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Seismic slip recorded in tourmaline fault mirrors from Elba Island (Italy).

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Abstract

This paper reports the first example of fault mirrors developed in an unusual protolith, consisting of tourmaline crystals with interstitial goethite. The deformation mechanisms active in the fault zone have been investigated from the outcrop to the nanoscale, aiming to identify possible traces of frictional heating at seismic slip rate, as observed for other fault mirrors in different protoliths. The investigation revealed the superposition of two main deformational stages. The first was dominated by brittle processes and produced a cataclastic/ultracataclastic principal slip zone, a few mm thick; the second was associated with seismic slip and produced a sharp discontinuity (the principal slip surface) within the cataclastic/ultracataclastic zone. The mirror-like coating, a few microns thick, occurs on the principal slip surface, and is characterized by 1) absence of interstitial goethite; 2) occurrence of truncated tourmaline crystals; 3) highly variable grain size, from 200 μm to 200 nm; 4) tourmaline close packing with interlobate grain boundaries, and 5) tourmaline random crystallographic orientation.

Micro and nanostructural investigations indicate the occurrence of thermally-activated processes, involving both interstitial goethite and tourmaline. In particular, close to the principal slip surface, goethite is completely decomposed, and produced an amorphous porous material, with local topotactic recrystallization of hematite. Tourmaline clasts are typically characterized by