Strain Localization and Ductile Failure in Feldspar Rocks

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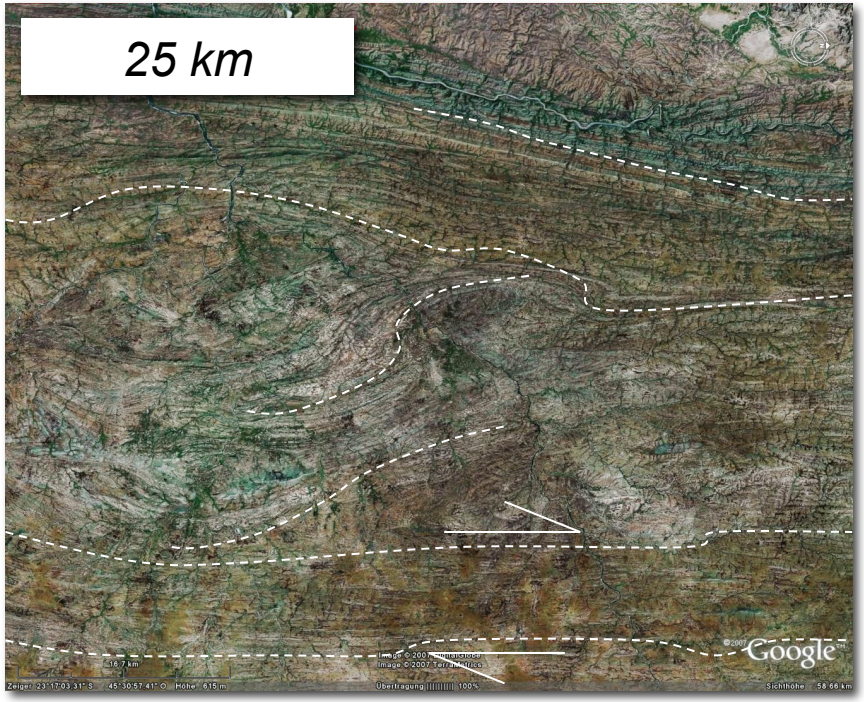
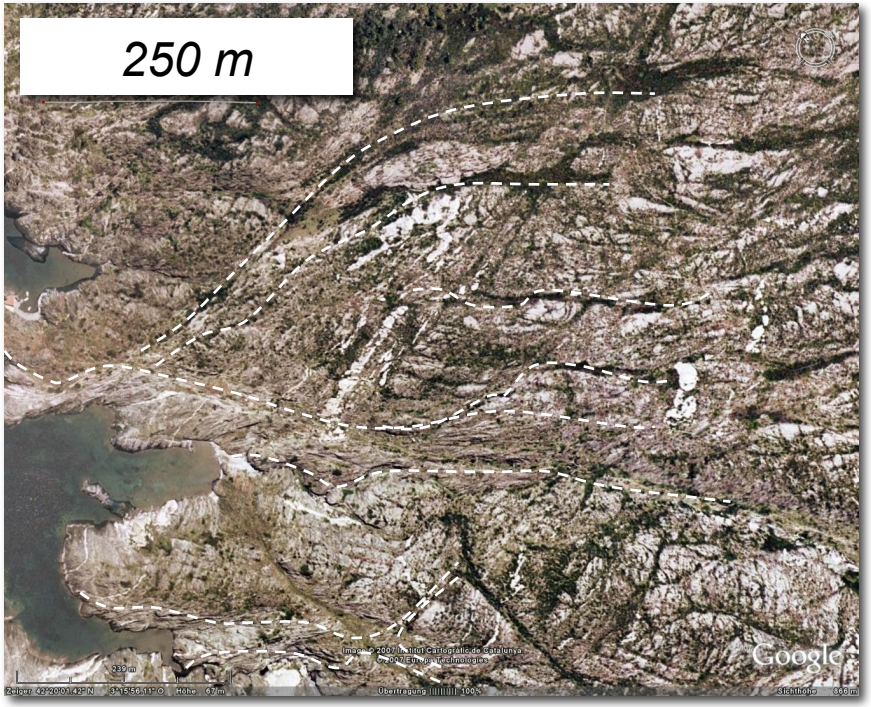




Shear Zones Cutting Through Lower Crust

SE Madagaskar

Quartzofeldspathic Granulites

700°C-800°C

~ 600-800 MPa

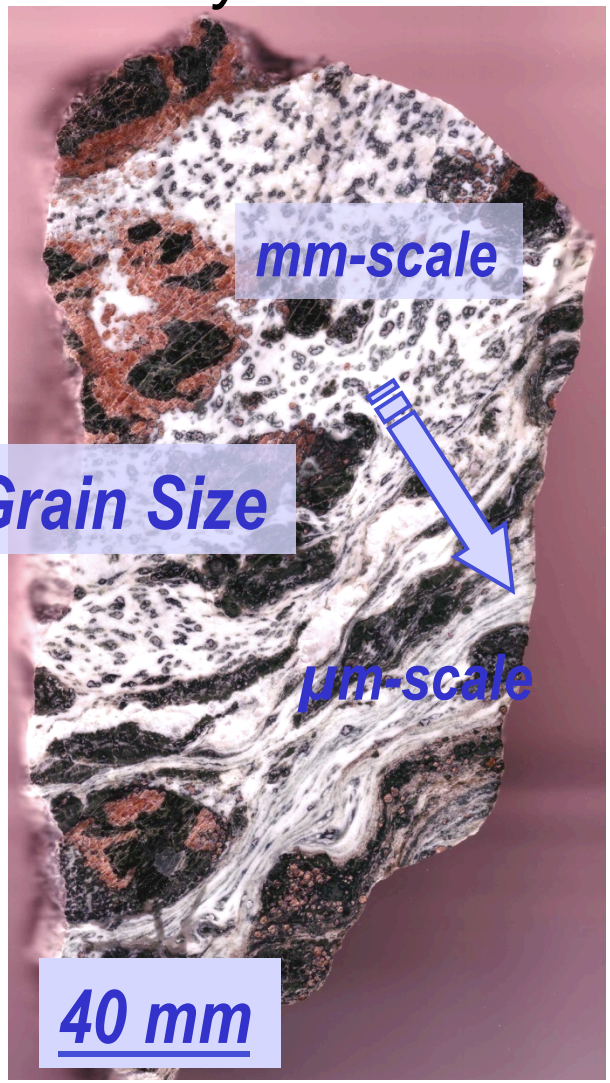
Cap de Creus

Metasediments

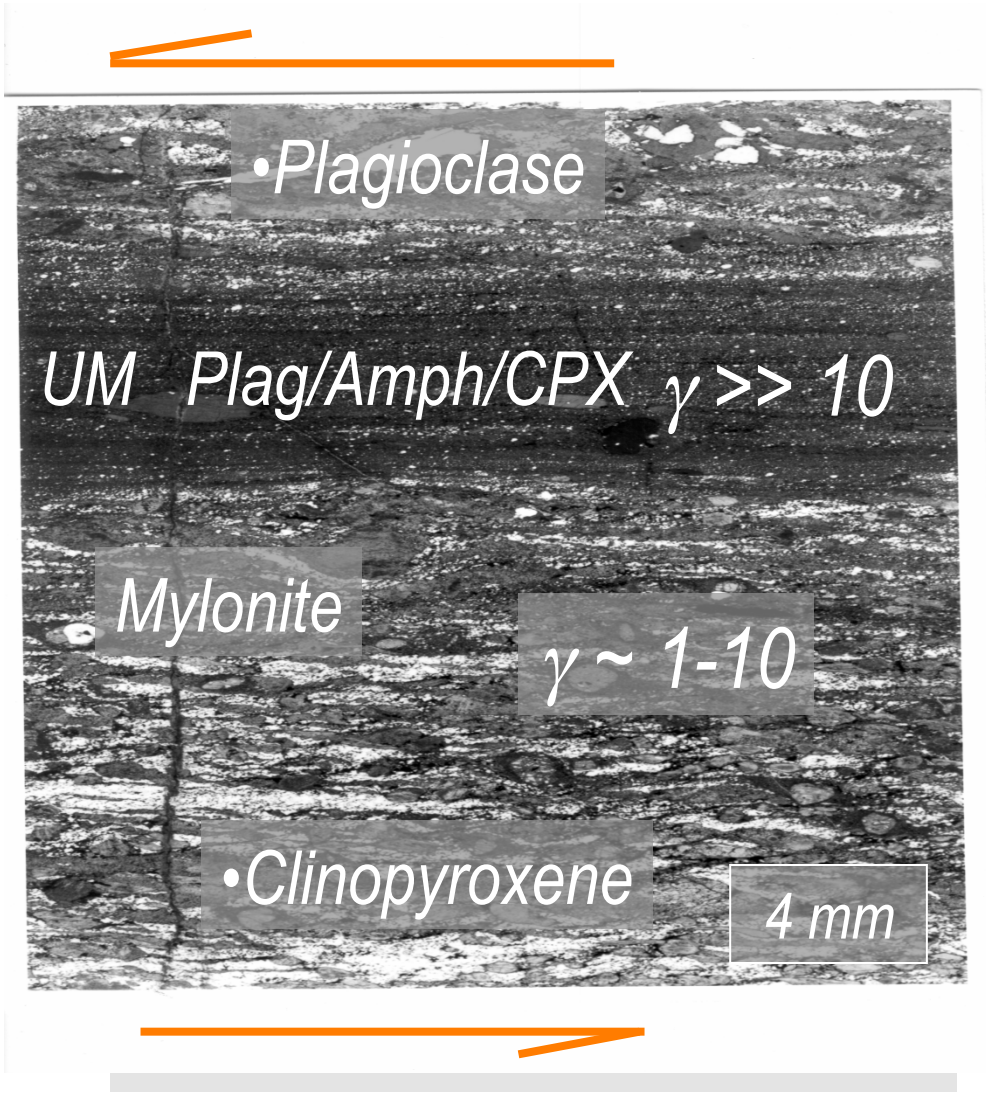
400°C-500°C

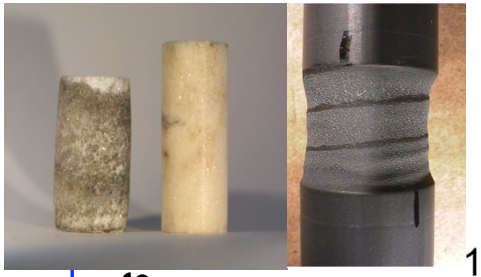
~ 250 MPa

Anorthositic Granulites, Norway



Shear Zone in Metabasites, Ivrea Zone

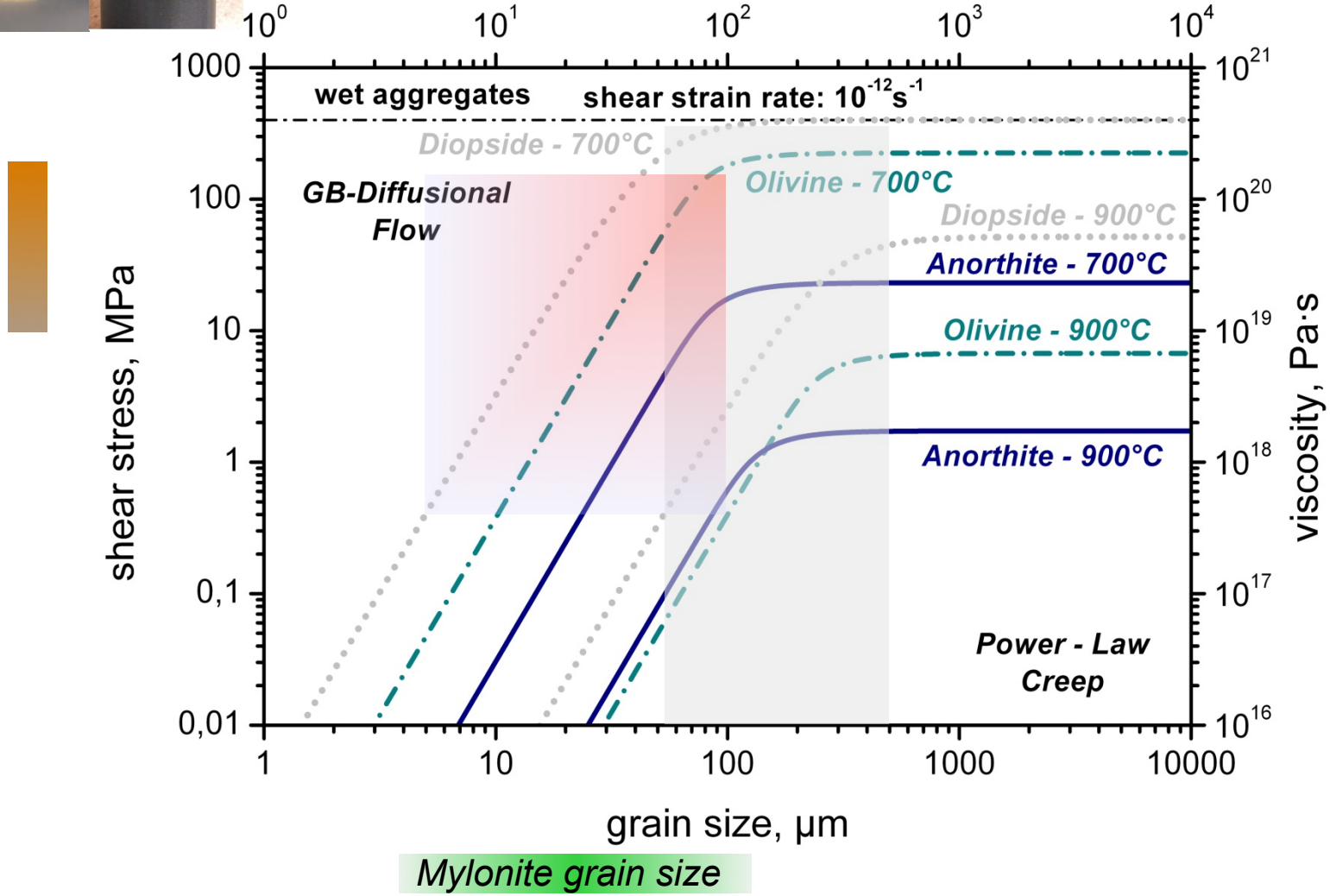




Lab Data vs. Field Observations

Synthetic Rocks at Hydrous Conditions

Stress estimates from shear zones



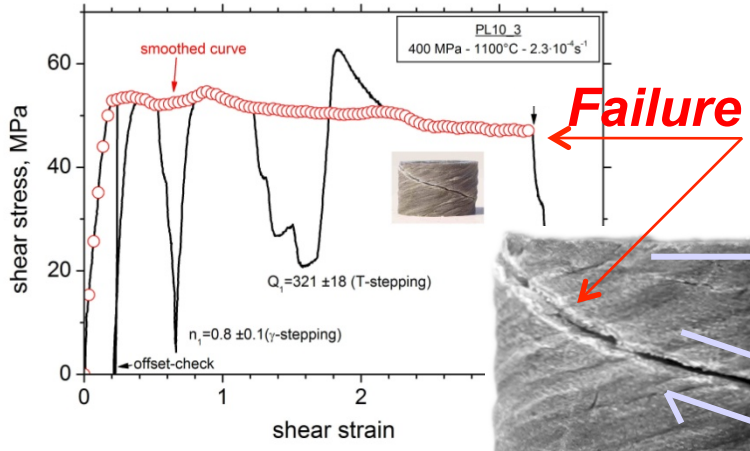
Mylonite grain size

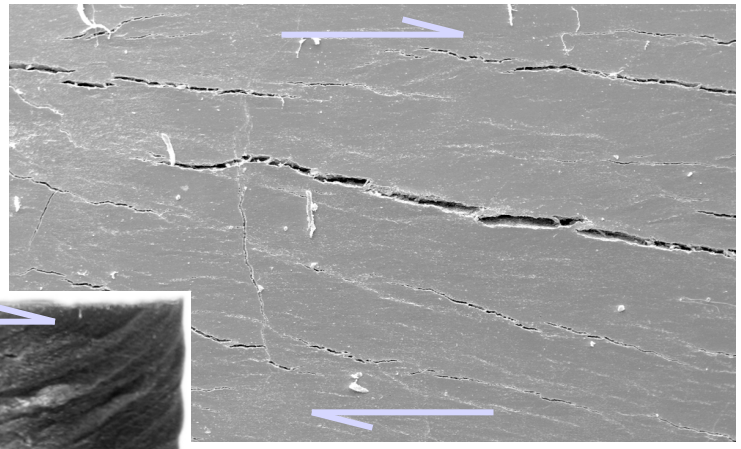
Viscosity from postseismic relaxation models

Rybacki et al., JGR 2006; Dimanov and Dresen, JGR 2005; Mei and Kohlstedt, JGR 2000

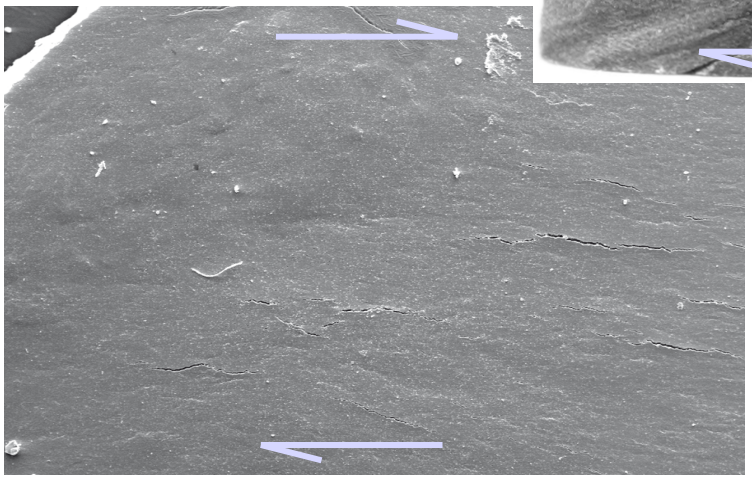
Ductile Failure in Feldspar Rocks

σ: 2 – 80 MPa, T: 900°C-1200°C, P_c: 100 - 400 MPa, 26 samples, 40% deformed in linear viscous creep to failure at $\gamma < 5$

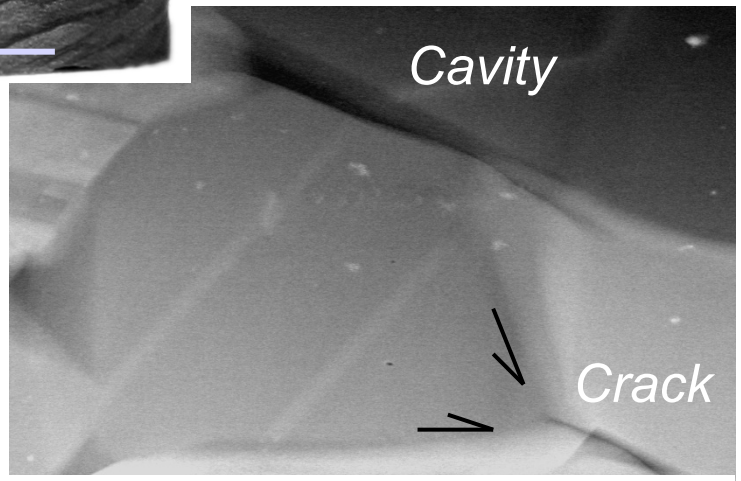




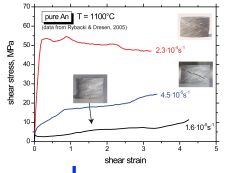
Mag. x 50, γ = 4



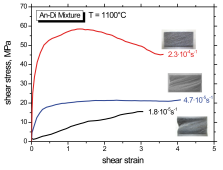
Mag. x 50, γ < 2.0



Mag. x 100000, γ = 4



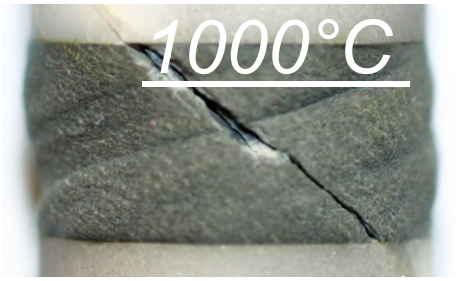
Localization and Failure

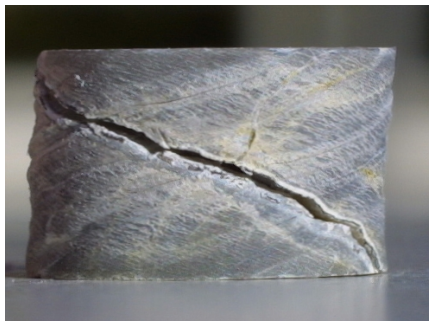


pure An *1100°C*

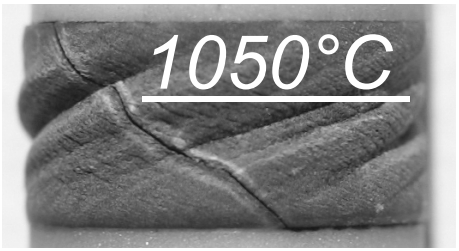
AnDi-mixture *~2·10^{-5}s^{-1}*

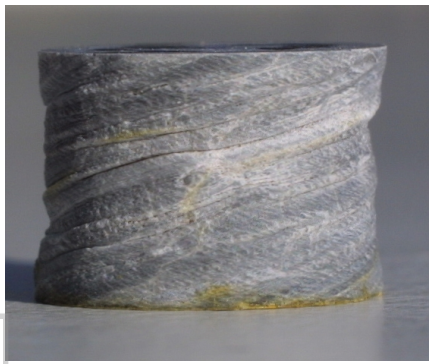
$\dot{\gamma} \approx 2 \cdot 10^{-4} s^{-1}$



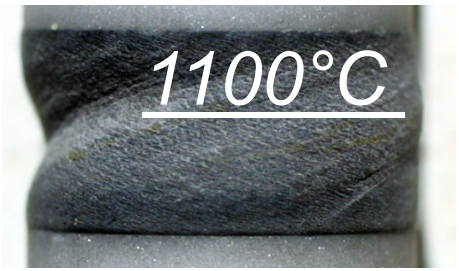


$\dot{\gamma} \approx 5 \cdot 10^{-5} s^{-1}$





$\dot{\gamma} \approx 2 \cdot 10^{-5} s^{-1}$



Cavitation, Failure

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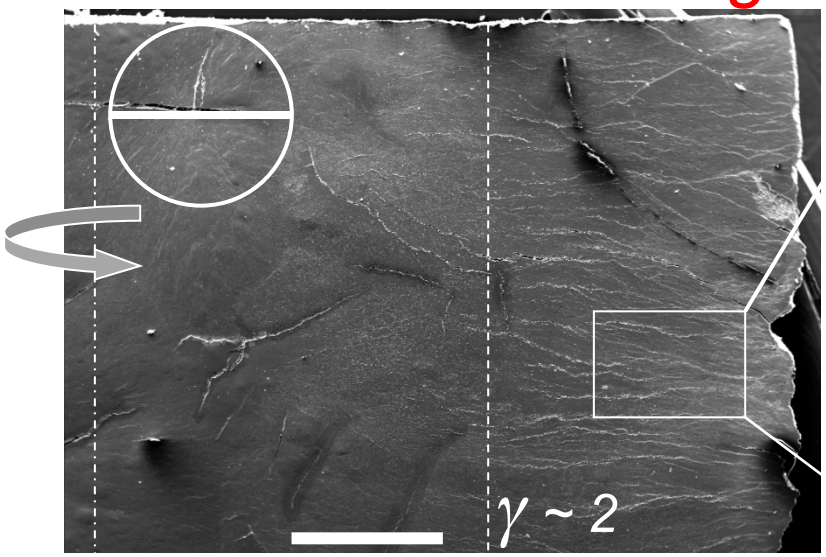
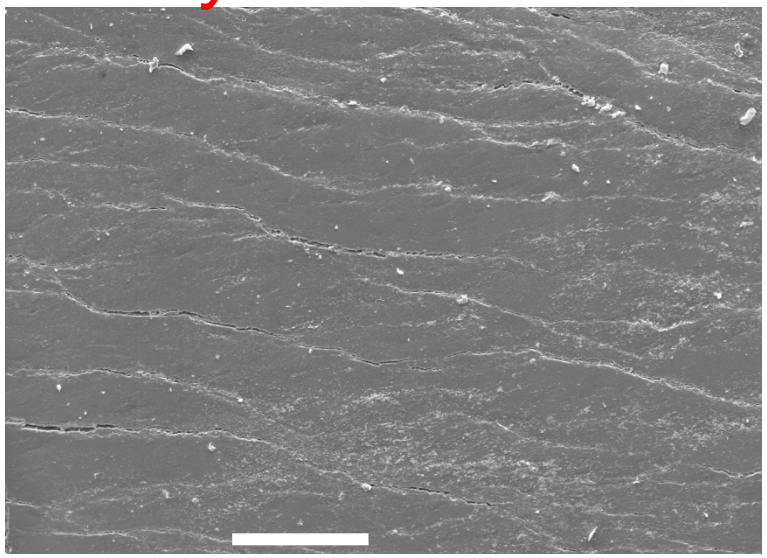
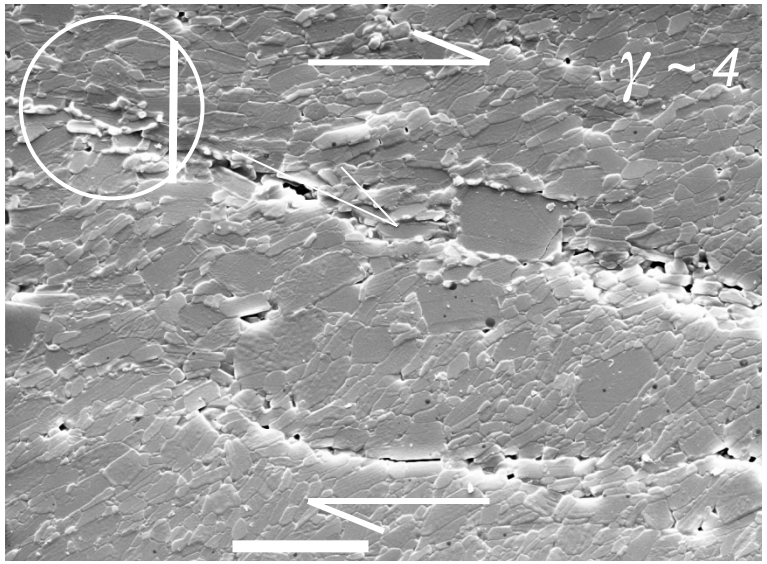
SEM BSE Images of Cavity Bands



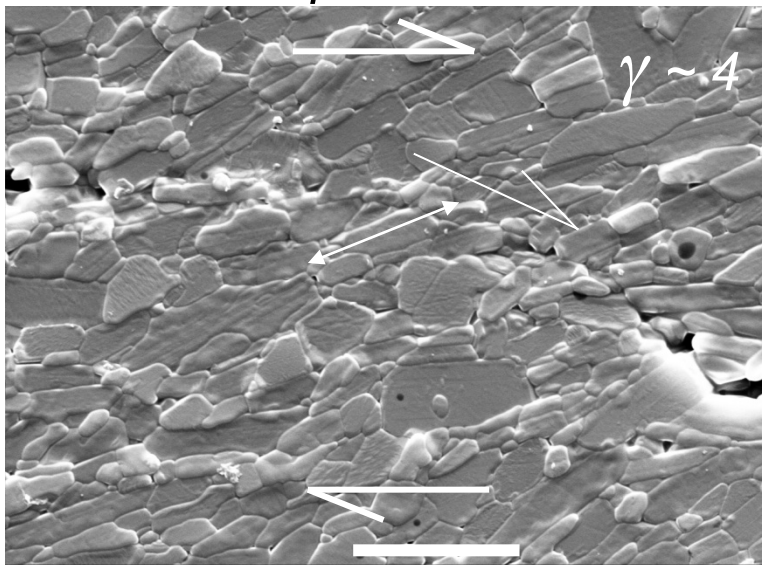
1 mm



200 μm



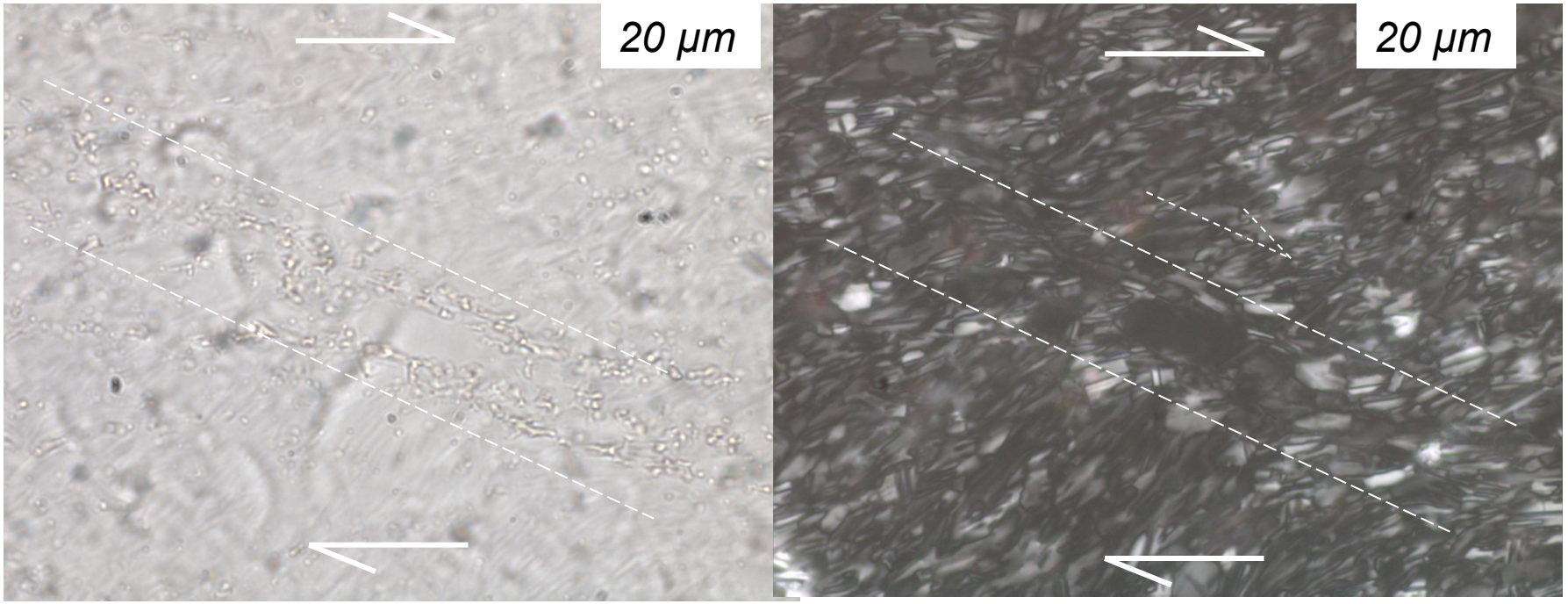
20 μm



10 μm

Rybacki, Wirth and Dresen, GRL, 2008, JGR, 2010

Cavity bands in optical thin sections



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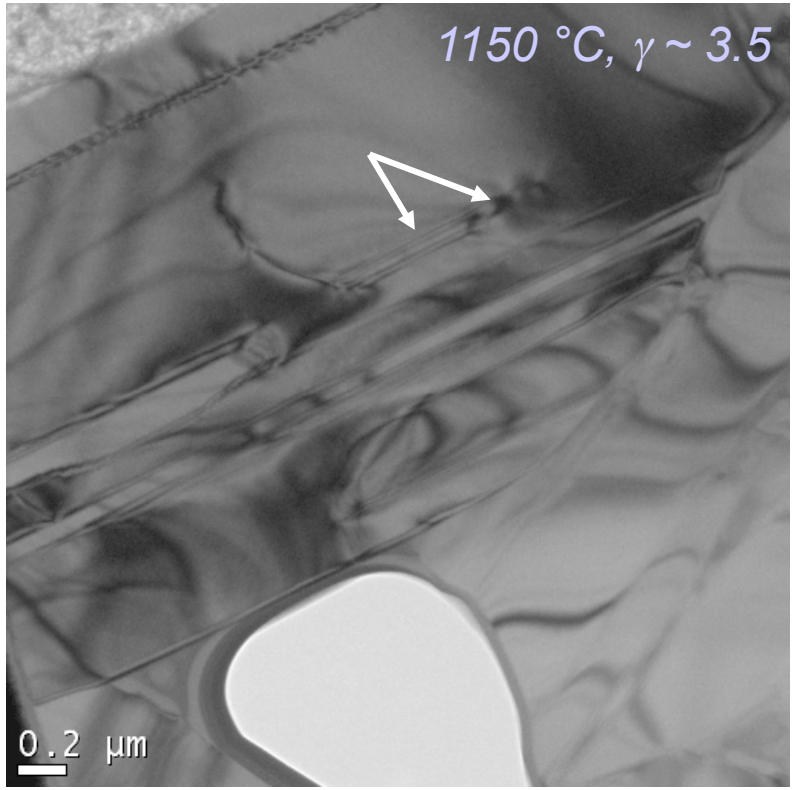
Pores, Cavities in TEM BF



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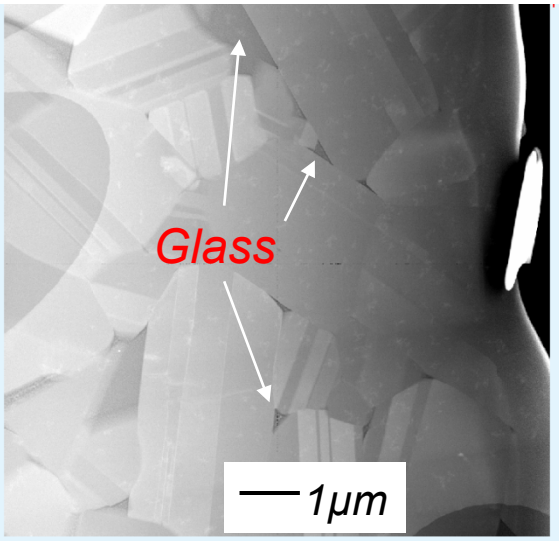
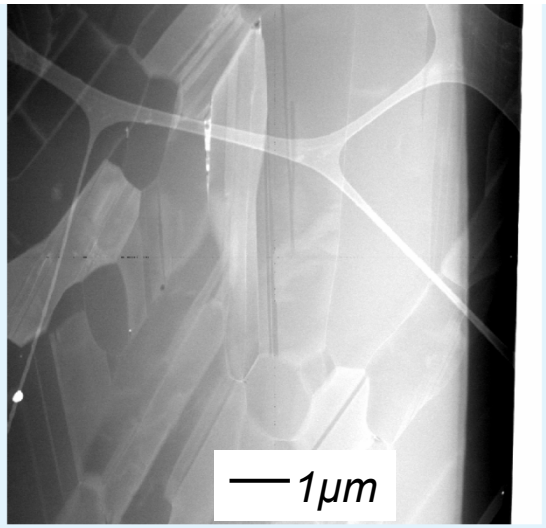
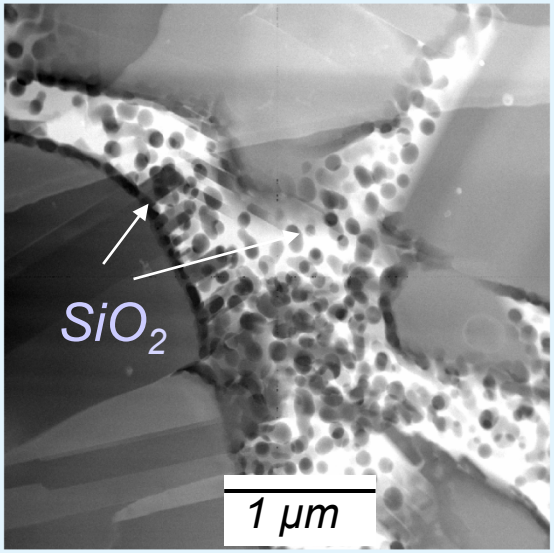
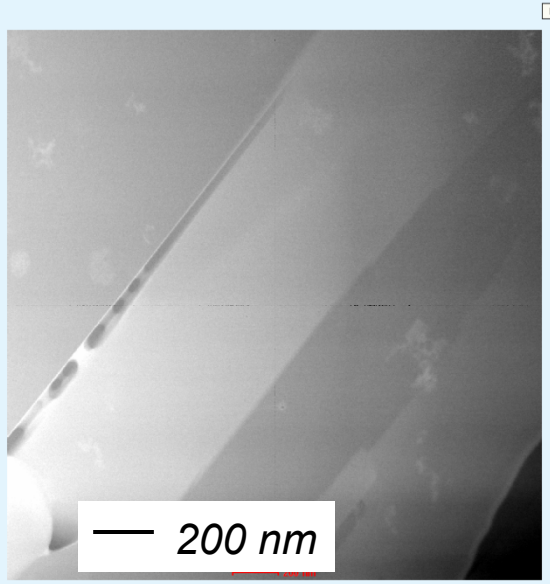
SiO_2 Glass in Shear Bands (FIB STEM)









Conclusions

- *Where strength at lower crustal depth is limited by fine-grained mylonite shear zones it is expected to be low*

- *Accelerated postseismic creep in fine-grained mylonitic shear zones in the near field is probably linear viscous*

- *Cavitation in fine-grained feldspar aggregates occurs at flow stresses 5-20 times lower than confining pressure*

- *Cavitation in ultramylonite shear zones may lead to episodic slip acceleration, porosity/permeability increase and ductile failure*

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