The Description and Classification of Mylonites from Northern Patagonia, Argentina

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NDSU Petrology 422
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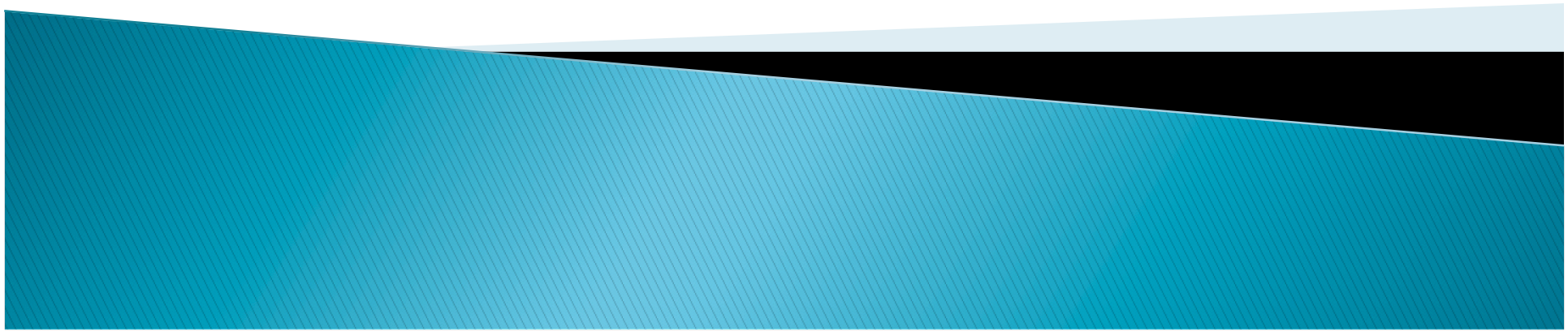
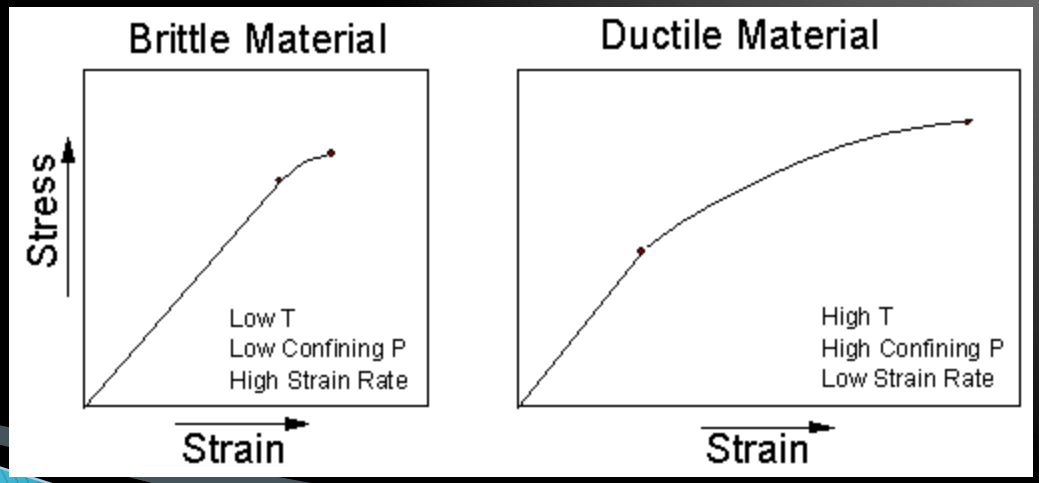


Outline

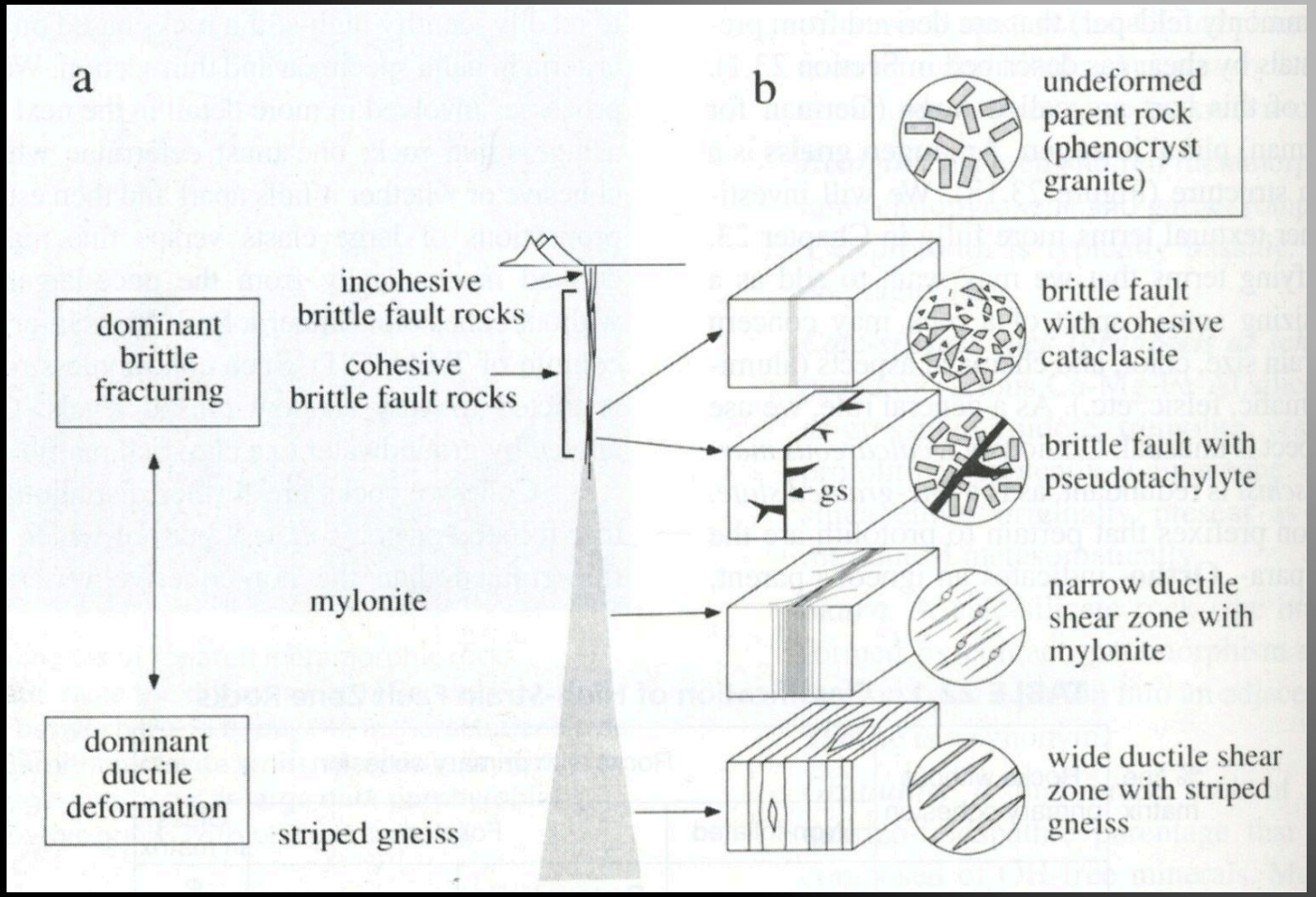
- Fault rocks
- Mylonites and how they form
- Geography and geology of the area
- Classification of mylonites
- Micro to macro scale
- Conclusion

Shear Zones

- High-strain zone where deformation in planar zones works to displace wall rock (Passchier and Trouw, 1996)
- Brittle deformation-cooler temp., lower pressure, strain rate faster; can contain fractures
- Ductile deformation-higher pressure and temp., strain rate lower; displays structures, such as foliation and lineation (Davis and Reynolds, 1996)



http://www.tulane.edu/~sanelson/geol111/deform.htm



Winter, 2010
Figure 22.2; Page 474

Rocks without Primary Cohesion

- Fault breccia- <70% fine matrix
- Fault gouge- >70% fine matrix
- Typically restricted to shallow crustal levels

Winter, 2010

Cohesive Rocks

- Foliation-general term used to describe a planar feature that occurs penetratively in a body of rock (Passchier and Trouw, 1996)
- Microbreccia- <70% clasts
- Cataclasite- >70% clasts

TABLE 22.1 Classification of High-Strain Fault Zone Rocks

% fine matrix	Rocks without primary cohesion	Rocks with primary cohesion			
		Non-foliated	Foliated		Glass in matrix
50	Fault breccia	Microbreccia	Protomylonite	Blastomylonite (if significantly recrystallized)	Pseudotachylite
70			Mylonite		
90	Fault gouge	Cataclasite	Ultramylonite		

After Higgins (1971)

Winter, 2010
Table 22.1, Page 473

Mylonites

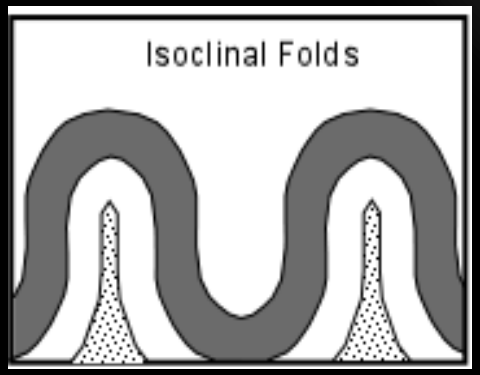
- Foliated, usually lineated fault zone rock
- Strong ductile deformation
- Structural term-no mineral composition
- Mylonite zones-any rock type; range in size from a millimetric scale to several km wide

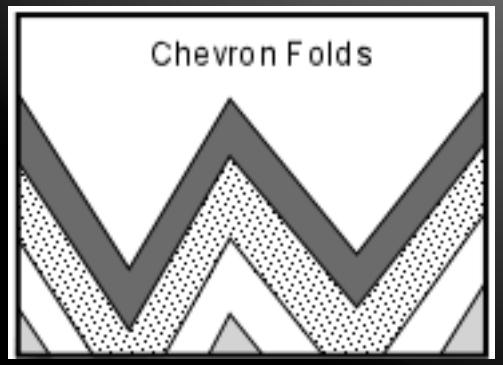
(Passchier and Trouw, 1996)

Mylonite Characteristics

- Well-developed foliation
- Porphyroclasts-remnants of resistant mineral grains
- Foliations may be subject to isoclinal folding

(Passchier and Trouw, 1996)





http://www.tulane.edu/~sanelson/geol111/deform.htm

Classification

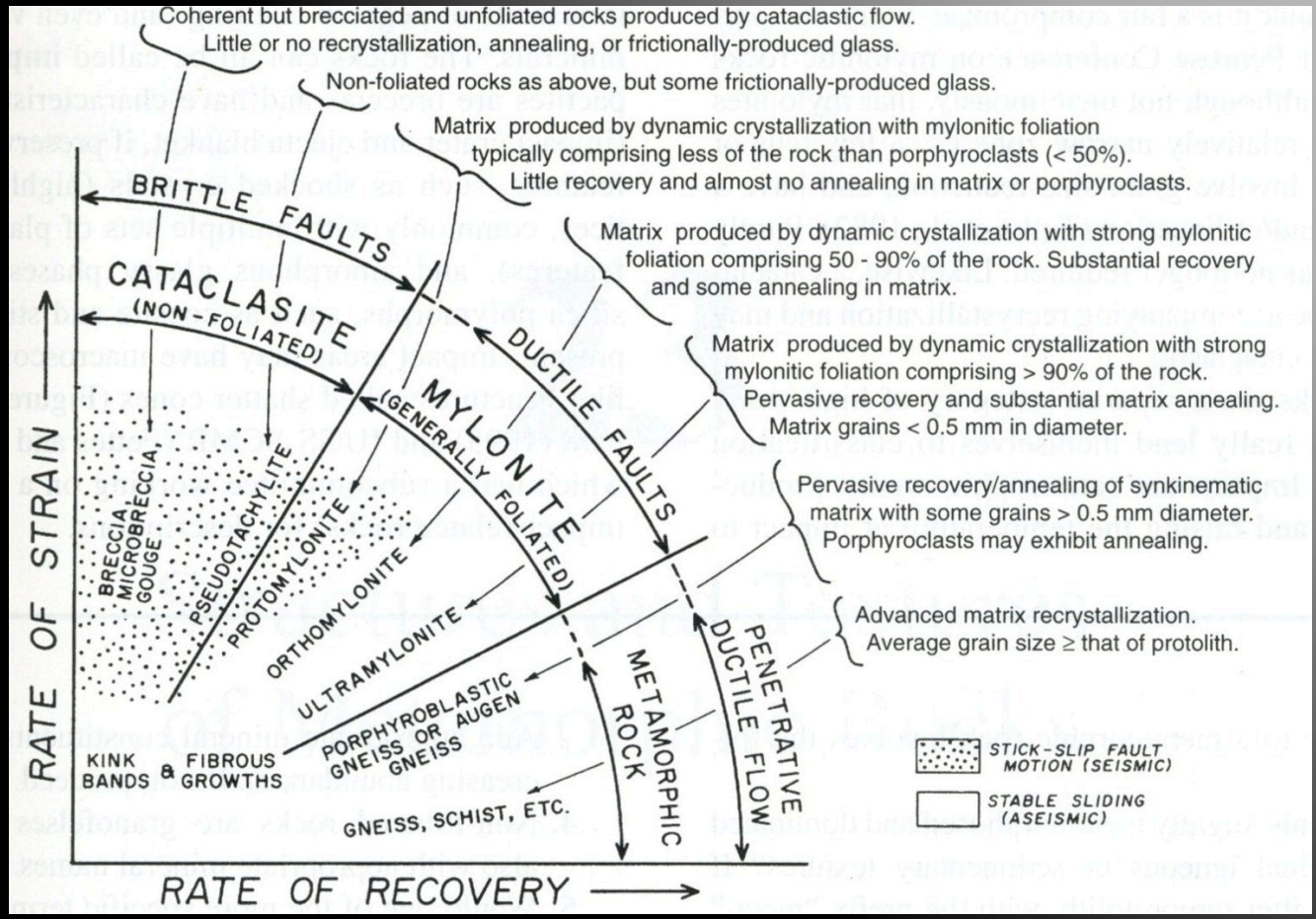
- Classified according to: metamorphic grade, lithotype or mineralogy, or percentage of matrix as compared to porphyroclasts

- Protomylonite- 10-50% matrix

- Mylonites (mesomylonites)- 50-90% matrix

- Ultramylonites- >90% matrix

(Passchier and Trouw, 1996)

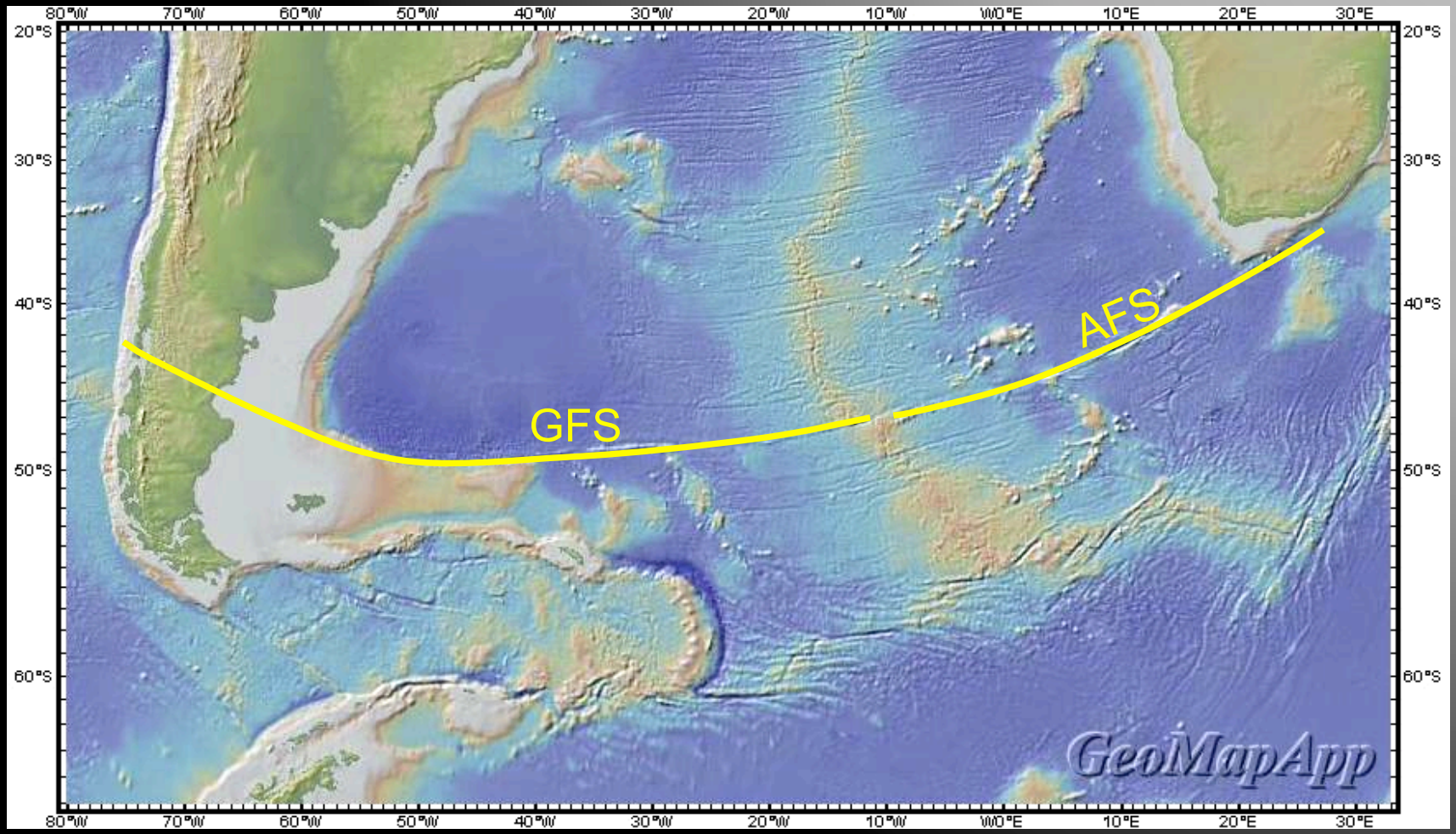


Winter, 2010
Fig. 22.3; Page 475

Guiding Questions

- Is there a sequence to the mylonites found in Argentina?

- Does their microstructure give clues to the macro scale?



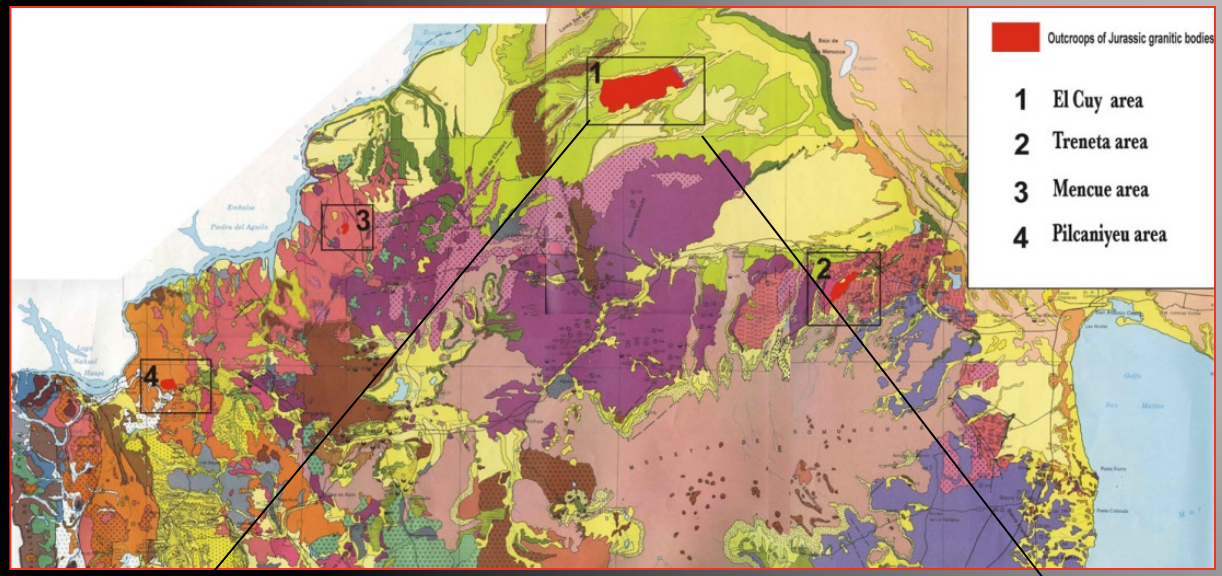
GFS = Gastre Fault Zone

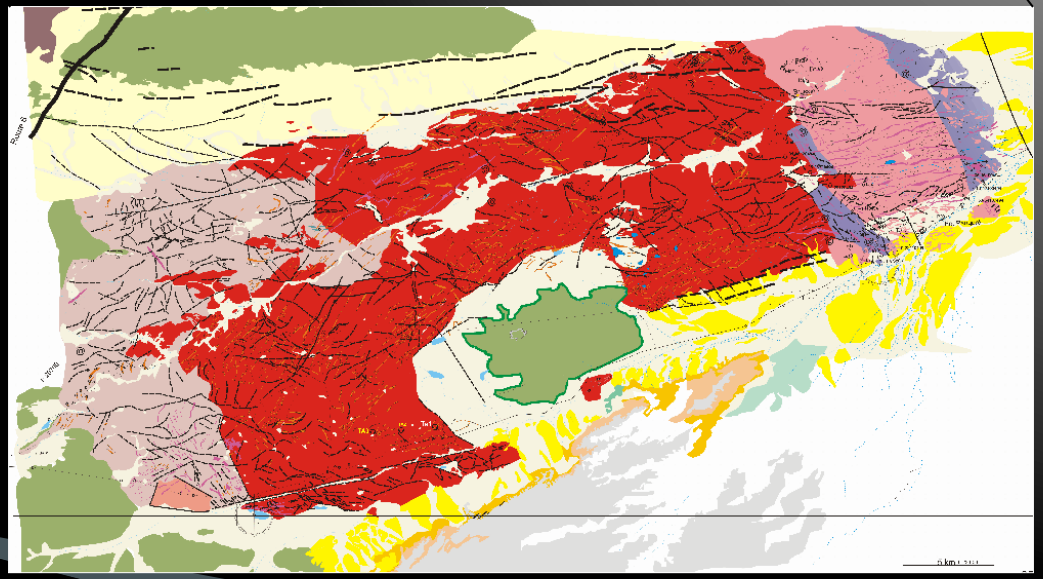
AFS = Aghulas Fracture Zone

(Saini-Eidukat(pers.comm., 2012)

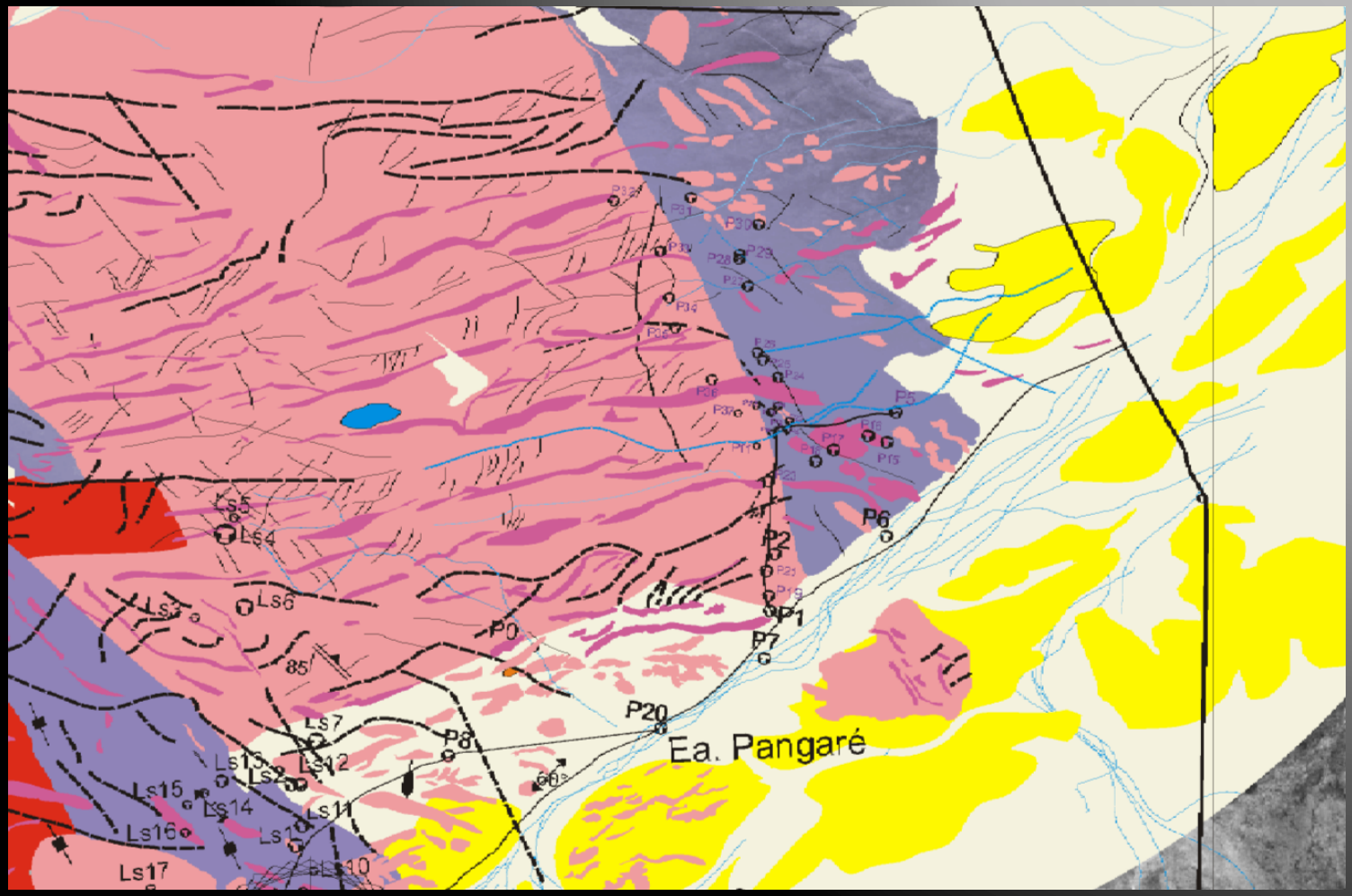
Patagonia, Argentina

Saini-Eidukat(pers.comm., 2012)





Saini-Eidukat(pers.comm., 2012)

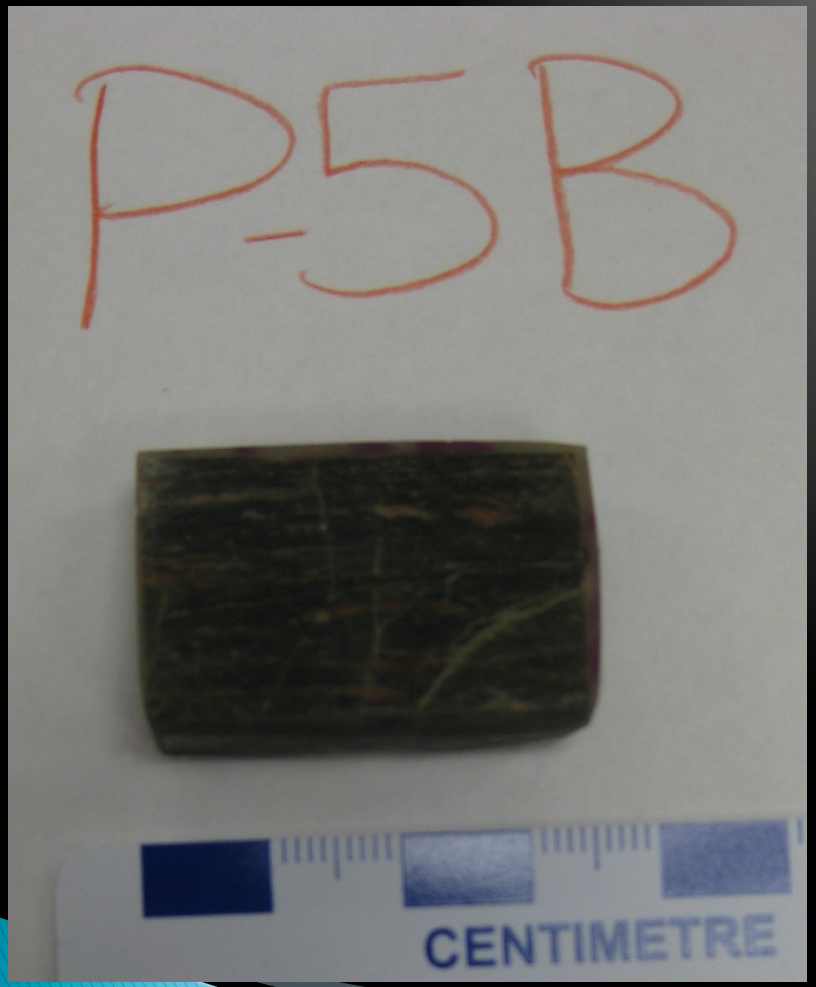


Saini-Eidukat(pers.comm., 2012)

P5 Sample-Protomylonite

Objective: 2.5X
Right: XP, Left: PPL
FOV: 8 mm

P5B-Mylonite (meso)

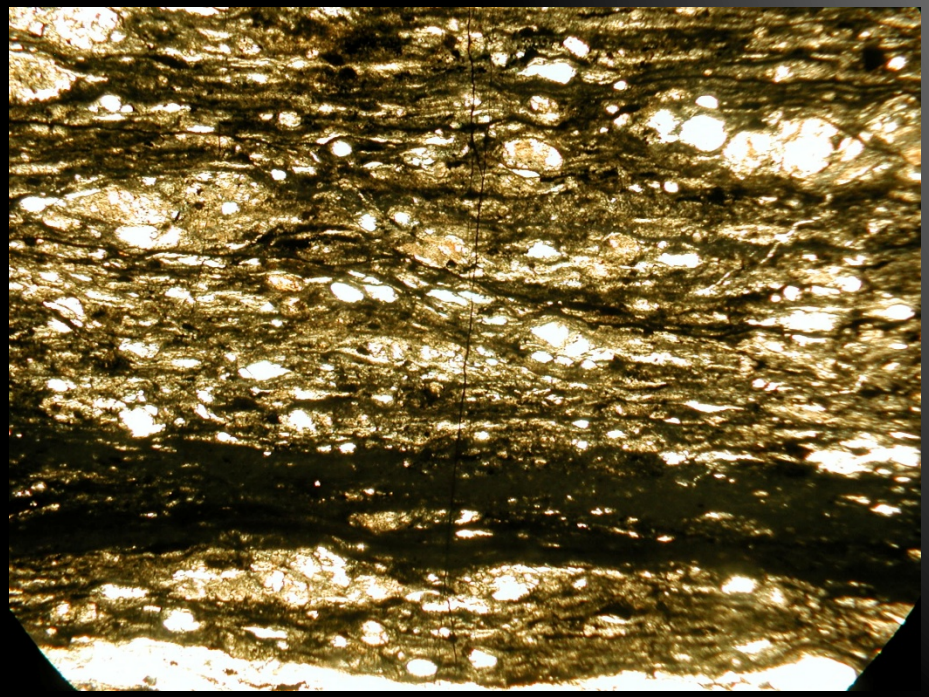


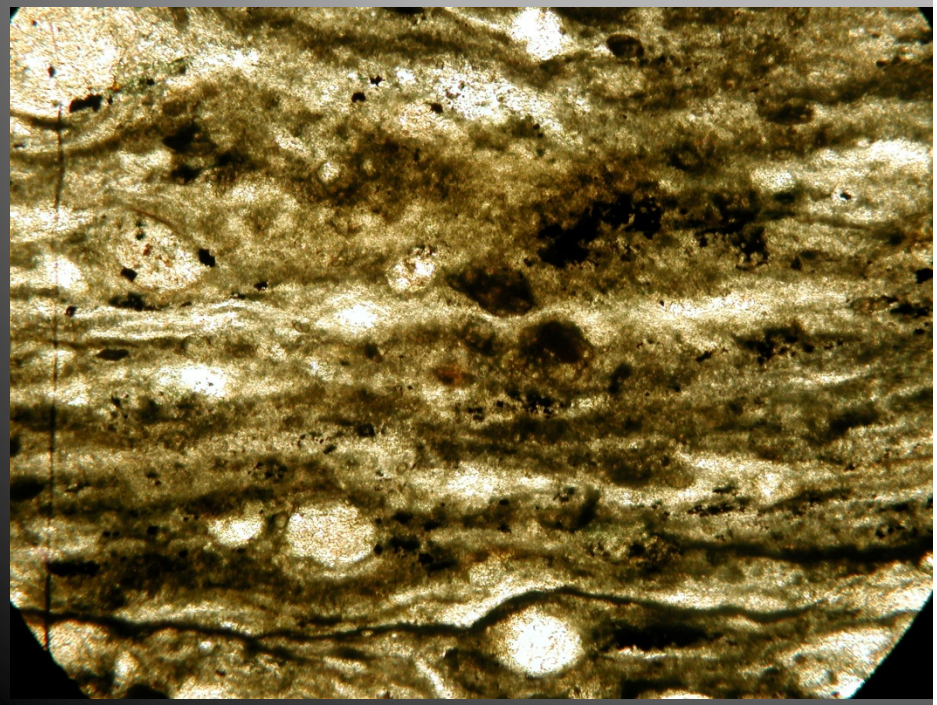
Objective: 2.5X
Right: XP, Left: PPL
FOV: 8 mm

P6-Mylonite (meso)

Objective: 2.5X
Right: XP, Left: XP
FOV: 8 mm

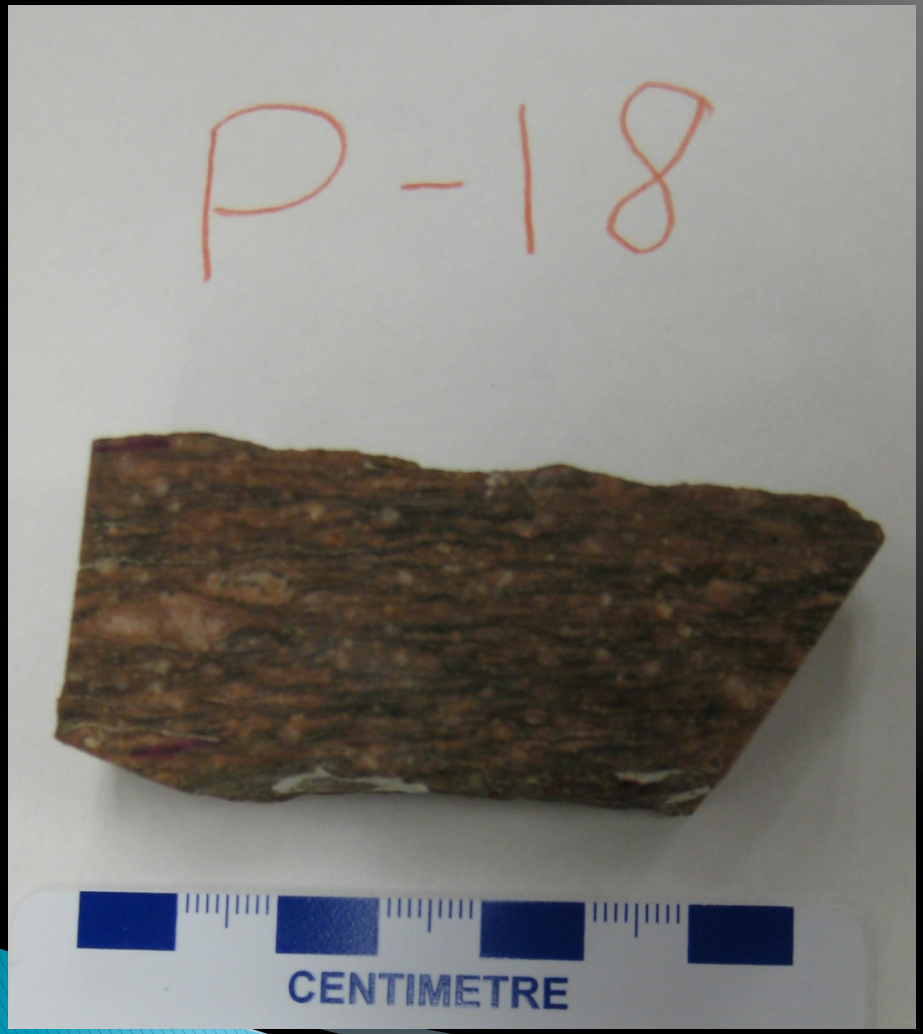
P5A- Ultramylonite

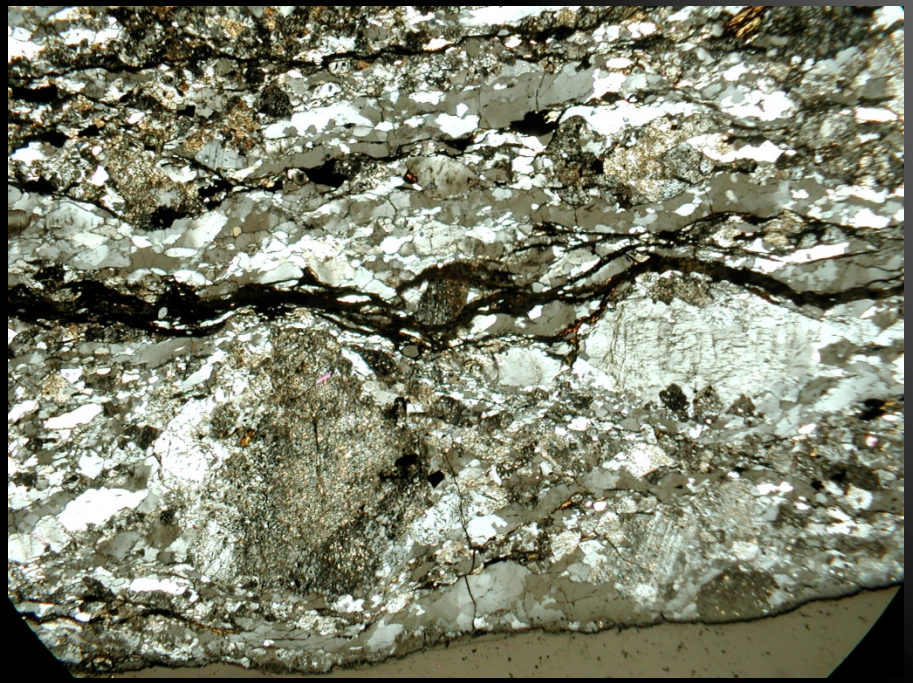


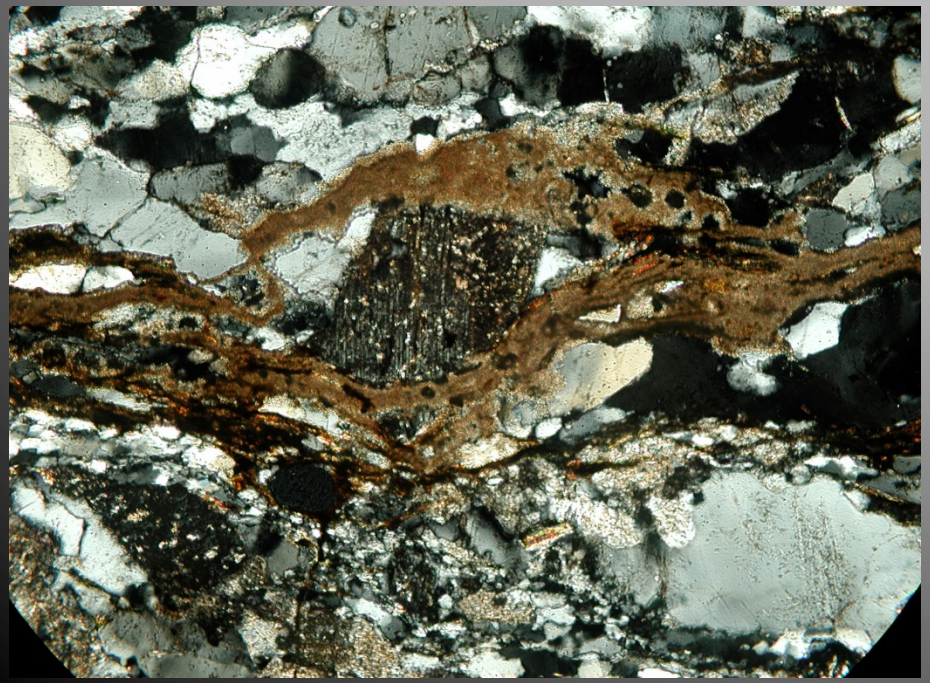


Right objective: 10X
FOV: 1.89 mm
Left objective: 2.5X
FOV: 8 mm
Right: PPL, Left: PPL

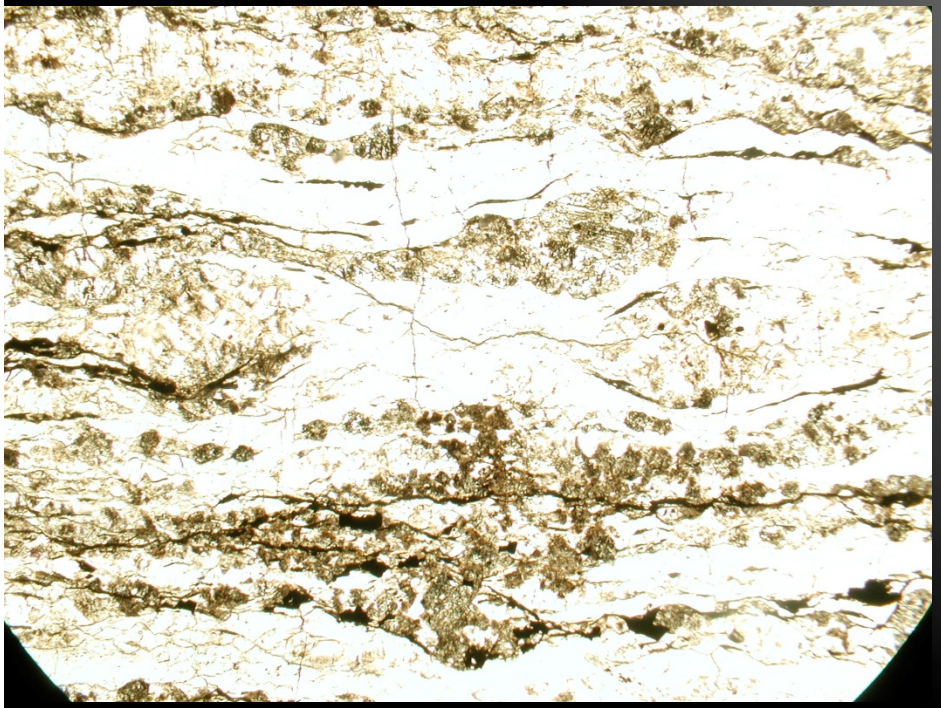
Granitic Augen-Mylonites

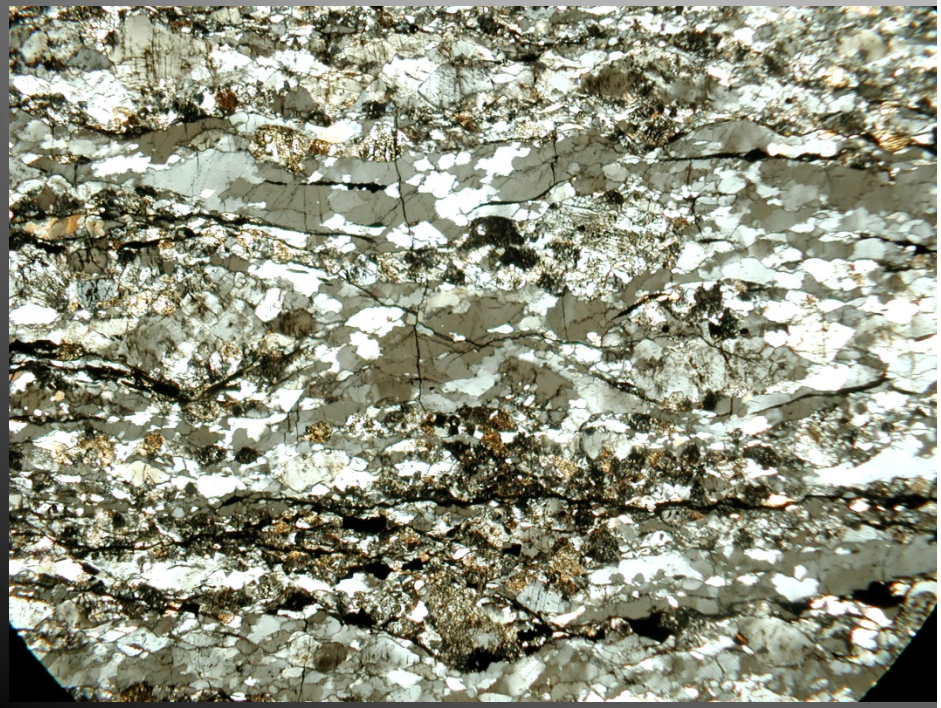






Right objective: 10X
FOV: 1.89 mm
Left objective: 2.5X
FOV: 8 mm
Right: XP, Left: XP

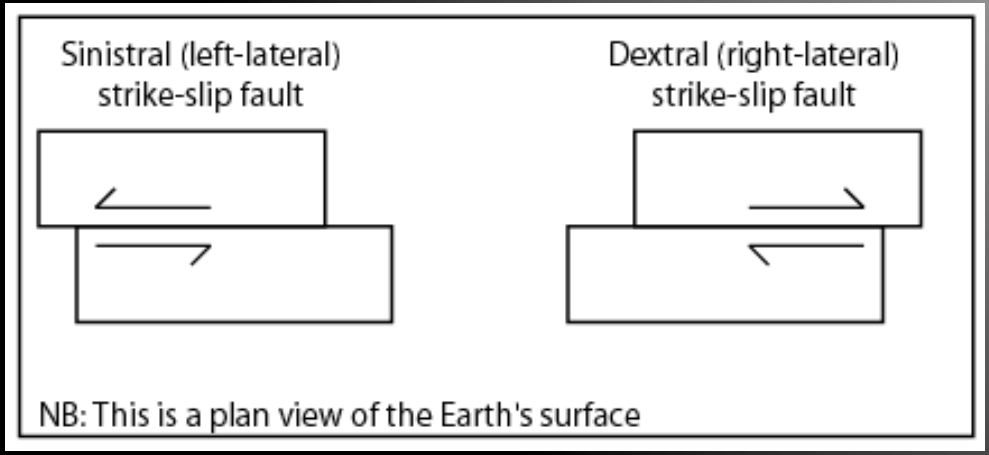




Objective: 2.5X
Right: XP, Left: PPL
FOV: 8 mm

Microstructure

- Sense of shear or sense of displacement- Sinistral (normal) or Dextral (reverse)



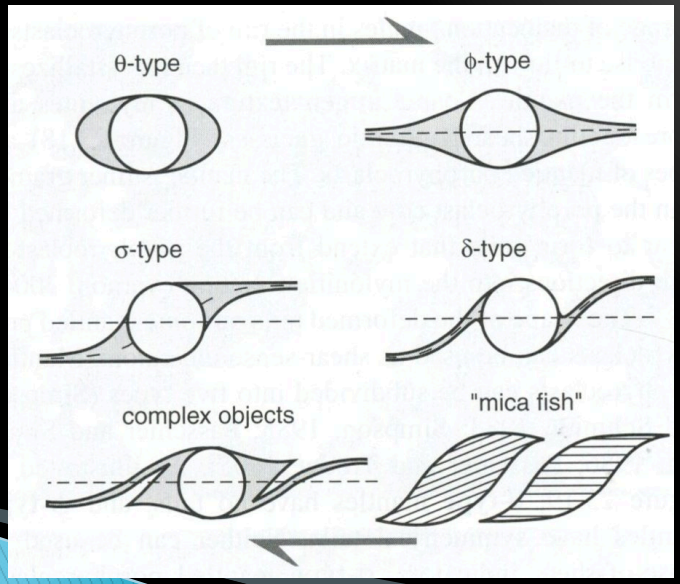
http://www.enotes.com/topic/Sinistral_and_dextral

(Passchier and Trouw, 1996)

Augen (eye)

- Area around augen can be further deformed by shear to form tails

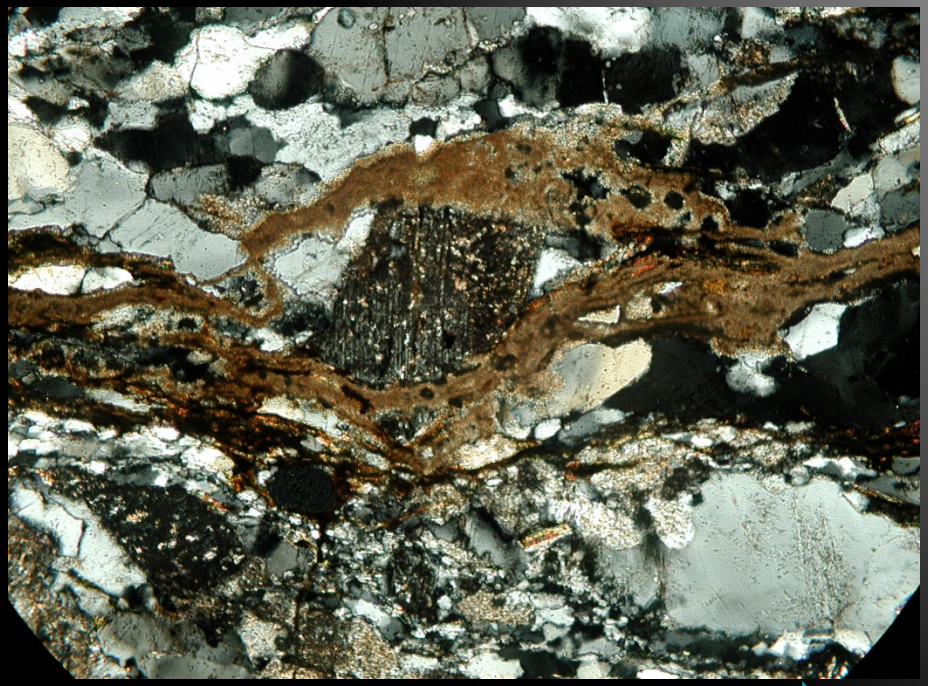
- Shape of deformed tails on some augens can be used as shear-sense indicator



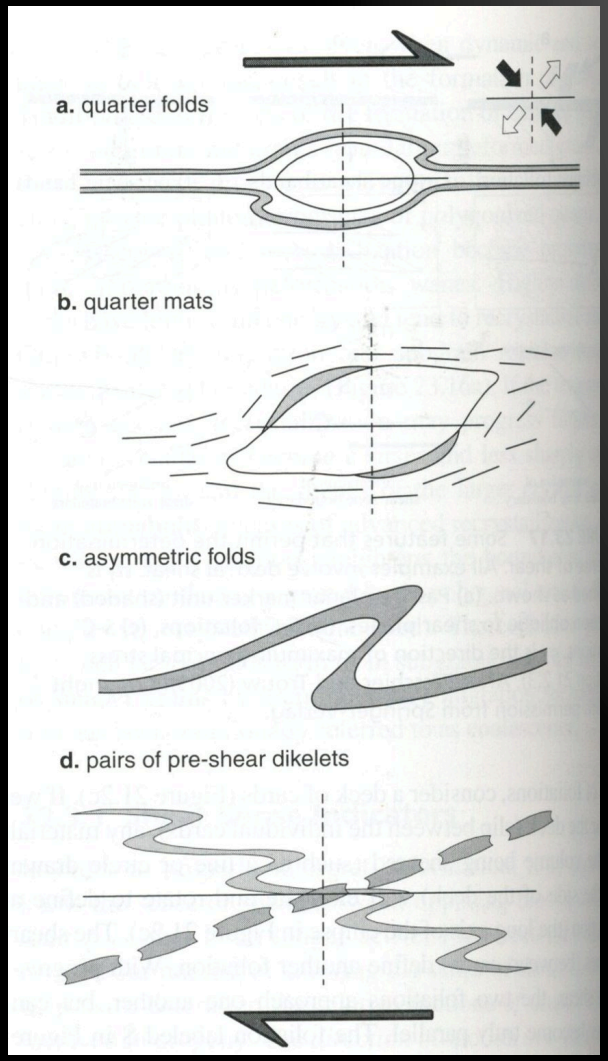
Winter, 2010
Fig. 23.19; Page 490

(Winter, 2010)

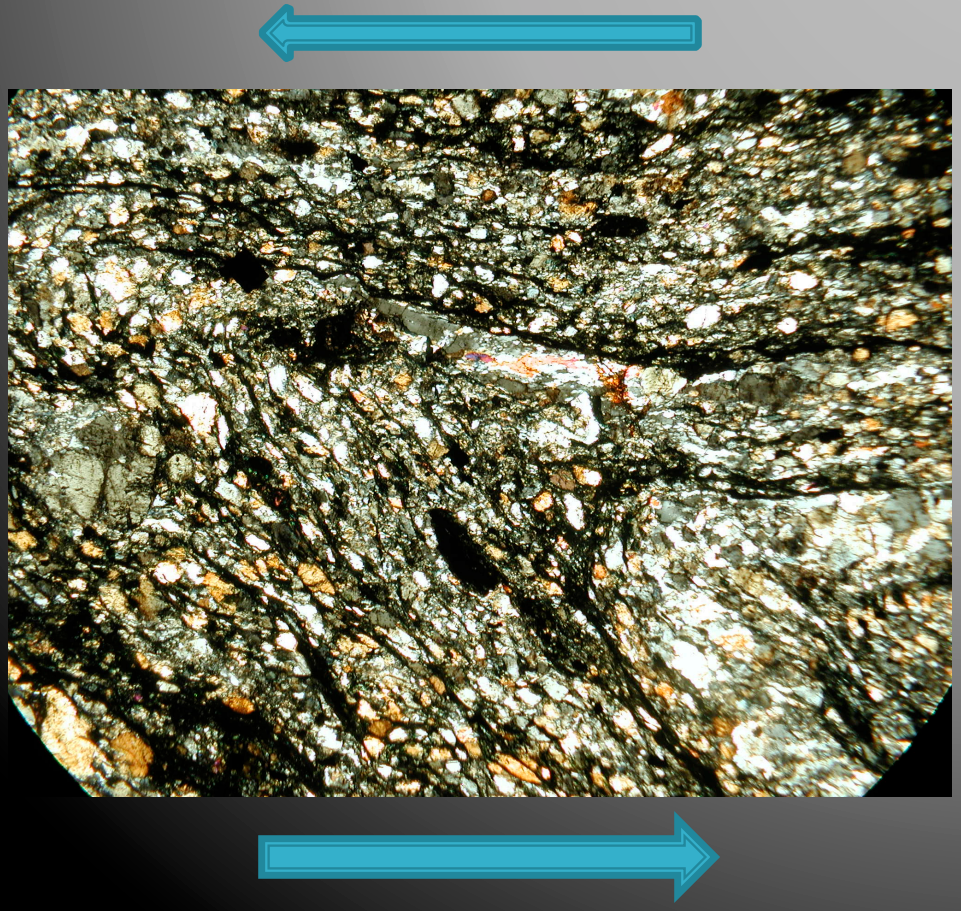
- Possible δ-type indicating sinistral movement



Right objective: 10X
FOV: 1.89 mm
XP



Winter, 2010
Fig. 23.20; Page 490



Objective: 2.5X
FOV: 8 mm
XP

Summary

- Sinistral (left-lateral) shear movement
- Shear sense or sense of displacement is not always visible
- By looking at microscopic features, macroscopic features can be inferred

Conclusion

- Mylonites are a foliated, ductile deformed fault rock
- Mylonites can be classified as protomylonites, mylonites (meso), or ultramylonites
- The mylonites from Argentina can be classified as a granitic-augen, protomylonite, mesomylonites, and ultramylonite(generally from west to east)
- Microscopic features such as augens and isoclinal folds can indicate shear zone movement on a macroscopic scale

Thank you!

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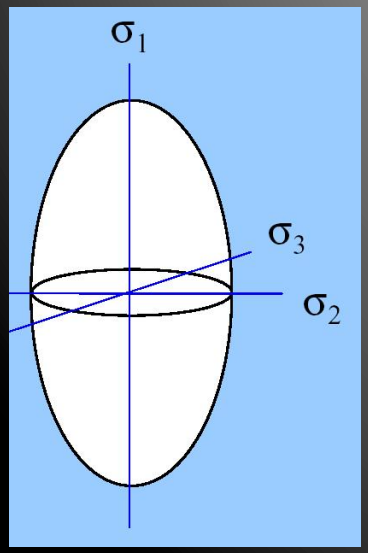
- Greatest principal stress direction- σ1
- Least principal stress direction-σ3
- Intermediate principal stress direction-σ2

(Davis and Reynolds, 1996)



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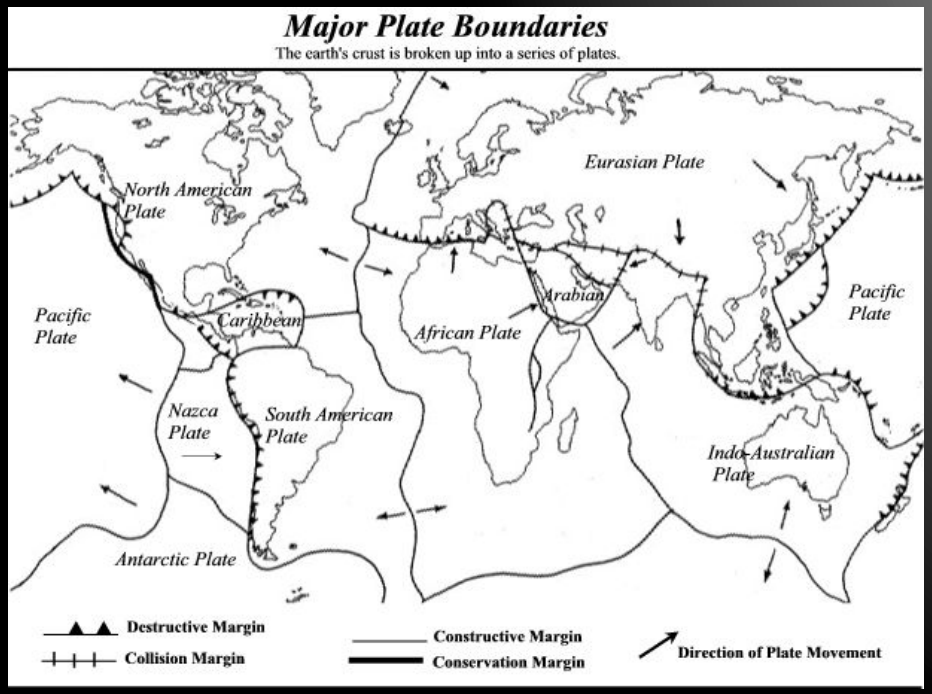
Continental scale



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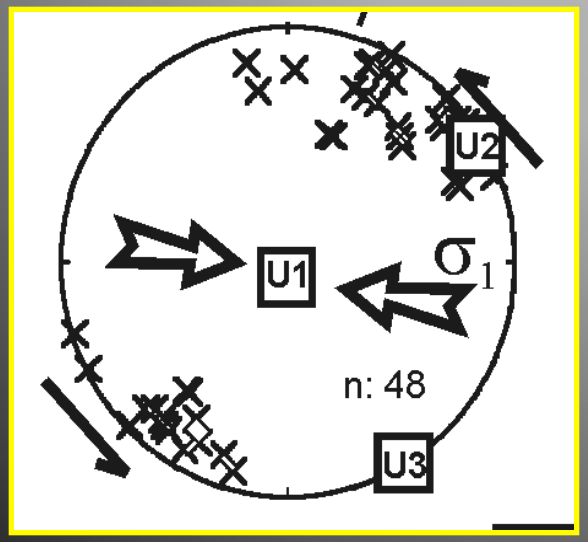

Saini-Eidukat(pers. comm., 2012)