BOOK OF ABSTRACTS

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Microstructures recording shear localization in the shallow part of a megathrust ancient analogue

A. Cerchiari (1), S. Mittempergher (2), F. Remitti (1), A. Festa (2)

(1) Department of Chemical and Geological Sciences, University of Modena and Reggio Emilia, Modena, Italy; (2) Department of Earth Sciences, University of Torino, Torino, Italy

The shallowest part of active megathrusts is characterized by the coexistence of coseismic slip and aseismic creep, slow slip events, low and very low frequency earthquakes. The mechanisms controlling this complex slip behavior are still poorly constrained. Ancient megathrusts now exhumed offer the opportunity to directly investigate at the meso- and microscale the deformation mechanisms occurring at depth.

The Sestola-Vidiciatico tectonic Unit (SVU) in the Northern Apennines is considered an analogue of a shallow megathrust shear zone, which accommodated subduction of the Adria plate under the Ligurian prism during early-middle Miocene, involving sediments from the seafloor to depth corresponding to 150° C maximum temperature.

After detailed field surveys, we performed optical, cathodoluminescence and SEM microscopy on samples from a 5 m thick marly fault zone marking the base of the SVU and characterized by mesoscopic cleavage, boudinage, extensional faults and low-angle thrusts coated by calcite veins. At the top of the shear zone, a sharp and continuous, 20 cm thick shear vein cuts all other structures. At the microscale, sedimentary laminae in less competent clay-rich domains are crosscut by “soft-sediment”-type deformation bands derived from the reorientation of mineral grains without fracturing, while more competent portions are strongly boudinaged and cut by calcite shear veins displaying a crack-and-seal texture and locally implosion breccias. Extensional veins with dispersed orientations and complex relations with shear veins mutually crosscut, appearing also affected by pressure-solution, progressively folded and shortened perpendicular to the shear zone from top to bottom.

Microstructures suggest that deformation started in not completely lithified sediments, with a progressive embrittlement determined by competence contrast and influenced by fluid pressure cycles. Our findings indicate the shear zone as decoupled from the footwall, progressive migrating and thinning, pointing out for fluid-assisted weak thrusting under low differential stress as a possible slip mechanism along shallow megathrust.