Geophysical Research Abstracts
Vol. 16, EGU2014-10931, 2014
EGU General Assembly 2014

Syn-orogenic extensional pulses within the contractional history of thrust wedges. The Val di Lima low-angle normal fault case study, Northern Apennines, Italy.

Luca Clemenzi (1), Giancarlo Molli (2), Fabrizio Storti (1), Philippe Muchez (3), Rudy Swennen (3), and Luigi Torelli (4)

(1) NEXT - Natural and Experimental Tectonics Research Group - Department of Physic and Earth Sciences "Macedonio Melloni", University of Parma, Italy., (2) Department of Earth Sciences, University of Pisa, Italy., (3) Department of Earth and Environmental Sciences, KU Leuven, Celestijnenlaan 200E, 3001 Heverlee, Belgium., (4) Department of Physic and Earth Sciences "Macedonio Melloni", University of Parma, Italy.

In this contribution we describe the Val di Lima low-angle fault system, a kilometric-scale extensional structure exposed in the central sector of the Northern Apennines thrust wedge, Italy. The low-angle extensional fault system delaminates the right-side-up limb of a km-scale recumbent isoclinal anticline that affects the carbonate-dominated Late Triassic to early Early Miocene non-metamorphic Tuscan succession. The low-angle fault system, in turn, is affected by superimposed folding and late-tectonic high-angle extensional faulting.

The three-dimensional configuration of the low-angle fault system has been investigated through detailed structural mapping and restoration of the superimposed deformations, while the fault damage zone architecture has been characterized in outcrops with appropriate exposure. Pressure-depth conditions and palaeofluid evolution of the fault system have been studied through microstructural, mineralogical, petrographic, fluid inclusion and stable isotope analysis of fault rocks and fault-related calcite and quartz veins. Our results show that the low-angle fault system was active during exhumation of the Tuscan succession, at estimated conditions of about 180°C and 5.2 km depth. The fault system had a twofold influence on fluid circulation within the orogenic wedge: i) it allowed the migration of low-salinity fluids, due to the increased permeability along the fault zone; ii) it favored footwall fluid overpressures where the fault core acted as an efficient hydraulic barrier. Abundant fluid circulation in fault damage zones also characterized the late-stage evolution of the low-angle fault system, allowing the recrystallization of calcite veins and limestone host rocks at shallower conditions ($\sim$ 4 km). Within this P-T framework, the fault zone architecture shows important differences, related to the different lithologies involved in the fault system and to the role played by the fluids during deformation. In particular, footwall fluid overpressures locally influenced active deformation processes and favored shear localization.

We propose that the folded low-angle extensional fault system indicates the occurrence of an extensional pulse that affected this sector of the thrust wedge during the orogenic contractional history. In particular, the fault system is considered to be the flat portion of a stair-case extensional fault system developed in the shallower portion of the thrust wedge to compensate for its supercritical taper produced by uplift of the internal zone due to deep-rooted thrusting.

Important pulses of wedge extension, similar to the one described here, are likely to occur during the geological history of most thrust wedges, because their long-term evolution is characterized by complex interactions among tectonics, gravitational body forces, and (sub)surface processes. The systems of brittle extensional fault zones, resulting from such extensional pulses, affect fluid circulation through the upper crust by producing articulated networks of hydraulic conduits, barriers, or mixed conduit-barrier systems. In particular, as demonstrated by our results, the effects of extensional fault zones on fluid circulation is twofold: i) they provide effective fluid pathways allowing deep infiltration of surface-derived marine or meteoric water; ii) they can trigger fluid overpressuring, especially in the footwall of shallow-dipping fault segments. Eventually, fluid circulation can exert a strong influence on the mechanical behavior of thrust wedges either by reducing the effective normal stress at depth or triggering the formation of hydrous clay minerals lowering the frictional properties of fault zones.