Kilometre-scale fracturing originating in ductile deformation along the down-dip extension of seismogenic fault domain

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Tectonic tremors and other related slow-earthquakes have previously been reported from the down-dip extension of seismogenic fault domains (e.g., Shelly, 2010). Failure during ductile deformation known as ductile fracture has also been reported in metals, alloys and experimentally deformed rocks, and proposed as a nucleation mechanism for large inland earthquakes (e.g., Shigematsu et al. 2004). Current studies of ductile fracture in rocks are limited to microstructural investigations, and the potential to evolve into the observed tectonic tremors and other slow-slip phenomena remains unclear. The current study aims to reveal if ductile failures can evolve into large-scale structures in the ductile to brittle-ductile transition regime.

The study area focuses on the Ryoke mylonites exposed along the hanging wall side of the Median Tectonic Line (MTL), in Mie prefecture of SW Japan. The mylonite in this region experienced a sinistral strike-slip during the late Cretaceous period, and can be classified into the higher and lower temperature mylonites. The active quartz slip system and application of two-feldspar geothermometry (Katori et al, 2021) indicates deformational temperatures of c. 450 ˚C and c. 350 ˚C, respectively. The dynamically recrystallised grain size of quartz in the mylonites is less than a few micrometres, indicating a high differential stress during ductile deformation.

This presentation shows the 3D fault zone architecture based on field and microstructural observations. Ductile strain estimates based on the fraction of recrystallised quartz grains in the mylonites determined by applying the Gaussian mixture model to electron backscattered diffraction data (Yeo et al, 2023). The distribution of the fracture density is estimated based on measurements of thin sections including studies of an intensively fractured cataclasite zone. The kilometre-scale mylonite and cataclasite distributions along fault was constructed using the least mean square fitting. We will demonstrate that the distribution of the highly fractured zone is spatially correlated to the region that experienced high ductile strain.

Keywords: 3D fault zone architecture, kilometre-scale structure, ductile strain, ductile fracture

