What is a Fault Zone?

A PERSPECTIVE FROM BENEATH THE BRITTLE-DUCTILE TRANSITION

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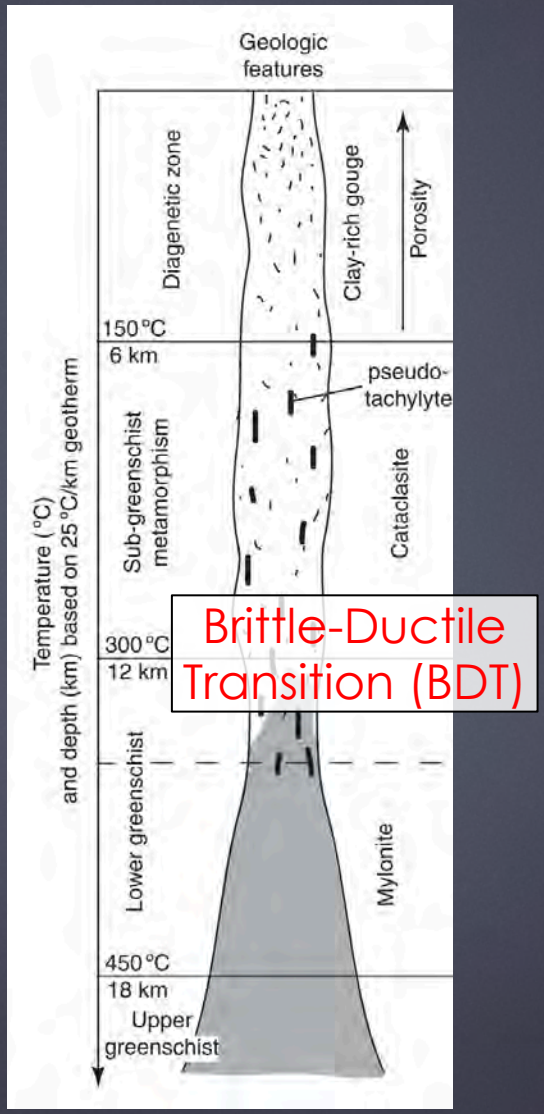
A traditional model of a fault zone

- Localized, discrete surface in upper crust
- Widening into a mylonitic shear zone with increasing depth



Fagereng and Toy, 2011; modified after Sibson (1977, 1983); Scholtz (1988, 2002).

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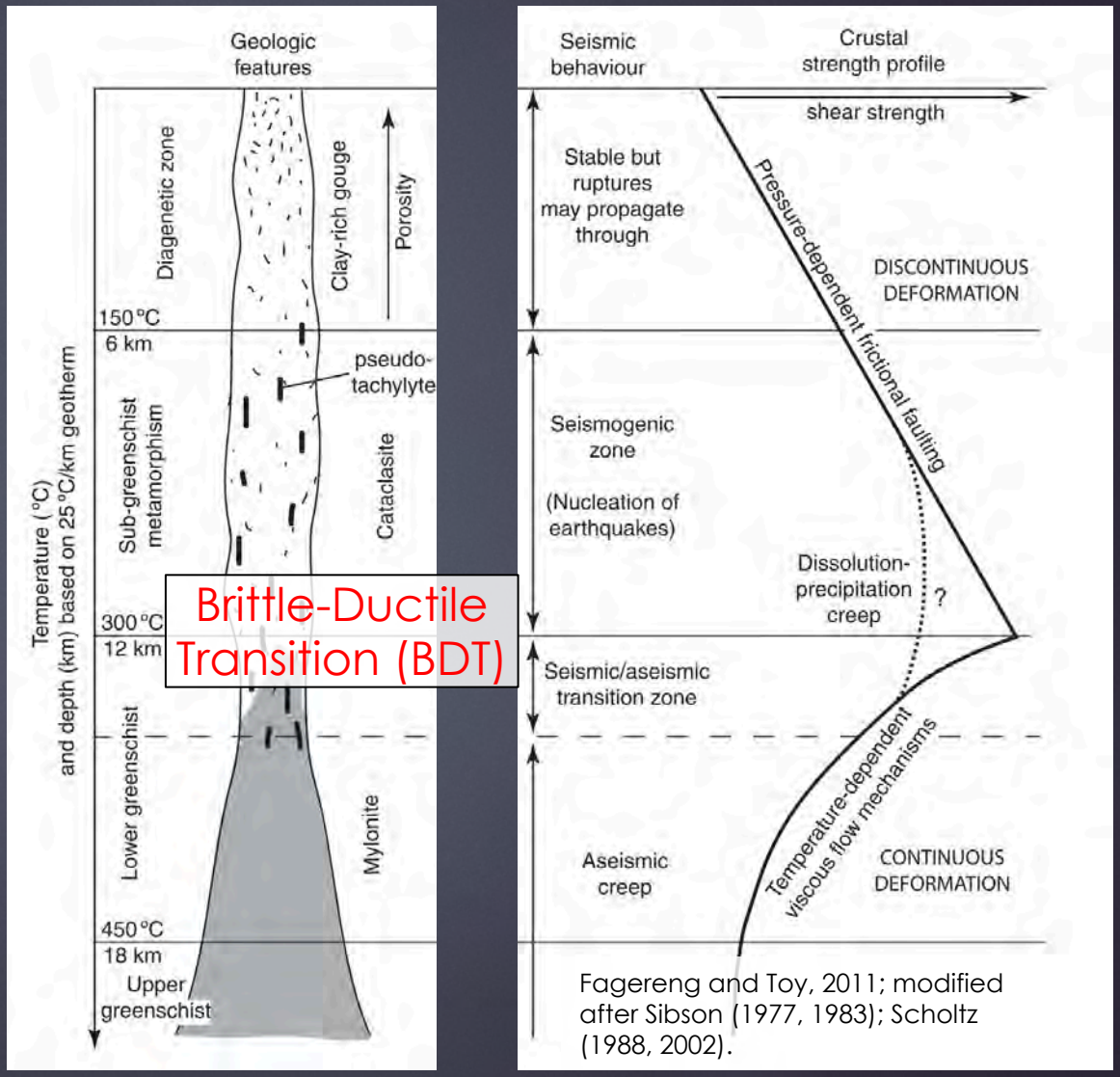
Why is this important?

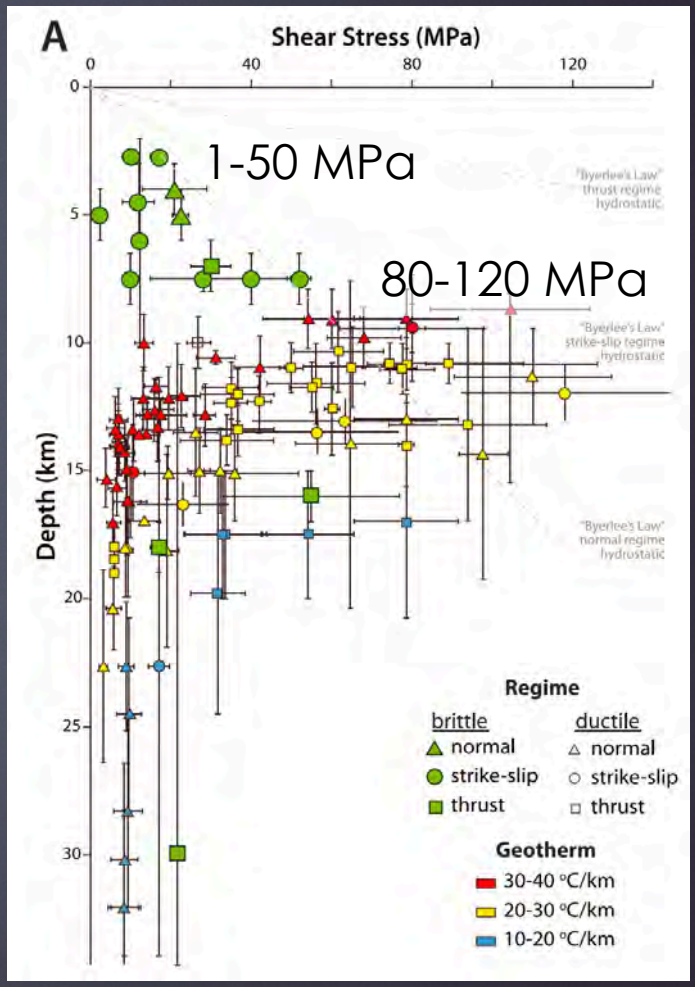
- BDT near peak in crustal strength
- Seismic/aseismic transition zone



Fagereng and Toy, 2011; modified after Sibson (1977, 1983); Scholtz (1988, 2002).

The BDT is a load-bearing layer in the crust

- Ductile shear zones sustain stresses higher than brittle faults
- Weak faults in the seismogenic zone can be loaded *from below* from high stress shear zones



Behr and Platt, 2011

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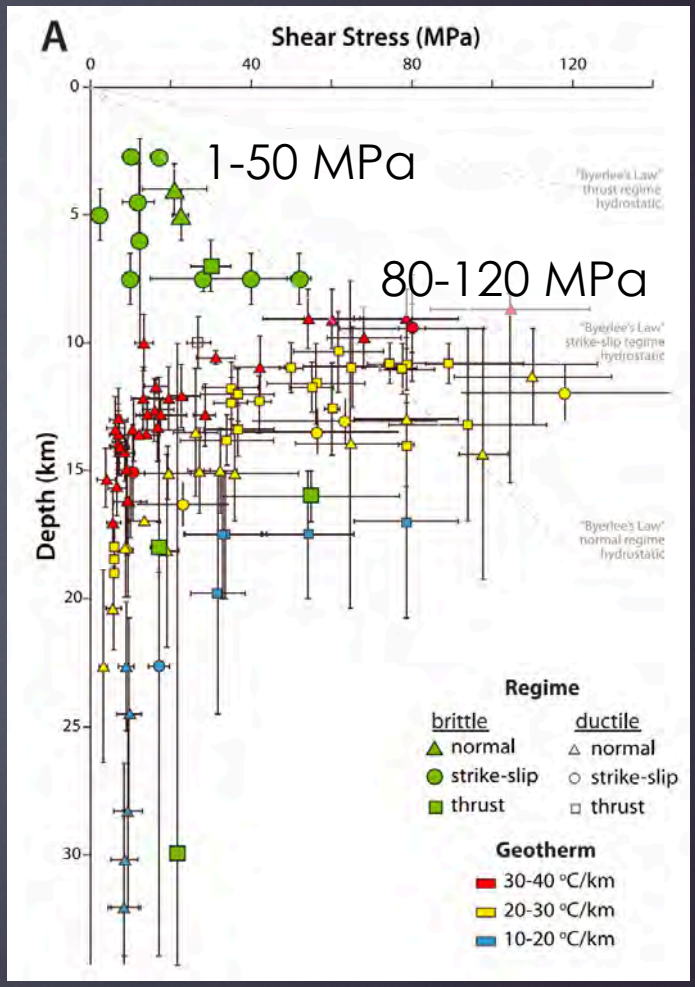
Important take-home:

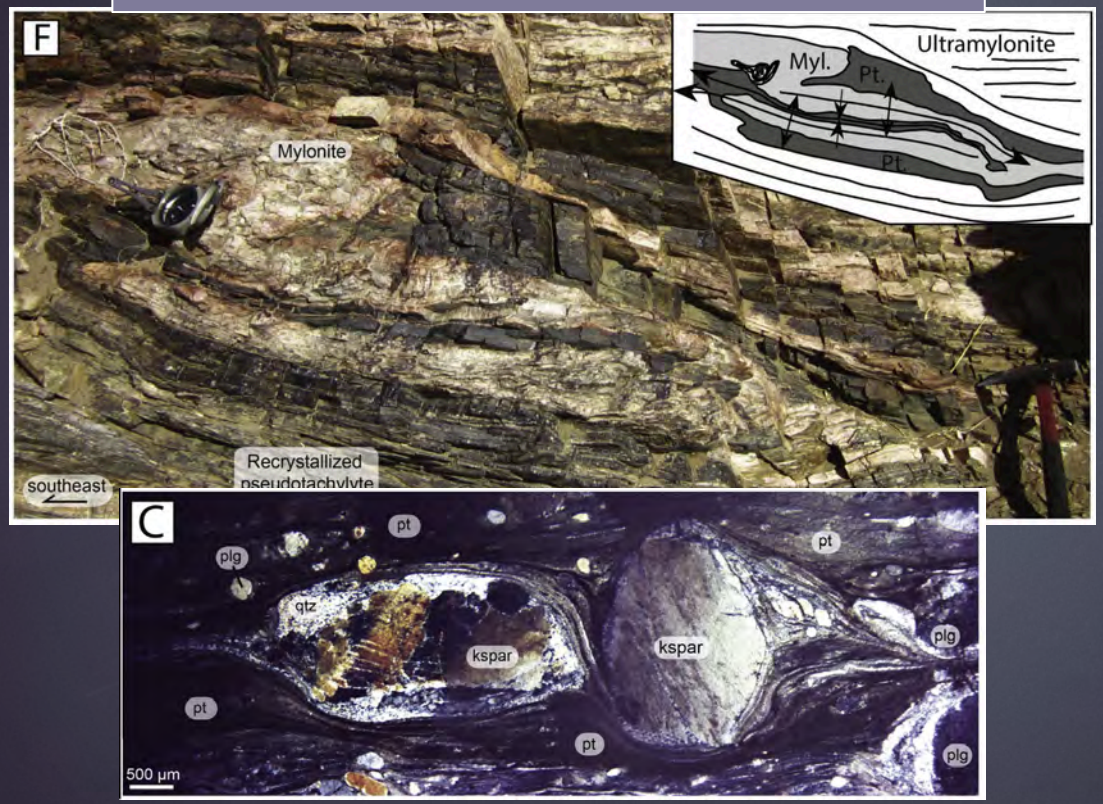
- High stress ductile shear zones promote seismic cycle feedbacks



Behr and Platt, 2011

Seismic cycle feedbacks in mid-crustal shear zones

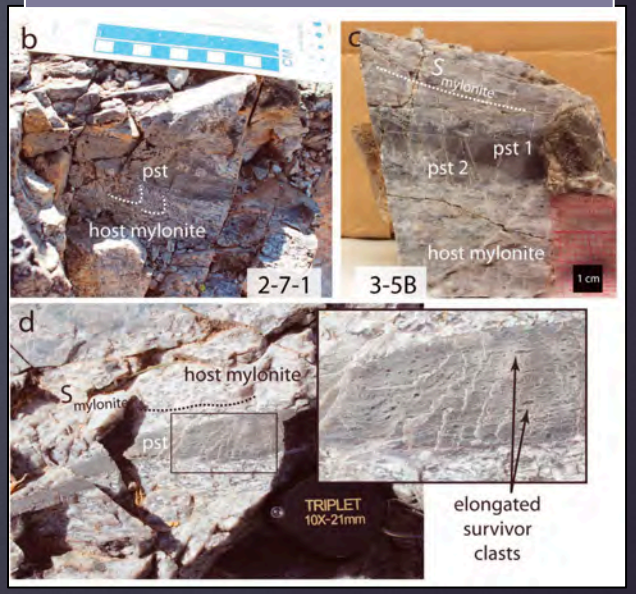
Pofadder Shear Zone, Namibia & South Africa



Melosh et al., 2018

- The rock record shows relationship between mylonites and pseudotachylytes

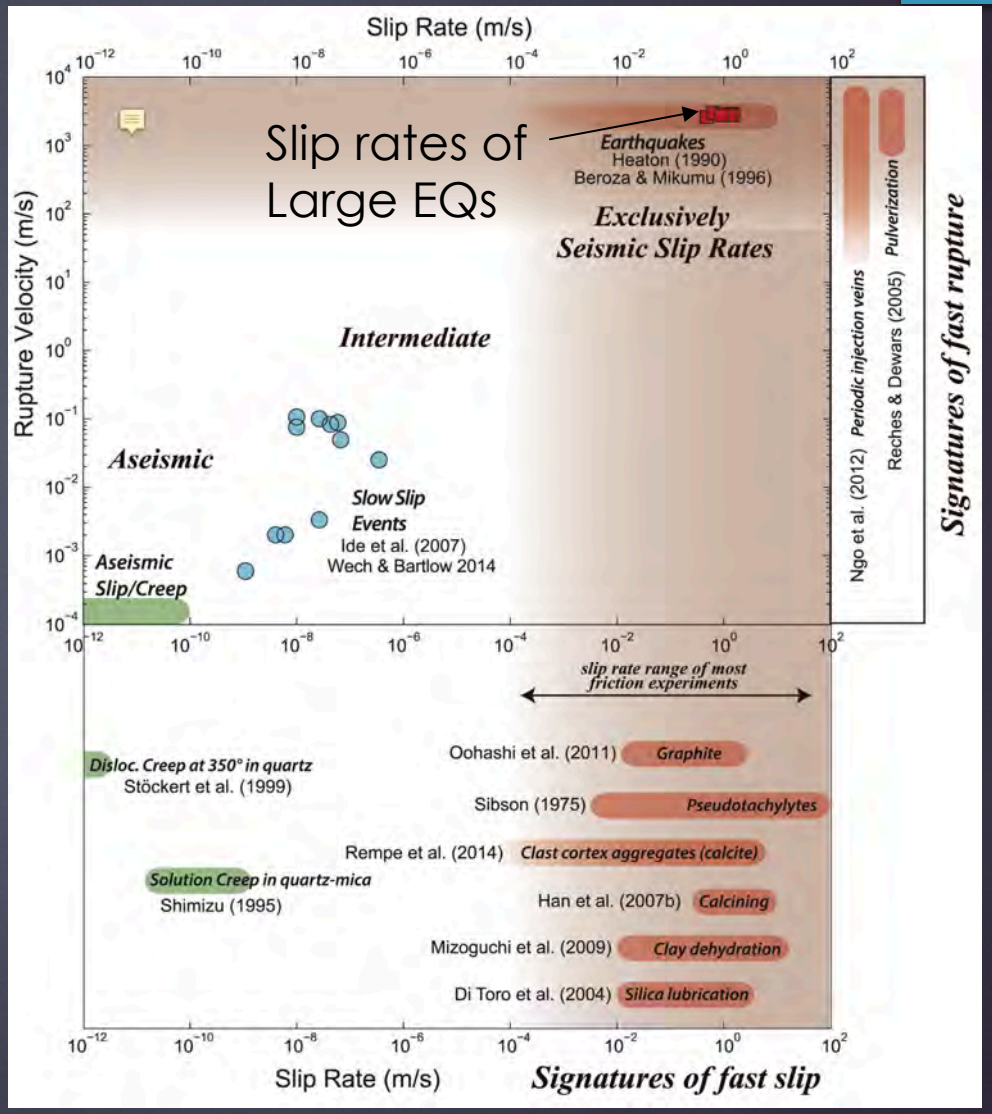
South Mountains, Arizona, USA



Stewart and Miranda, 2017

Fault behavior in the rock record

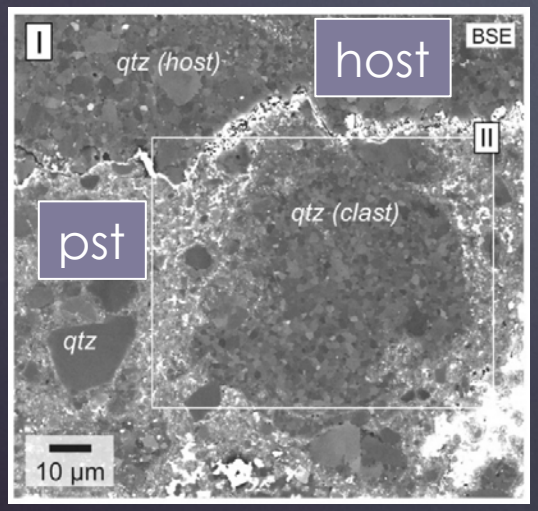
- Pseudotachylytes are not the only evidence of earthquakes in the rock record
- Evidence for fast slip rates
- Evidence for fast rupture propagation
- Field + lab techniques



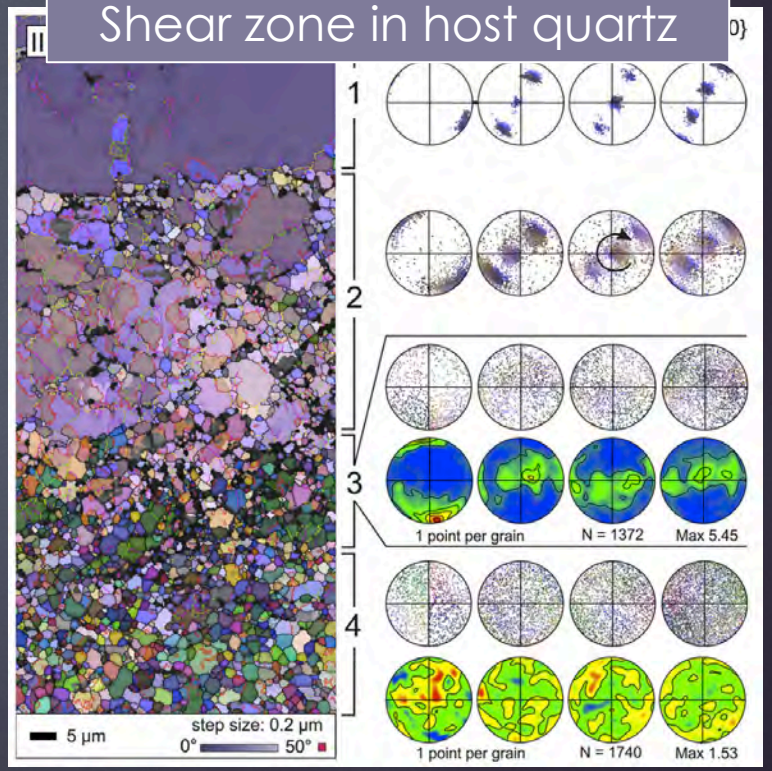
Rowe and Griffith, 2015

Unique structures for transient and steady-state deformation ?

- Host rocks adjacent to pseudotachylyte have shear zones
- Crystal-plastic deformation during rupture propagation



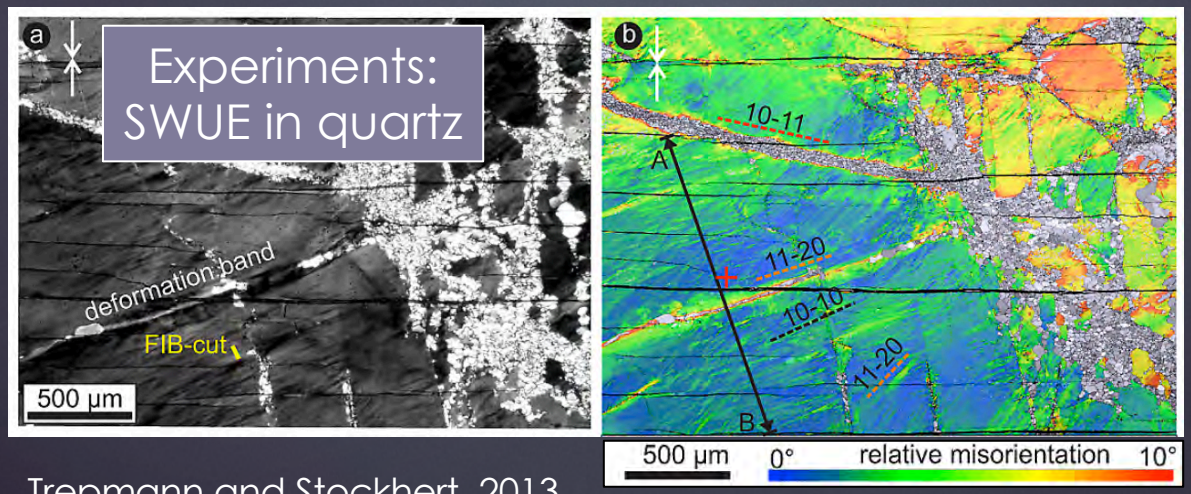
Schneeberg Normal Fault Zone (Eastern Alps)
Shear zone in host quartz



Bestmann et al., 2012

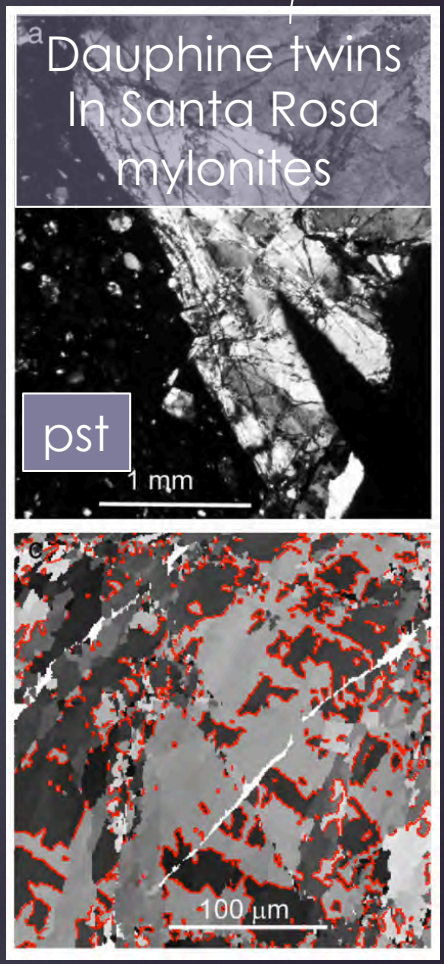
Unique structures for transient and steady-state deformation ?

- Quartz Dauphiné mechanical twinning
- Short-wavelength undulatory extinction (SWUE)
- Planar Deformation Features (PDFs), deformation lamellae



Trepmann and Stockhert, 2013

See Zamora-Tamayo #154



Wenk et al., 2011

Conclusions

- BDT is a major load-bearing layer in the crust
- Under-recognized evidence of seismic activity in the rock record
- Micro- and nano-scale investigation
- How to quantify rheology when both brittle and crystal-plastic fabrics coevolve?

"Hot slicks" in BPT mylonites