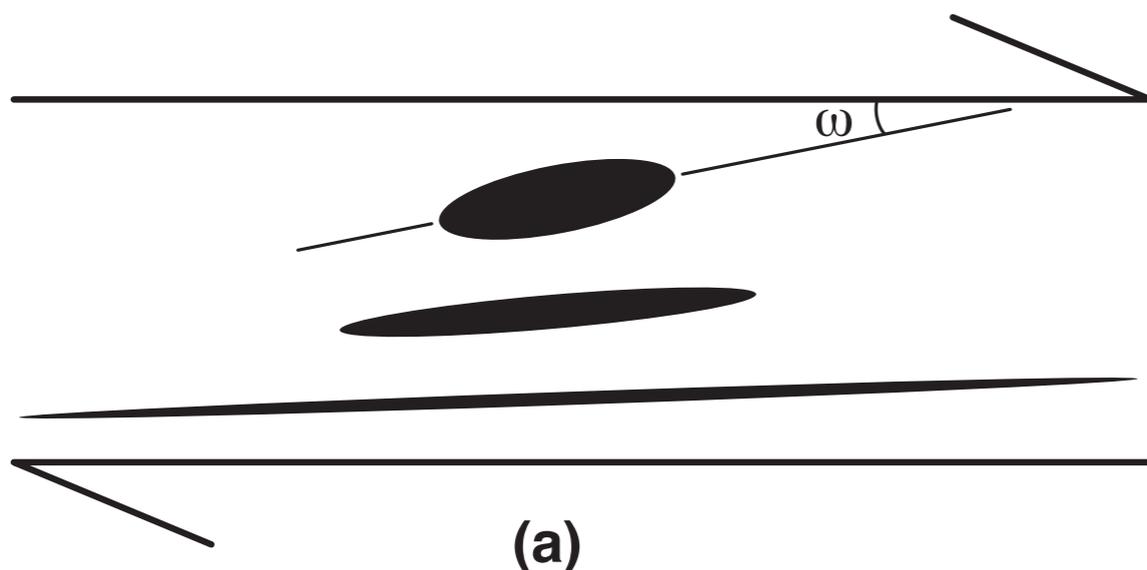


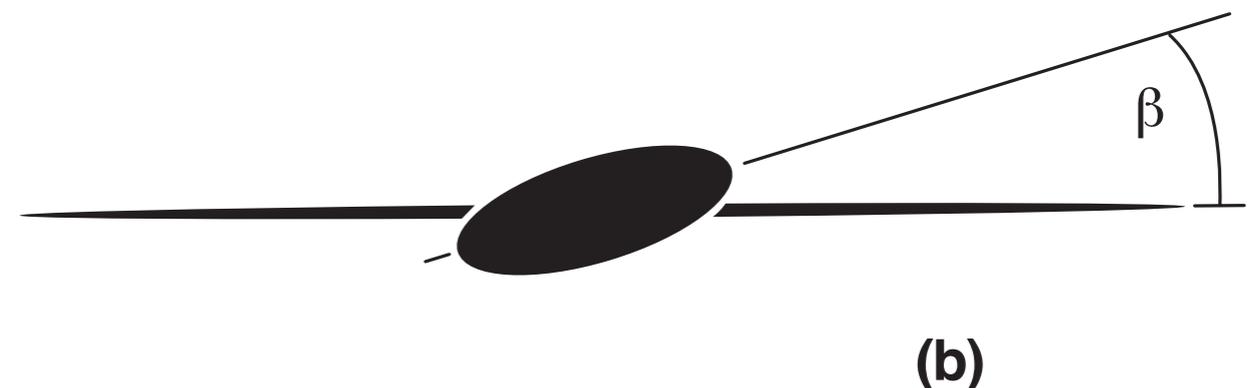
# Indicatori cinematici

# Rotazione interna ed esterna

- **rotazione esterna** (spin): rotazione di un oggetto nella zona di taglio rispetto ad un sistema di coordinate esterne (di solito i limiti di una zona di taglio);
- **rotazione interna** (vorticity) che rappresenta la rotazione di un oggetto rispetto ad un sistema di coordinate interne;
- **Indicatori cinematici**: strutture riconoscibili che testimoniano la componente rotazionale della deformazione

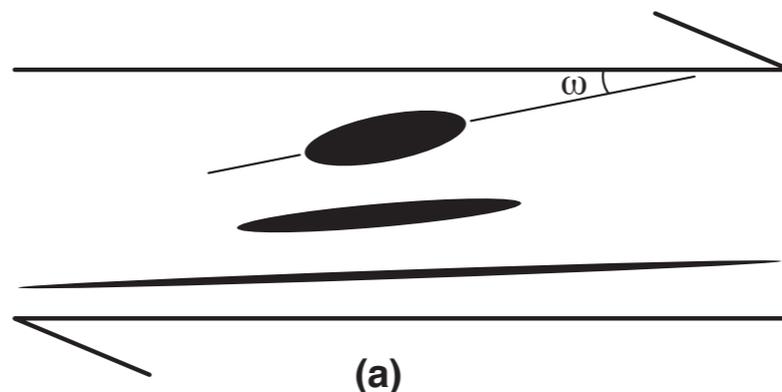
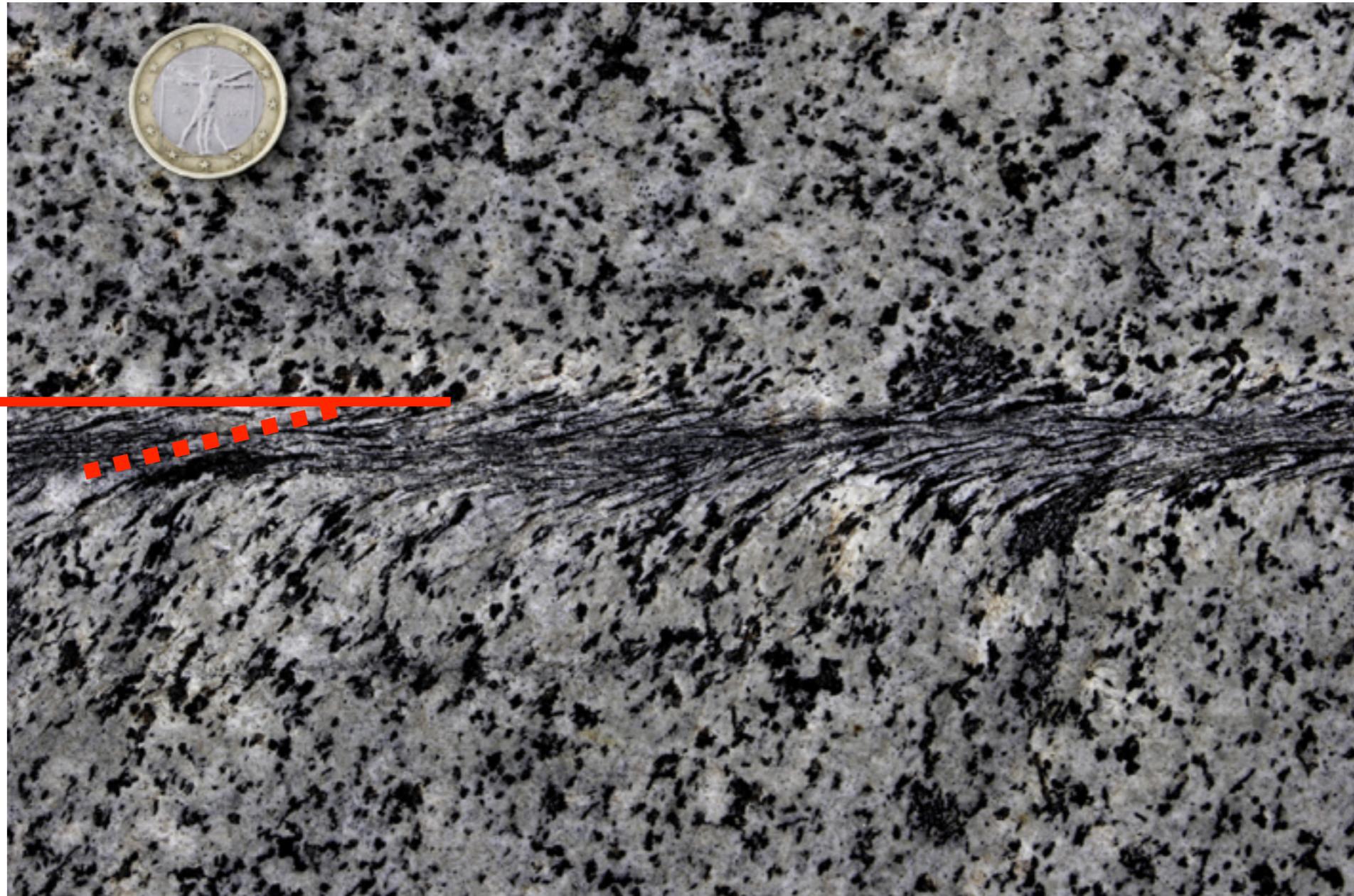


rot. esterna

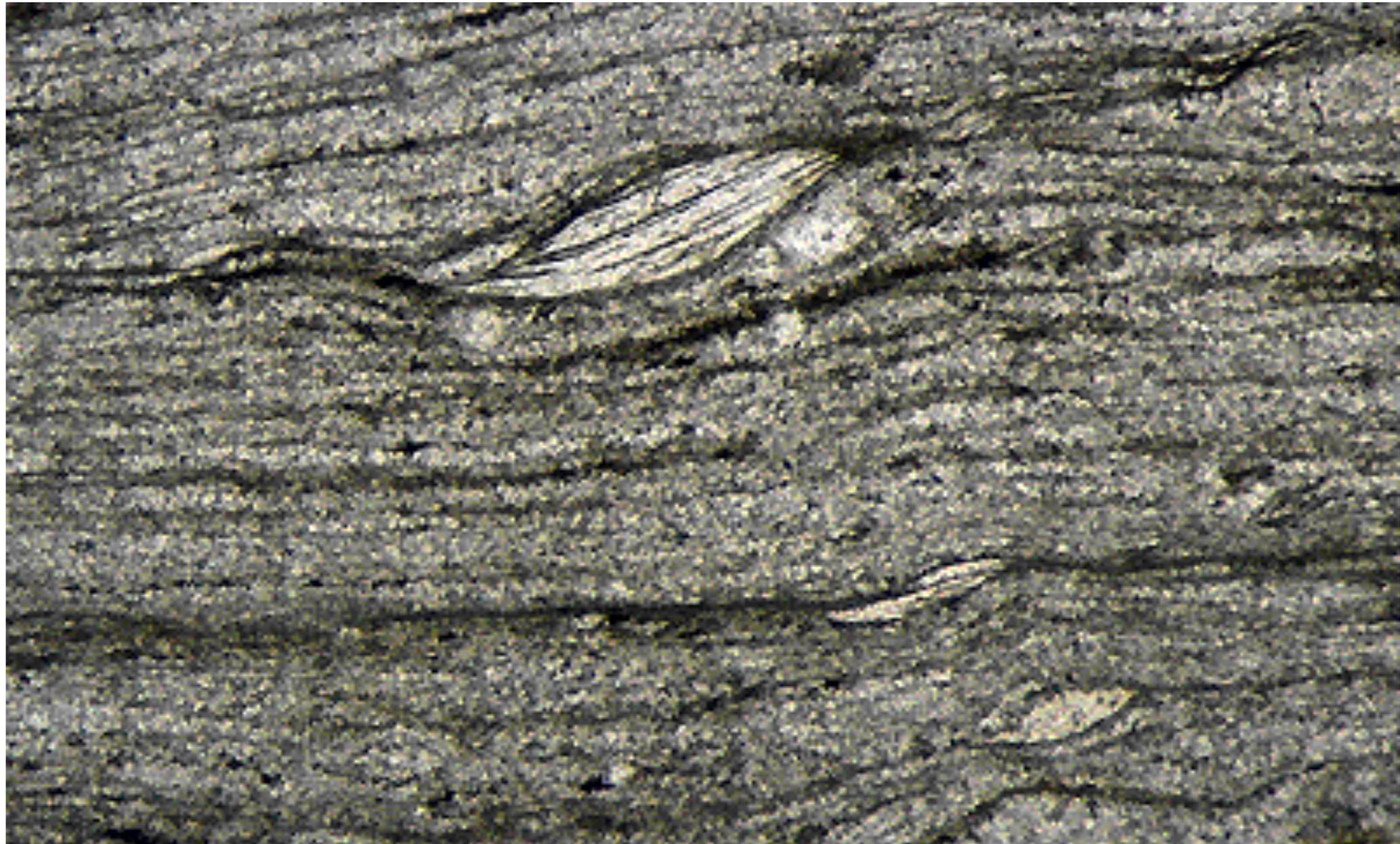


rot. interna

# Rotazione esterna (spin)

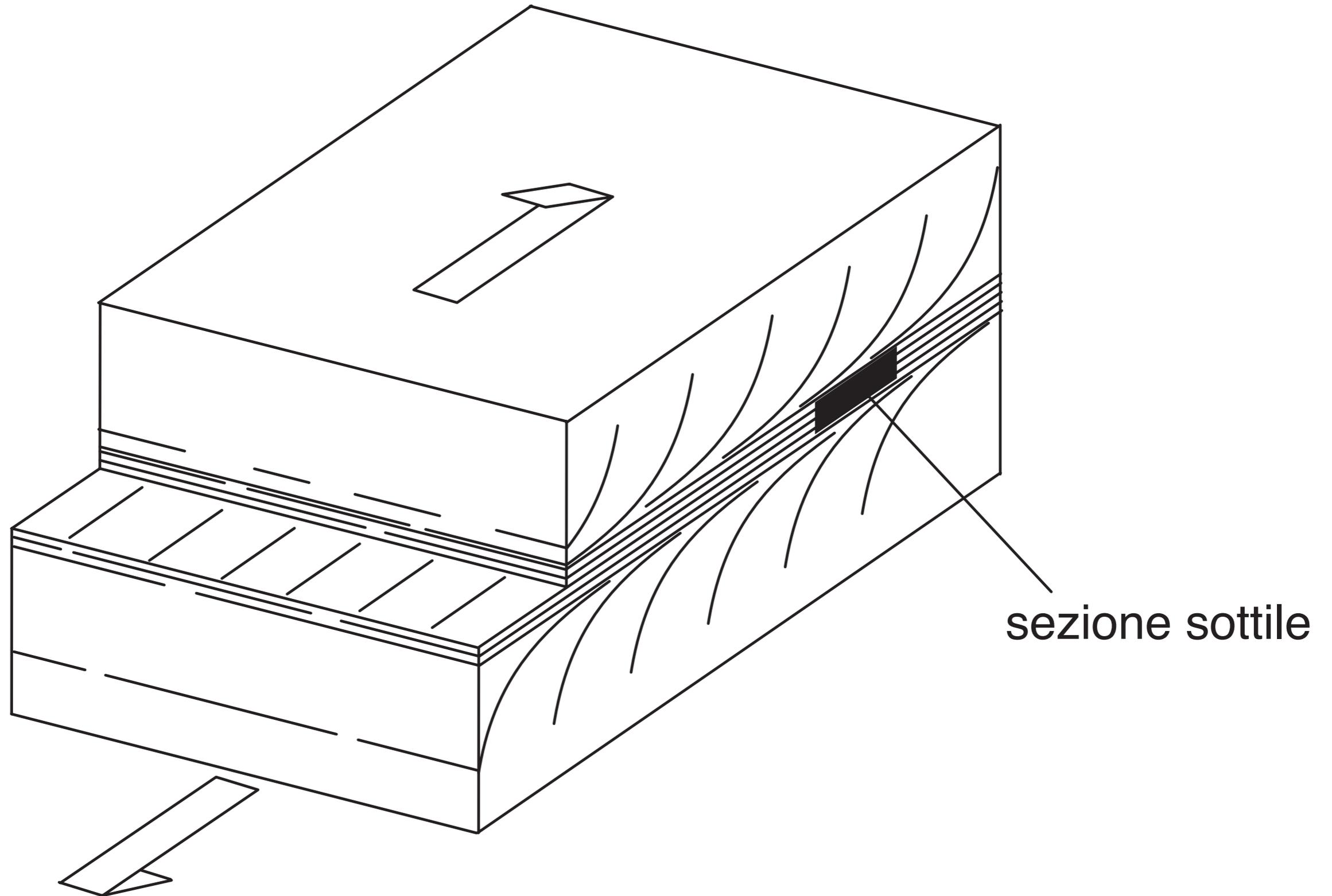


# Rotazione interna (vorticity)



(b)

# Orientazione sezioni

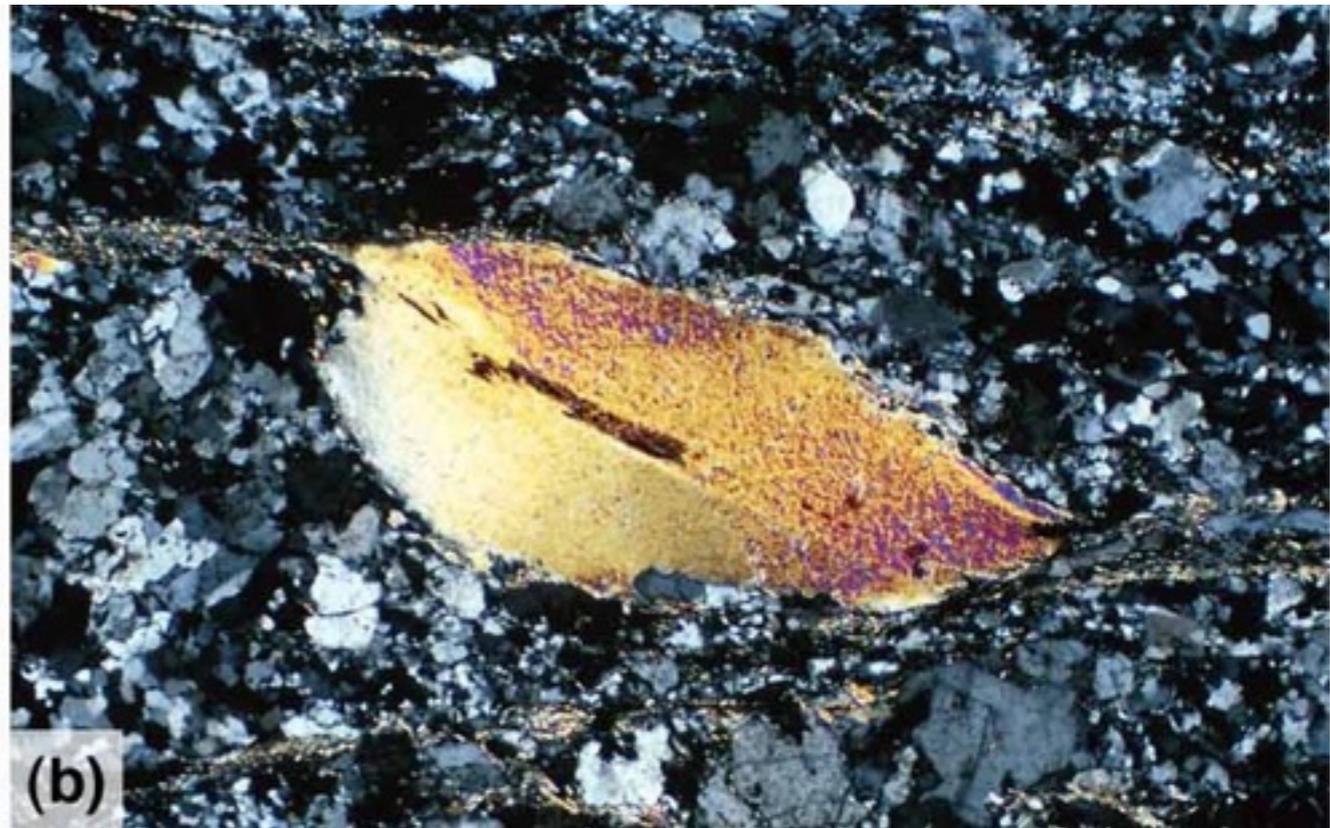


# Indicatori cinematici

- Porfiroclasti asimmetrici
- Foliazioni complesse
- Superfici S-C
- Shear band
- Orientazioni preferenziali di forma
- Orientazioni cristallografiche preferenziali (tessitura)

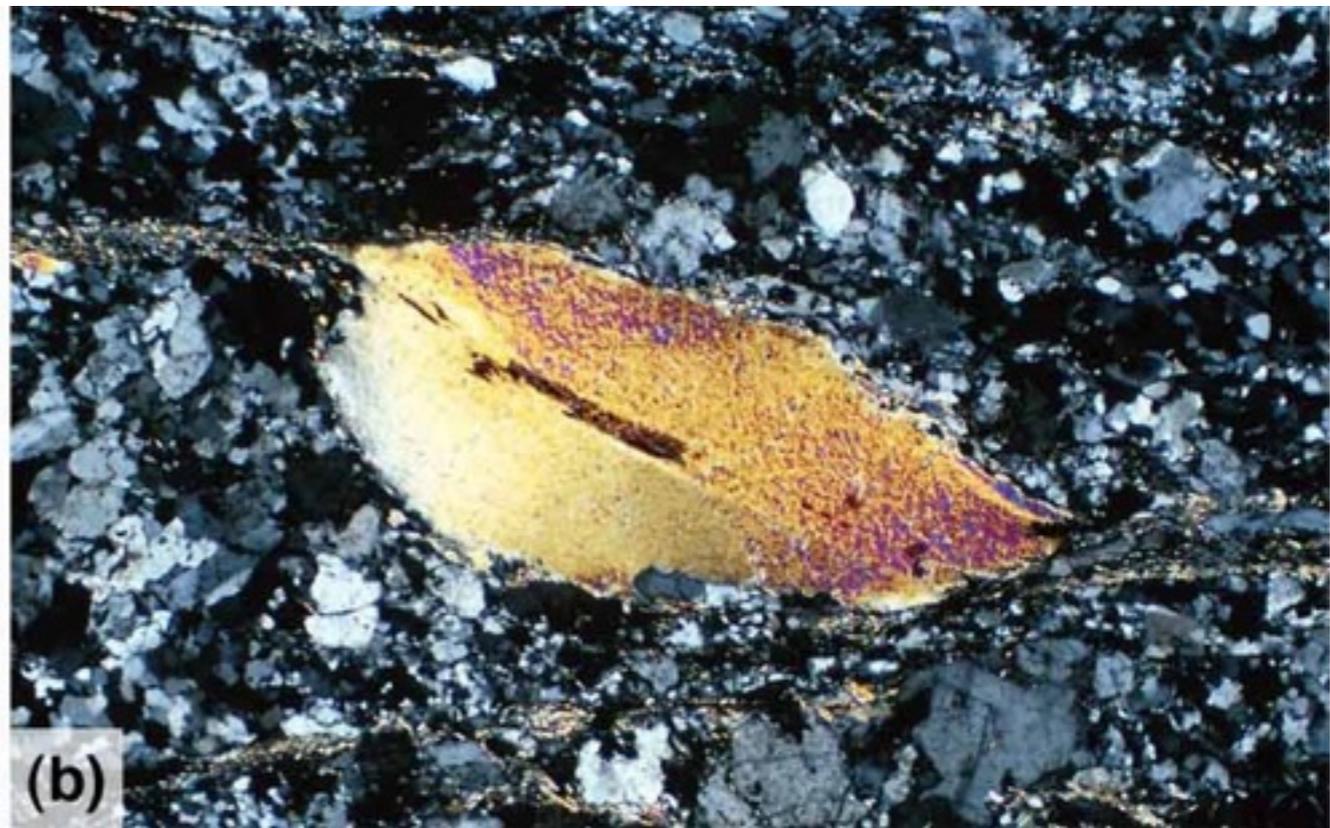
# Porfiroclasti asimmetrici

- Porfiroclasti: cristalli o aggregati di cristalli di grandi dimensioni rispetto ad una matrice a grana fine.
- Di solito muscovite, feldspati, dolomia, ecc.



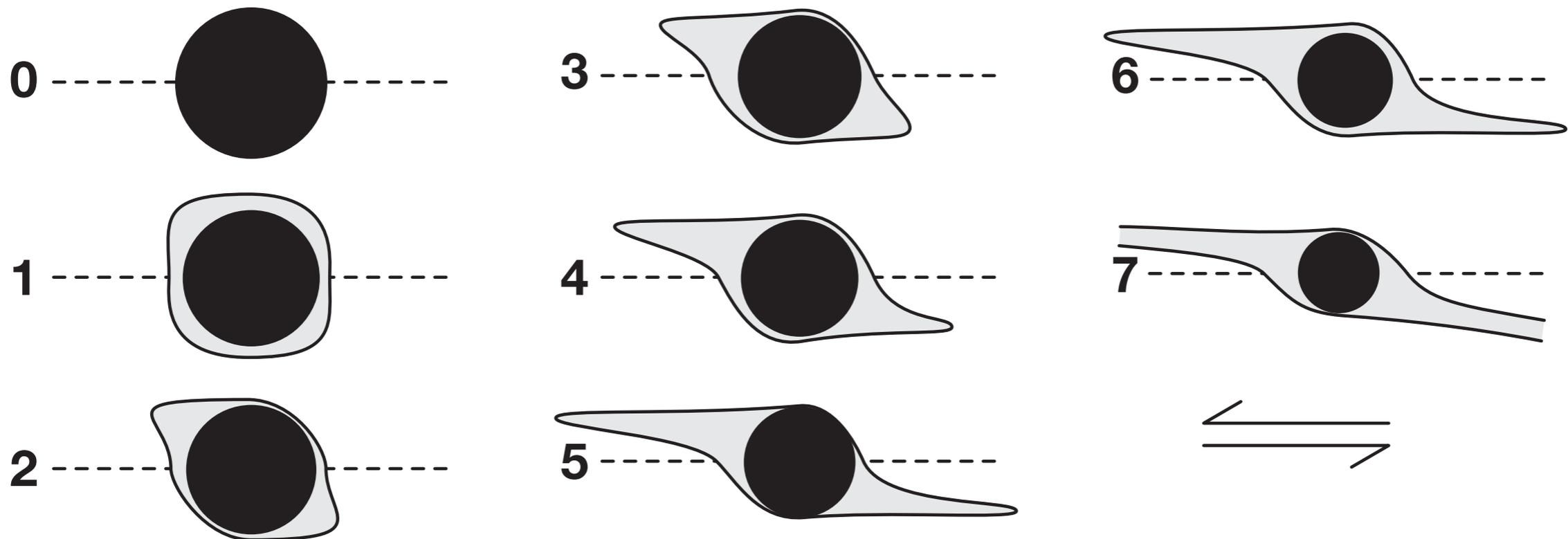
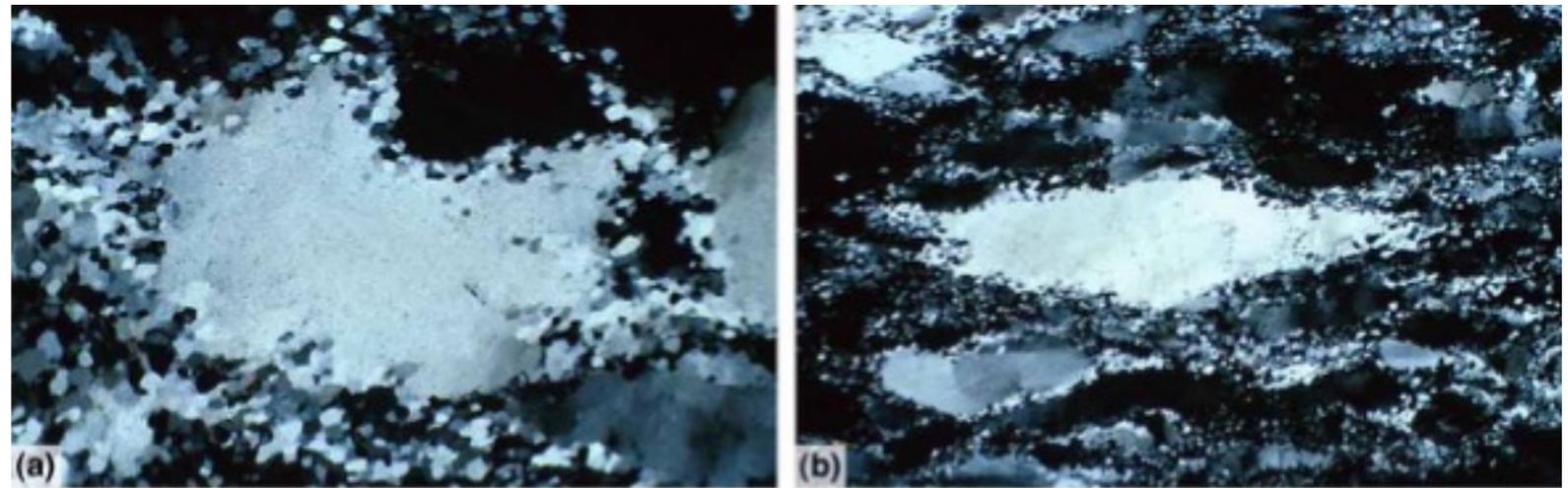
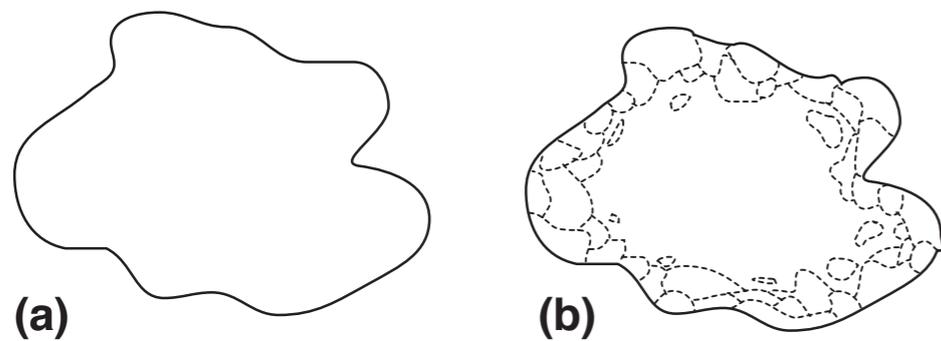
# Porfiroclasti asimmetrici

- Attorno si possono avere code di ricristallizzazione
- se la specie mineralogica che ricristallizza è la stessa del porfiroclasto si parla di porfiroclasti ricristallizzati
- se invece è un'altra specie mineralogica si tratta di code di pressione



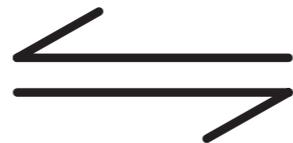
# Porfiroclasti asimmetrici

- si formano in miloniti a seguito di ricristallizzazione sintettonica



# Porfiroclasti asimmetrici

"no stair stepping"



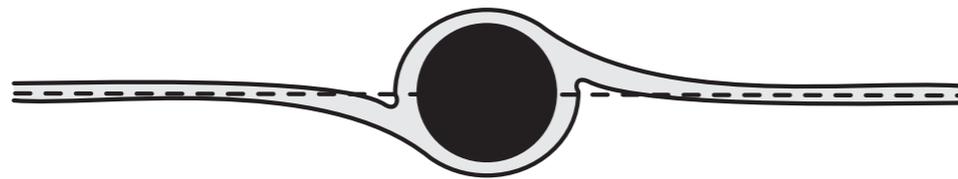
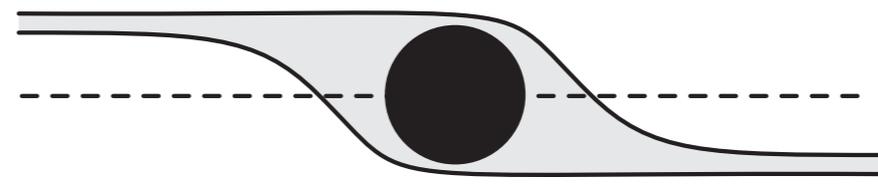
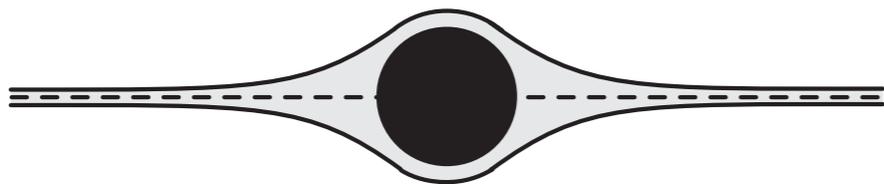
"stair stepping"

*simmetrici*

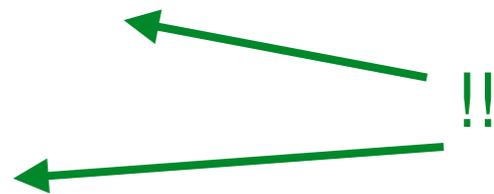
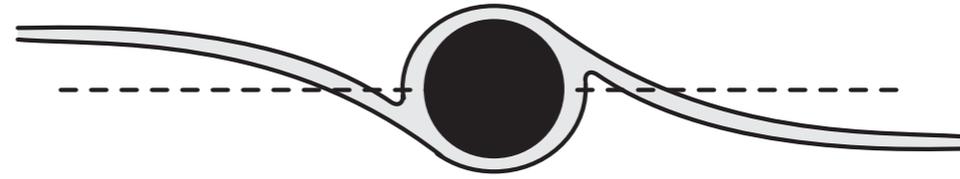
*asimmetrici*

$\phi$

$\sigma$

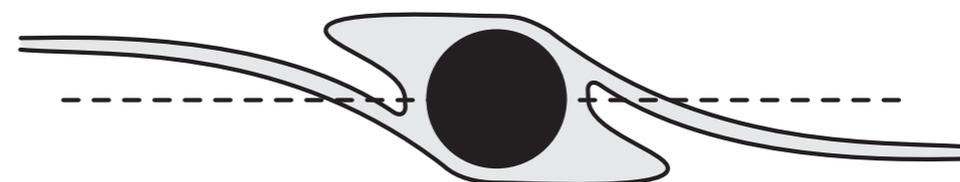
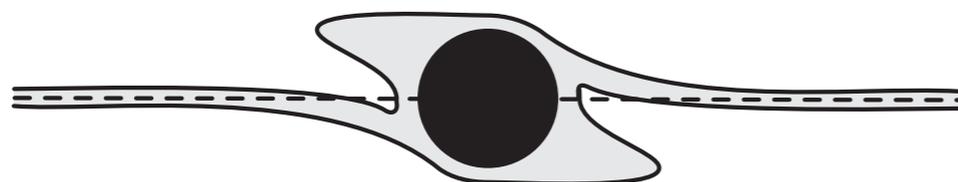


$\delta$



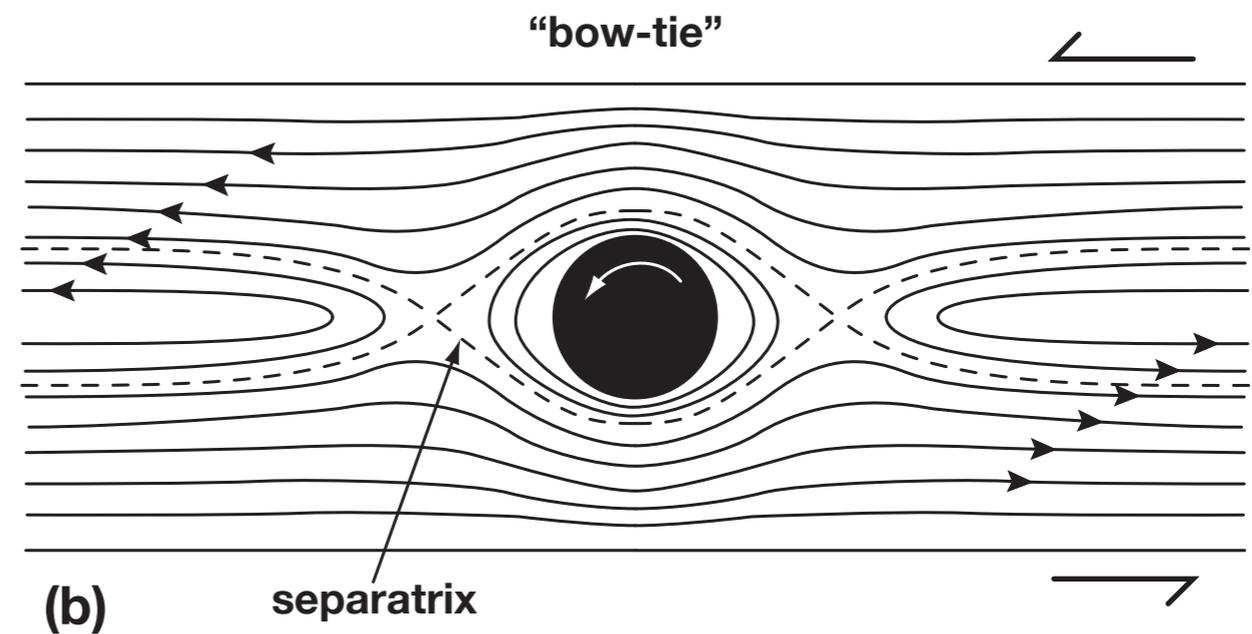
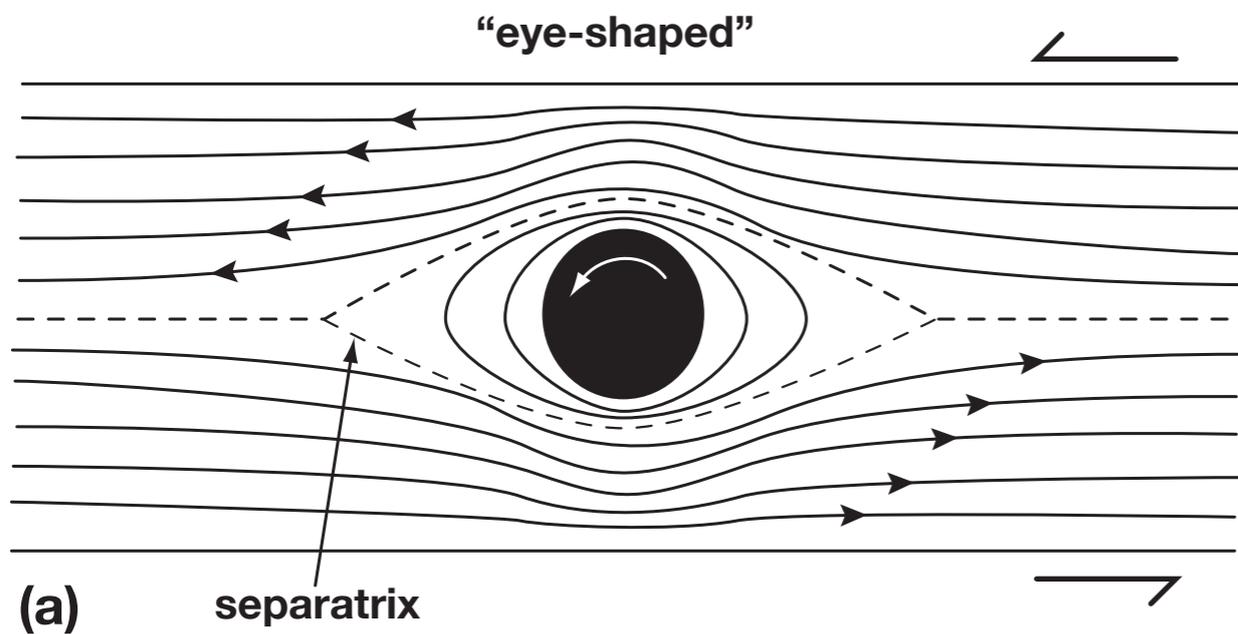
*code tagliano linea mediana*

porfiroclasti complessi



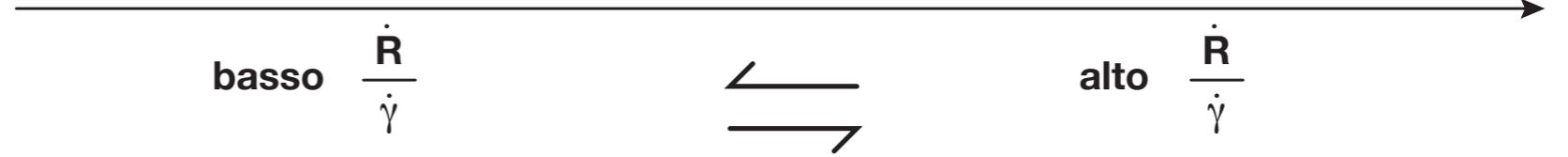
# Porfiroclasti asimmetrici

- possibili vettori spostamento in prossimità di un porfiroclasto che ruota in una matrice



# Porfiroclasti asimmetrici

volume relativo ricrist.

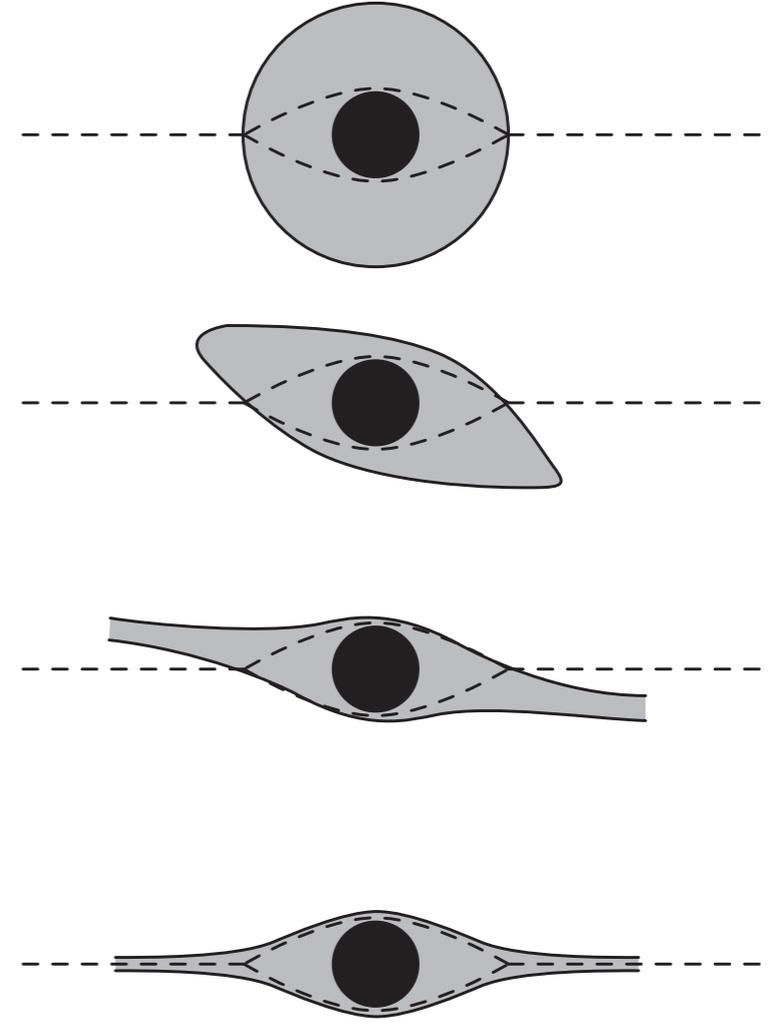
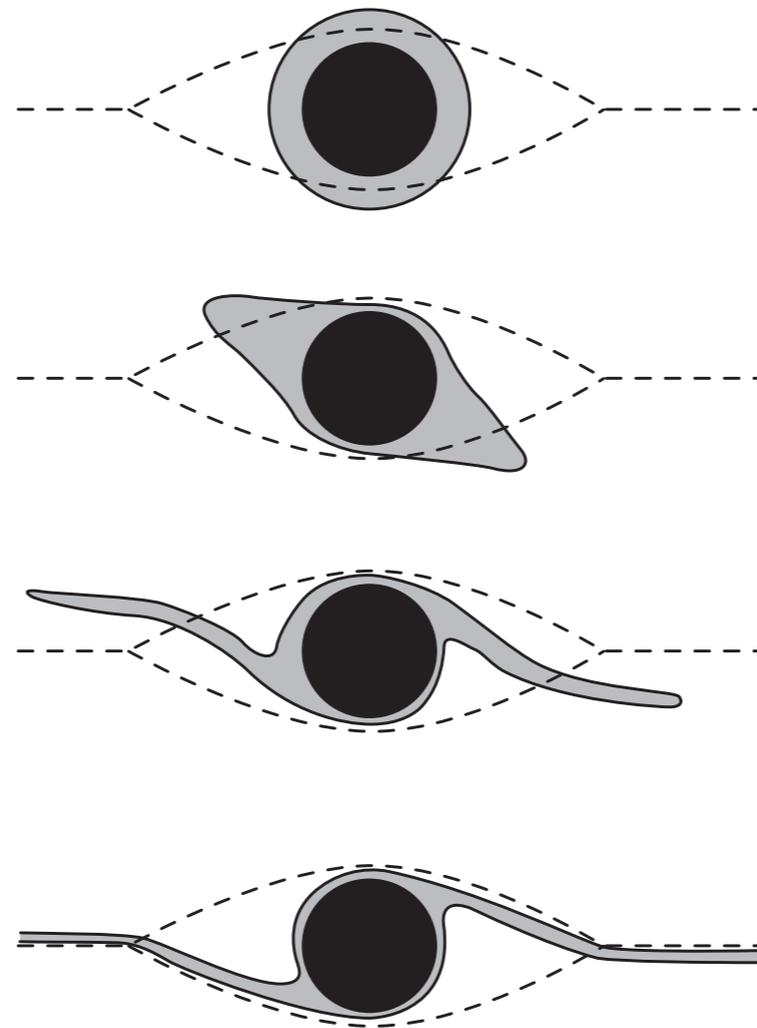


intersezione

non intersezione

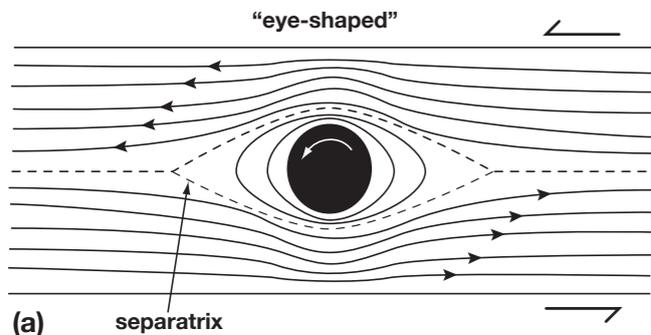
strain

eye-shaped

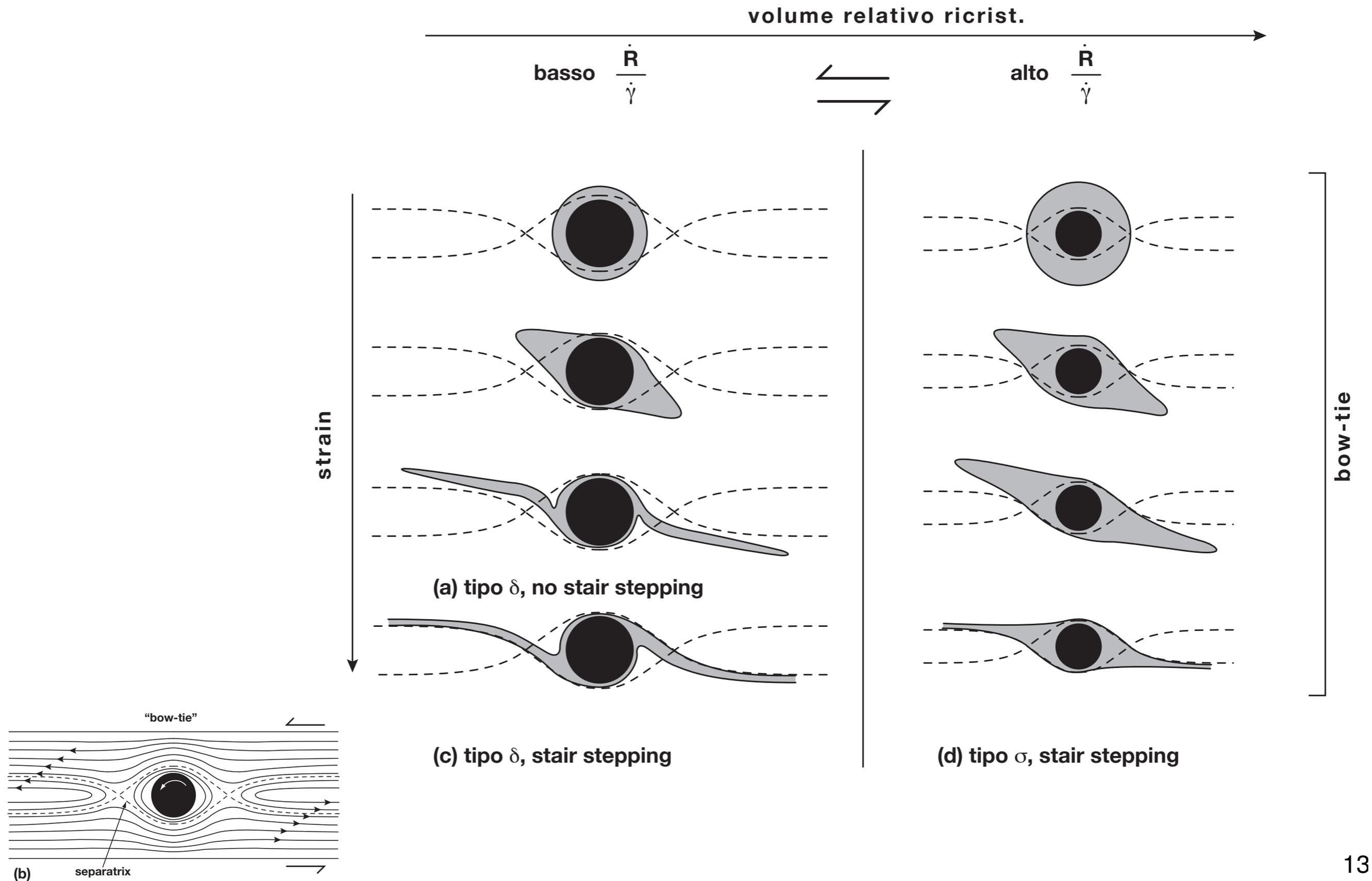


(a) tipo  $\delta$ , no stair stepping

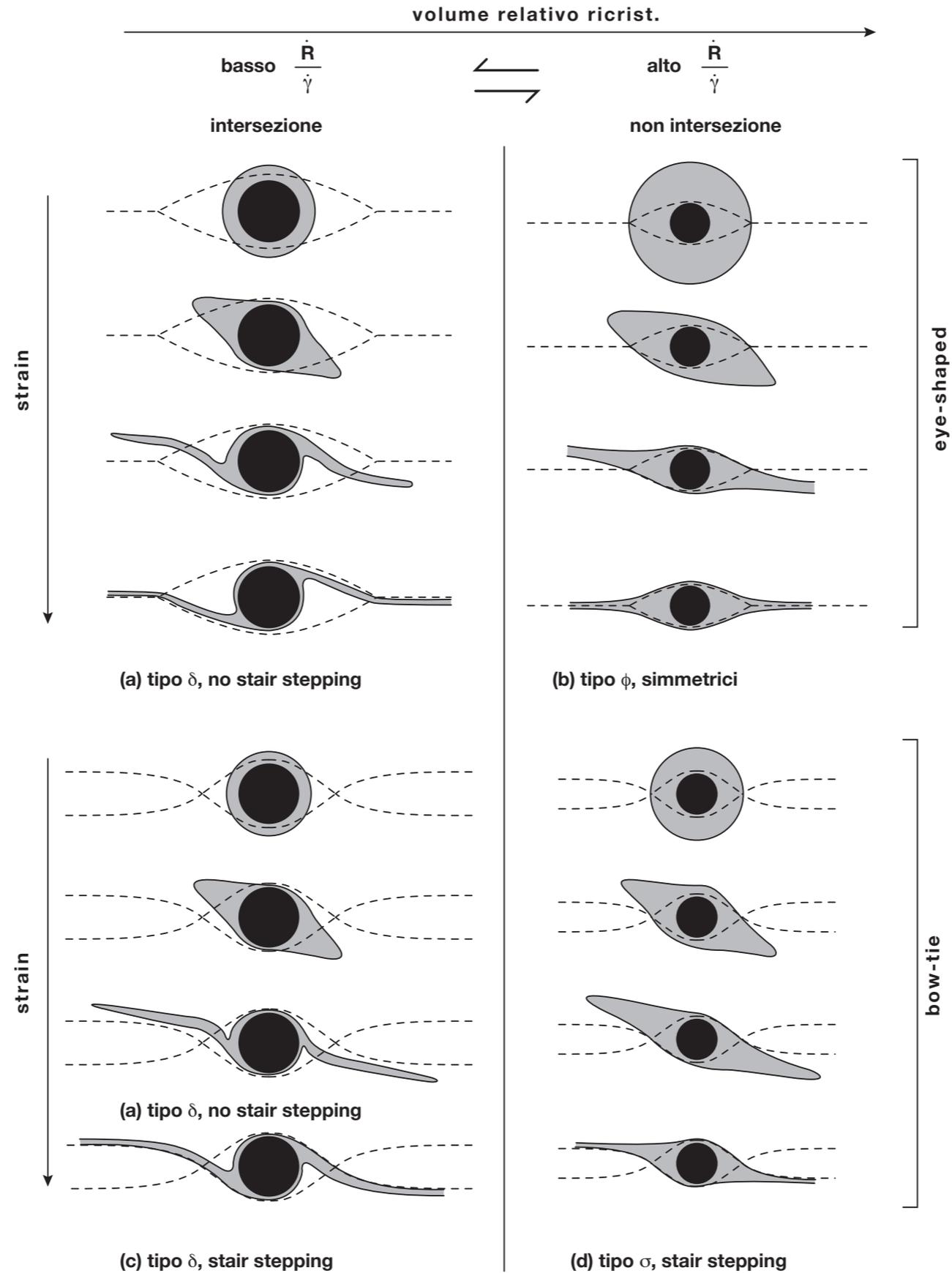
(b) tipo  $\phi$ , simmetrici



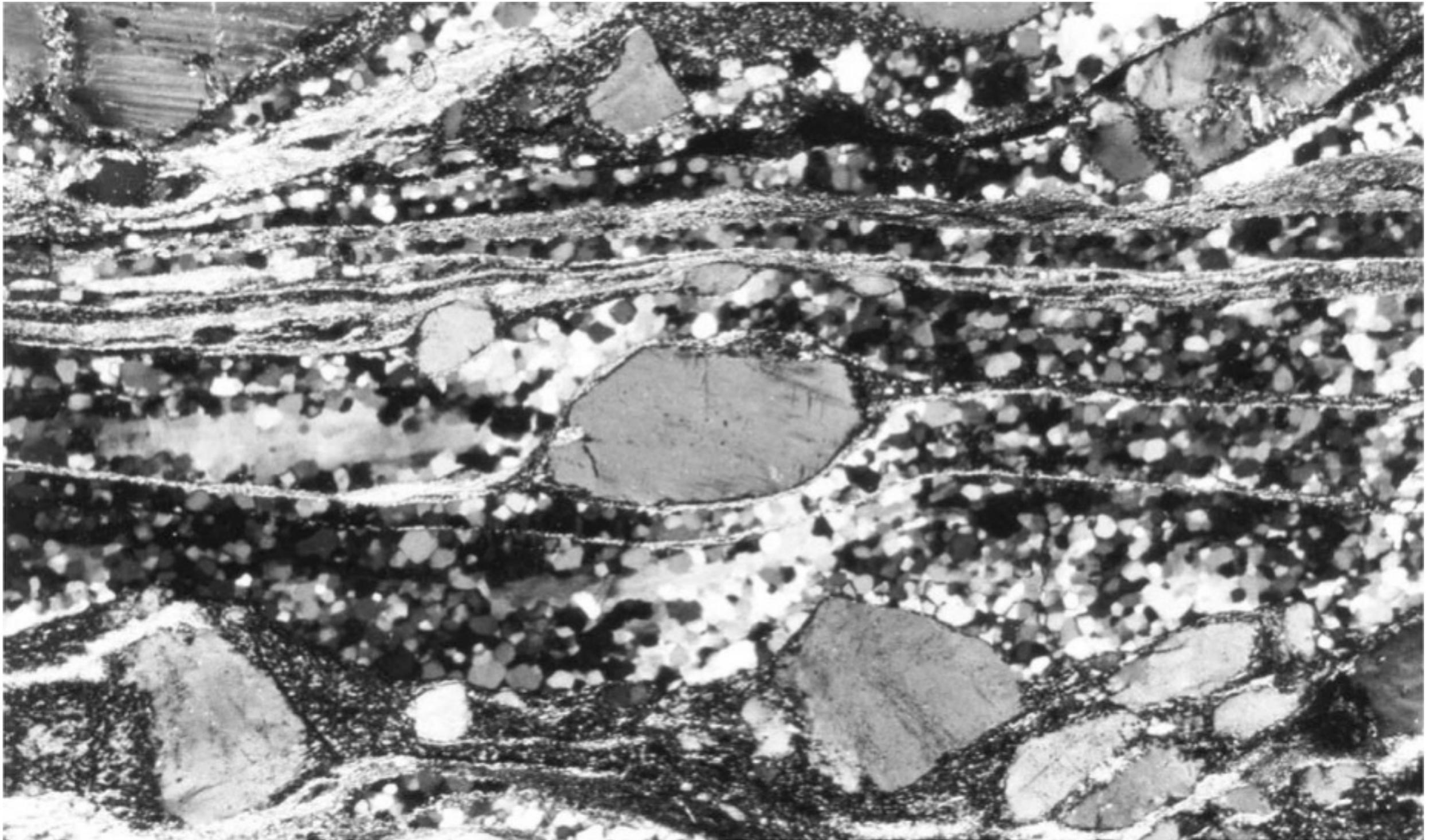
# Porfiroclasti asimmetrici



# Porfiroclasti asimmetrici

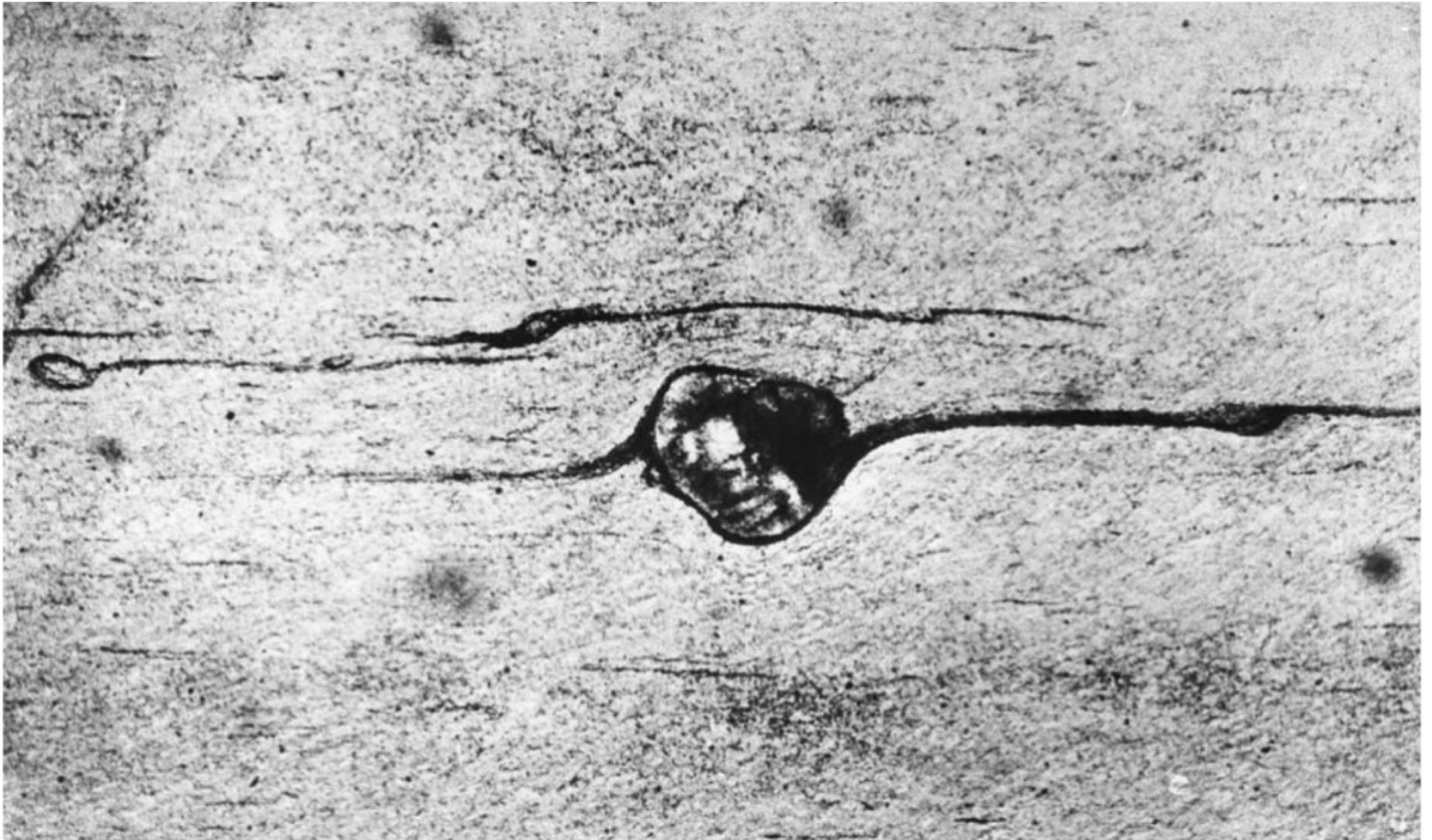


# Porfiroclasti asimmetrici



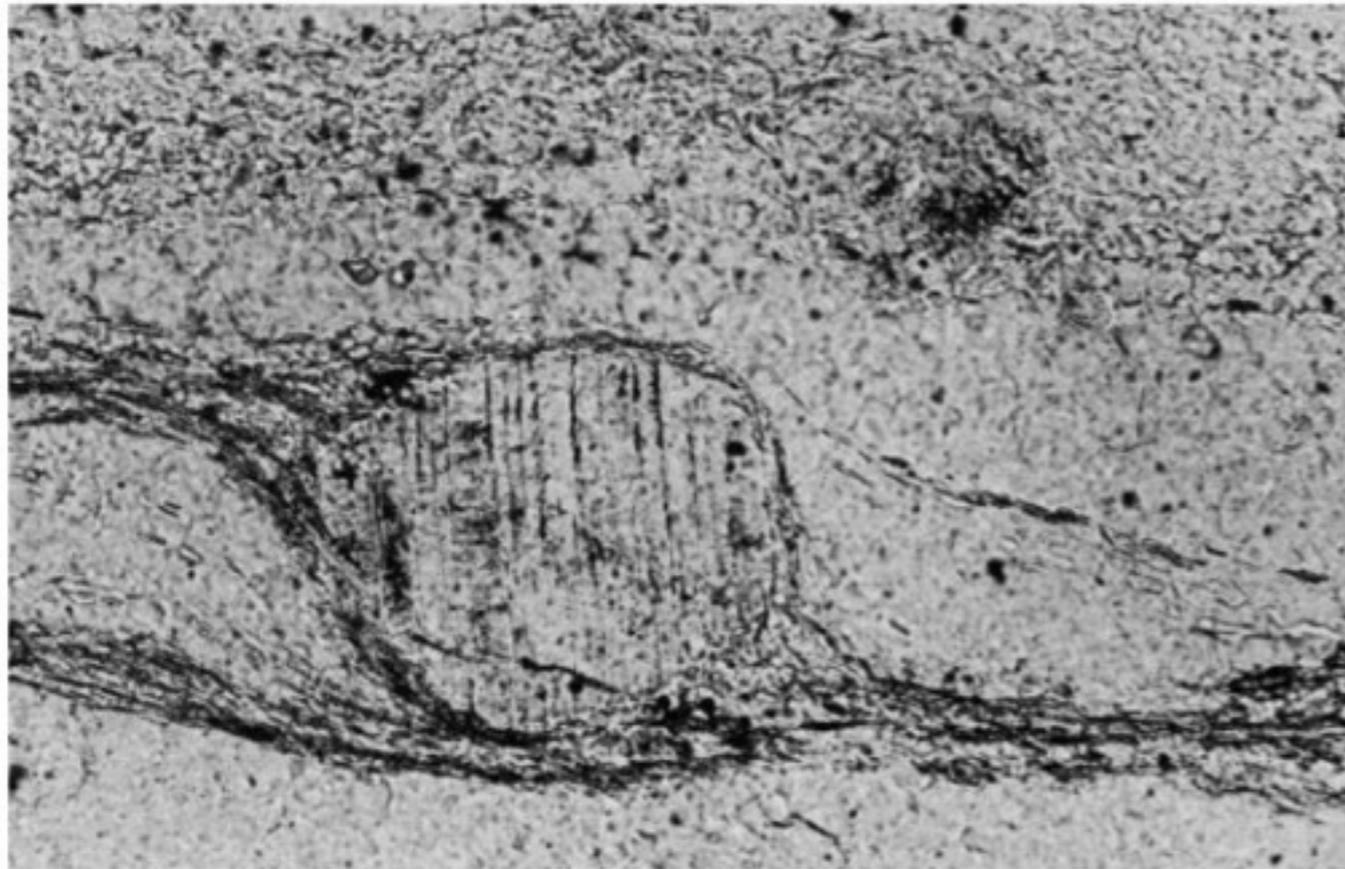
# Porfiroclasti asimmetrici

porfiroclasti tipo  $\delta$

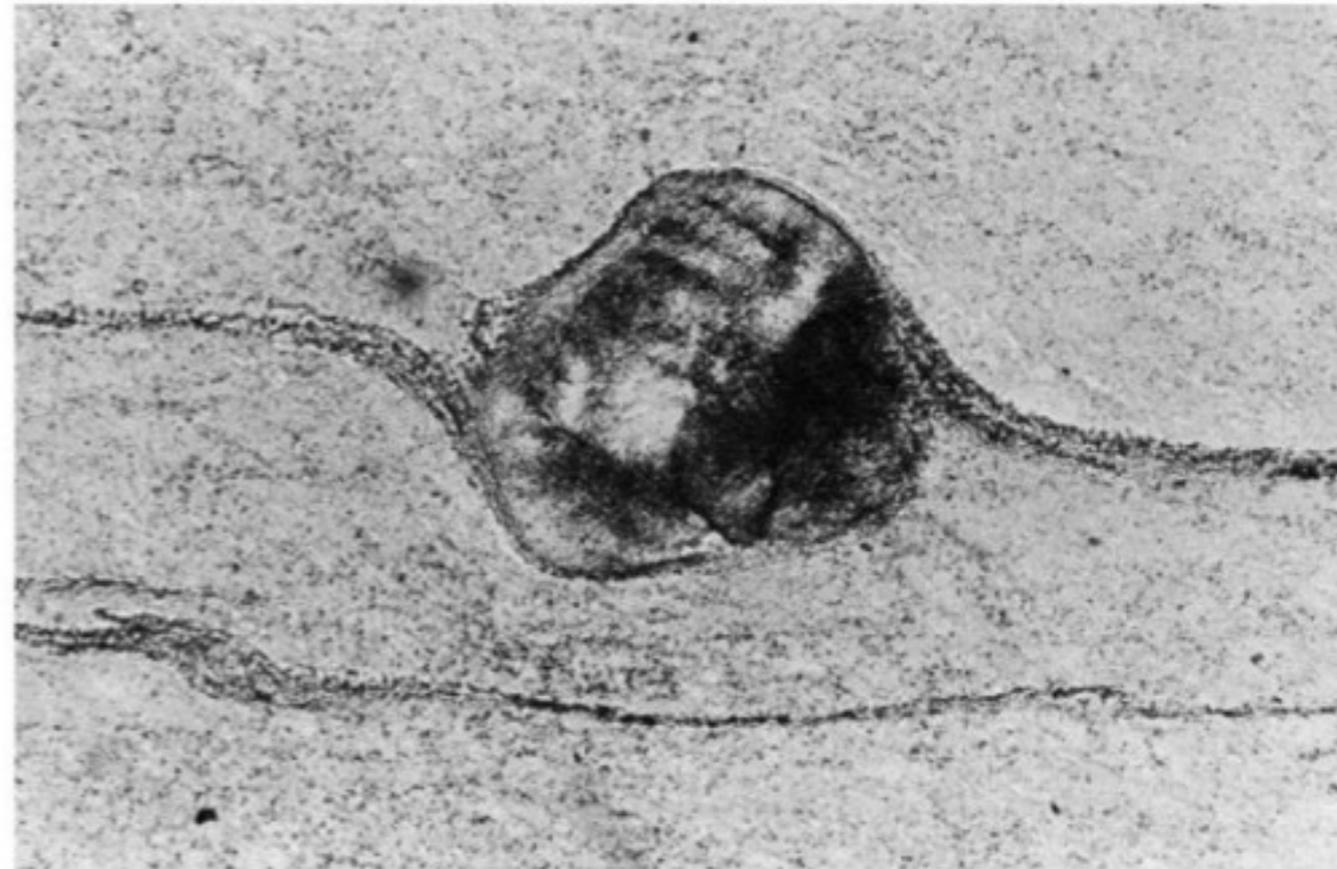


# Porfiroclasti asimmetrici

tipo  $\sigma$



tipo  $\delta$



# Porfiroclasti asimmetrici

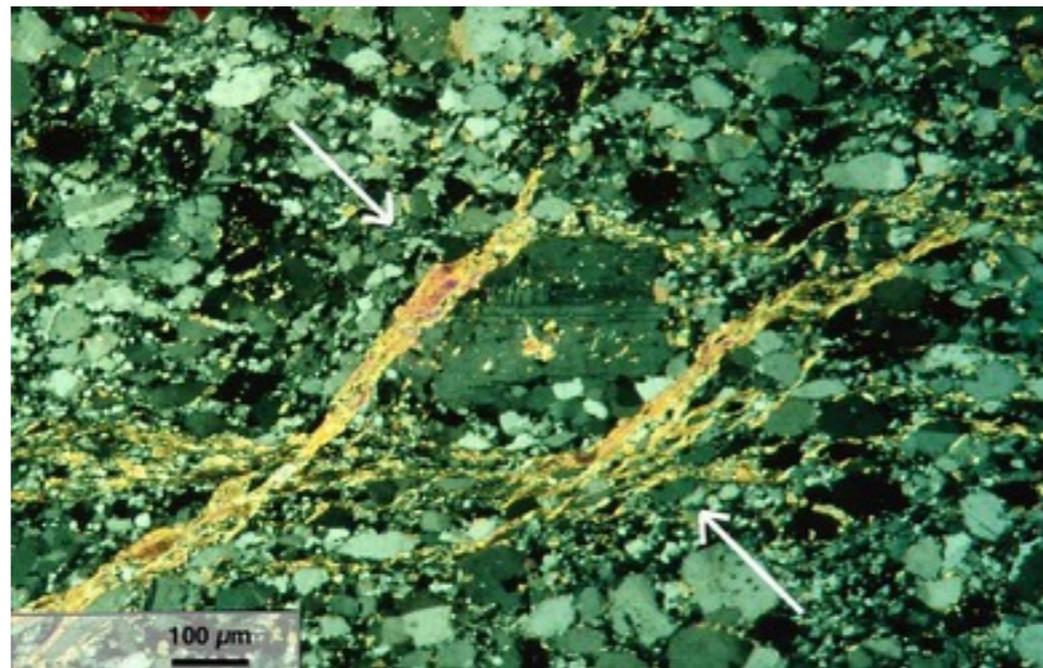
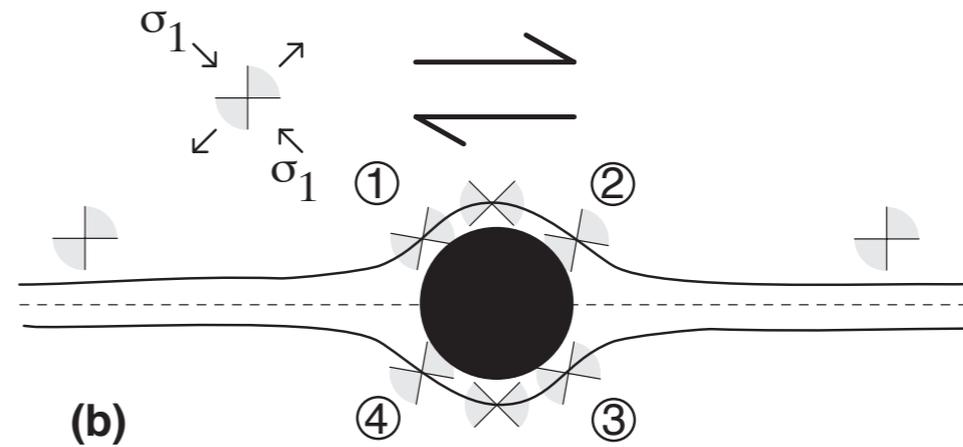
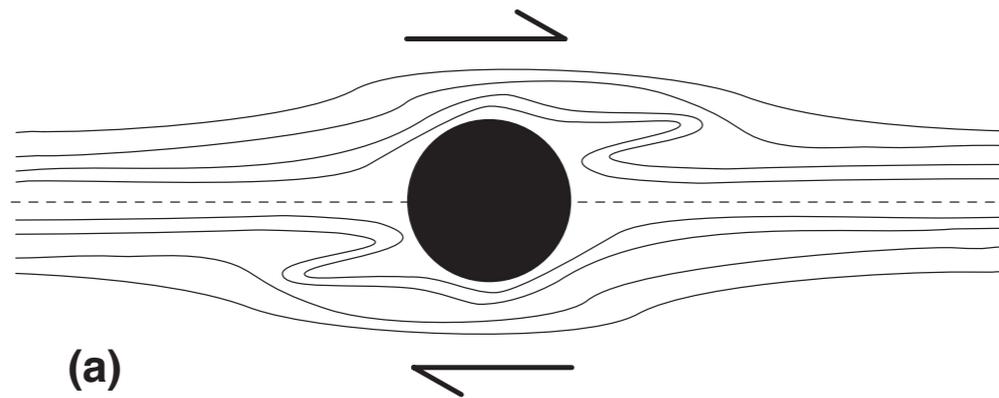
a tutte le scale



# Porfiroclasti asimmetrici

Altre strutture attorno a porfiroclasti asimmetrici:

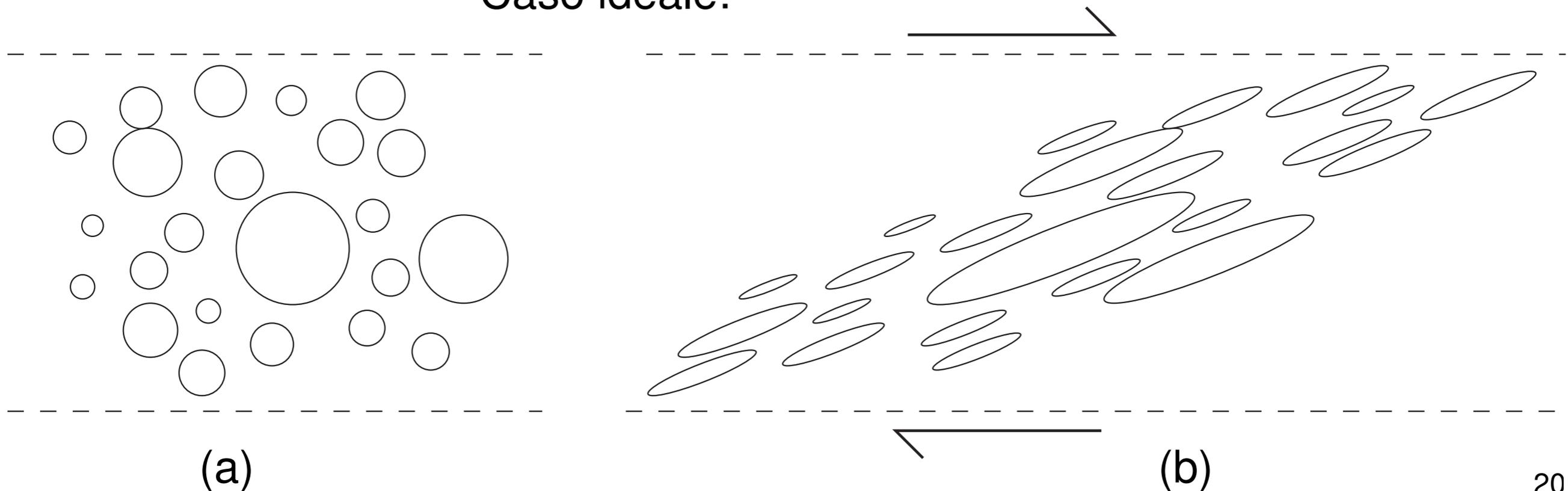
- quarter fold
- quarter mat



# Foliazioni complesse

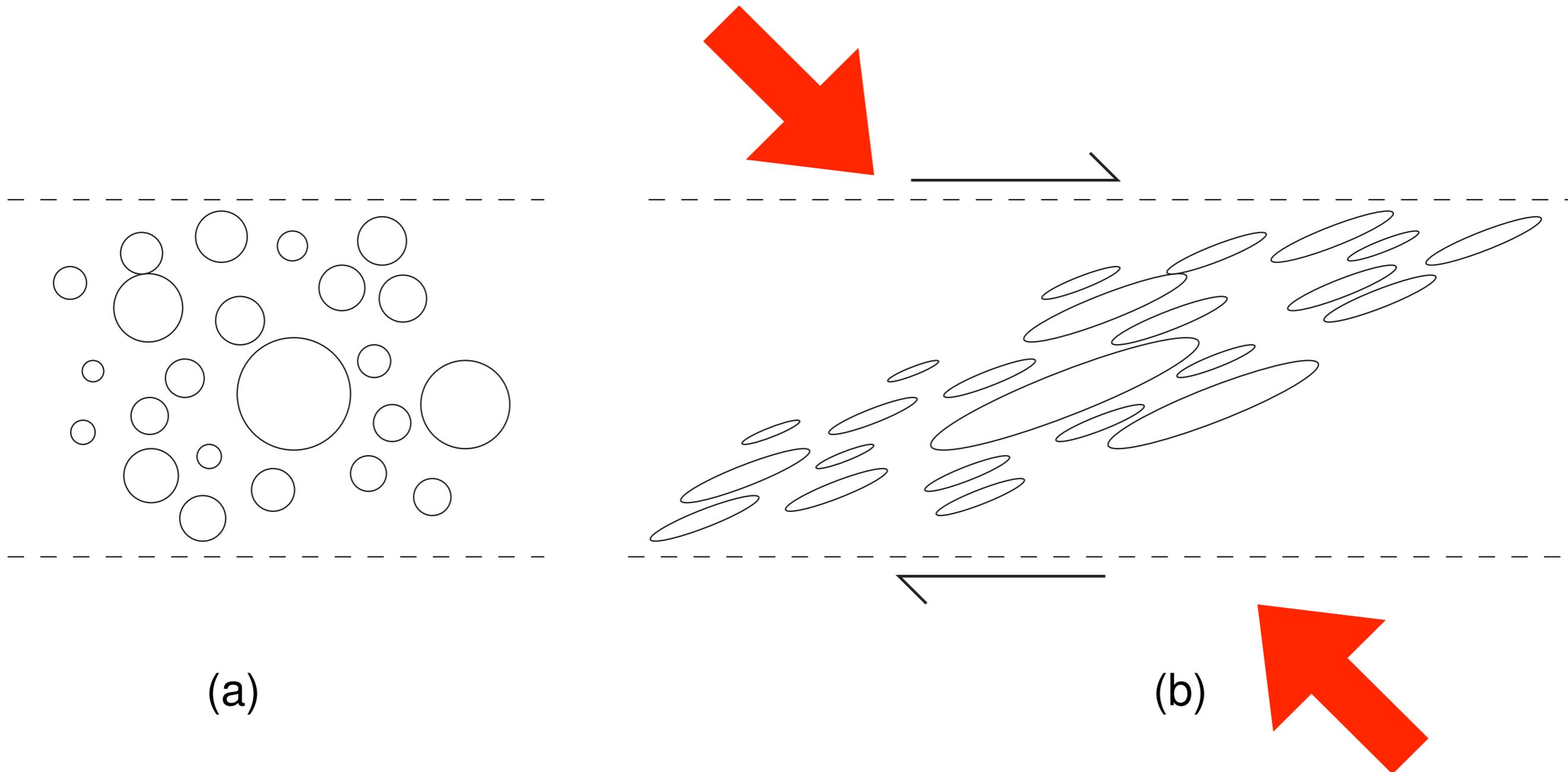
- Oltre alla foliazione principale si possono formare altre foliazioni
- i rapporti tra queste foliazioni sono degli indicatori cinematici:
- Superfici S-C
- Shear band

Caso ideale:



# Superfici S-C

- Foliazione in una zona di taglio
- roccia omogenea, isotropa, continua

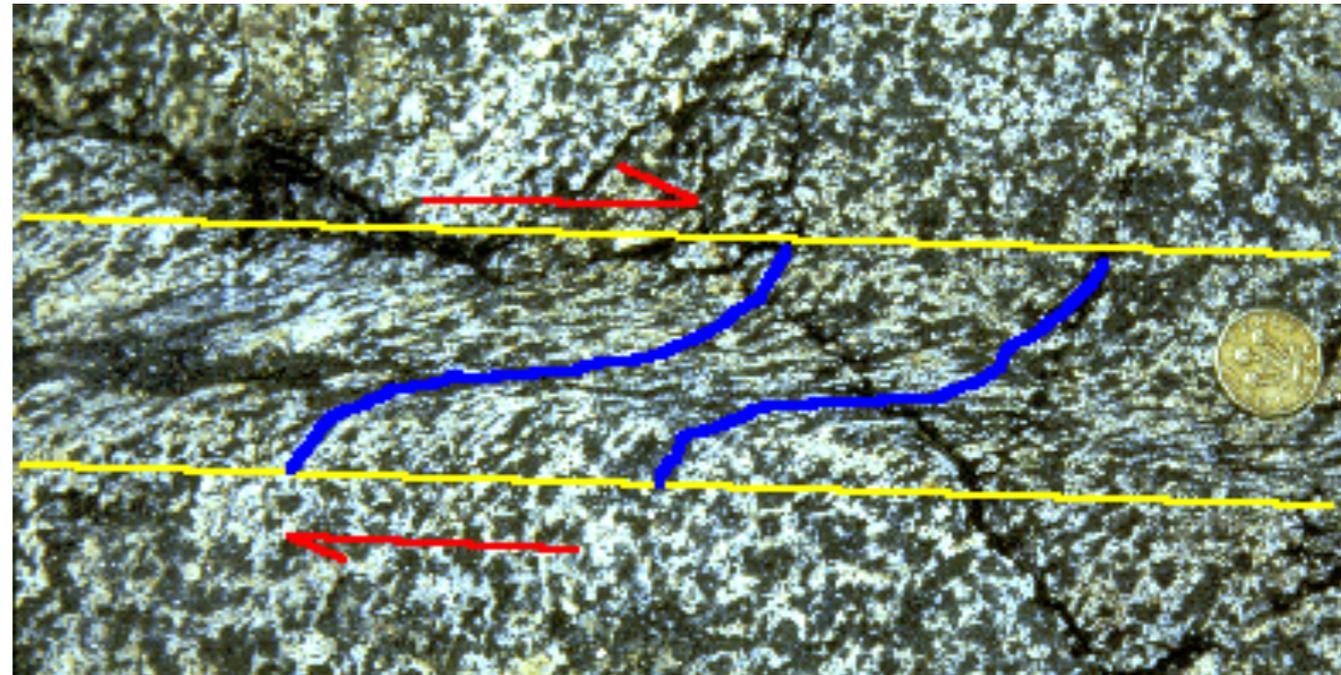
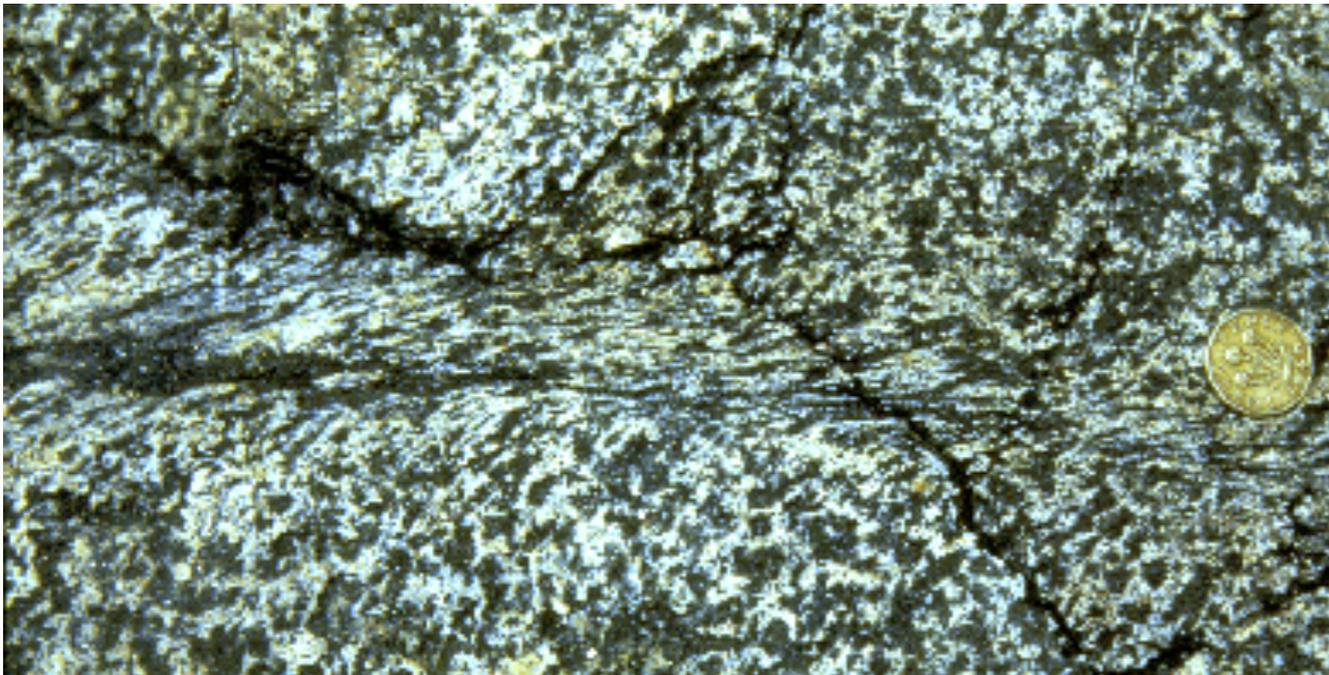


(a)

(b)

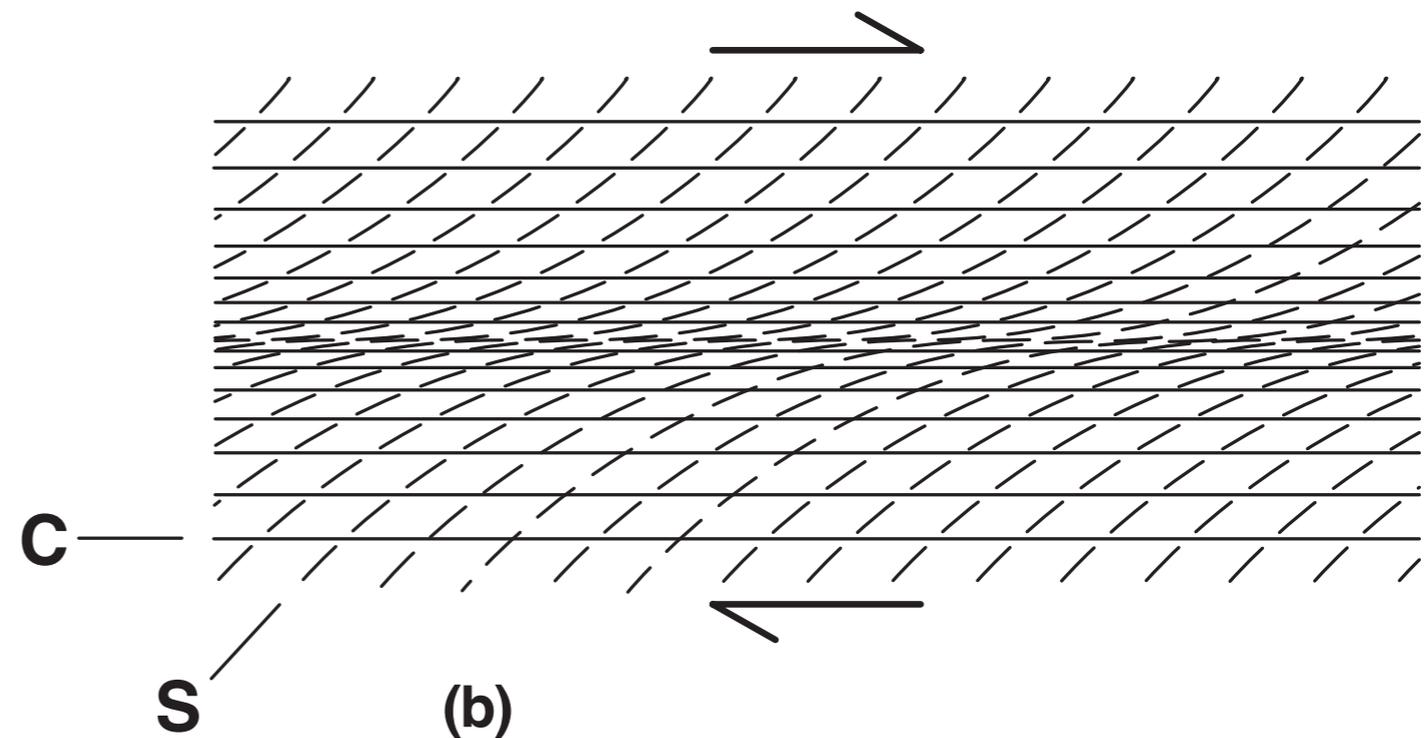
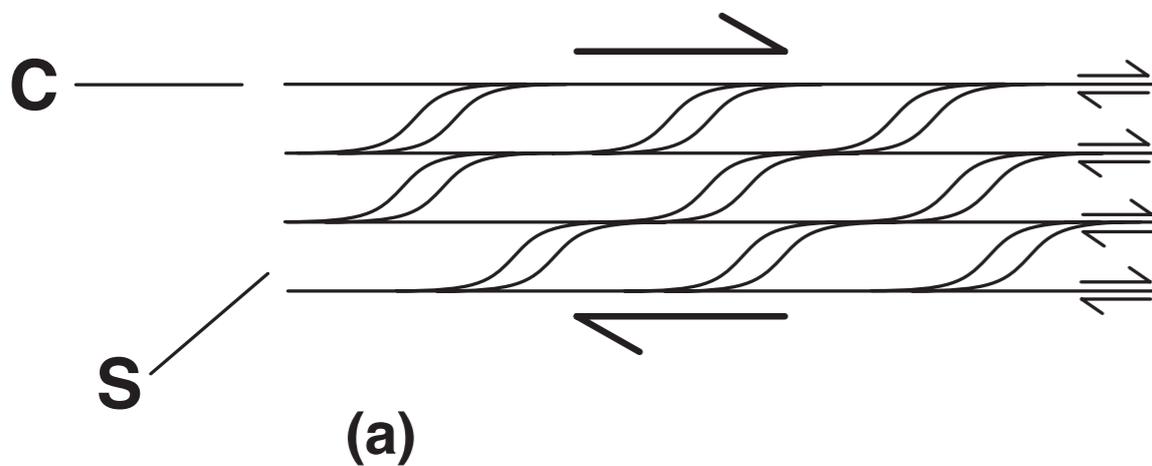
# Superfici S-C

- Foliazione in una zona di taglio
- roccia omogenea, isotropa, continua

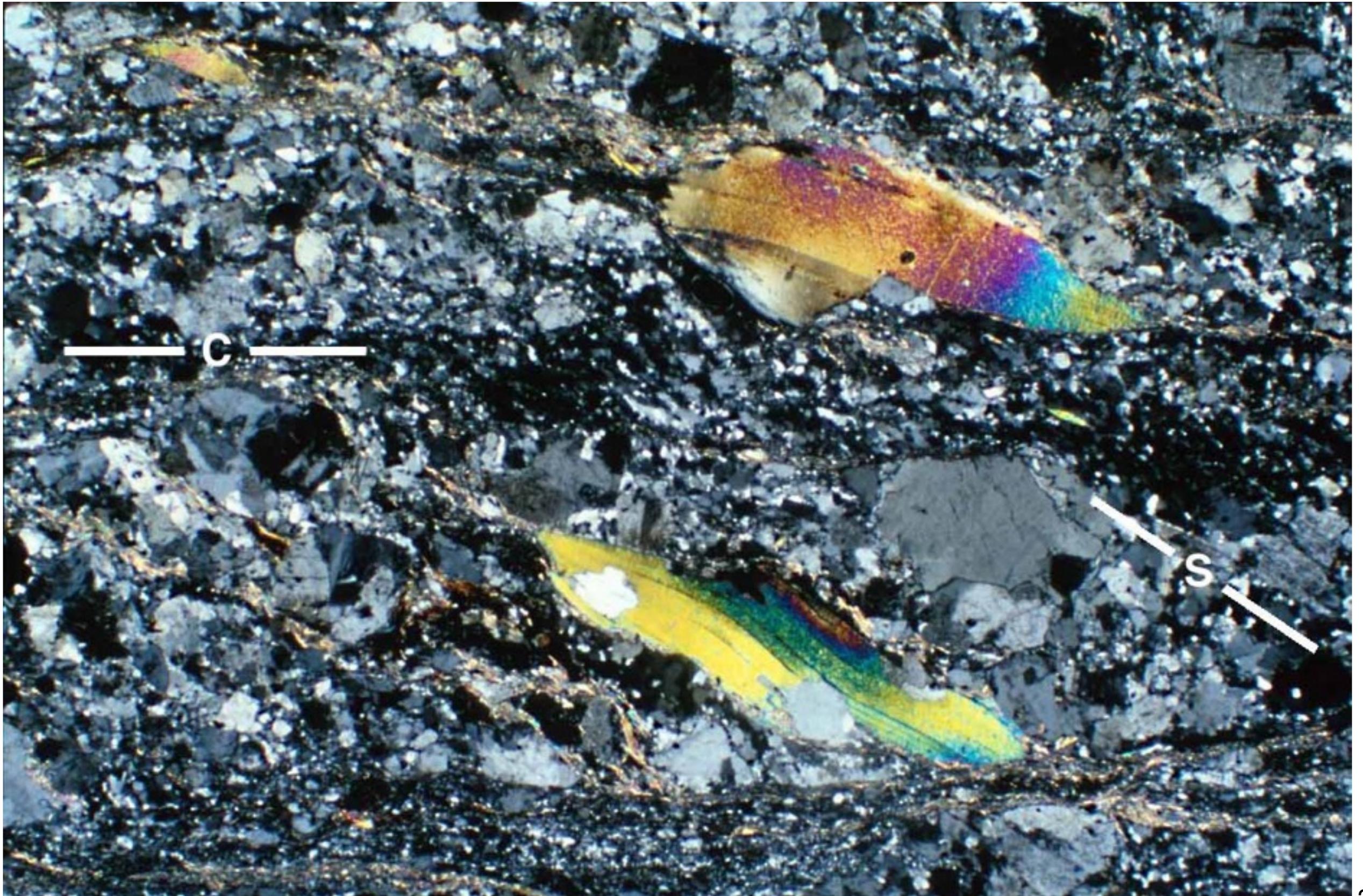


# Superfici S-C

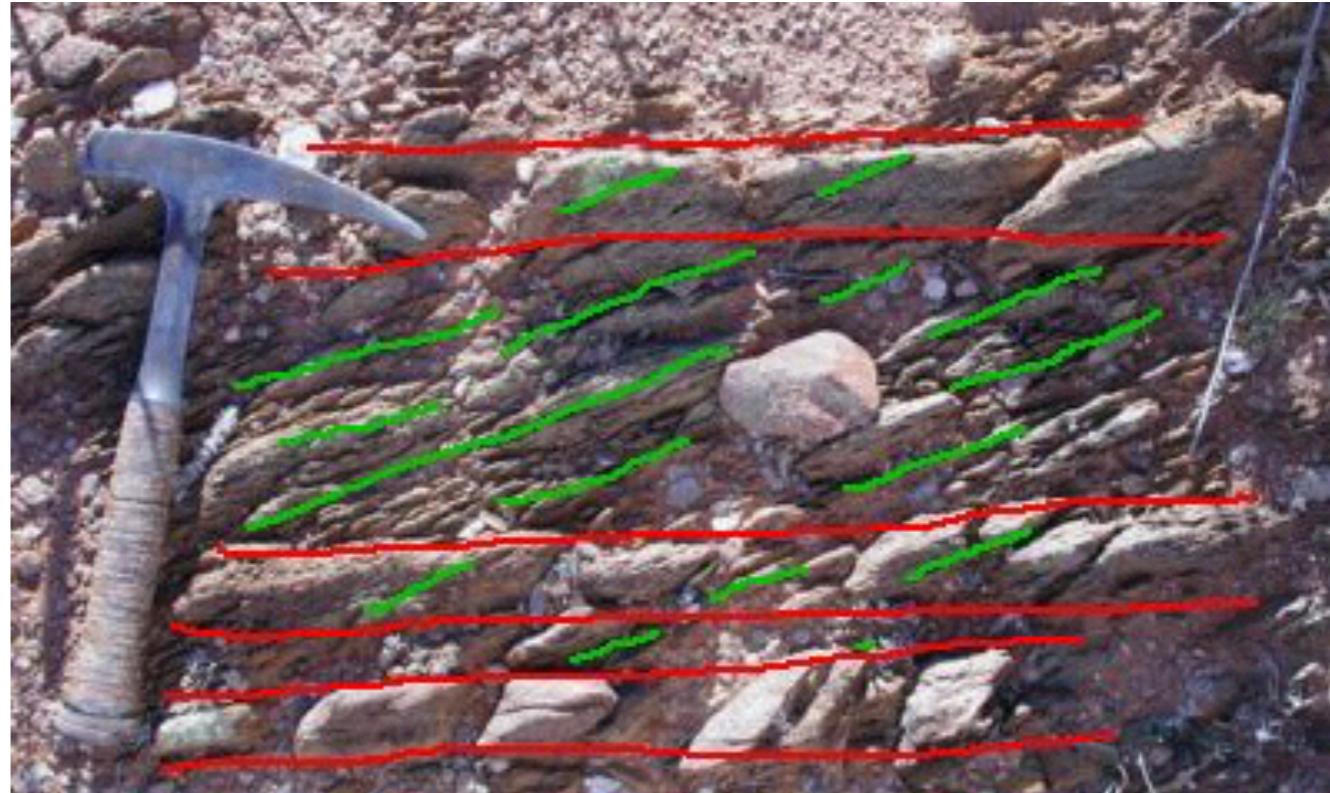
- Foliazioni oblique in una zona di taglio
- superfici C, dal francese *cisaillement*, (parall. Limiti zona di taglio)
- superfici S, dal francese *schistosité* (*foliazione obliqua rispetto ai limiti zona di taglio*)



# Superfici S-C



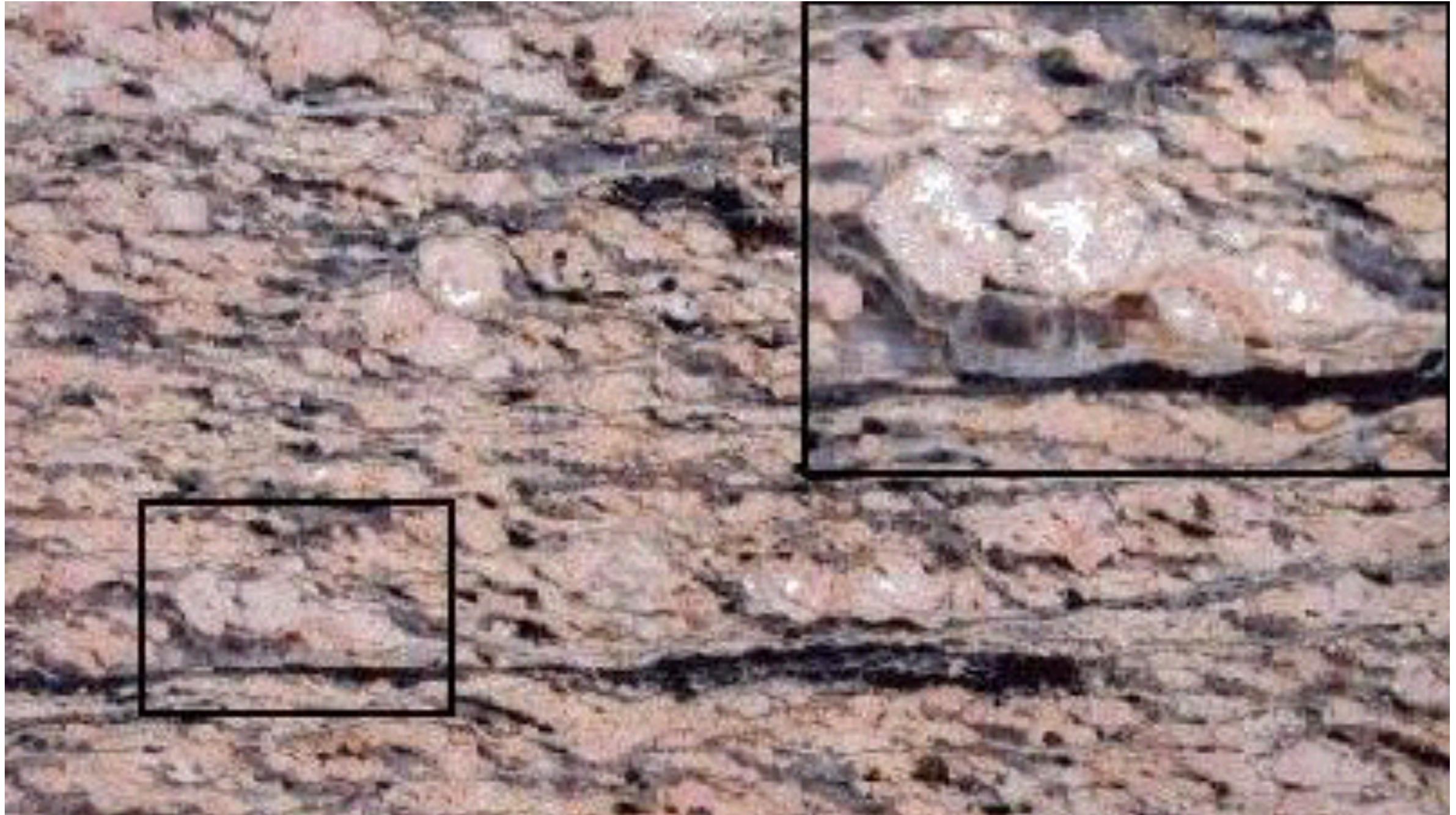
# Superfici S-C



# Superfici S-C



# Superfici S-C

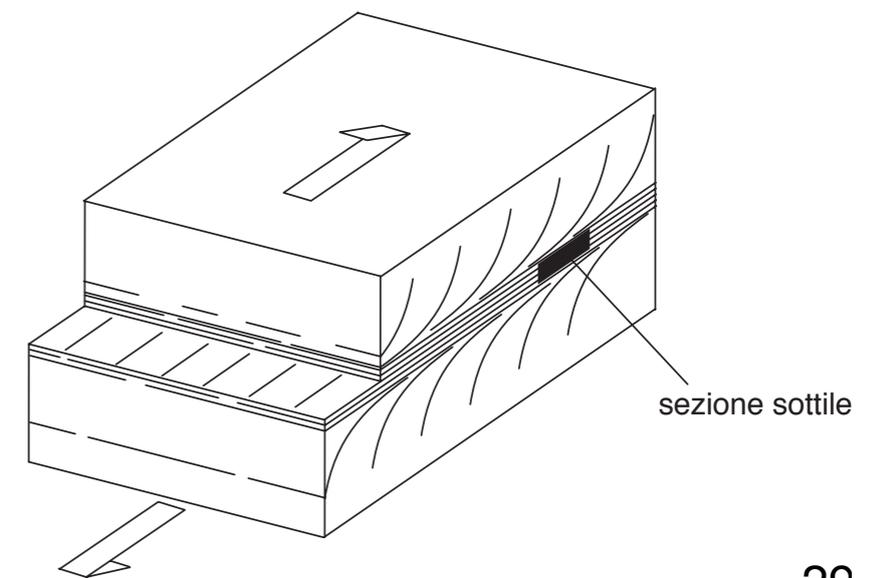
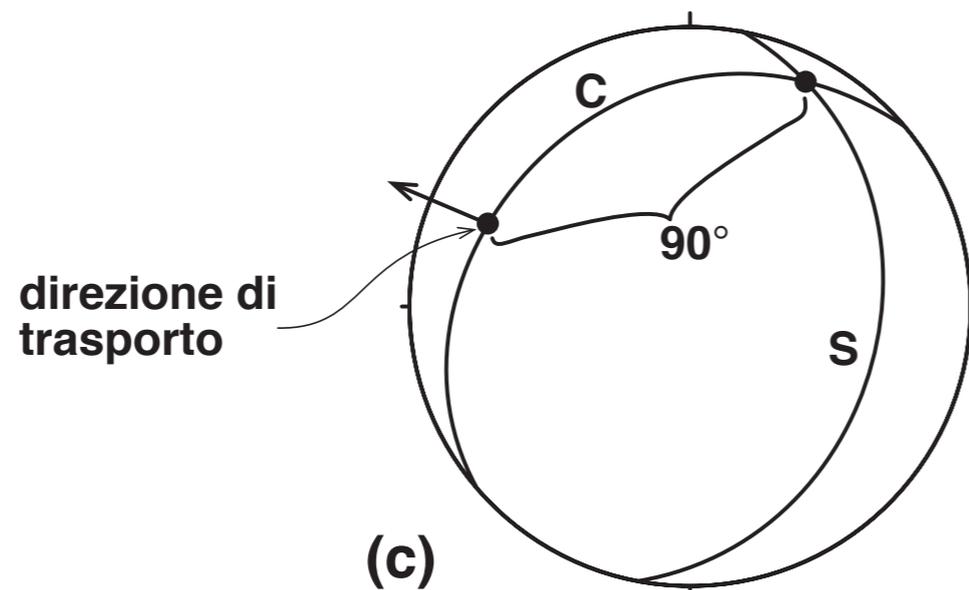
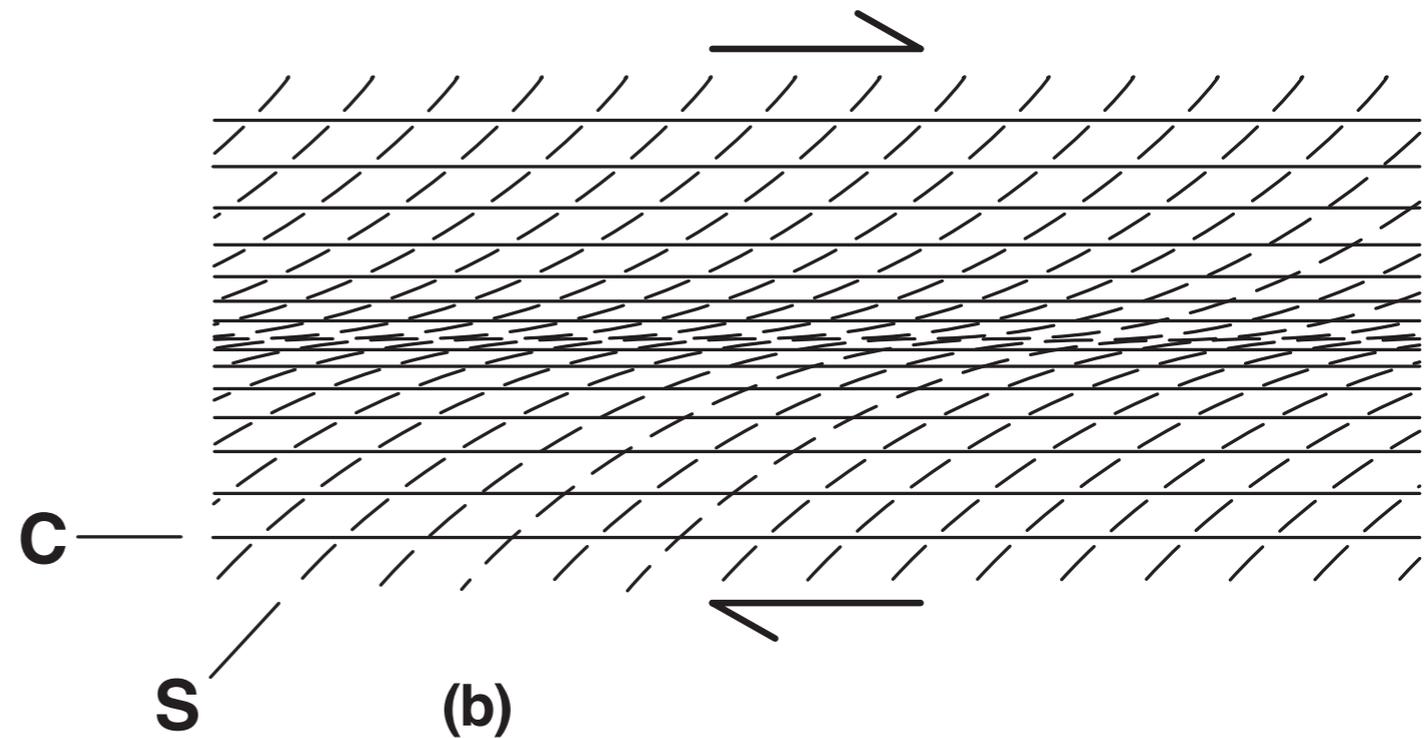
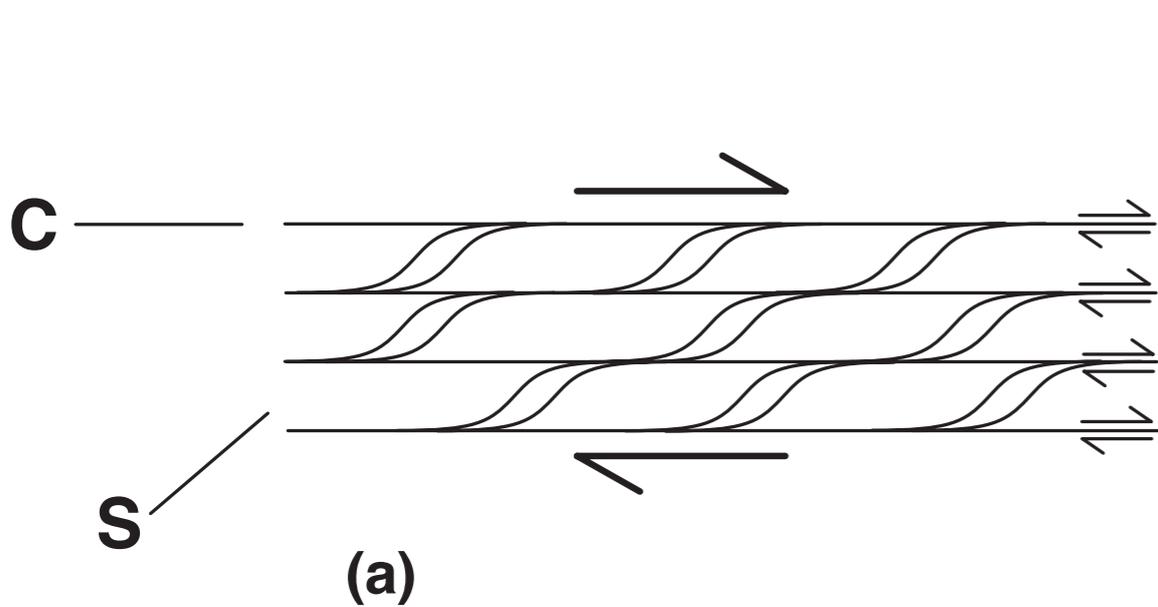


# Superfici S-C



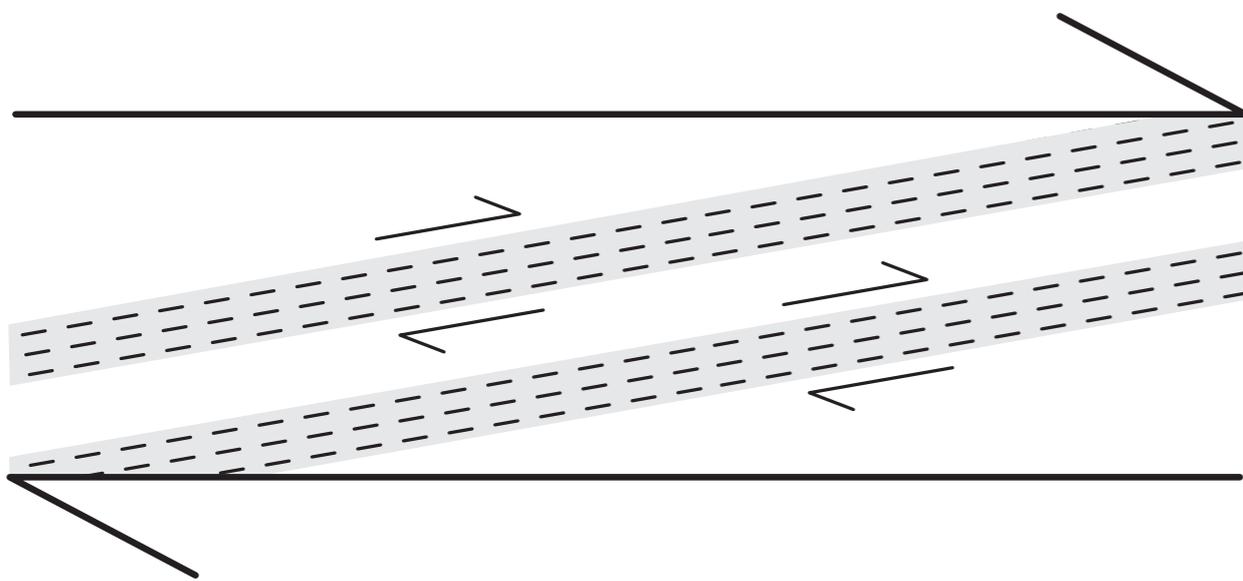
# Superfici S-C

- si può ricavare direzione e senso di movimento

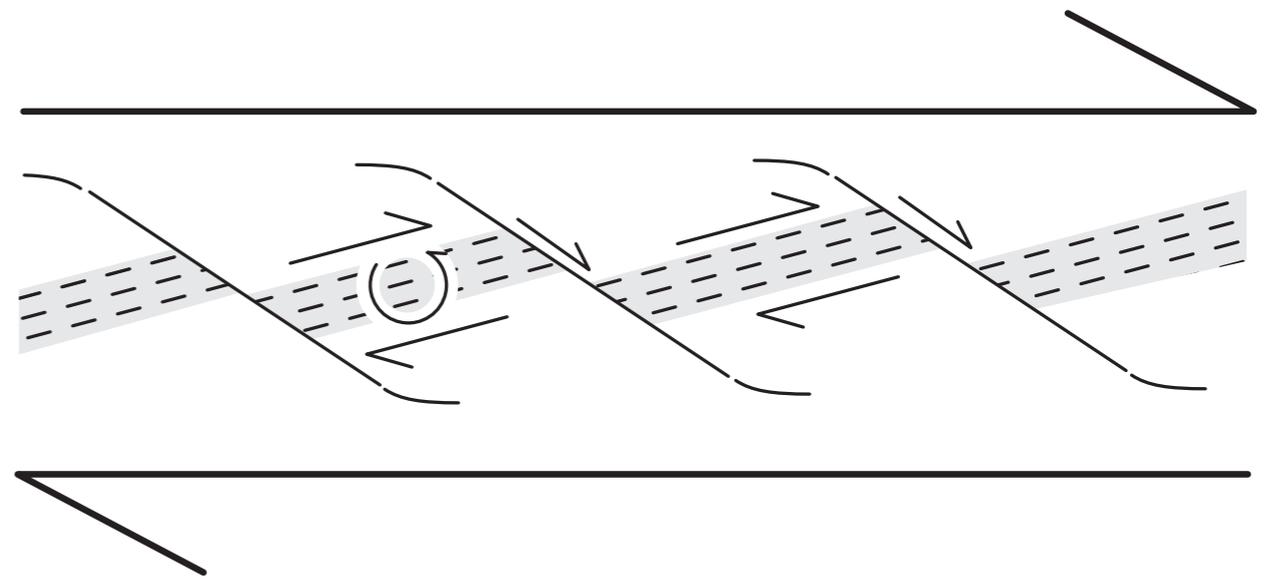


# Shear band

- zone di taglio a piccola scala in miloniti, con movimento sintetico rispetto al senso generale di trasporto
- Localmente tagliano la foliazione milonitica, ma dopo breve tratto diventano parallele
- perdono progressivamente di importanza



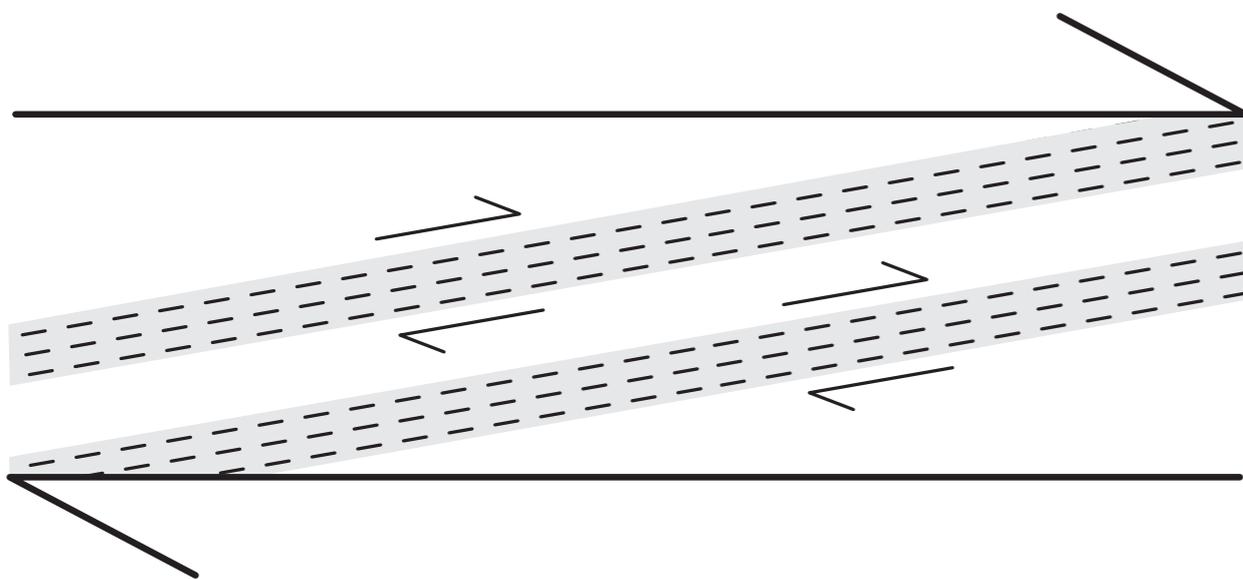
(a)



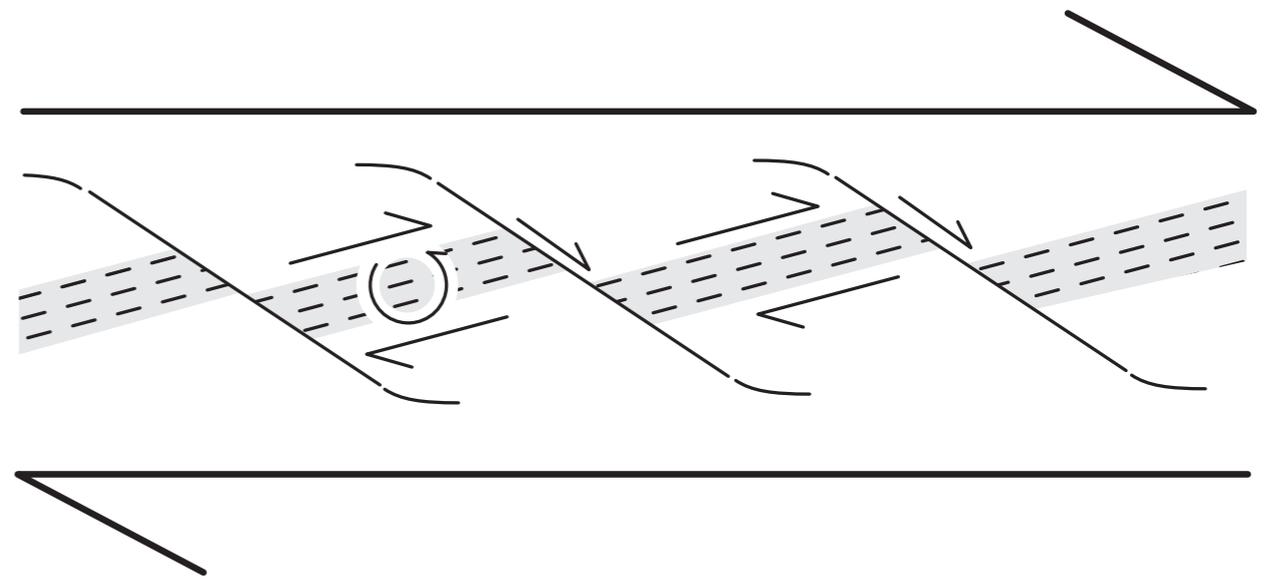
(b)

# Shear band

- si formano negli stadi finali di una deformazione milonitica
- in miloniti con livelli fillosilicatici
- necessarie per mantenere costante lo spessore della zona di taglio
- dette anche “superfici S-C”

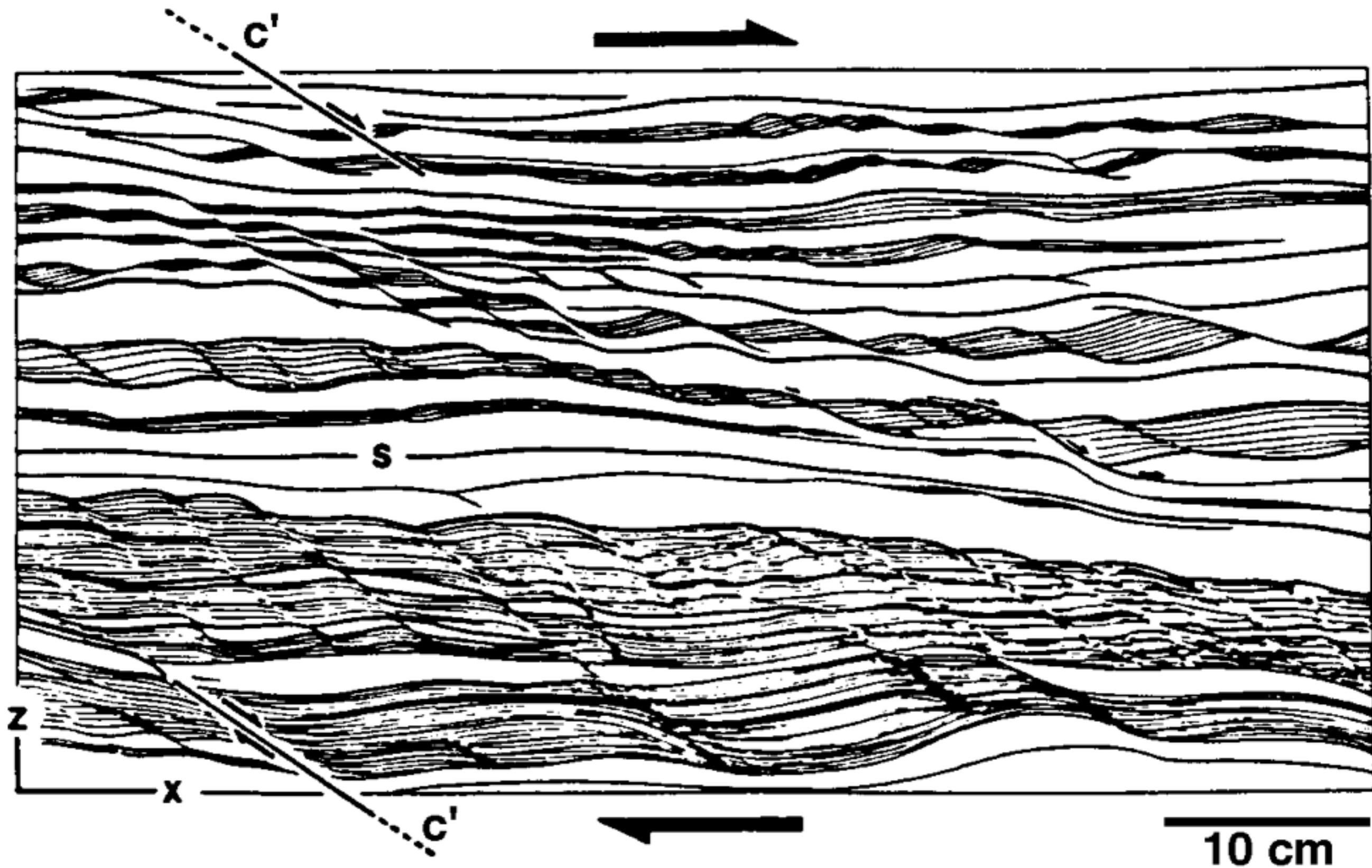


(a)



(b)

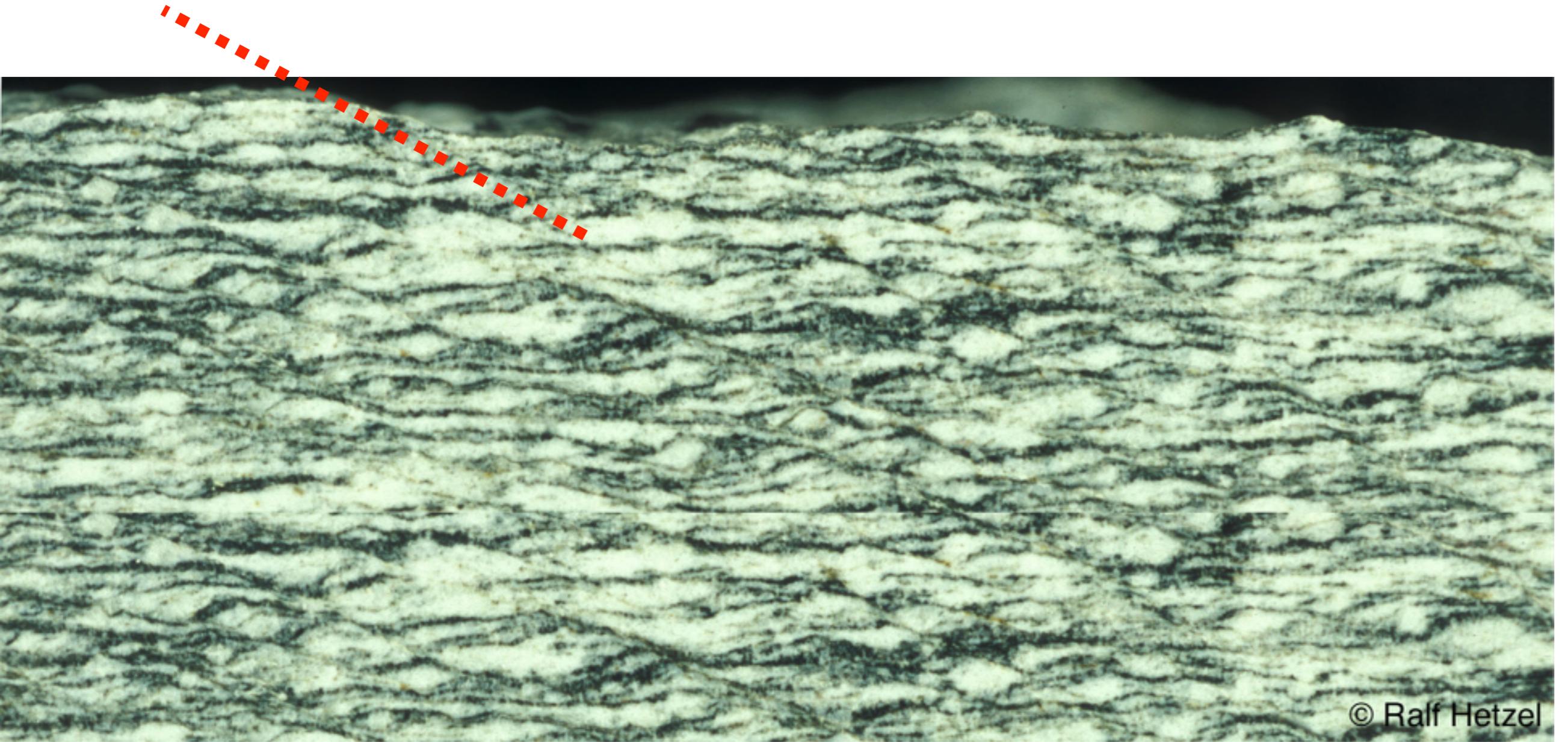
# Shear band



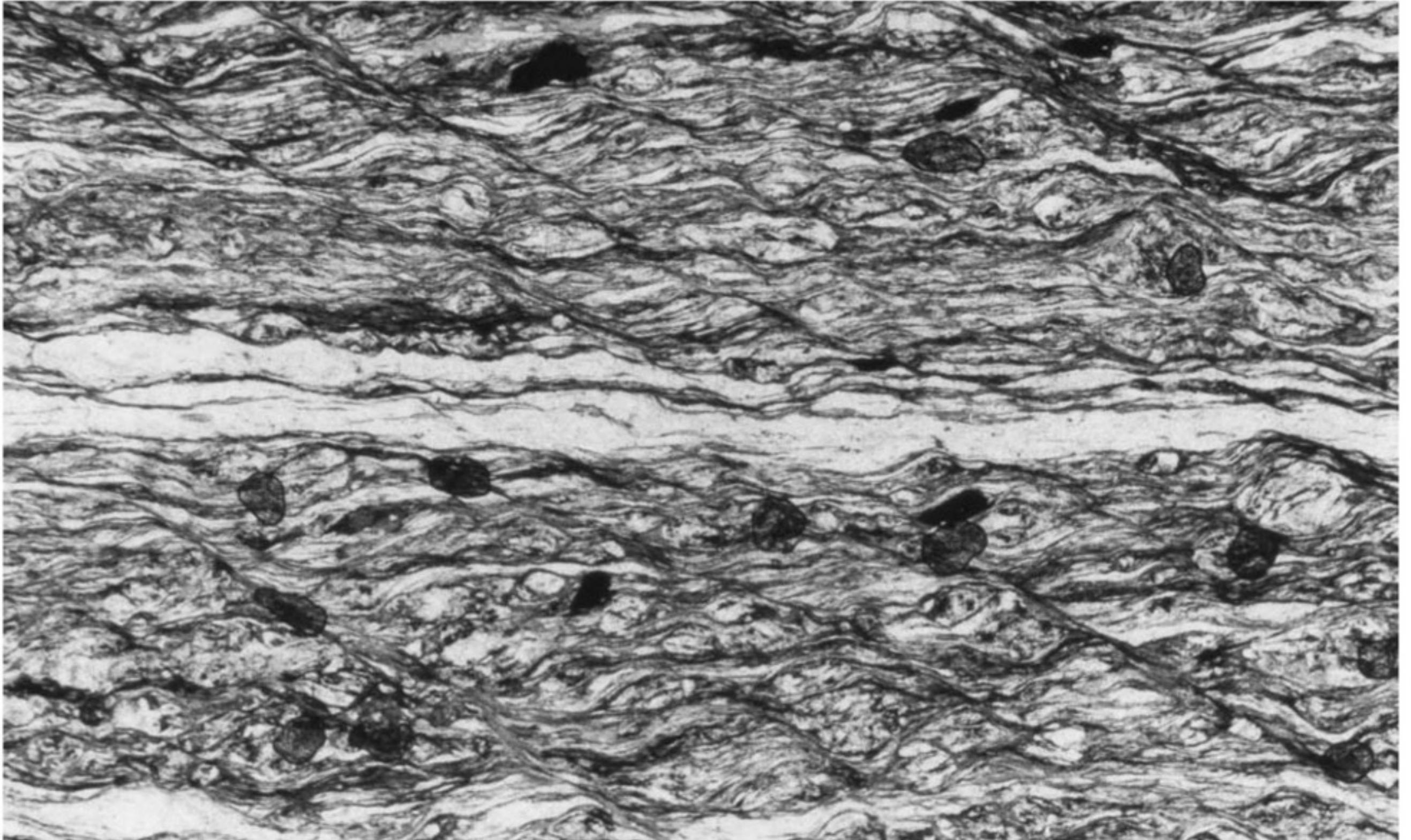
# Shear band



# Shear band

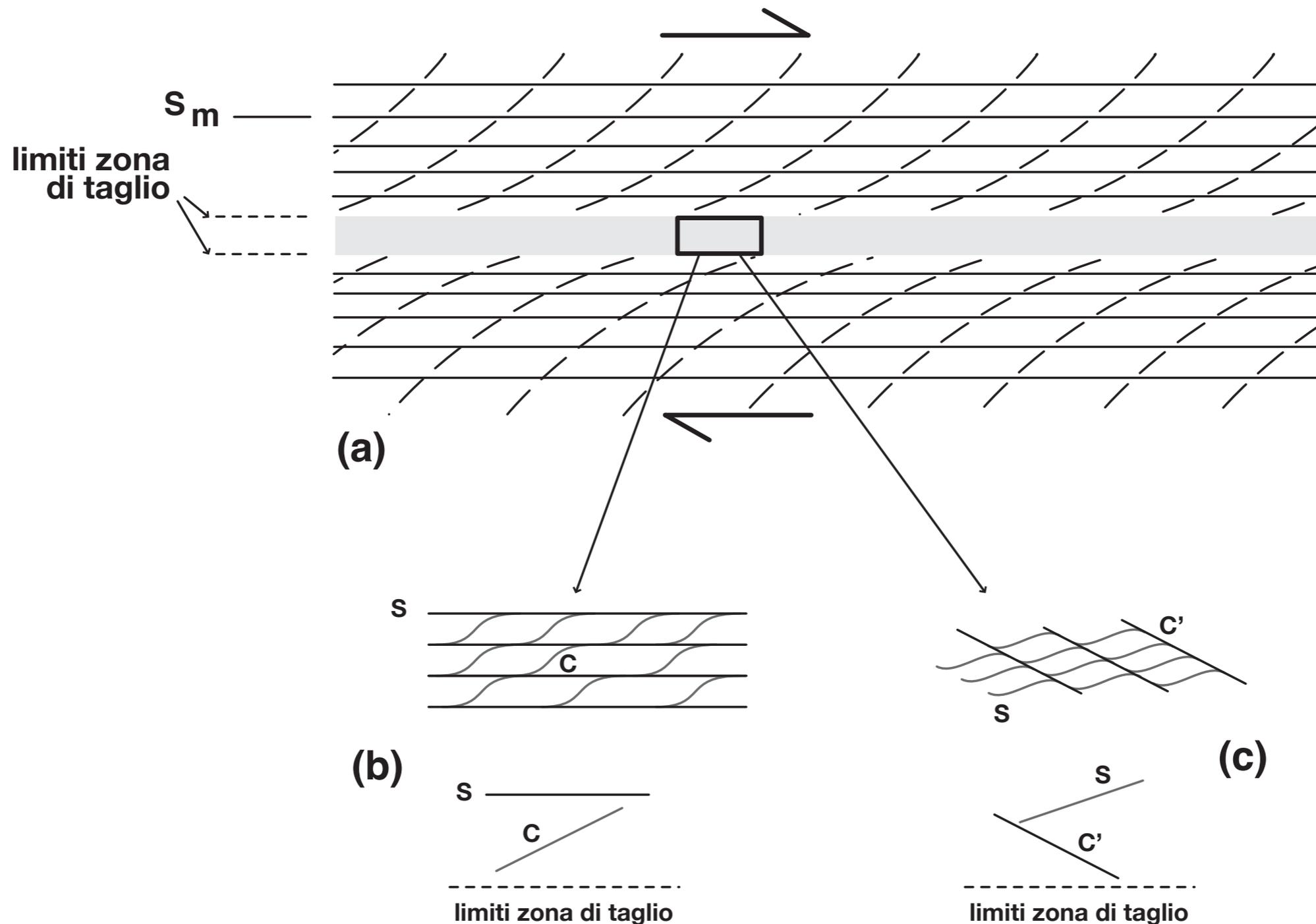


# Shear band



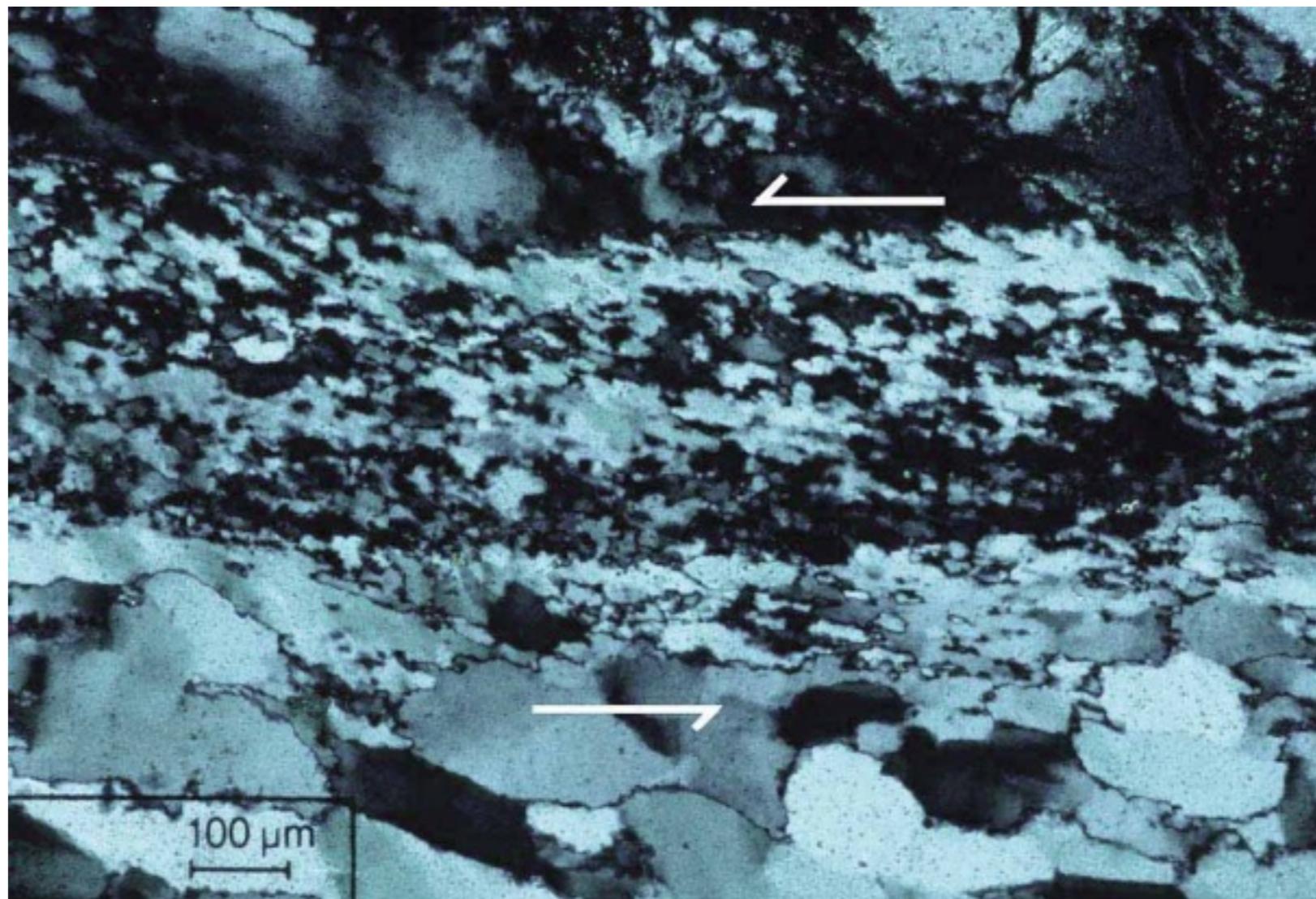
# Differenza S-C e Shear band (S-C')

- a piccola scala simili
- differente orientazione rispetto ai limiti zona di taglio (superfici lungo cui avviene la maggior parte del movimento)

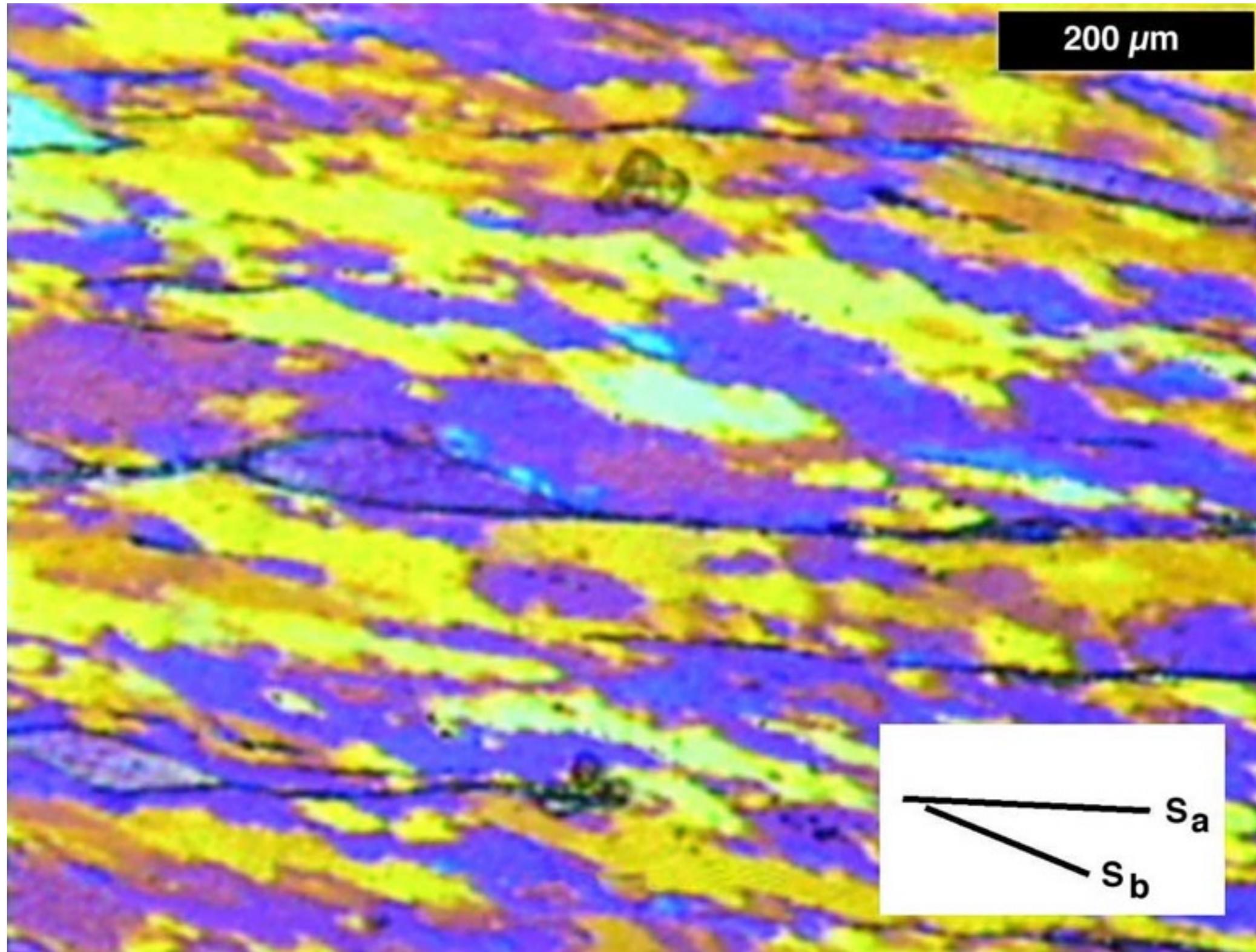


# Orientazioni preferenziali di forma

- In livelli ricristallizzati dinamicamente singoli granuli sono spesso allungati e obliqui rispetto alla foliazione milonitica principale;
- I grani sono allungati nella direzione di trasporto e la loro orientazione perciò può essere usata come indicatore cinematico

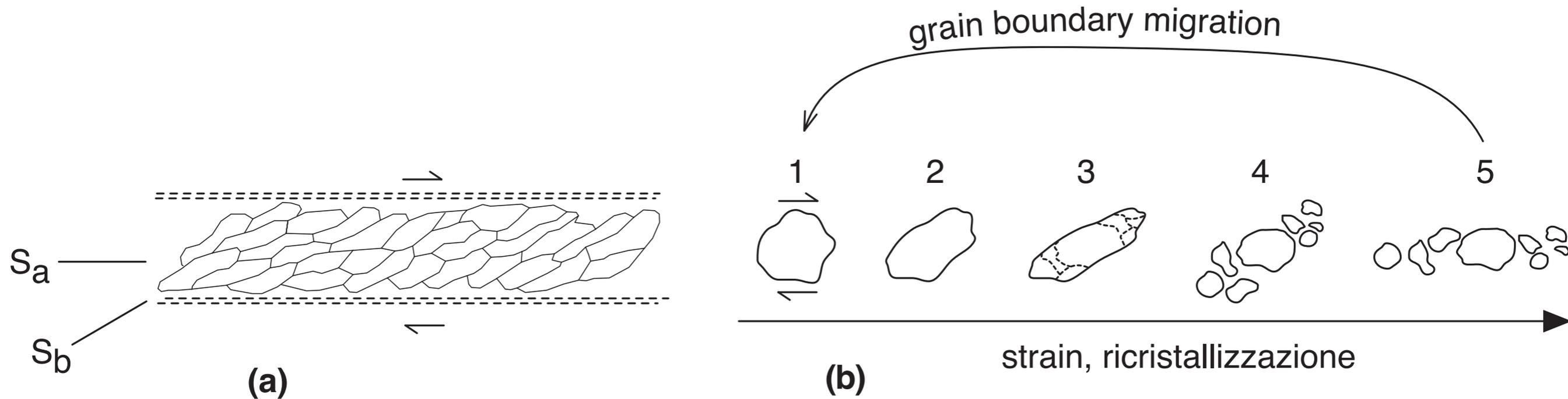


# Orientazioni preferenziali di forma



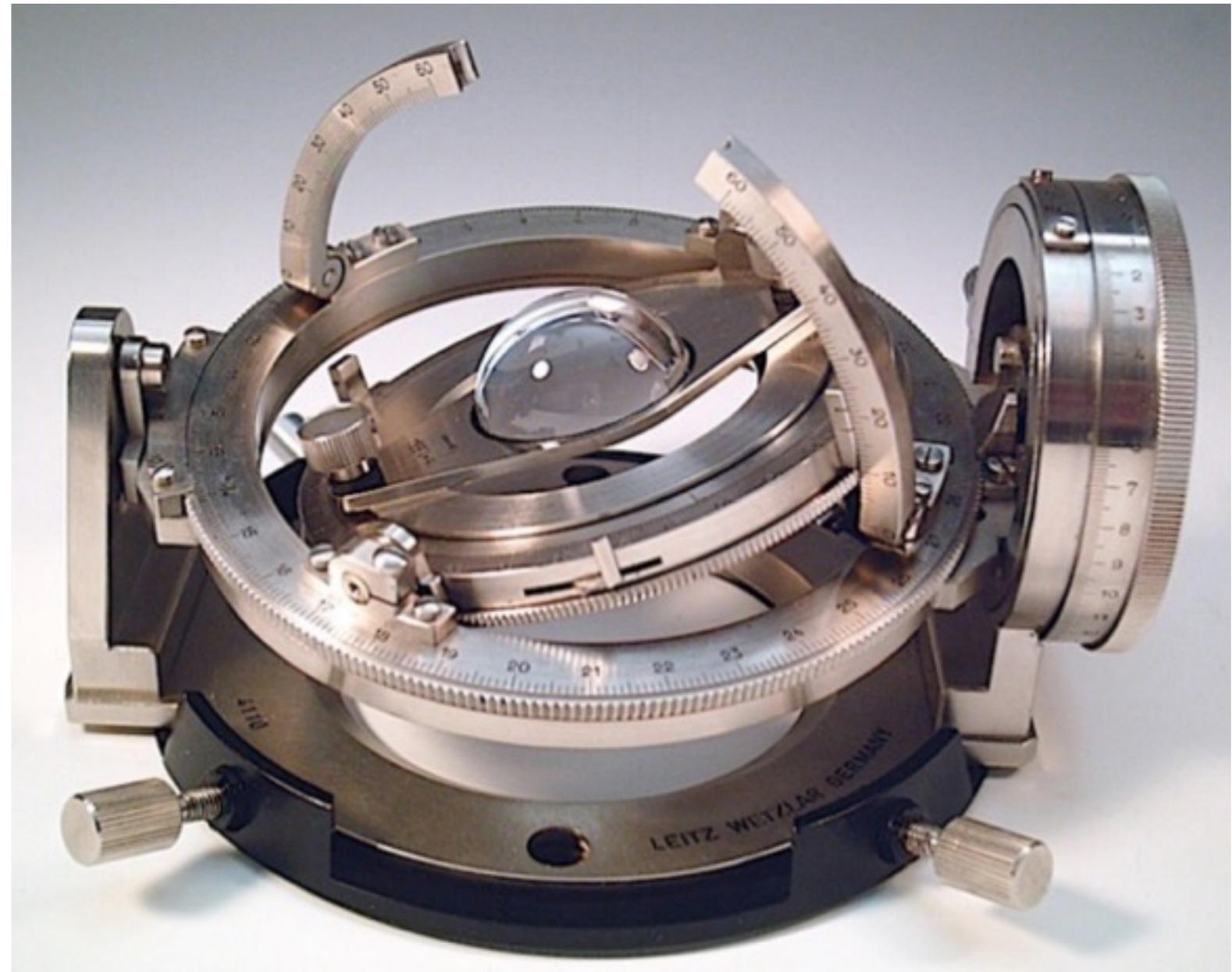
# Orientazioni preferenziali di forma

- Sviluppo di orientazione preferenziale di forma (microstrutture orientate)



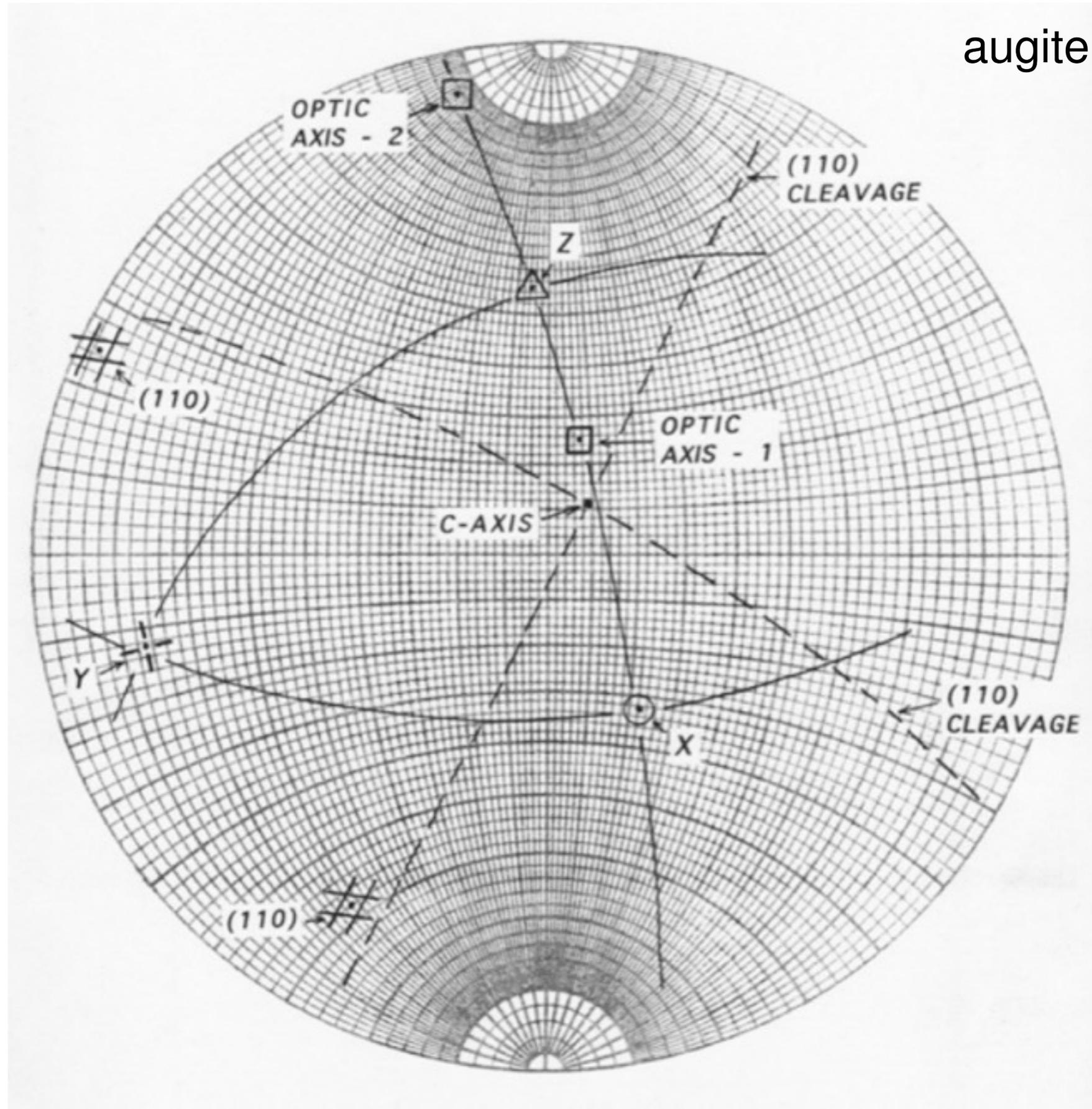
# Orientazioni cristallografiche preferenziali

- Rocce con tessitura
- SEM, R-X, tavolino universale, microscopio ottico

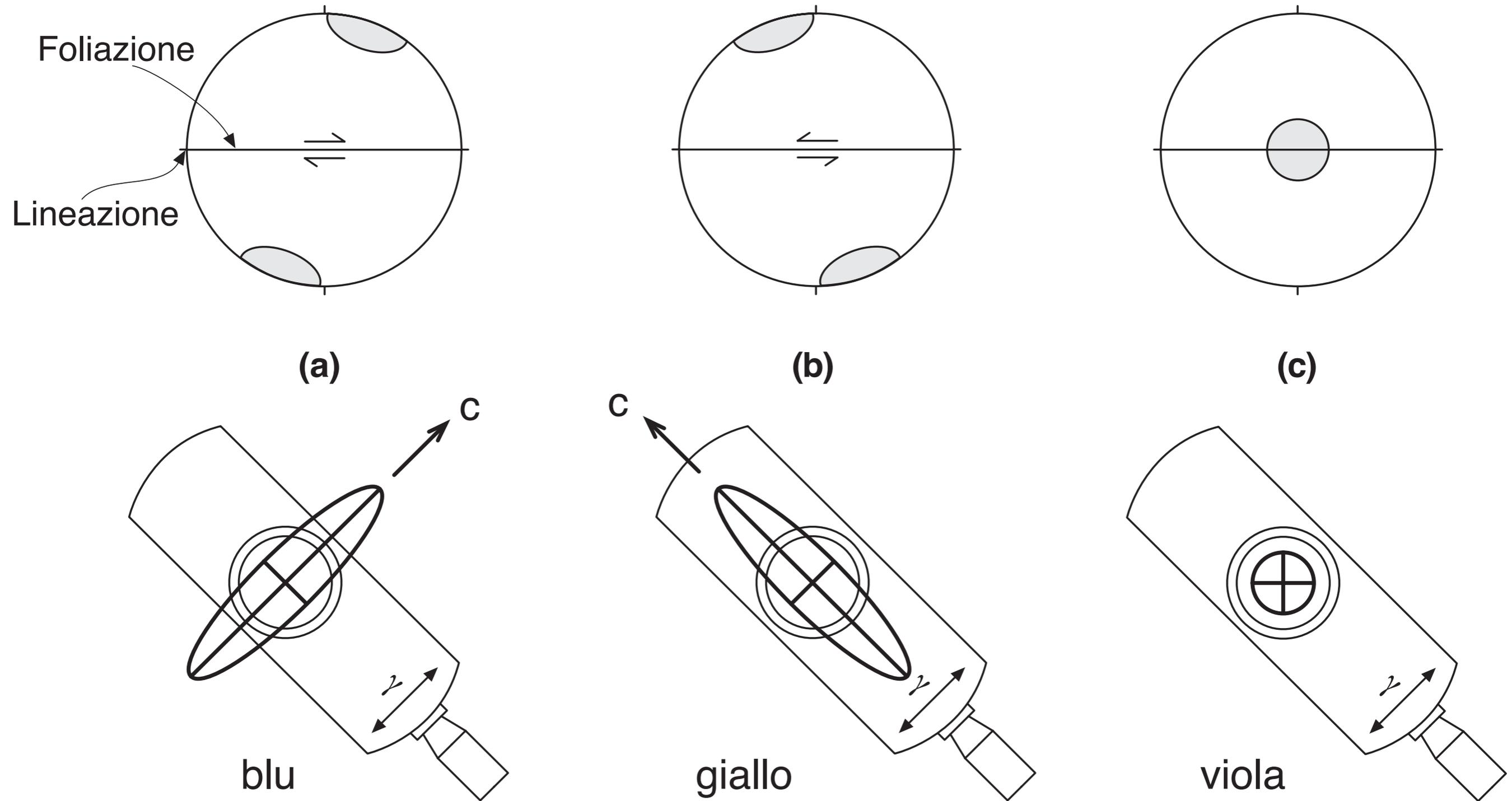


# Tavolino universale

augite



# Orientazioni cristallografiche preferenziali



# Orientazioni cristallografiche preferenziali

