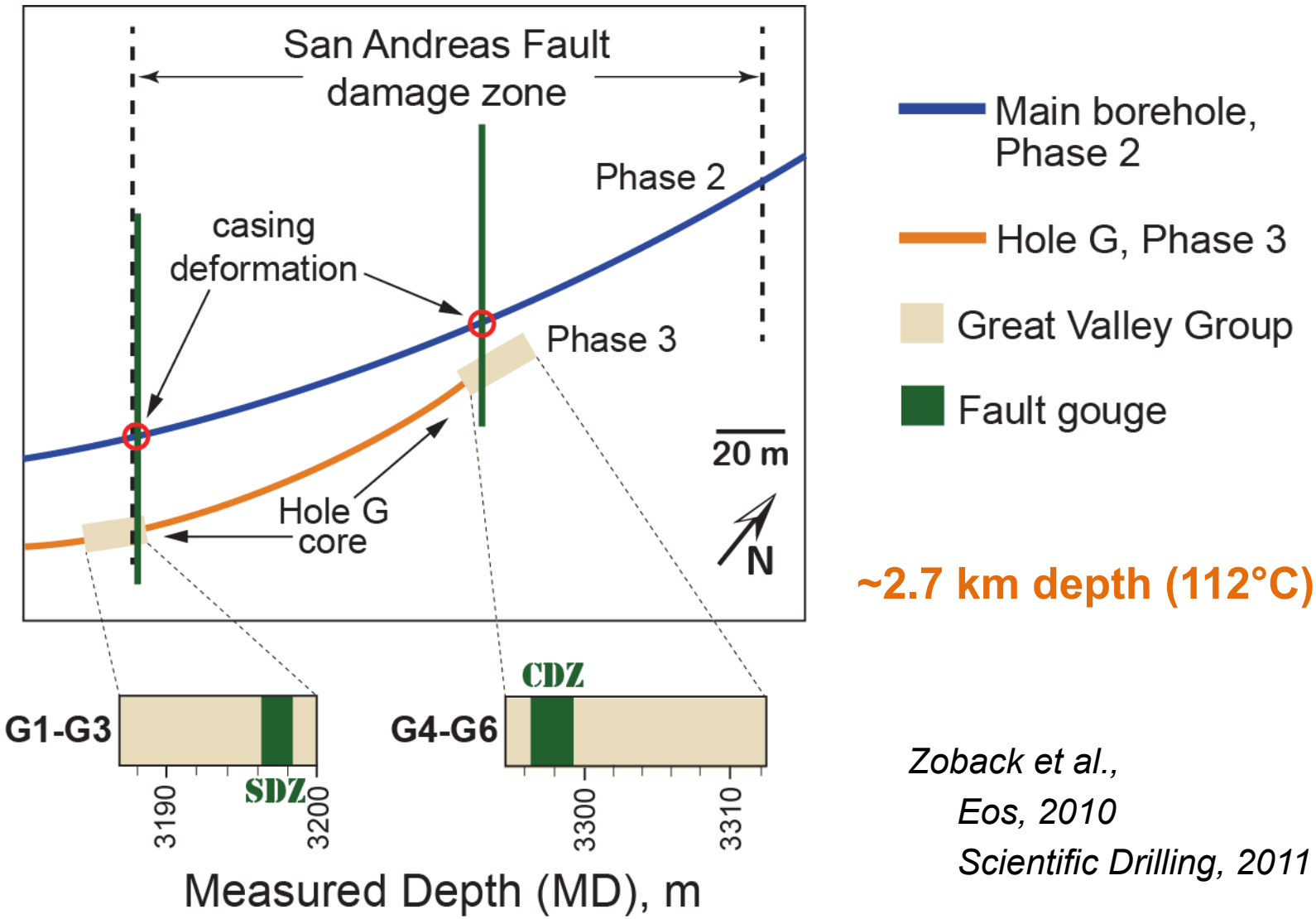
Chemomechanical Controls on Creep Processes in the San Andreas Fault Revealed in SAFOD Core

D. E. Moore, M. J. Rymer, and D. A. Lockner

USGS
science for a changing world

SAFOD Location

SAFOD – Hole G Core

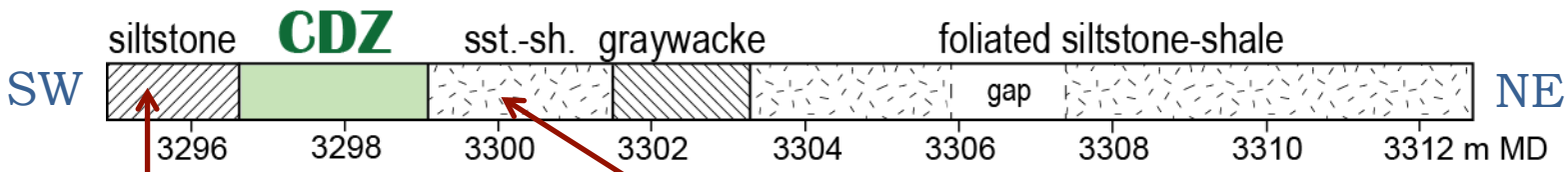


~2.7 km depth (112°C)

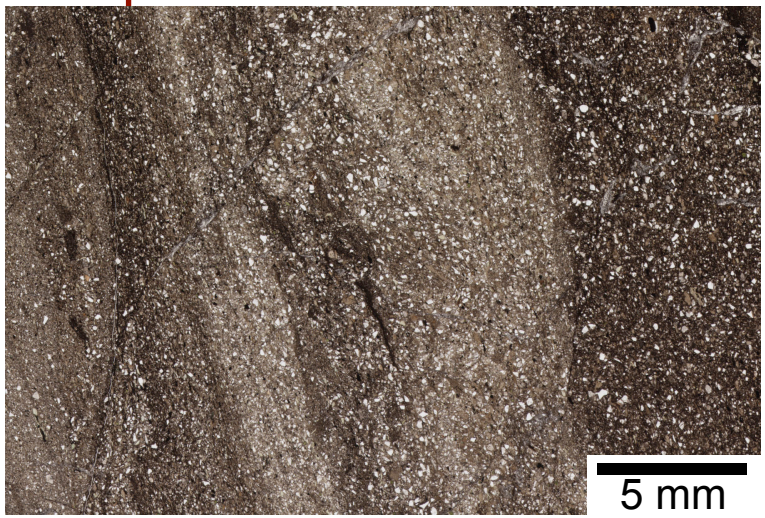
Zoback et al.,
Eos, 2010
Scientific Drilling, 2011

Rock Units Adjacent to CDZ

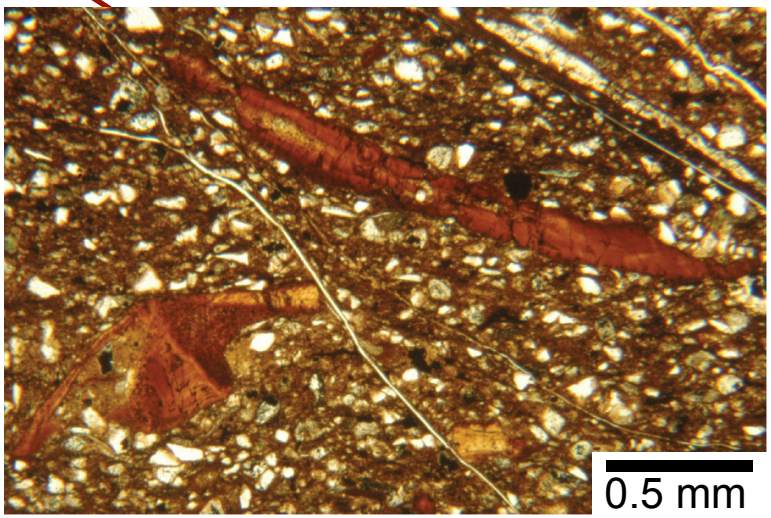
G4 – G6



Bradbury et al. (2011)



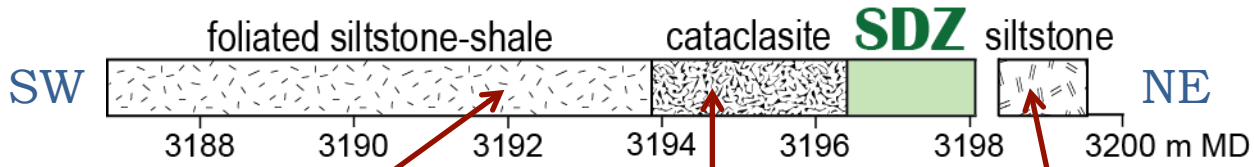
3295.5 m



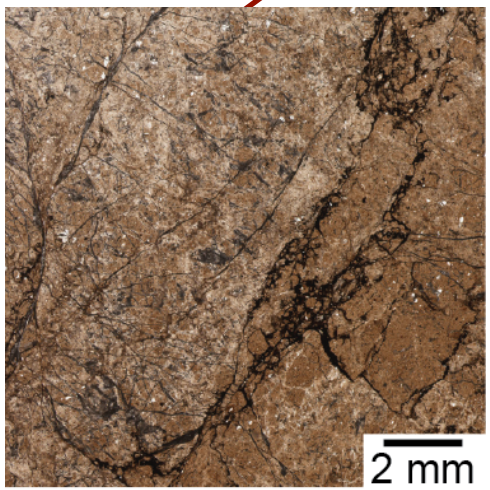
3300.1 m

Rock Units Adjoining SDZ

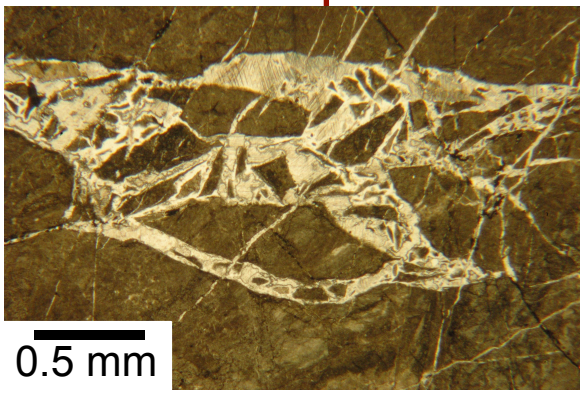
G1 – G3



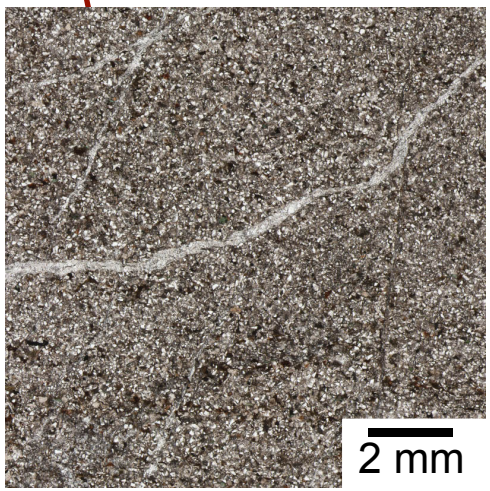
Bradbury et al. (2011)



3192.0 m

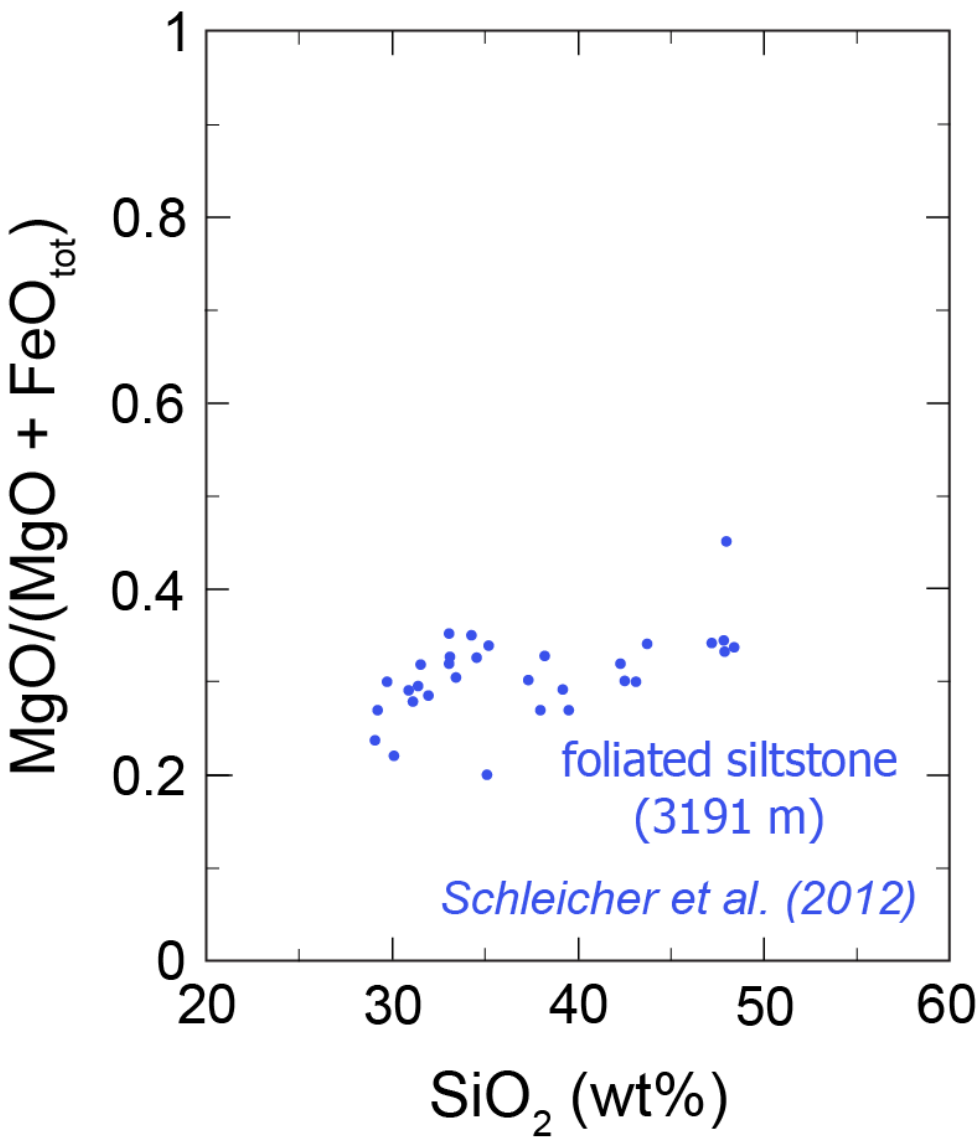


3194.9 m

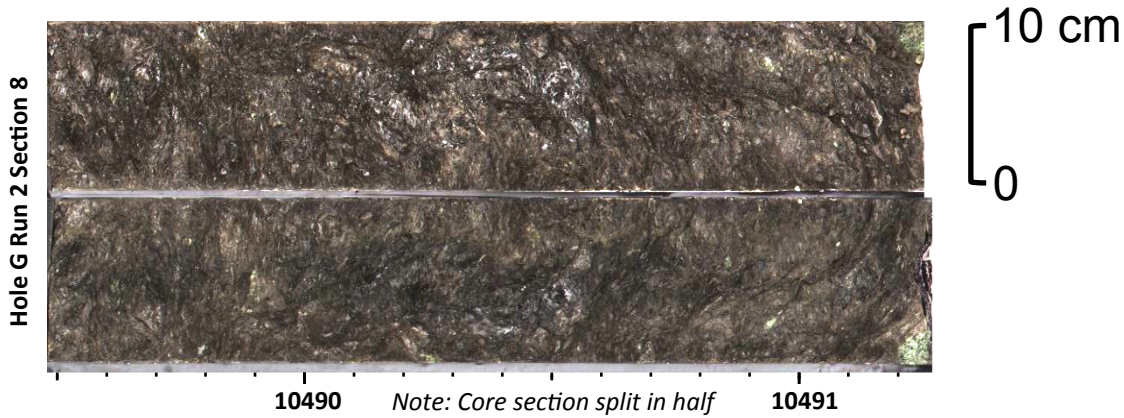


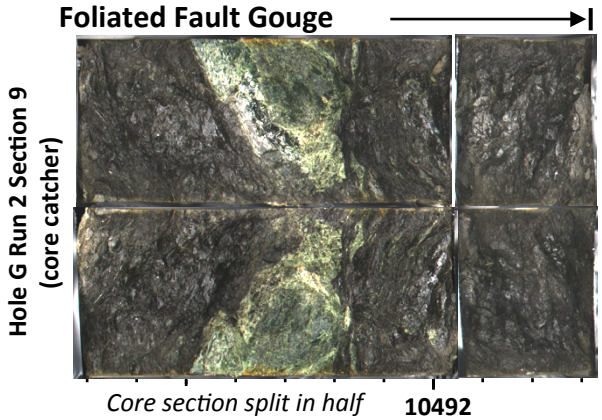
3198.8 m

Clay Chemistry, 3191 m



Southwest Deforming Zone (SDZ)





Gouge width: 1.6 m

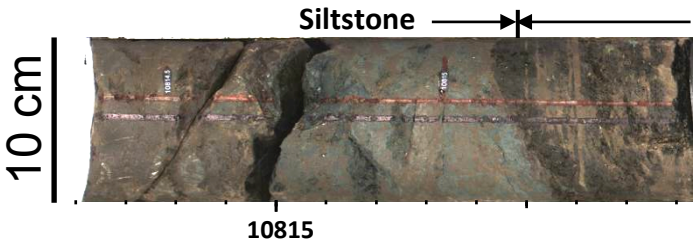
Casing deformation width: ~1.8 m

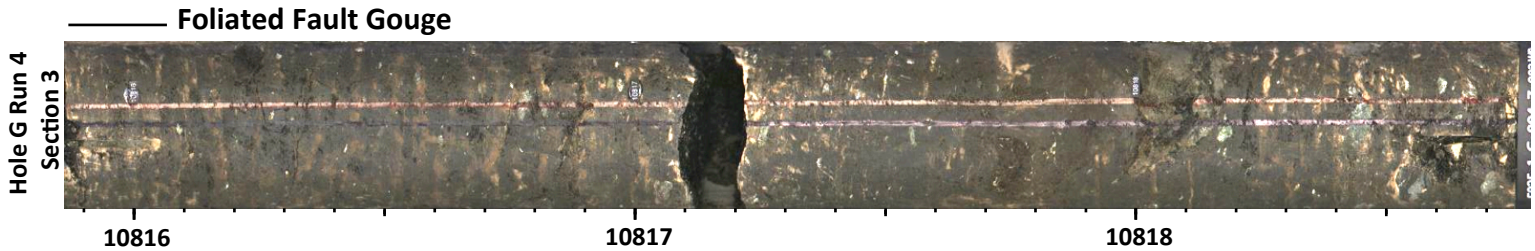
Core photos: www.earthscope.org

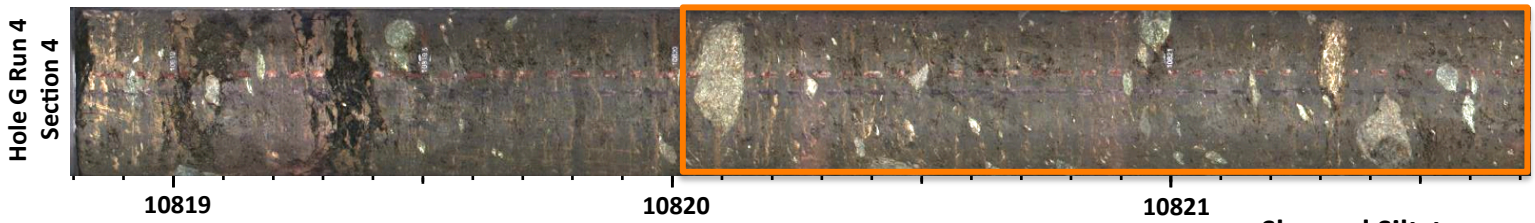
Central Deforming Zone (CDZ)

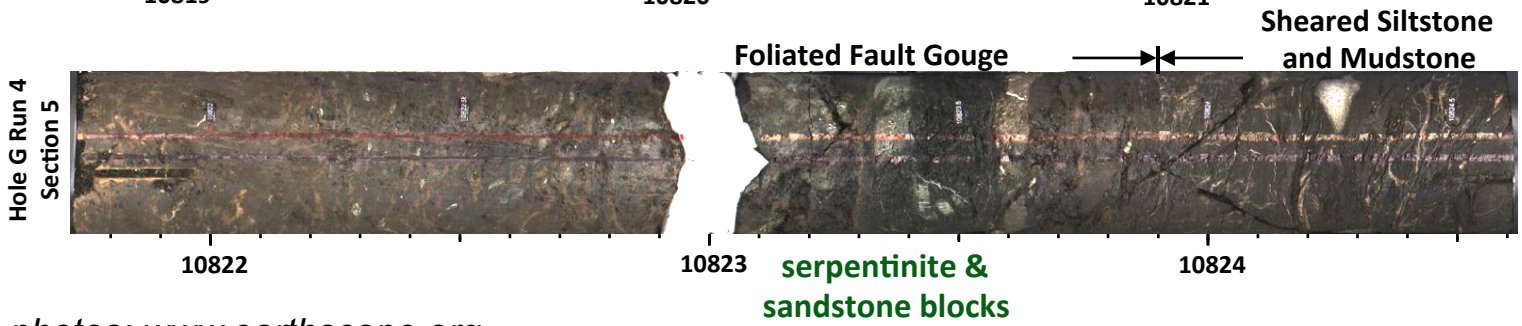
Gouge width: 2.6 m

Casing def. width: ~2.7 m



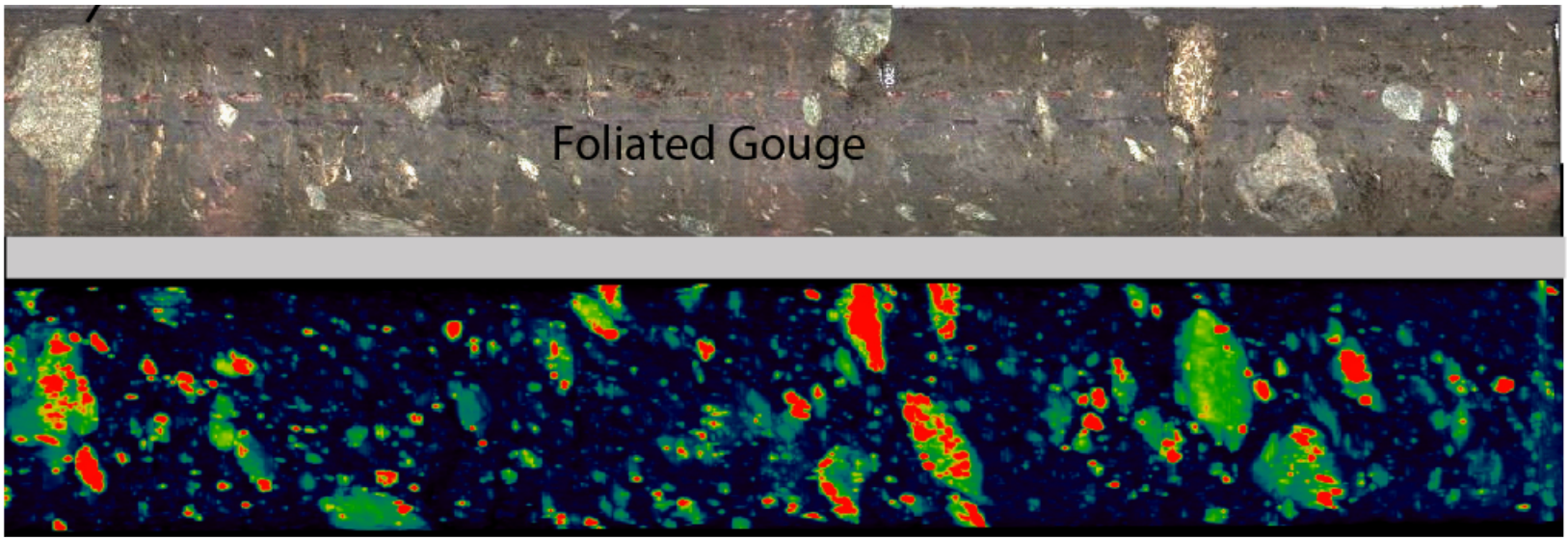




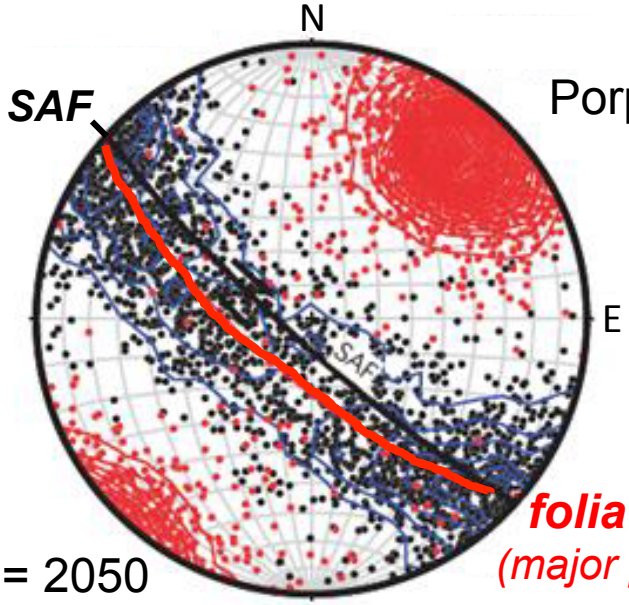


Core photos: www.earthscope.org

Porphyroclast Orientations



CAT Scan



Porphyroclasts > 0.8 mm

- minor axis
- major axis

CDZ

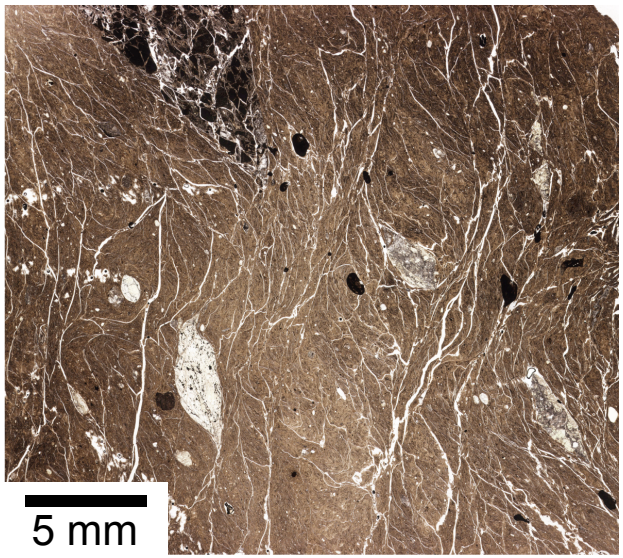
foliation
(major plane)

N = 2050

Sills (2010); Chester et al. (2010);
J. Chester, in Zoback et al. (2010)

Gouge Matrix

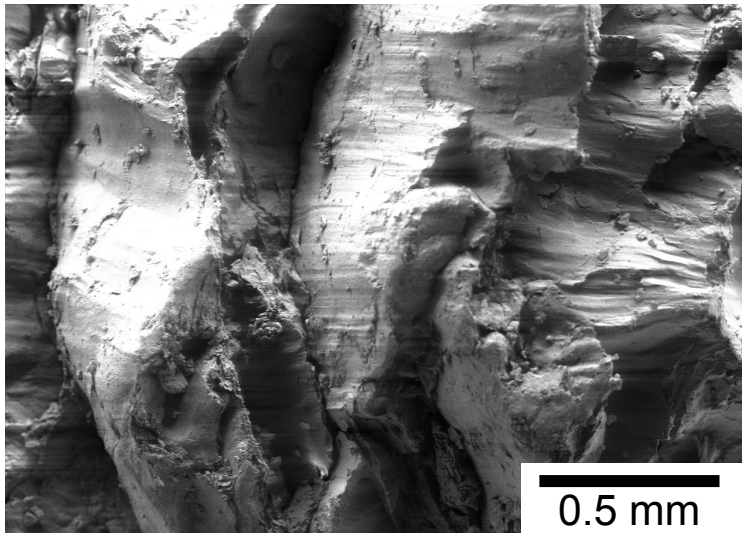
3297.6 m



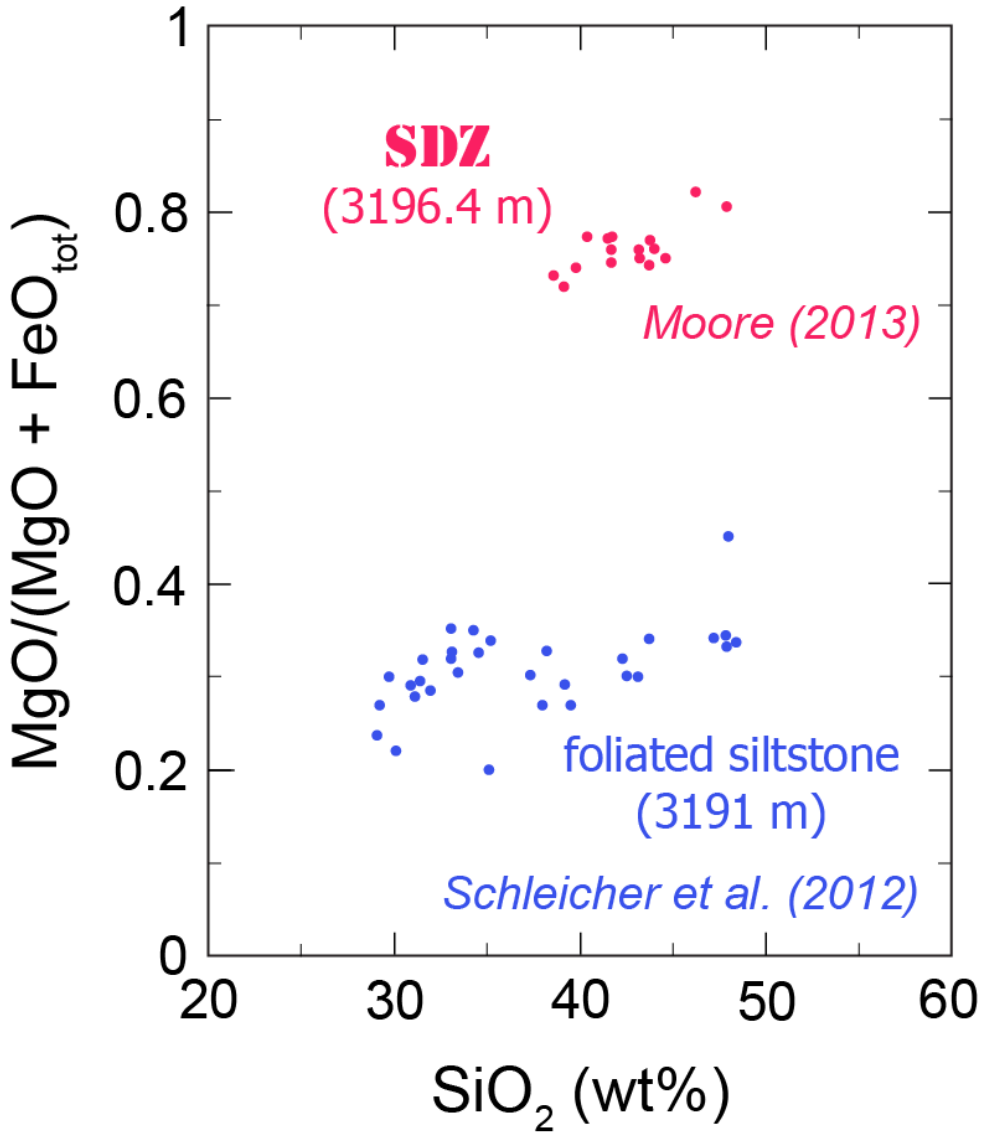
CDZ

3298.6 m

3297.1 m



Clay Chemistry Comparison

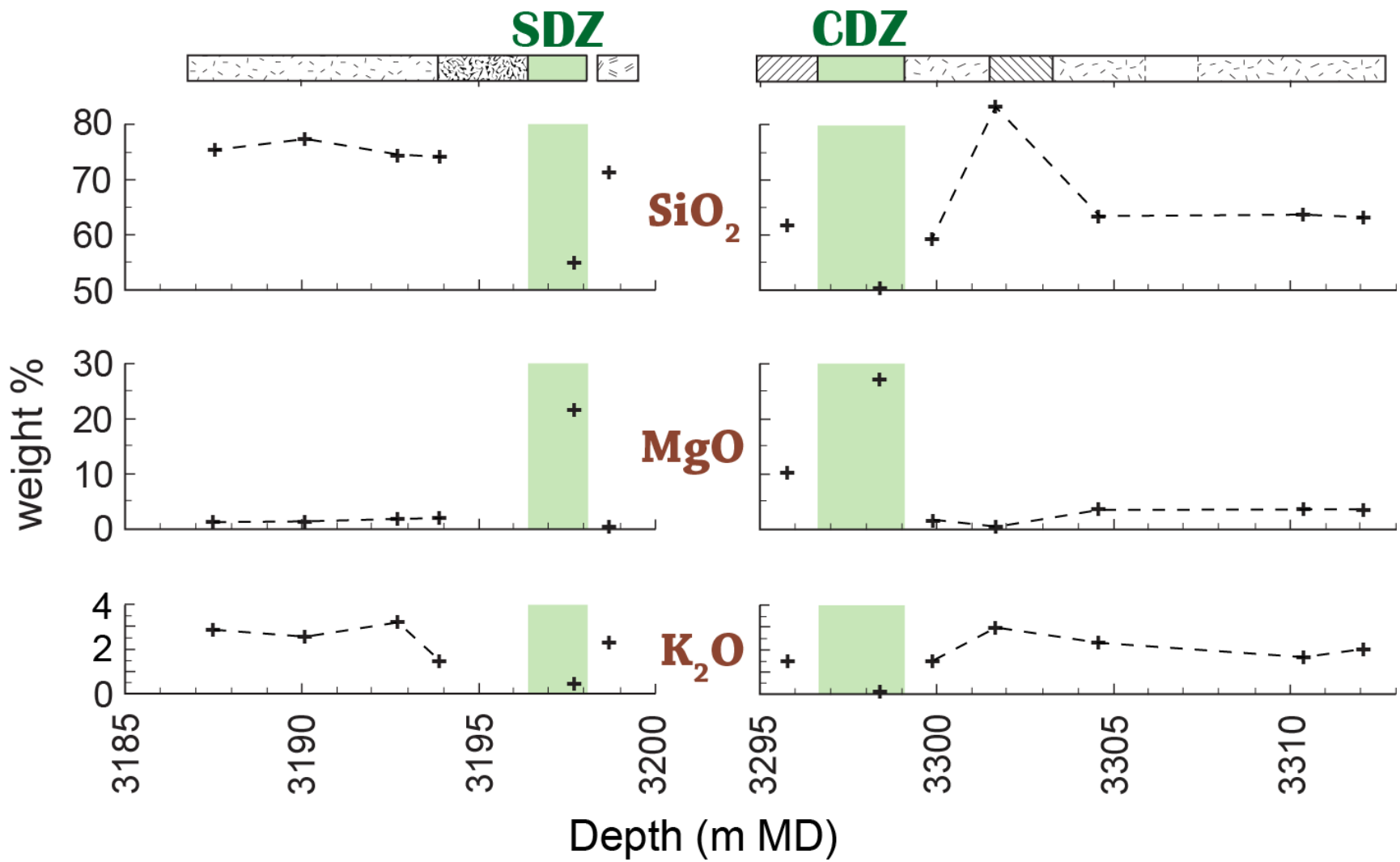


Saponite

Corrensite

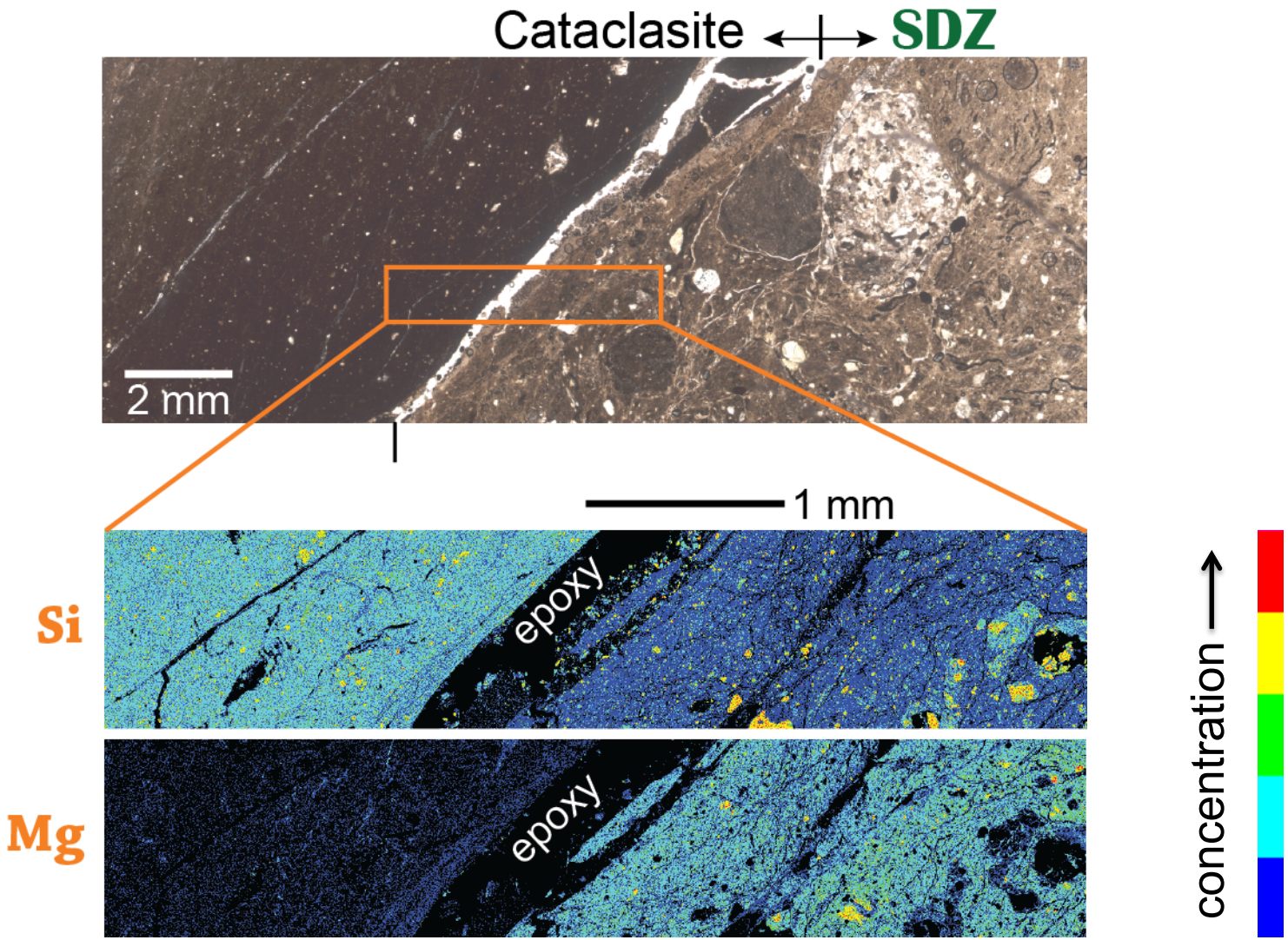
~20-24 wt% MgO

Whole-Rock (XRF) Chemistry

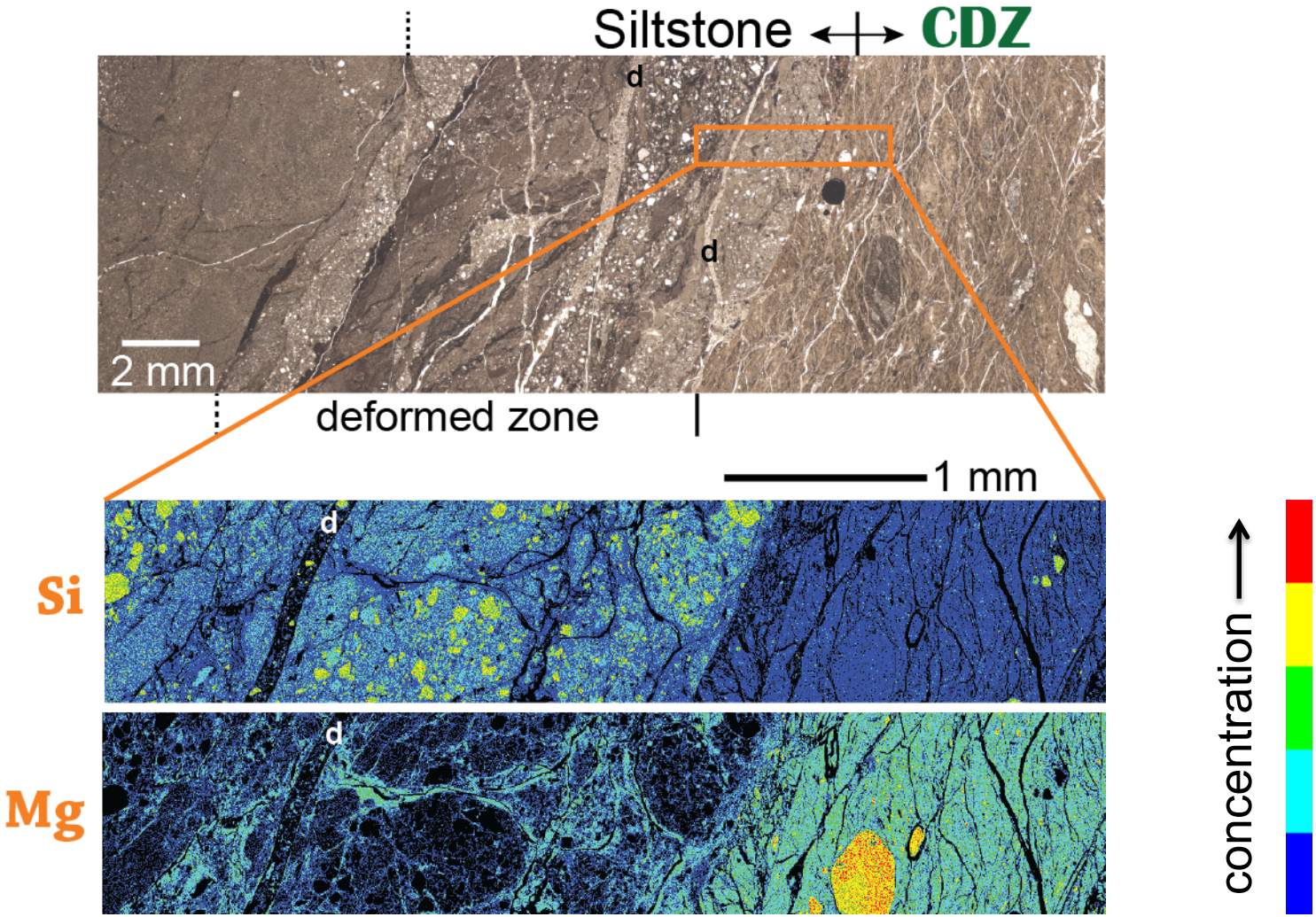


Bradbury et al. (2011)

SW Boundary SDZ

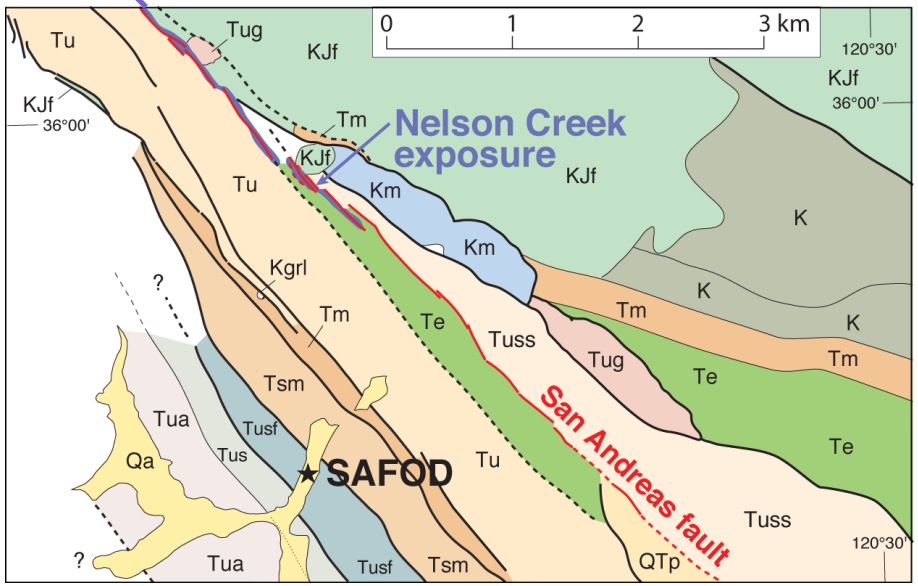


SW Boundary CDZ

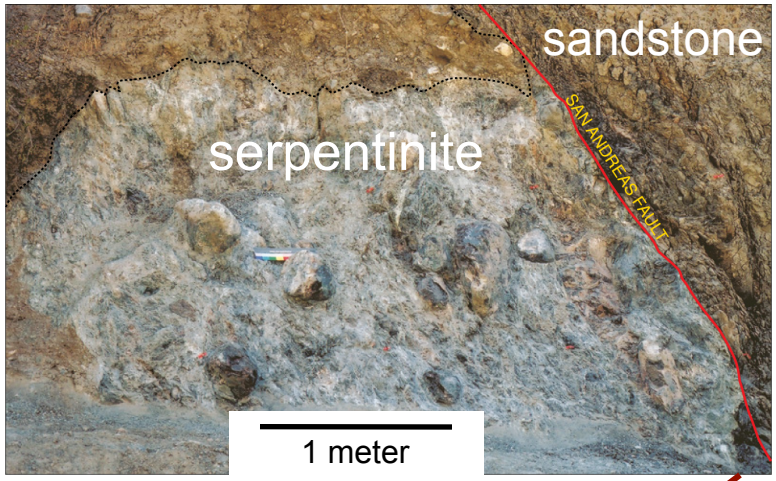


Origin of Gouge Zones

serpentinite continues for ≥1 km to NW.

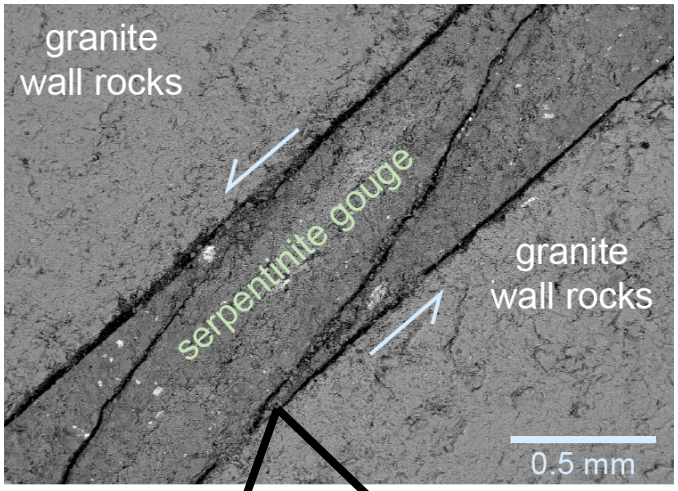


■ serpentinite



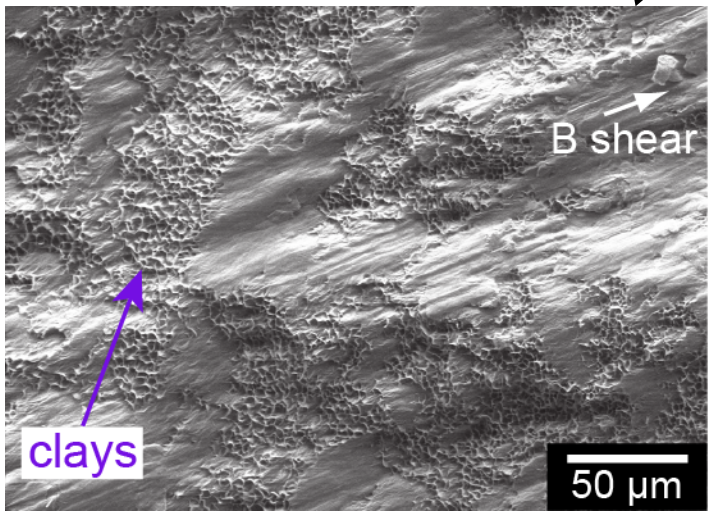
Moore and Rymer (2012)

Laboratory Approximation of Gouge Formation

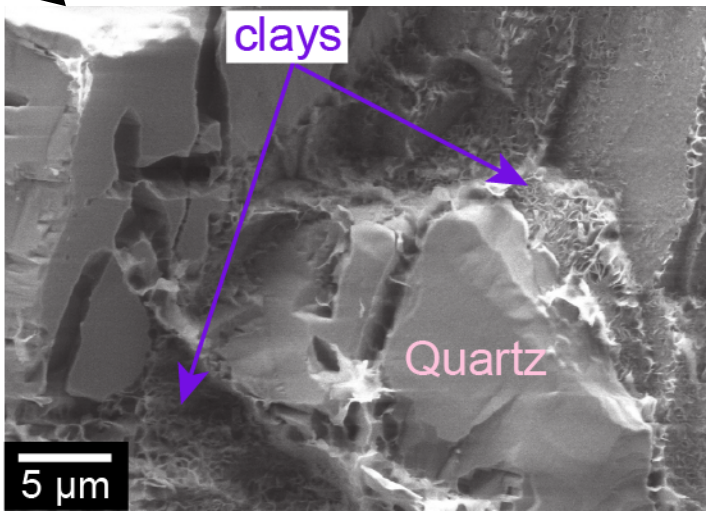


250°C
15 days

Serpentinite Gouge



Granite

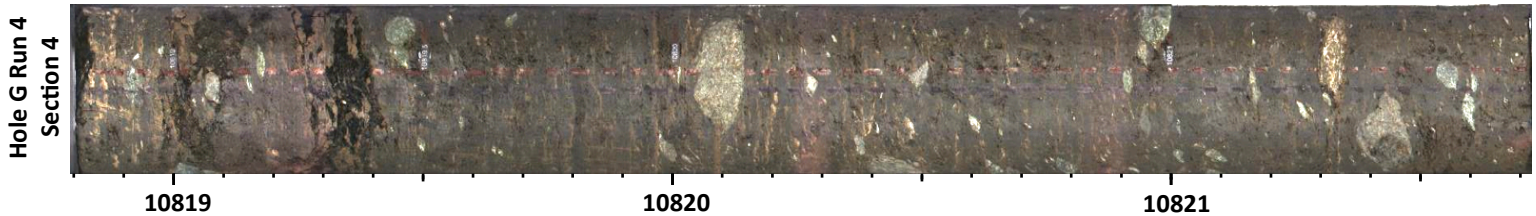


Moore and Lockner (2013)

Long-Term Shear – SDZ and CDZ*

***2-2.5 m.y.?** *(Titus et al., 2011)*

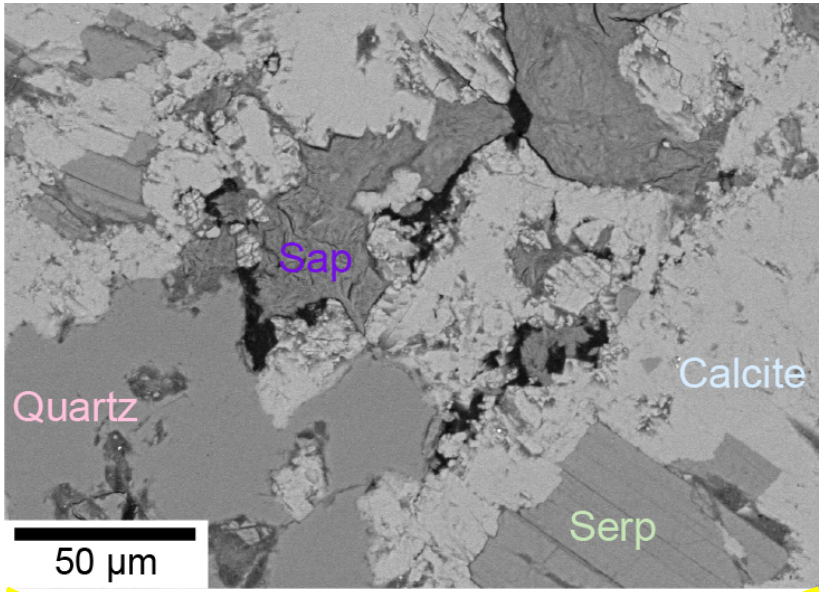
SDZ

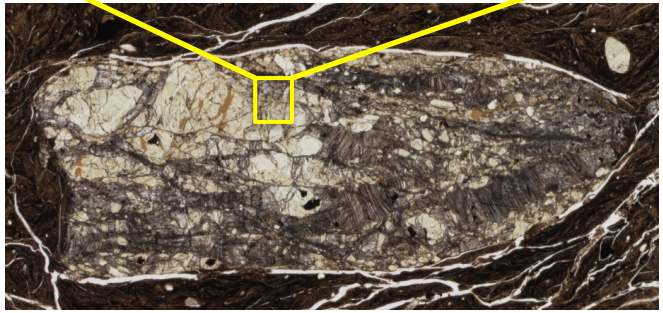


CDZ

Continuing Metasomatic Reactions

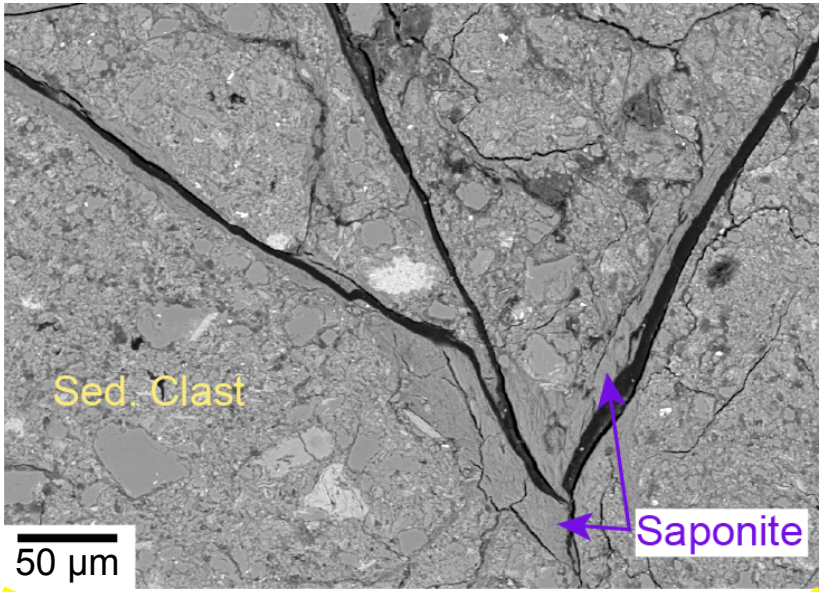
CDZ – 3297.5 m

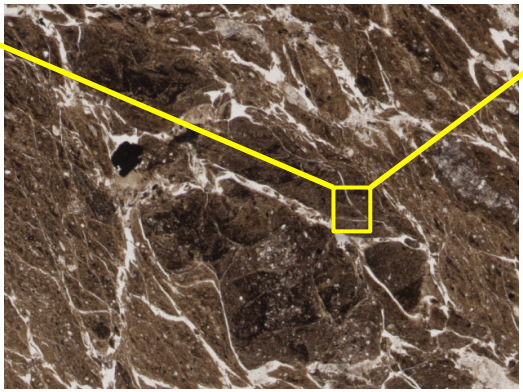




serpentinite clast

CDZ – 3298.9 m





sedimentary clast