Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12360

Stress and strain rate variations in a chemically reacting shear zone: the role of metasomatism in producing slow slip and tremor

WILLIAM F HOOVER[1], CAILEY CONDIT[1], AMY MOSER[2], VICTOR GUEVARA[3] AND PETER LINDQUIST[1]

[1]University of Washington

[2]University of California, Santa Barbara

[3]Amherst College

Presenting Author: will.f.hoover@gmail.com

Episodic tremor and slip (ETS) occurs at rates between seismogenic slip and continuous aseismic creep and is geophysically observed in many subduction zones coincident with a fluid-rich plate interface. Rheological modeling suggests talc- and chlorite-rich metasomatic schists host slow slip events [1]. However, little work has investigated the deformation microstructures that might record ETS in these rocks. Here we present an integrated geochemical-microstructural study of metasomatic rocks from a paleosubduction interface in the Catalina Schist (Pimu'nga/Santa Catalina Island, California) exhumed from lawsonite-blueschist to epidote-amphibolite facies conditions characteristic of modern ETS. We collected chlorite-actinolite, actinolite, and talc-actinolite rocks from a highly deformed metasedimentary-ultramafic reaction zone. Combined electron back-scatter diffraction (mineral orientation) and energy dispersive spectroscopy (chemical) mapping of actinolite in these samples reveals microstructural differences between talc-free and talc-bearing samples. In the talc-free samples, actinolite has a strong crystallographic preferred orientation, but internal deformation of grains is rare and euhedral chemical zoning is often truncated consistent with deformation by dissolution-reprecipitation creep and rigid body rotation. In the talc-actinolite schist, subgrain development and dislocation arrays suggest deformation by dislocation creep and/or cataclasis. Actinolite major element compositions in talc-free and talc-bearing samples converge rim-wards suggesting growth and deformation occurred during reaction zone development via the exchange of Si, Al, Ca, and Mg. The deformation microstructures of actinolite across the reaction zone are best explained by variations in strain rate controlled by the presence of talc. We suggest localized high strain rates in talc-bearing layers, recorded by actinolite microstructures indicative of higher stresses, reflect deformation during slow slip events. Actinolite microstructures in the talc-free layers reflect lower strain rates (and lower local stresses) during intervening aseismic creep. This pattern is consistent with rheological modeling that predicts slow slip deformation in talc-rich rocks under high pore fluid pressures [1]. Temporal evolution of the reaction zone mineralogy produced time-dependent variations in rock strength and transient conditions necessary for ETS. The results from this interdisciplinary study highlight the importance of considering chemical reaction in studying ETS and subduction zone deformation more broadly.

[1] French, M.E., Condit, C.B., 2019. *Earth Planet. Sci. Lett.* 528, 115828.