Brecciated lawsonite-rich veins control brittle creep processes in the deep slow slip and tremor region

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Deep Slow Slip and Tremors (SSTs) are a combination of transient clusters of tectonic tremors and slow slip associated with extremely elevated fluid pressures (Audet & Kim, 2016). SSTs are thought to promote a transition from viscous to brittle plate interface rheology (Behr & Bürgmann, 2021) and likely exert a first-order control on megathrust seismicity. Nevertheless, the deformation mechanisms governing the source of SSTs remain elusive (Oncken *et al.*, 2021). For the first time, we document the occurrence of vein networks precipitated and brecciated within the deep SST region (blueschist-facies). These lawsonite-rich vein sets exhibit extensive evidence of brittle deformation and are spatially related to localized, finely milled (cataclastic) shear bands (Fig. 1). Petro-geochemical data reveal that brittle deformation was accompanied by the injection of several ultramafic-, mafic- and metasedimentary-derived fluid pulses (Fig. 1). Our results suggest that metamorphic veins represent mechanical weaknesses within the rock volume prone to localized shearing, brittle deformation and episodic injection of externally-derived fluids. These networks demonstrate the importance of former vein sets as structural heterogeneities in triggering fluid-controlled brittle creep events. The combined effects of fluids and metamorphic veins could trigger nucleation and propagation of SSTs and thus determine where slip will occur along deep subduction interfaces.

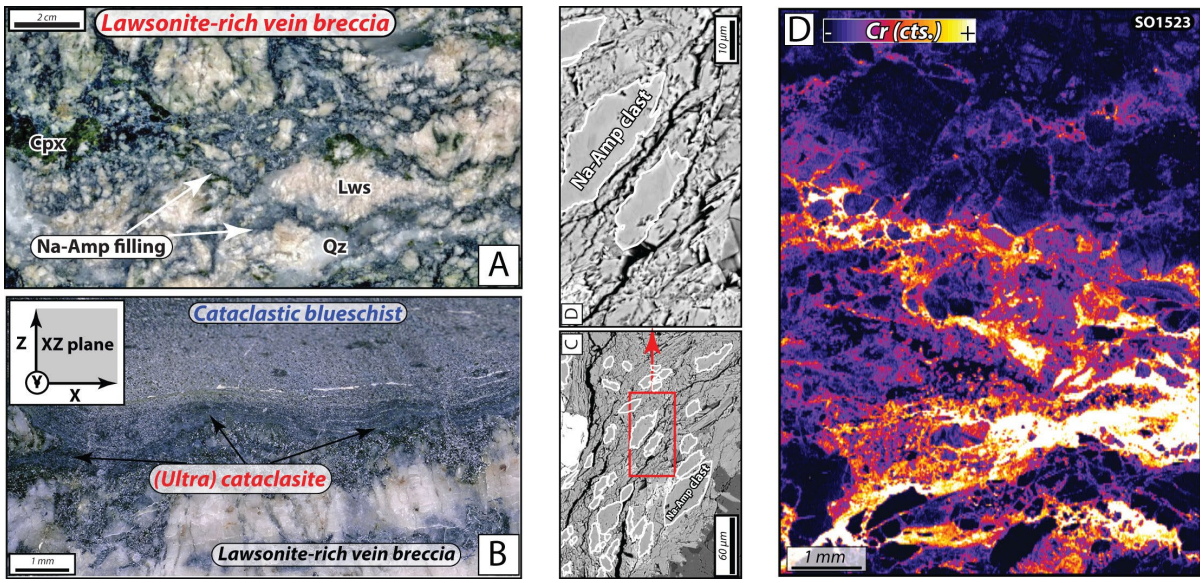

Figure 1- A. Lawsonite vein breccia. B. Vein breccia-host margin. C. BSE image of ultracataclastic shear bands. D. Inset from panel C. D. LA-ICP-MS map depicting Cr distribution.

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