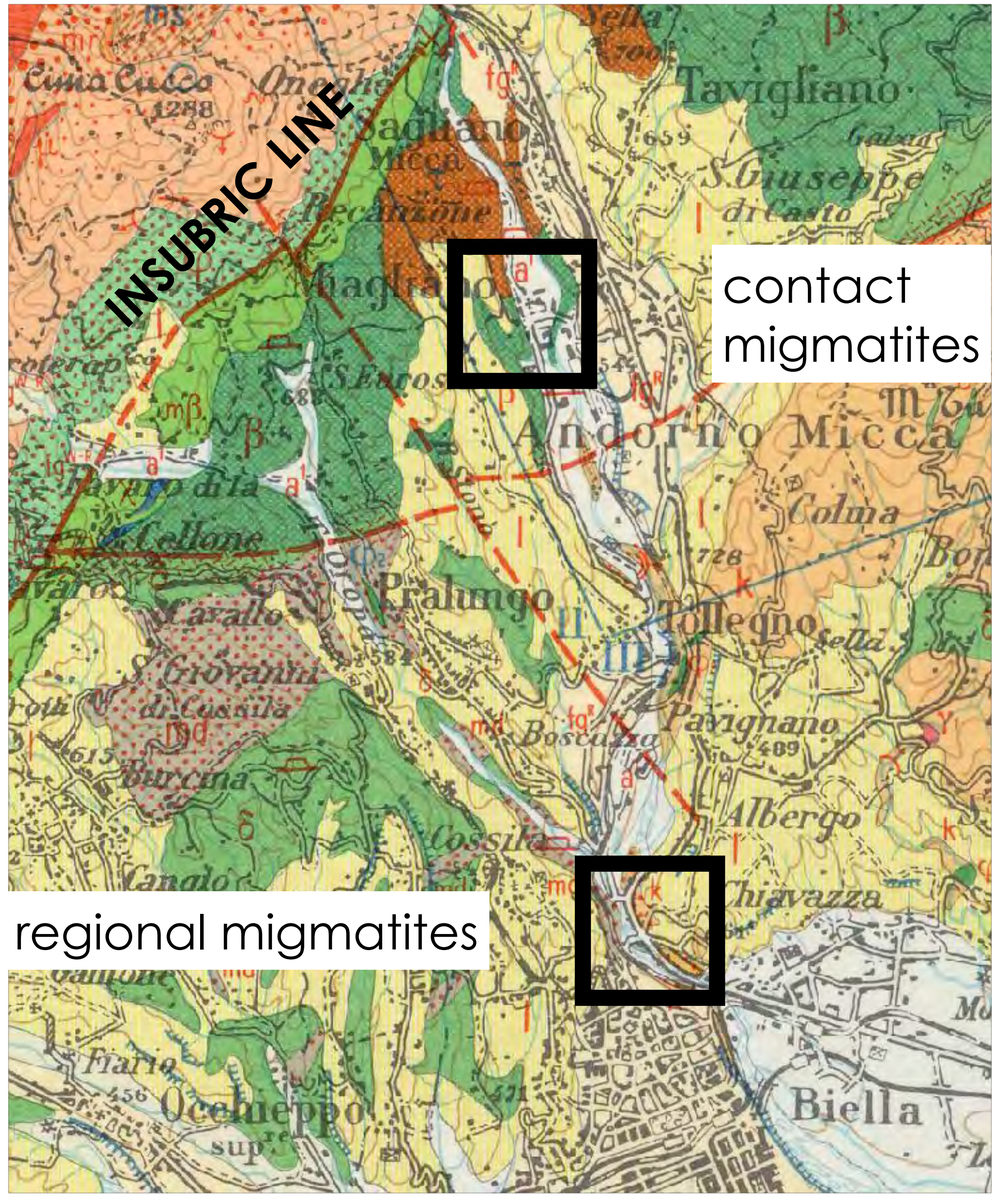
- metatexite-diatexite transition anywhere between 0.02 to 0.2 melt fraction
- strain has, obviously, a role

Modified from Sawyer 2008

migmatites in the field - the Ivrea basement near Biella



1:100000 Geologic Map of Italy (1967)



Ivrea high-grade basement @ Lanificio Pria

Ivrea high-grade basement @ Lanificio Pria

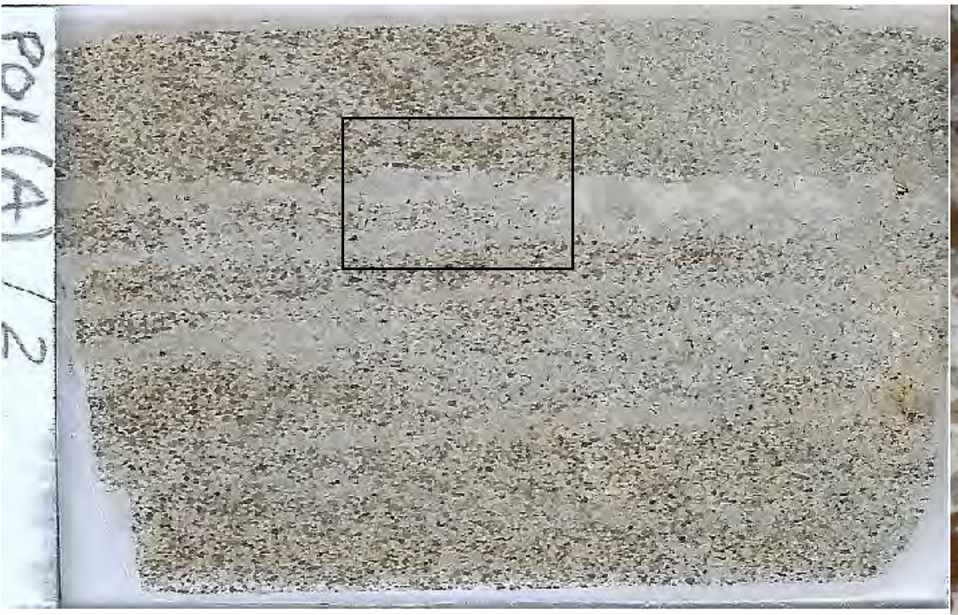
schollen vs schlieren

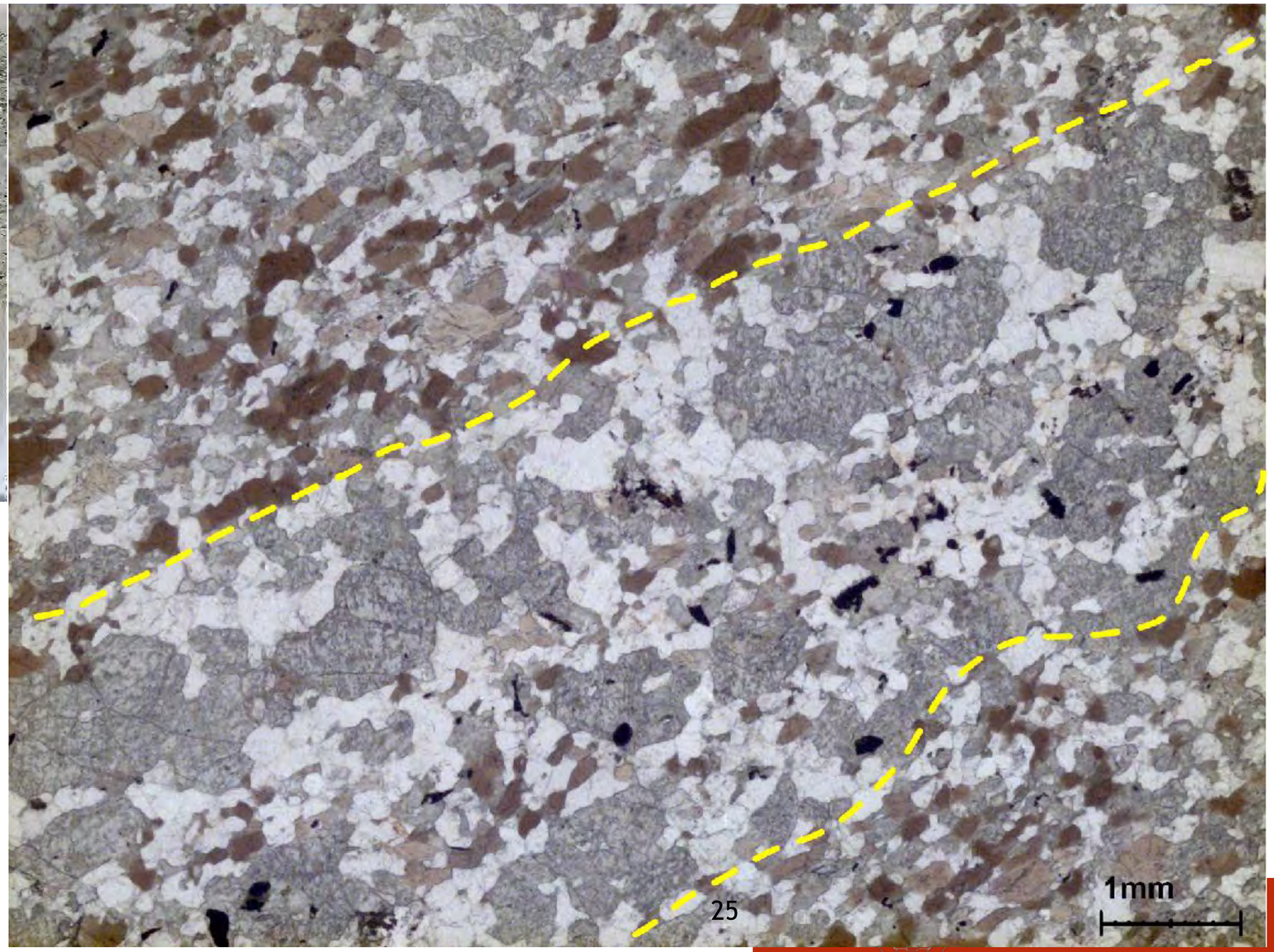
Schollen, angular object floating in leucosome

Schlieren, elongated trails of mafic minerals


Ivrea high-grade basement @ Biella poligono
leucocratic vein
metatexite
(foliated amp-
gabbro)
in-source
leucosome?

neosome in amphibole-metagabbro

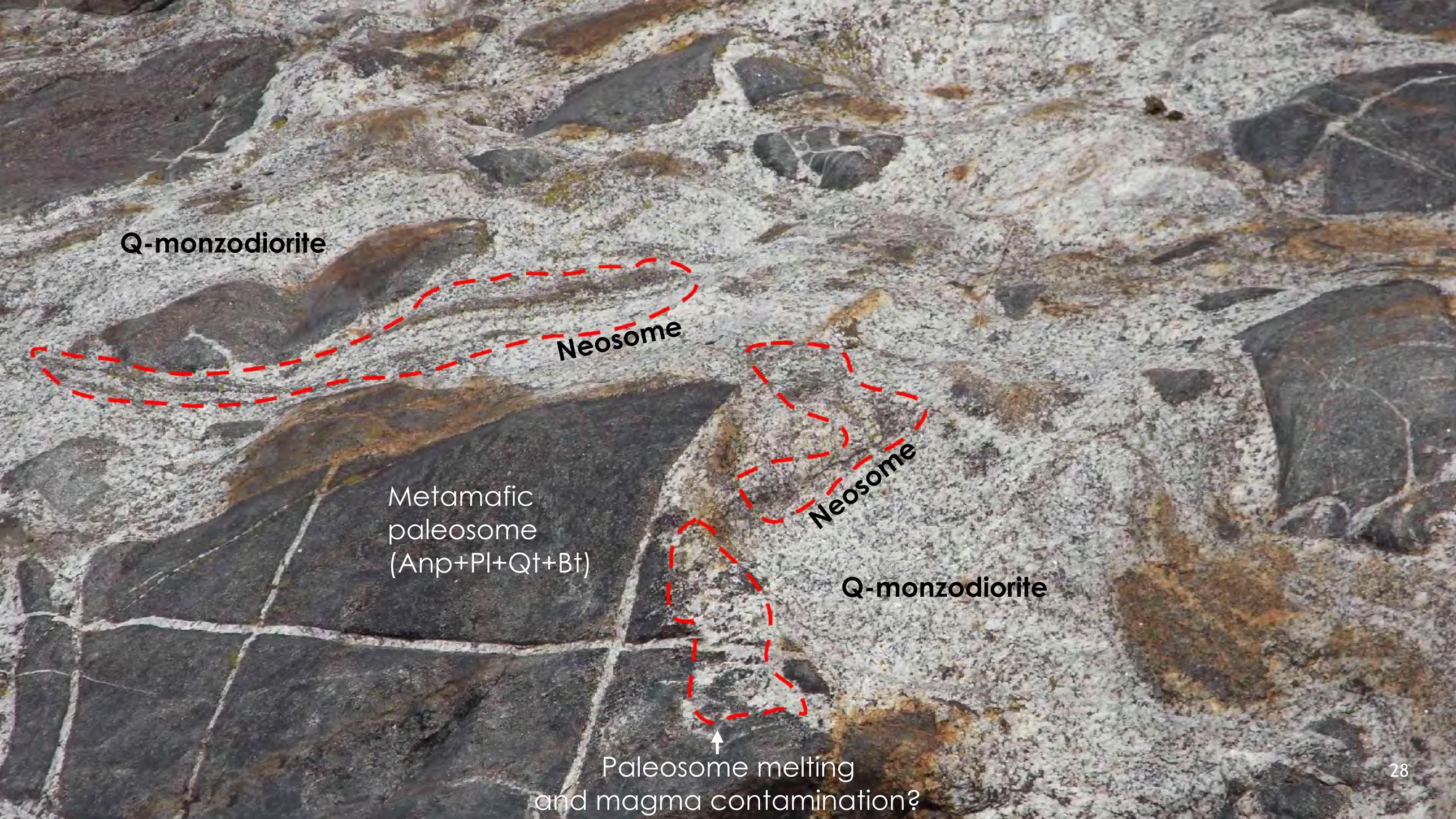




coarsening
less amphibole
hypidiomorphic

basement disruption by oligocene Miagliano Qt-monzodiorite intrusion


Metamafic
paleosome
(Amp+Pl+Qt+Bt)
Q-monzodiorite


Q-monzodiorite
Neosome
Metamafic
paleosome
(Anp+Pl+Qt+Bt)
Neosome
Q-monzodiorite
Paleosome melting
and magma contamination?

stoping and migmatization

stoping and migmatization

stoping and migmatization

mafic selvedges

Epilogue

- Working with migmatites requires a specific mind-set
- Correct interpretation of field structures helps lab work (e.g. geochemistry)
- The SW Ivrea basement: interested anyone?

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