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Velocity weakening along a frictional-viscous, low-angle normal fault (N-Kea, Western Cyclades)

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We examined the northwestern edge of the island of Kea, which is dominated by high- and low-angle extensional faults. Recent studies demonstrated that the Miocene extensional event with consistent and pervasive SW-directed shear is observed throughout the whole island and has also been documented on Kythnos and Serifos (Western Cyclades). In NW Kea the major low-angle normal fault is called the Otzias Bay Detachment which we focus of this study.

Typical microstructures from rock analogue experiments using halite-muscovite mixture deformed with different sliding velocities (Niemeijer and Spiers, 2007) suggest two major different deformation mechanisms: In the velocity strengthening regime (i.e. low sliding velocities), the samples record a mylonitic fabric with a continuous, anastomosing foliation resembling SCC' type foliation formed by slip along the mica flakes and diffusive mass transfer processes. In contrast, the microstructures in the velocity-weakening regime (high sliding velocities) resemble a cataclasite with no foliation and a large variation in grain size and a chaotic fabric. The deformation mechanism involves pervasive granular flow with grinding and rounding of grains associated with dilation and compaction solution transfer processes.

Samples collected along a profile across the Otzias Bay Detachment record strikingly similar structures with a variety of transitions between the mylonitic and cataclastic end-members. Interestingly, both transitions from mylonitic to cataclastic fabrics but also cataclastic fabrics overprinted by mylonitic SCC' foliations can be observed. All deformation mechanisms are associated with the formation of different generations of extension gashes suggesting the general presence of diffusive mass transfer mechanisms. Some veins generations are ductily rotated and folded with fold axes perpendicular to the stretching lineation. Other vein generations are cataclastically deformed together with its host rocks. Cross cutting relationship of frictional dominated and viscous dominated deformation mechanism suggests that the switch between both regimes occurred several times. We therefore suggest that the Otzias Bay Detachment operated as a subhorizontal extensional fault within the brittle/ductile transition zone and that the dominant deformation mechanisms were controlled by non-constant sliding velocities switching between the velocity strengthening and the velocity weakening regime.

Niemeijer, A.R. and Spiers, C.J., 2007. A microphysical model for strong velocity weakening in phyllosilicate-bearing fault gouges. Journal of Geophysical Research, 112(B10405): doi:10.1029/2007JB005008.