# Combining synchrotron and acoustic emission techniques to reveal the secrets of high PT faulting

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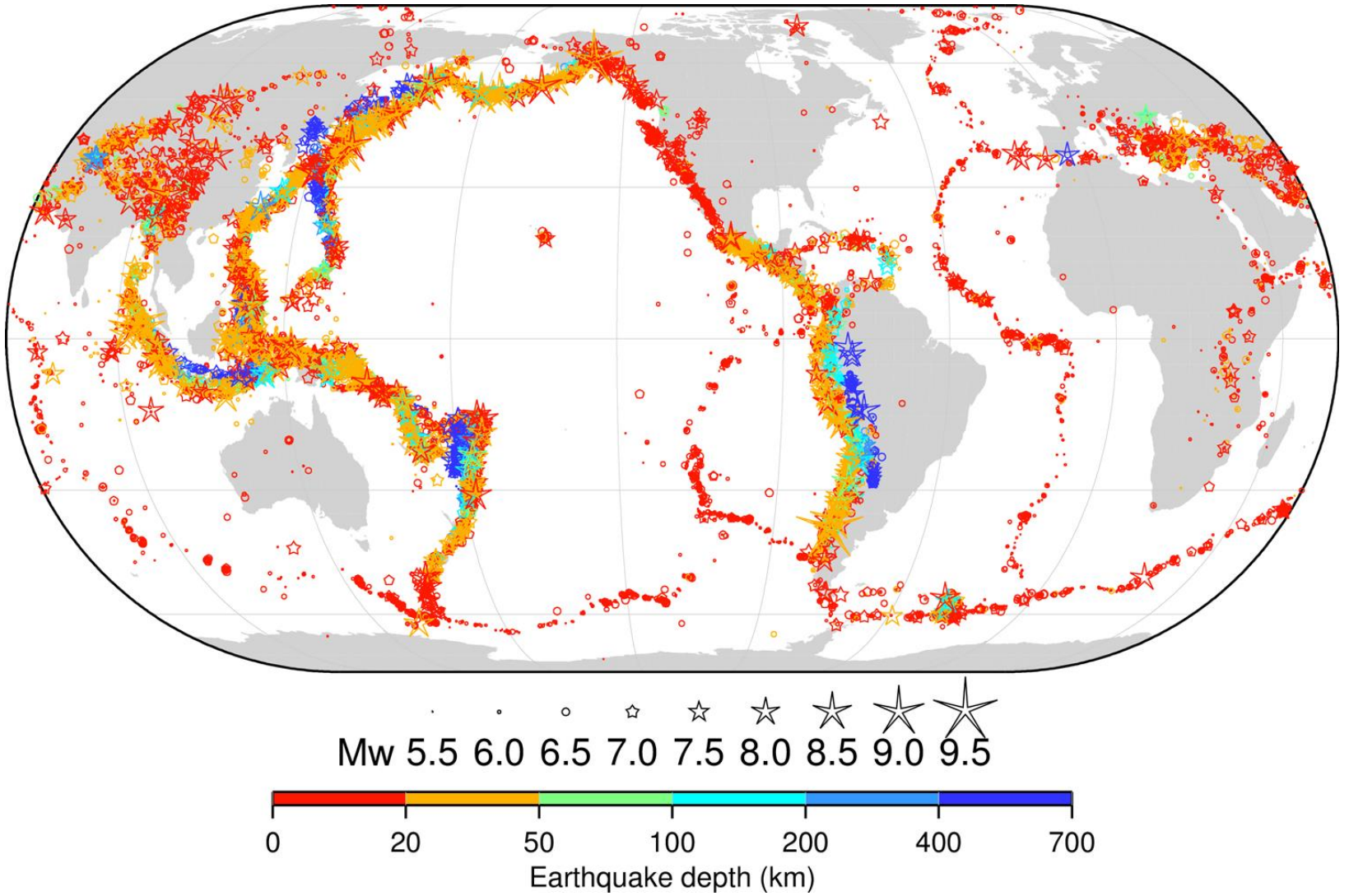
# Depth-magnitude distribution of seismicity

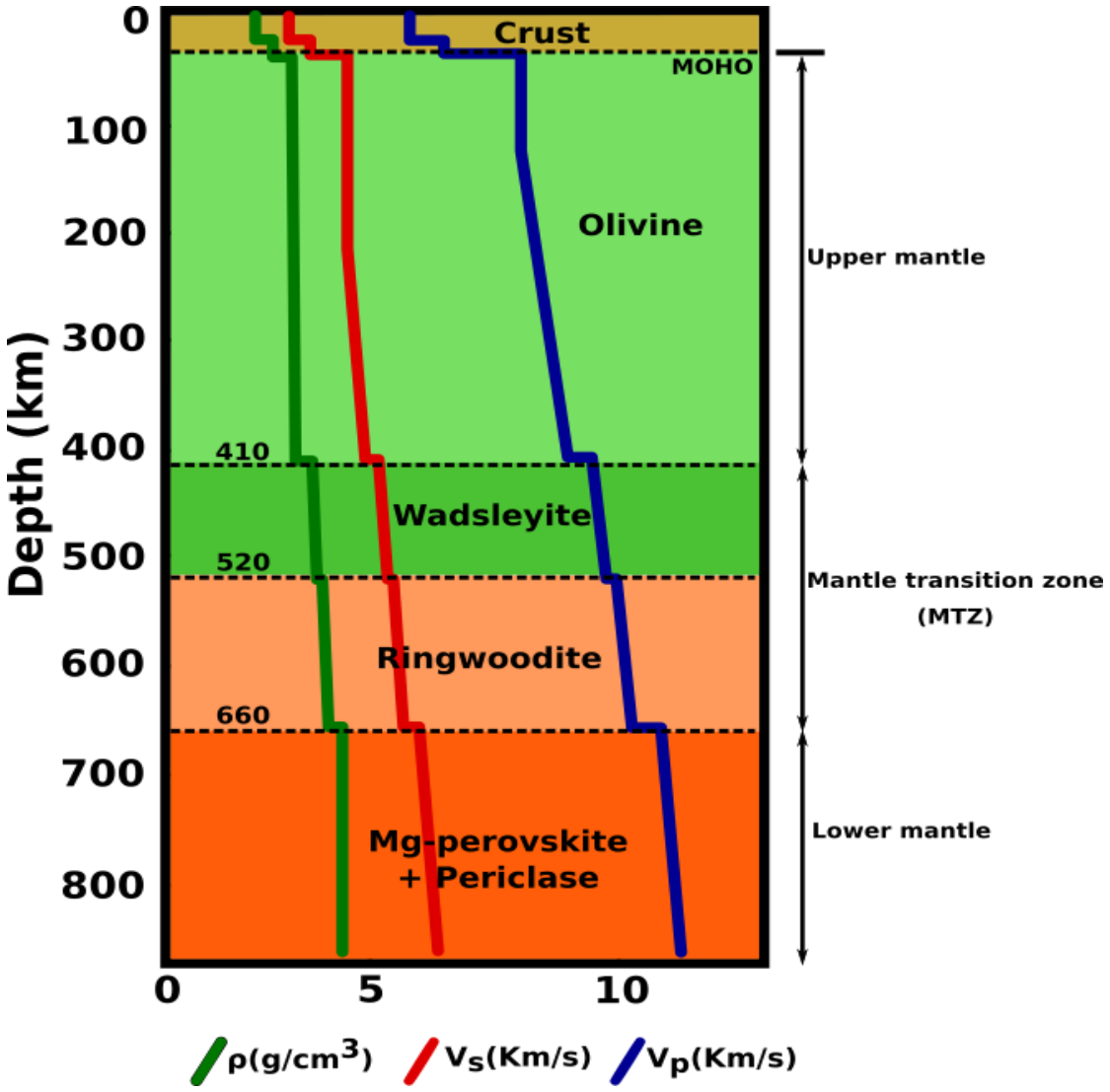



> 300 km depth

**Deep-focus earthquakes**

**Subduction zones** where the lithosphere is old and/or descends rapidly

# Olivine transformations at depth




*https://www.alexstrekeisen.it/english/vulc/olivine.php*

Seismic discontinuities

↓

Phase transitions of olivine

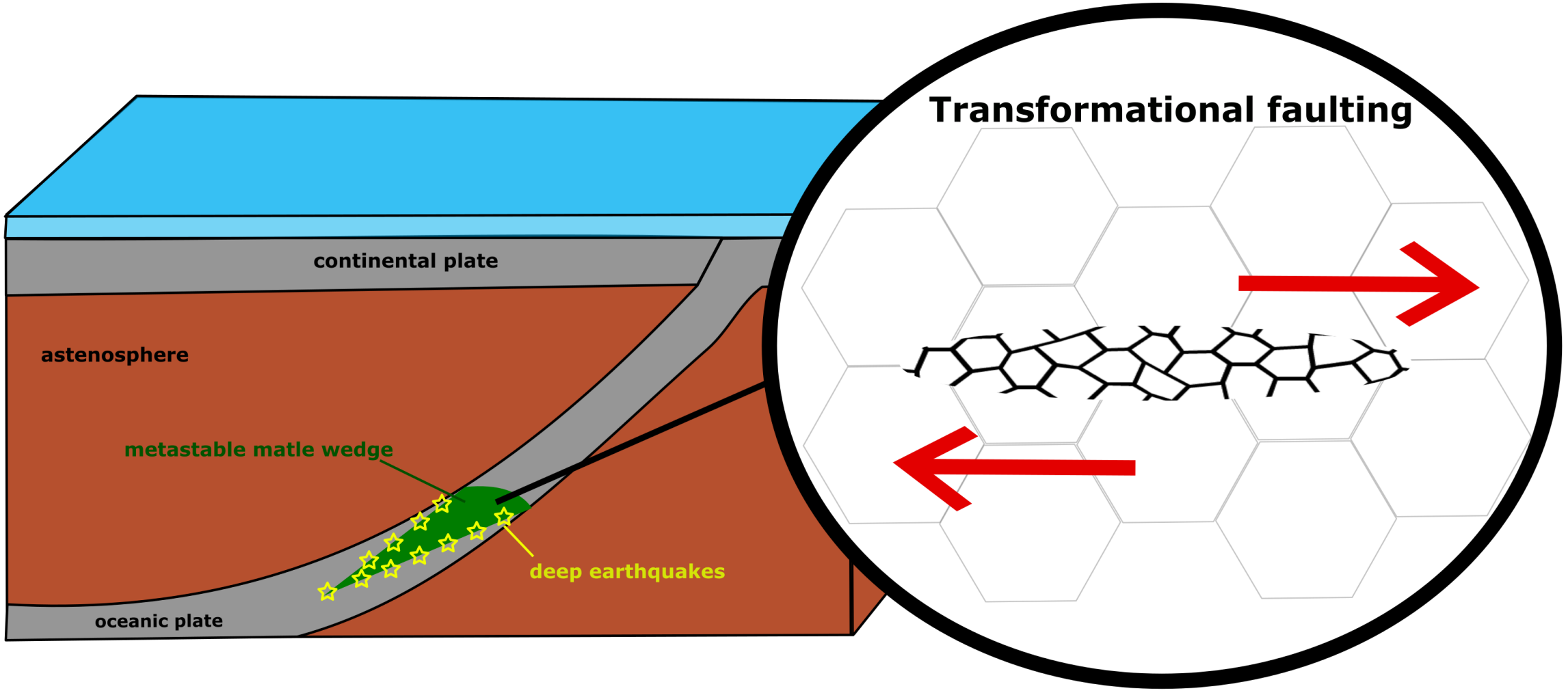
↓

Important rheological implications

↓

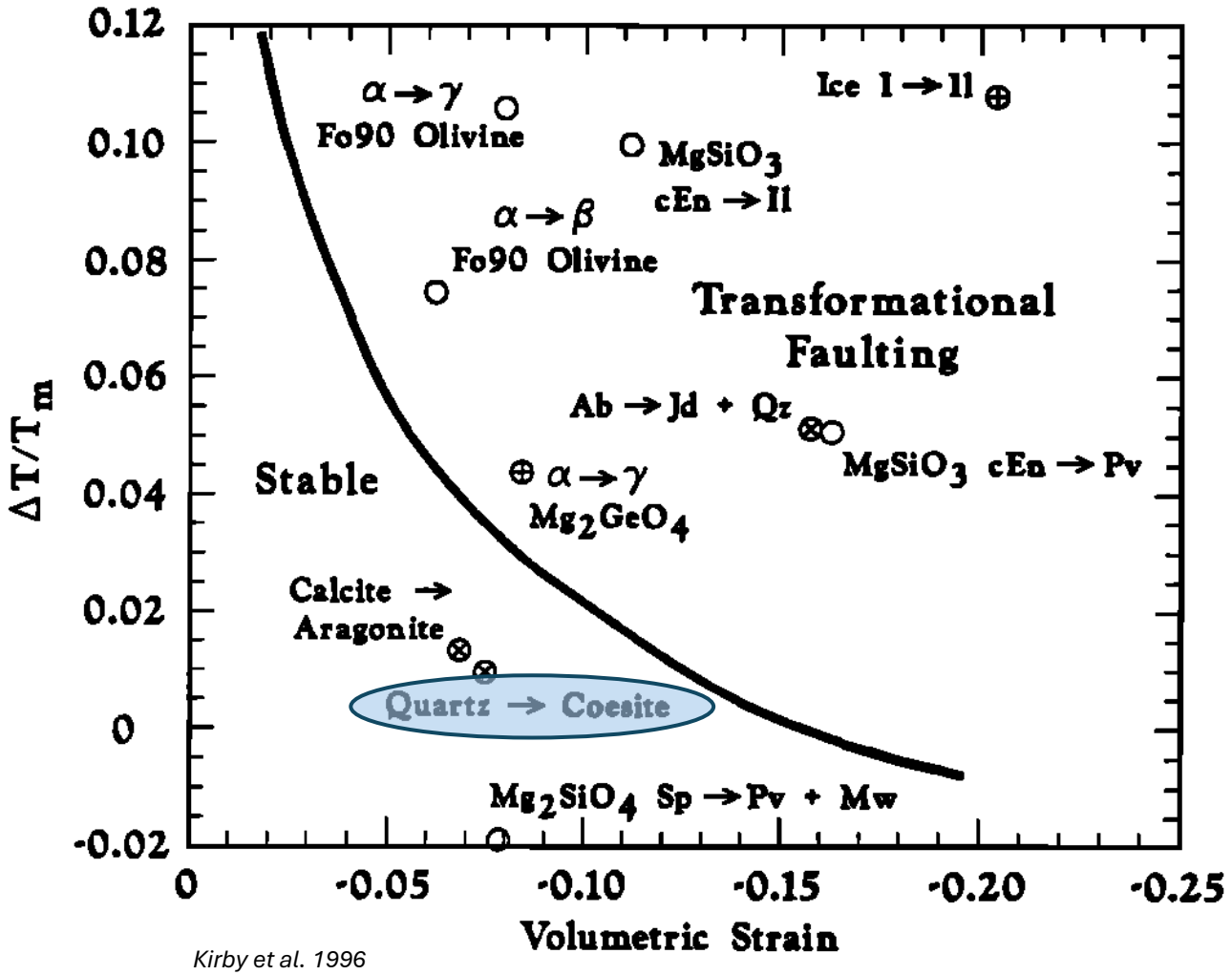
Several studies suggest that they could be a cause of **transformational faulting**

# Transformational faulting



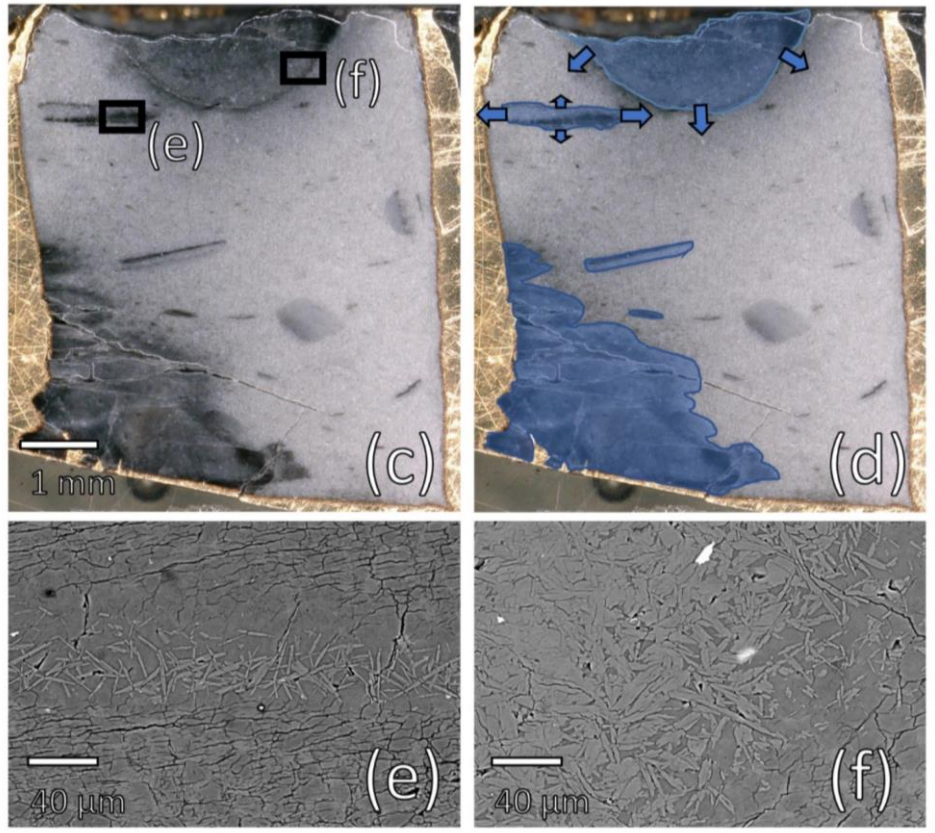

Modified after Ohuchi et al., 2022

# What about other transitions?




*Kirby et al. 1996*

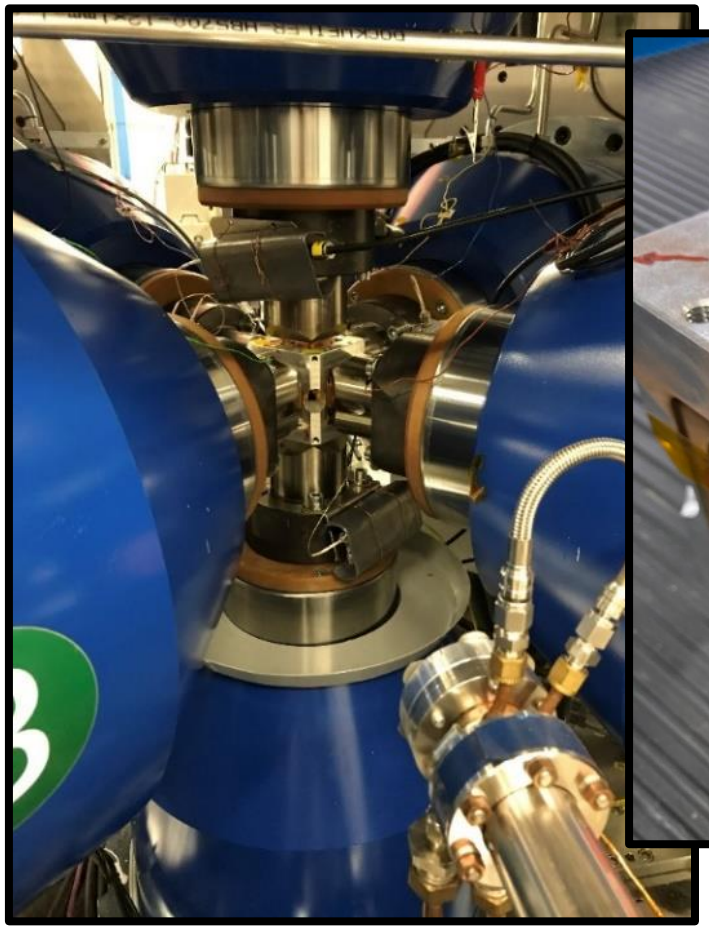
*Gasc et al., 2022*



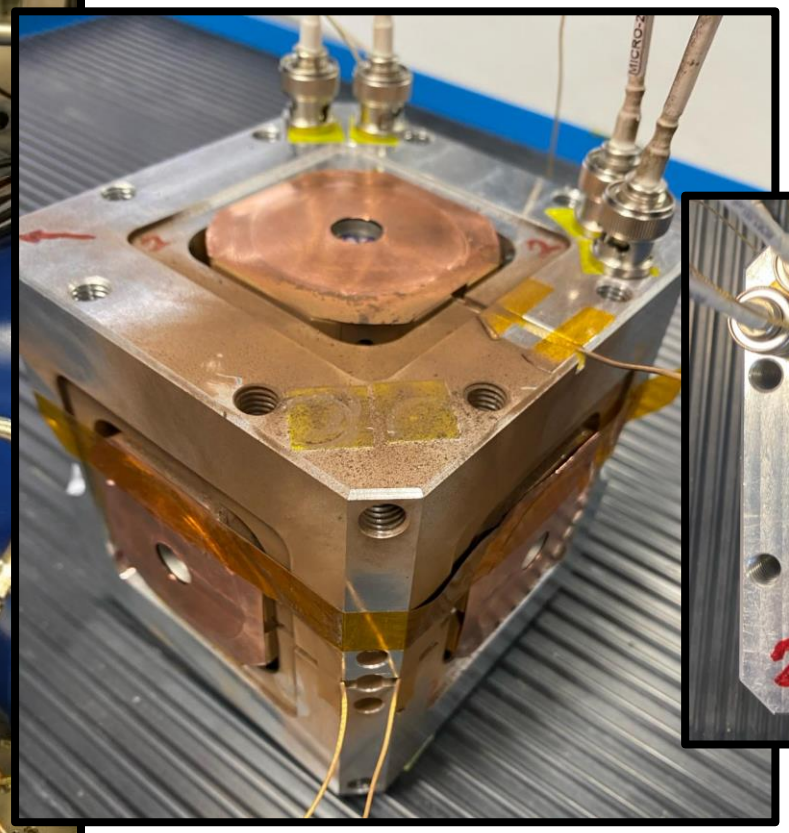

**Quartz-coesite**: no strain localization
Stable front propagation

# Synchrotron experiments at PETRA III

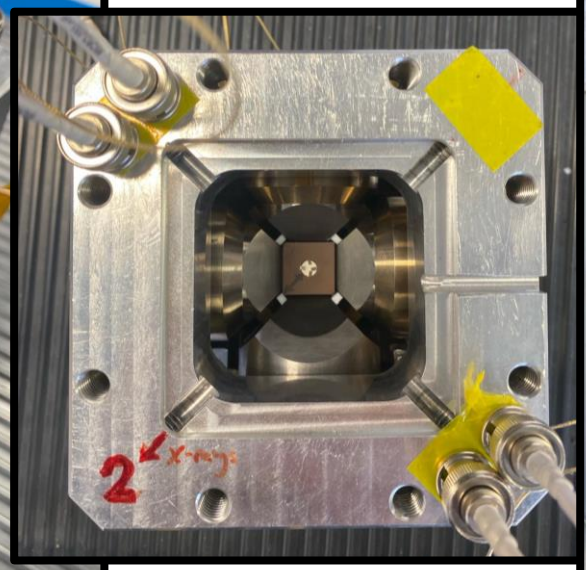
High T and P experiments combining synchrotron x-ray radiation and acoustic emissions



Large volume press at PETRA III

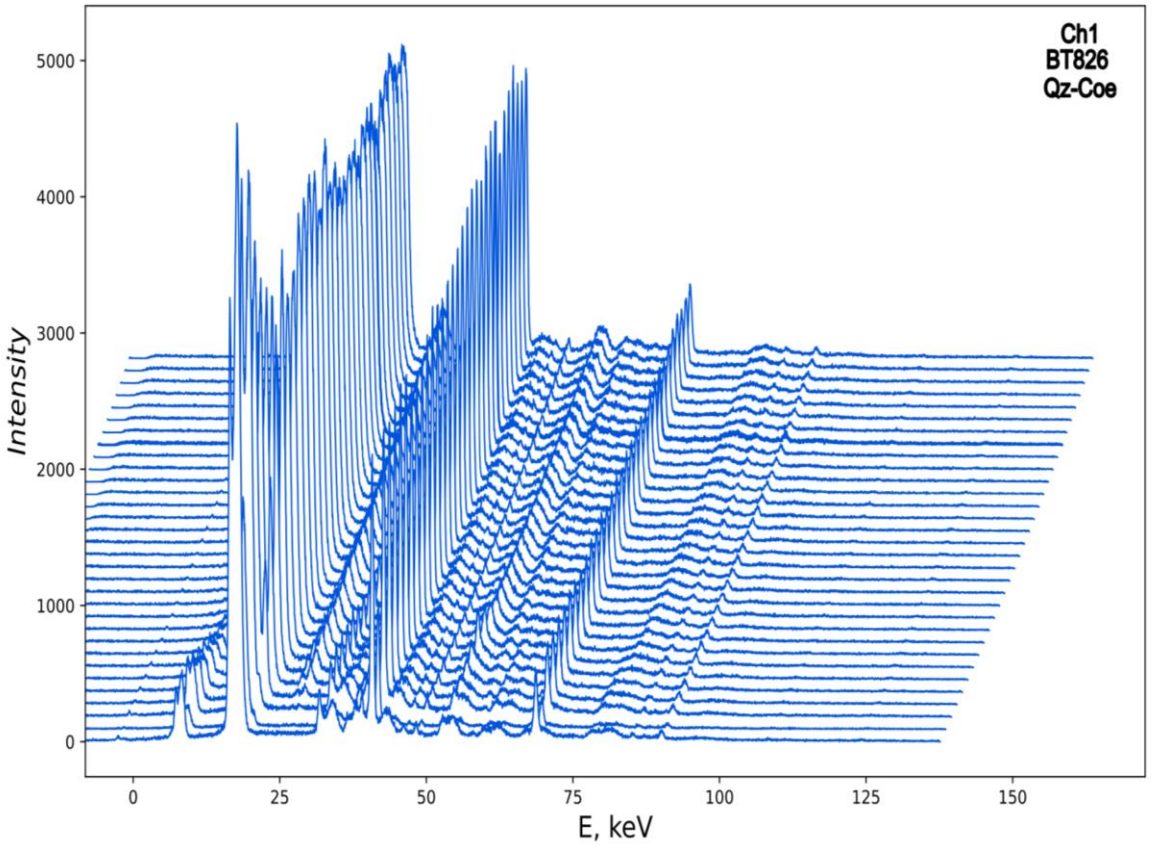


Cube of the assembly

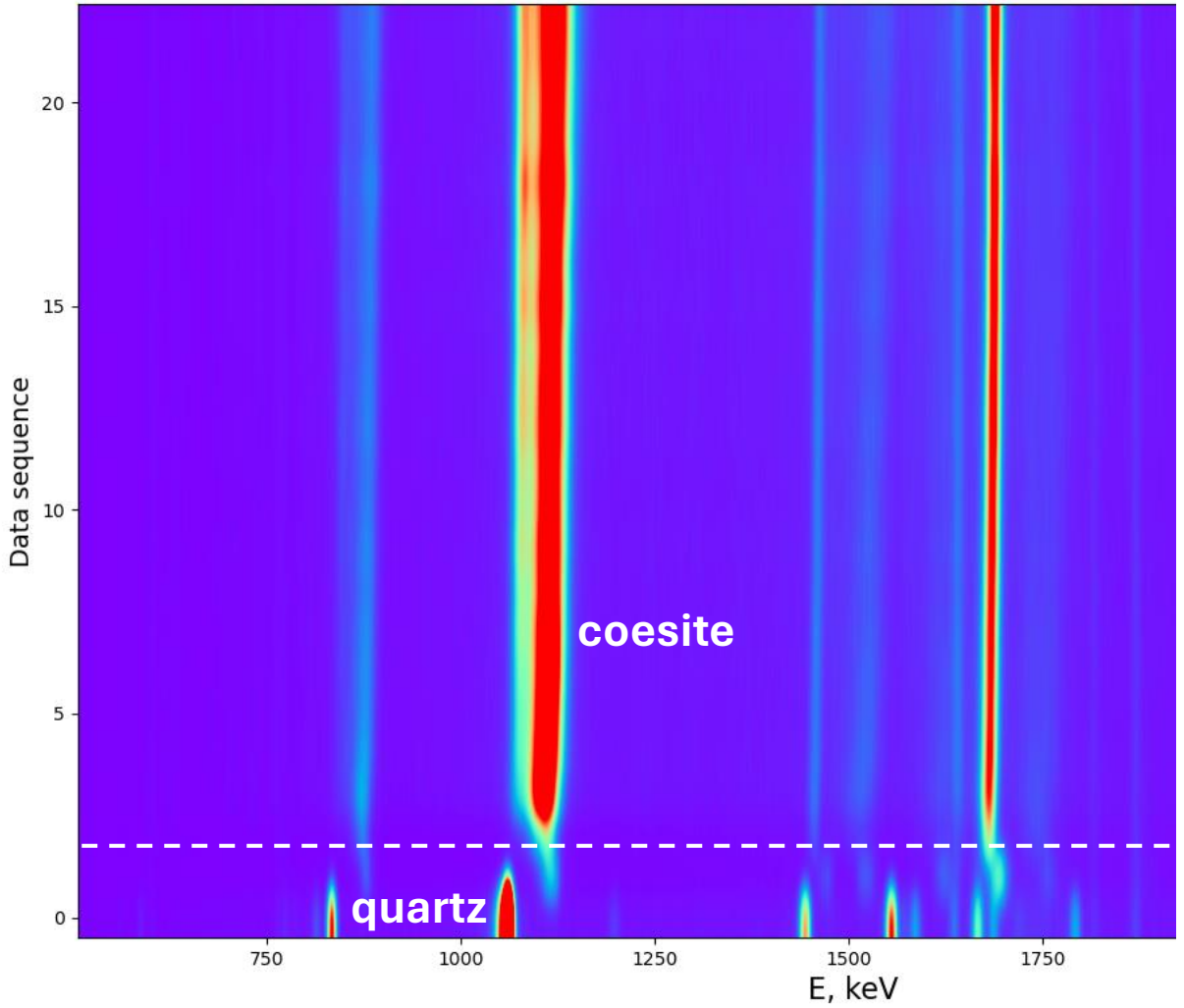


first stage anvils + acoustic transducers

# Experimental results

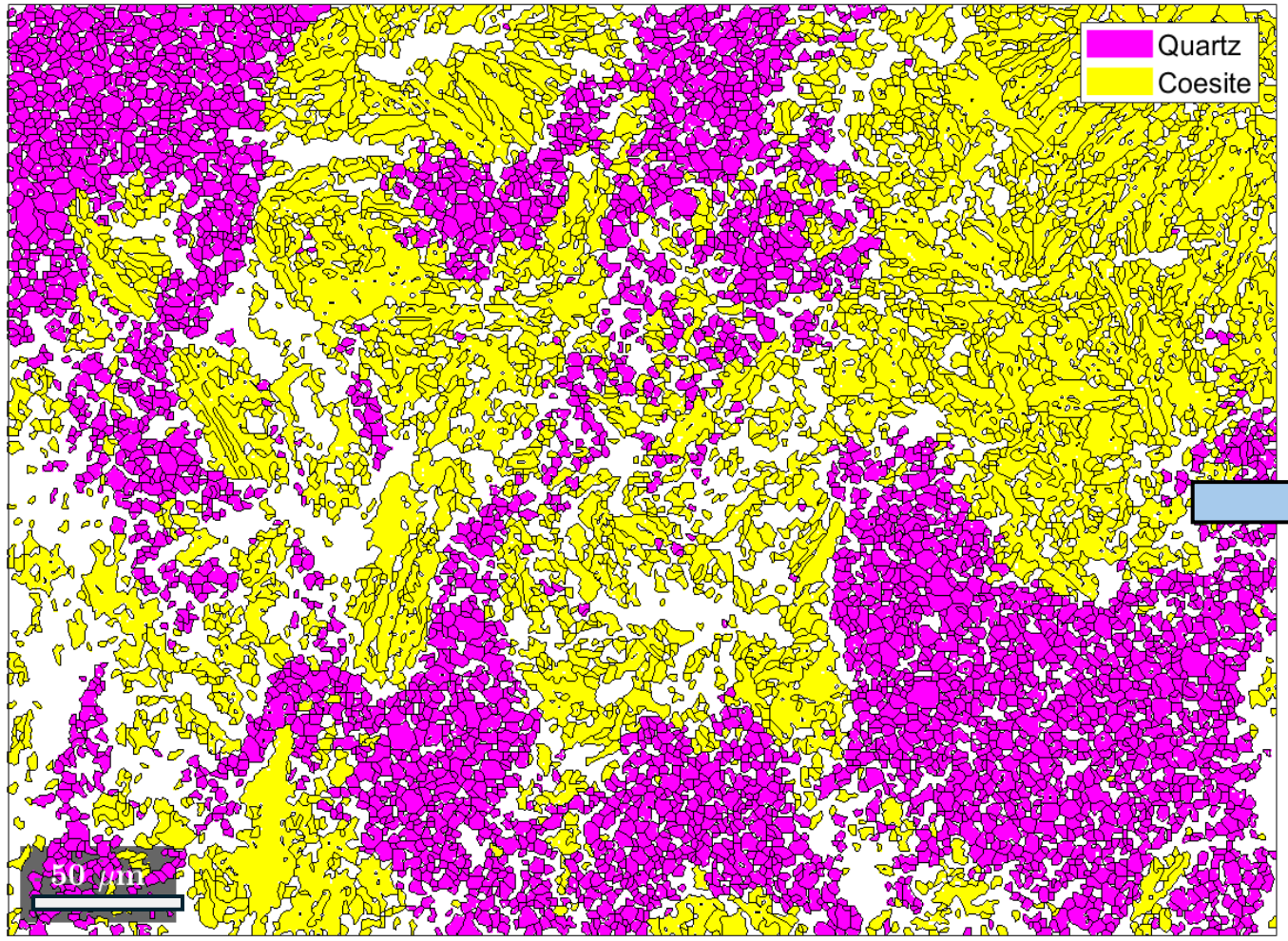



X- ray diffraction patterns, every 100s

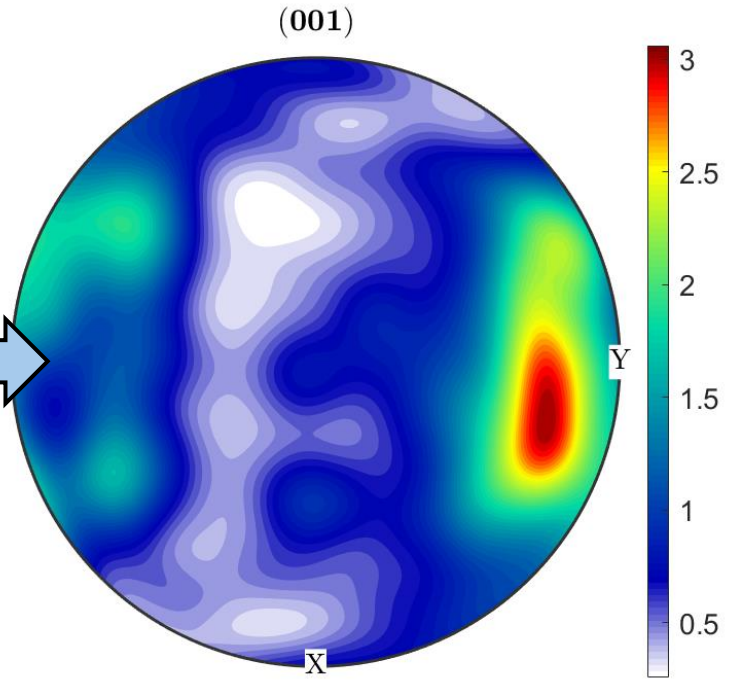


# EBSD results

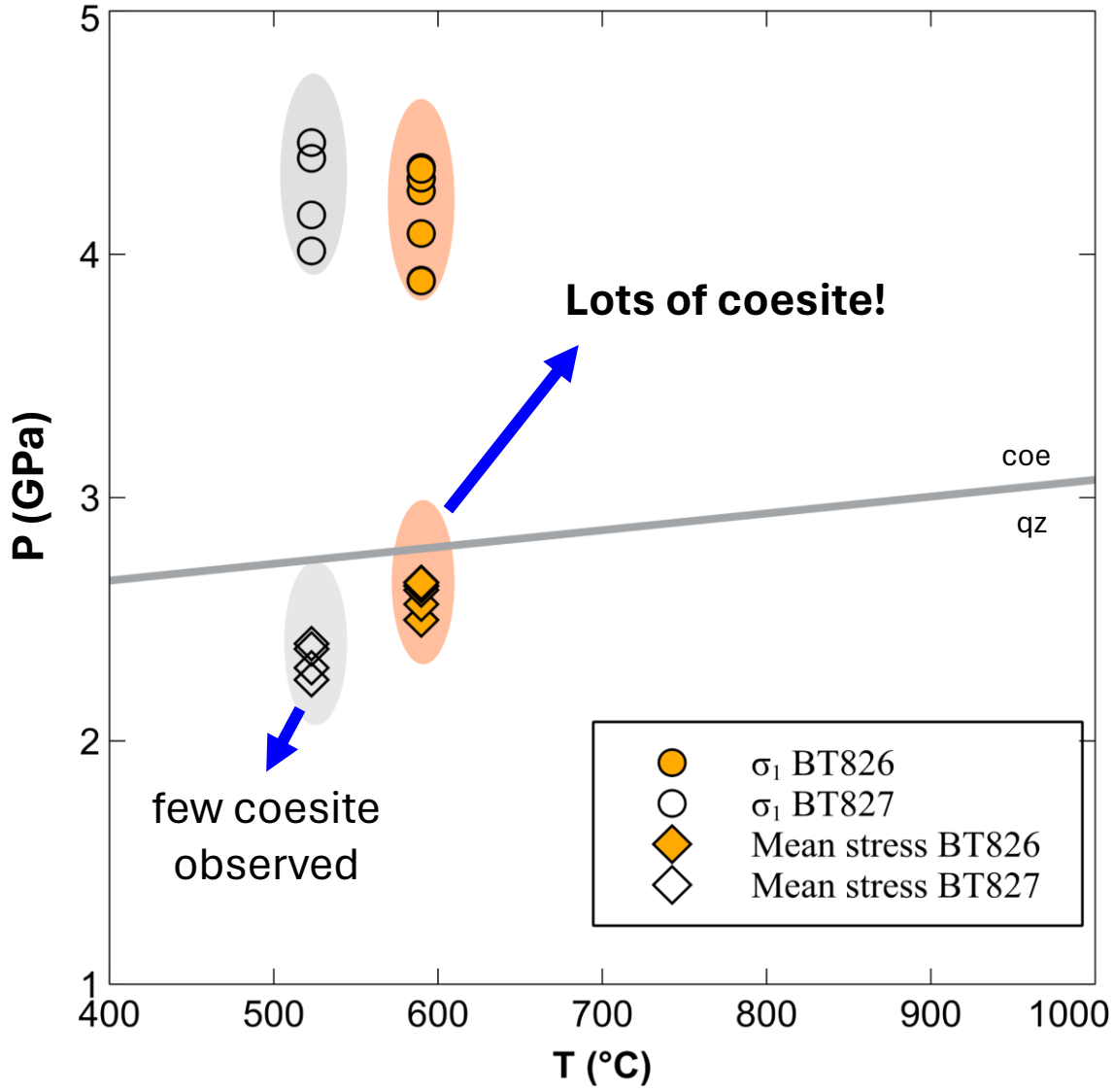
BT826: lots of coesite




Coesite strong preferred orientation

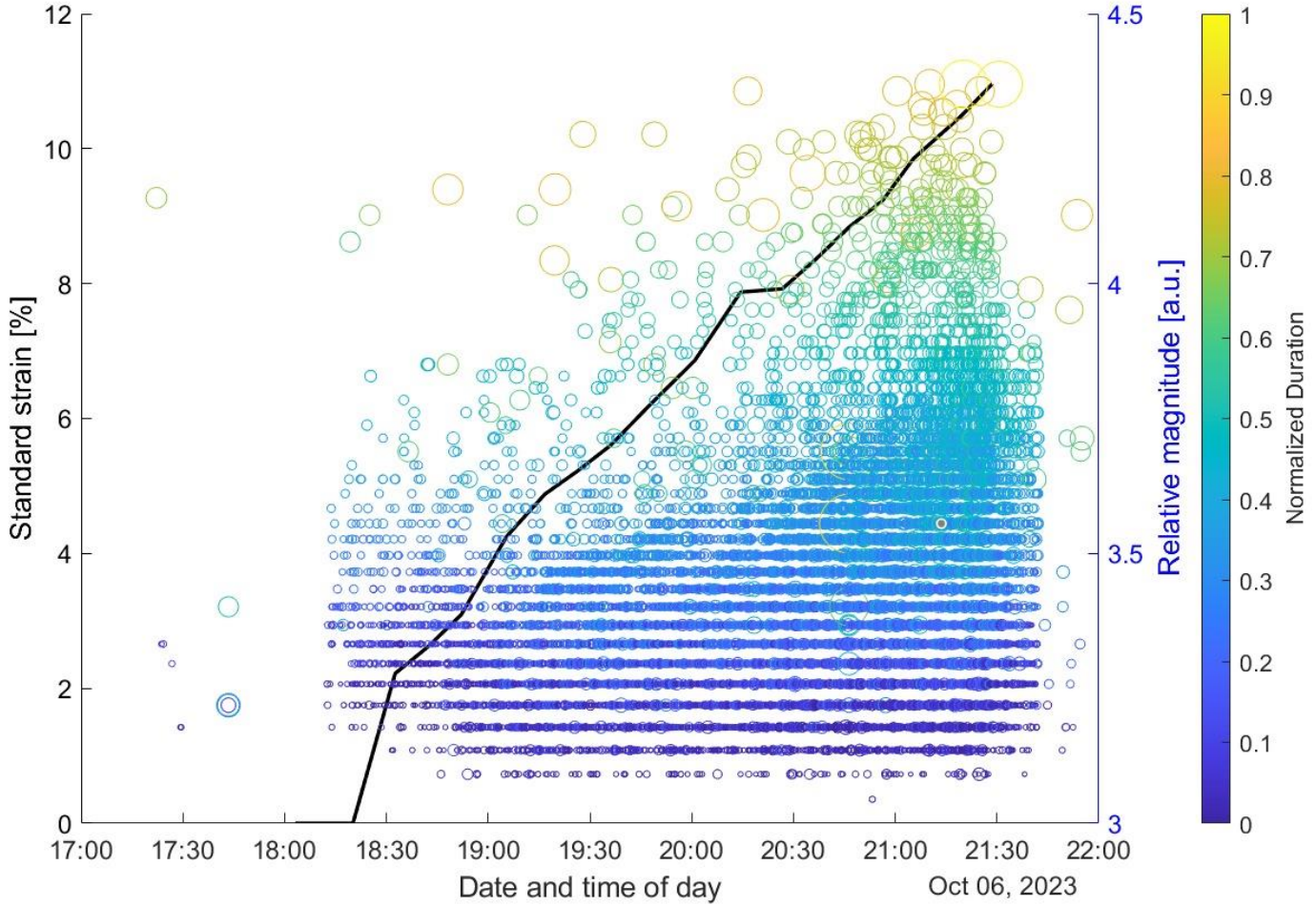


# Quartz-Coesite stress and mean stress (pressure)



# Acoustic emissions during sample shortening

Ongoing Olivine → Ringwoodite

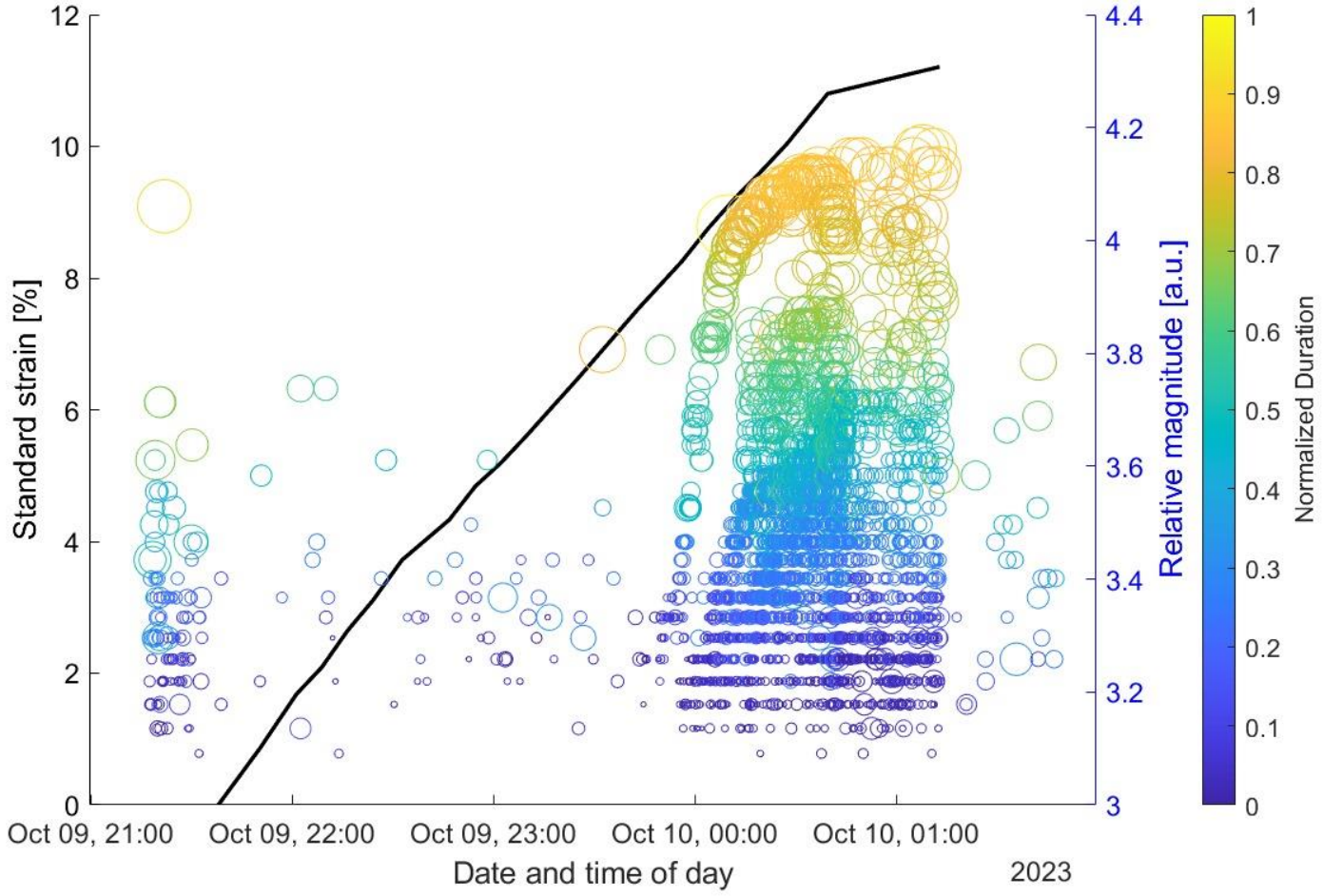



We collected **23 000 AEs !!**

Lower magnitude implies smaller events

# Acoustic emissions during sample shortening

Ongoing Quartz → Coesite




Remarkable AE series

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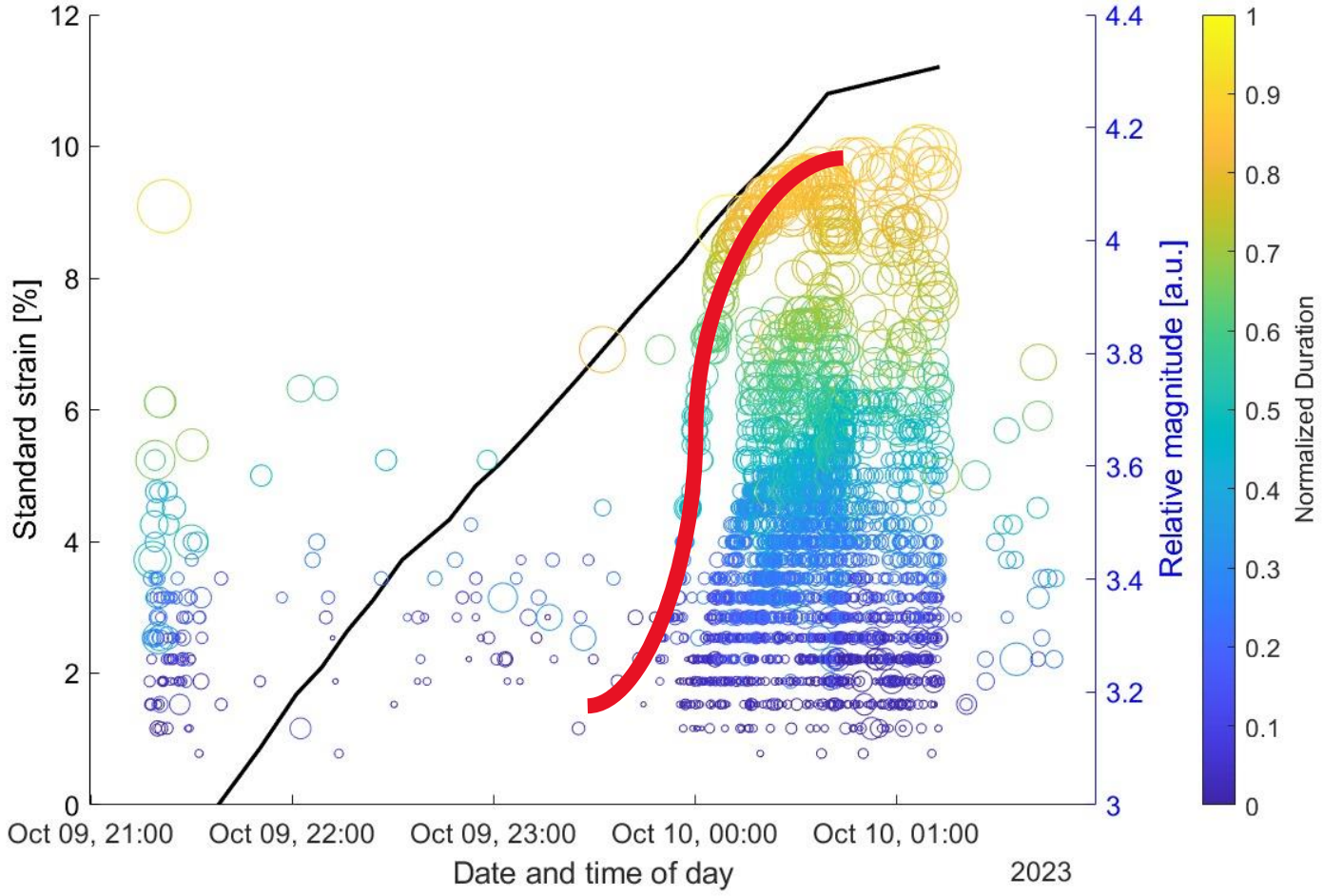
Ongoing Quartz → Coesite

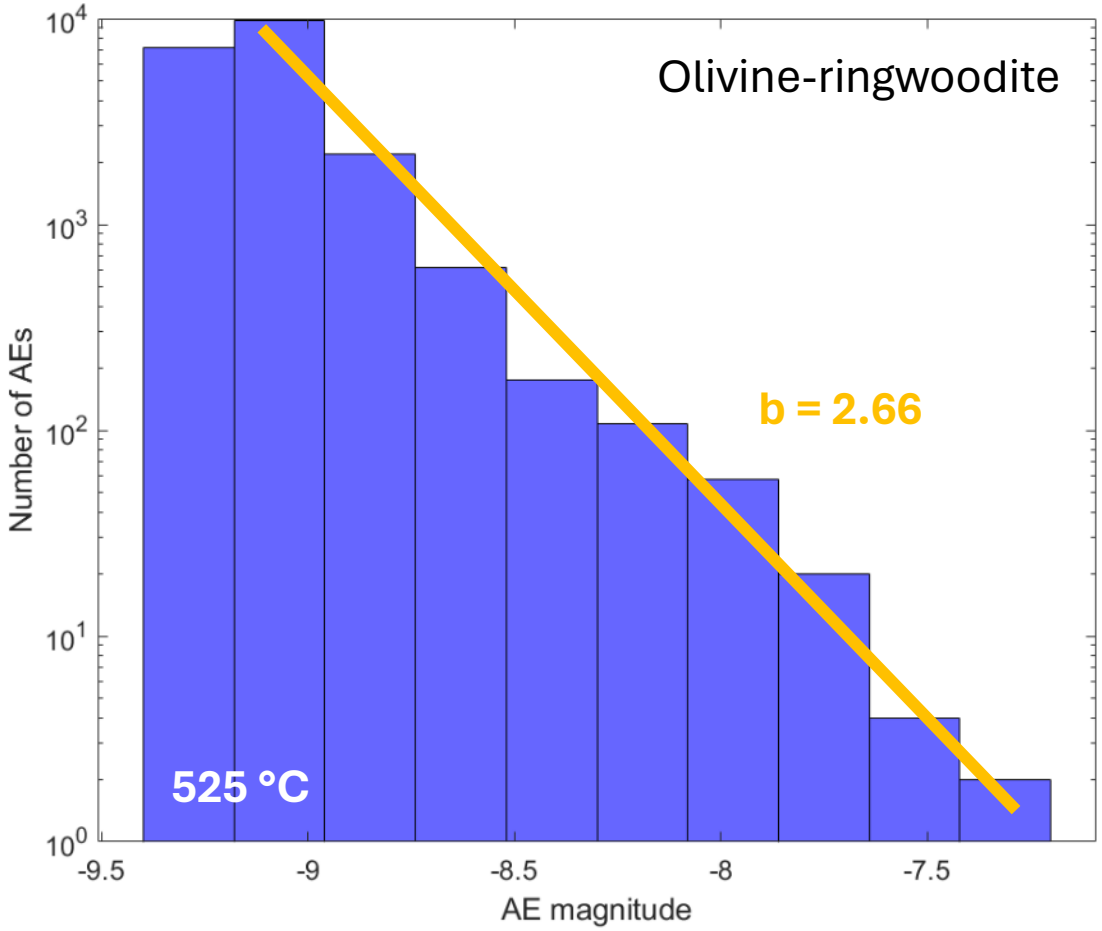



Remarkable AE series

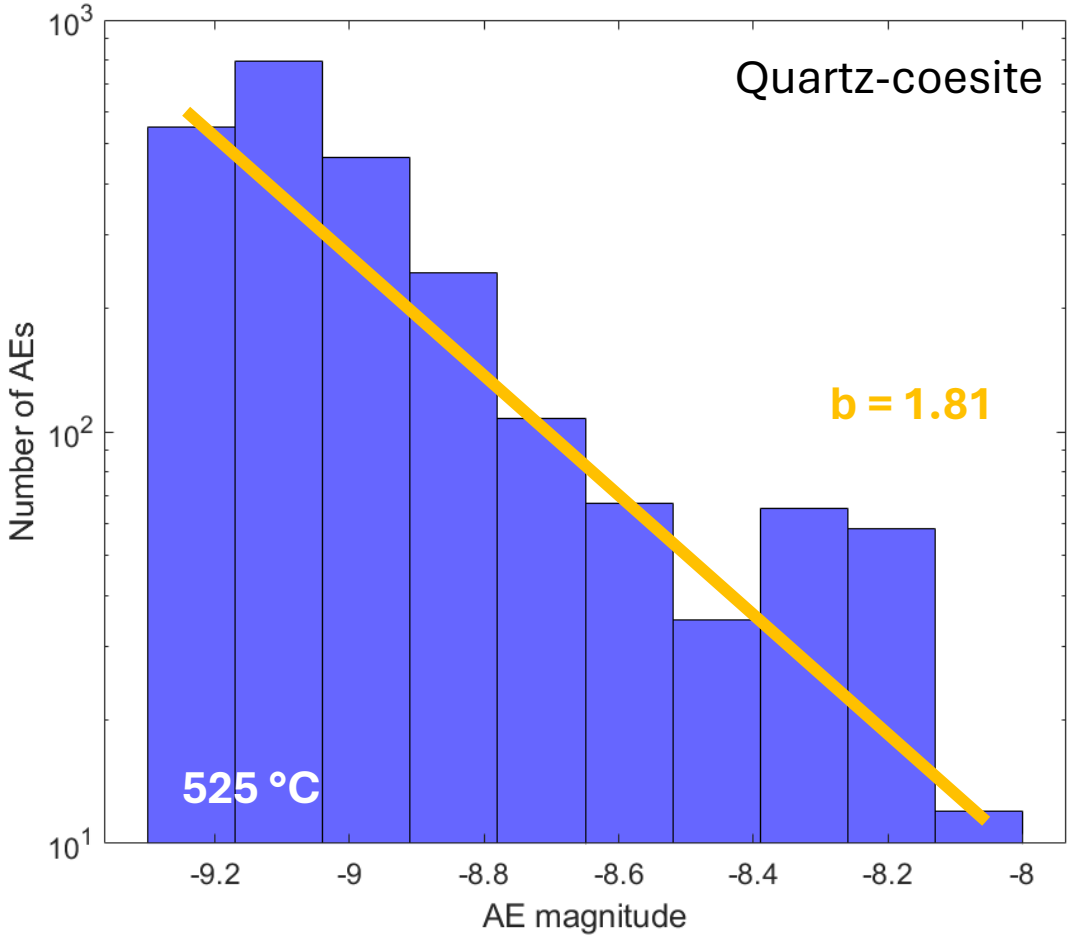
**Fault propagation**

# Magnitude-Frequency distribution (b-value)

High b-value reflects a diffuse mechanism (grain-scale events)

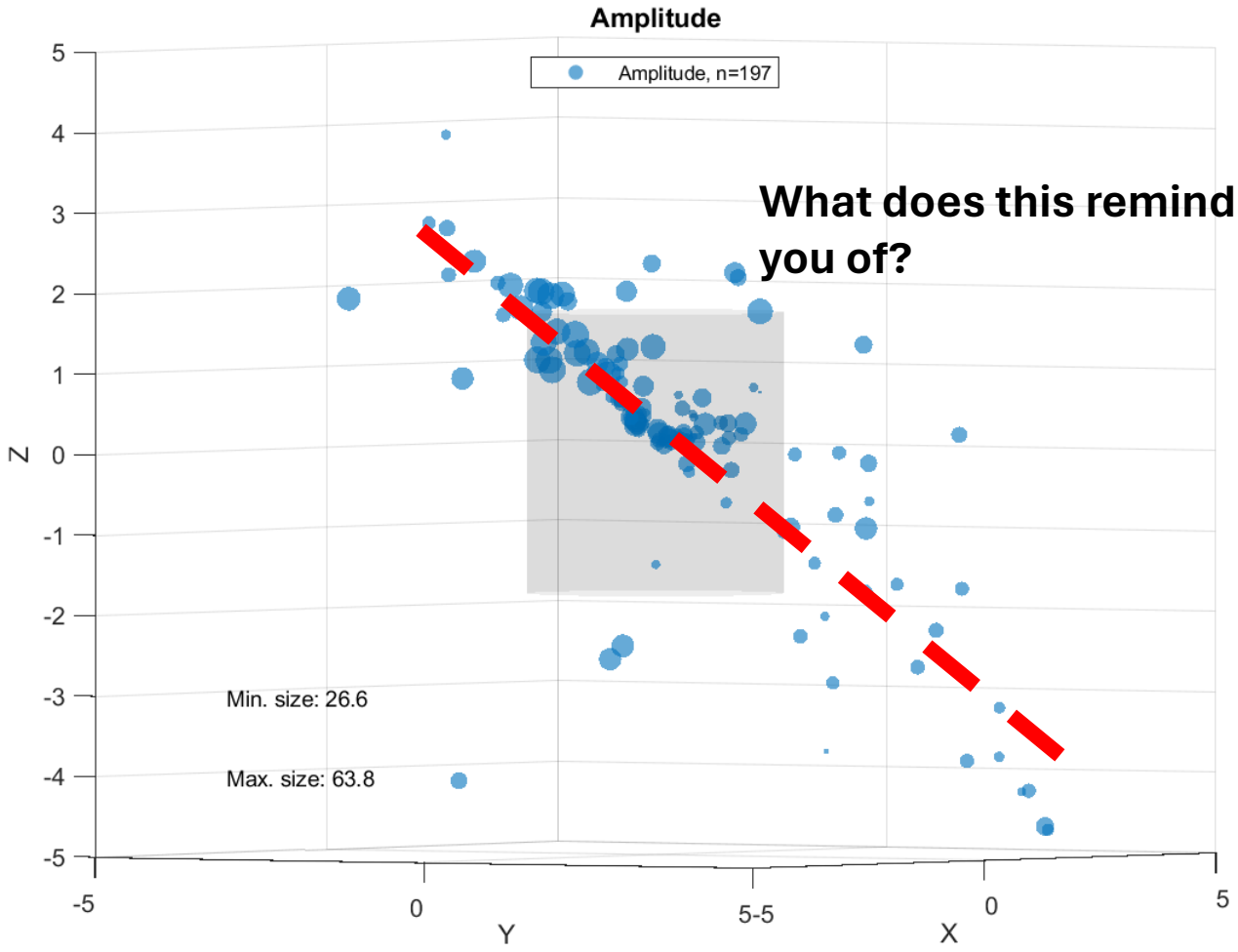



Lower b-value is consistent with a more localized deformation

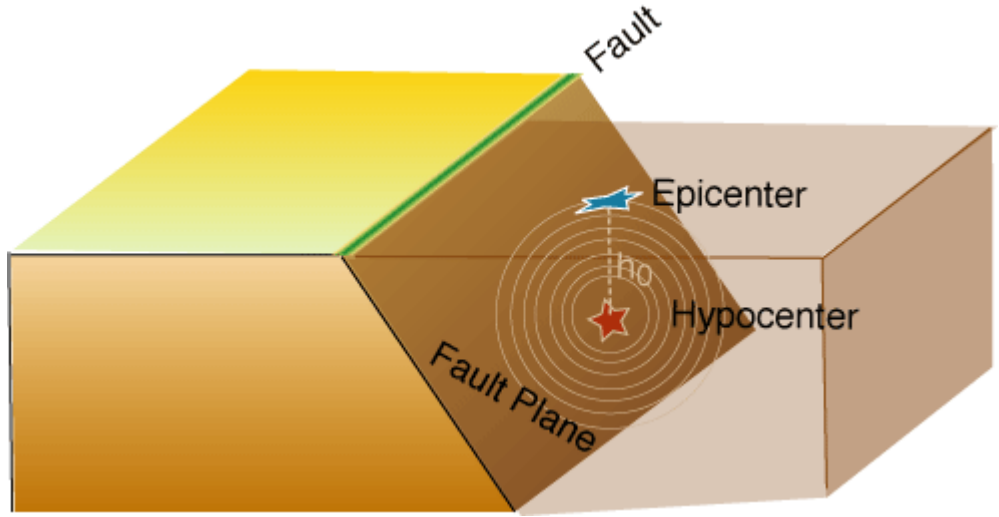


# Acoustic Emission location

Thanks to the arrival time differences on 6 channels we can locate the events




**Yes, a fault plane!!**



# Few conclusions

- EBSD data suggest a preferred orientation of the coesite growth
- AEs record events as little as grain-scale (olivine- ringwoodite)
- Experiments on quartzite show clear evidences of transformation-induced faulting
- New experiments well within the coesite field are needed

**Thank you for the attention!**