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The ‘Cretan Detachment’ (Greece): a Miocene thrust or low-angle normal fault?

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The tectonic units of Crete are divided in a Lower- and an Upper Nappe system that are separated by the so called Cretan Detachment. The Upper Nappe System was almost not affected by Alpine metamorphism but the Lower Nappe System experienced high-pressure/low-temperature metamorphism. Therefore, it has been suggested that the tectonic contact represents a low-angle top-to-the N extensional shear zone. However, a number of studies present conflicting and/or not very convincing kinematic indicators and came to the conclusion that the Cretan Detachment reflects bivergent extension with a strong component of coaxial deformation or a top-to-the S thrust. Recent data on calcite twinning, Raman spectroscopy of carbonaceous material and illite crystallinity from the Upper and Lower Nappe System also suggest that the Cretan Detachment might be a Miocene thrust, which was active at mid to upper crustal conditions..

In this work, we investigate fault rocks from several locations in in Eastern Crete, where the Tripolitza Unit (Upper Nappe System) is juxtaposed against the Phyllite-Quartzite Unit s.l. (Lower Nappe System). The Tripolitza Unit in the hanging wall consists of Upper Triassic platform carbonates and the Phyllite-Quartzite Unit s.l. in the footwall is composed of violet-greenish slates and quartz-rich phyllites. Major displacement is localized in an almost horizontal detachment with up to several meter thick foliated ultracataclasites and fault gouges, which record numerous kinematic indicators like duplex structures, scaly fabrics, Riedel fractures, which consistently confirm top-to-N displacement. The cataclastic material is mainly derived from the violet and greenish slates in the footwall that are below the detachment zone strongly folded with subvertical limbs overprinted by a subhorizontal axial plane slaty cleavage. Asymmetric crenulation cleavage can be (and has been!) easily confused with SSC’ fabrics, obscuring the clear picture of a top-to-the N sense of shear. The only slightly recrystallized carbonates of the overlying Tripolitza Unit are cut by parallel steeply S-dipping antithetic normal faults forming bookshelves, which are tilted towards the north. Numerous injection dykes, polished slicken sides and truncated grains at principal slip surfaces probably suggest seismic movement along the Cretan Detachment. New (U-Th)/He zircon ages are dispersed and as old as 130 Ma, but a significant population of the dates are ca. 14.5 Ma. These dates are much younger than the published zircon fission track dates for eastern Crete, and help constrain the temperature of deformation to 200 $\pm$ 20°C. Although we do not question the occurrence of an earlier thrusting component along this tectonic contact, our data from mainly cataclastic rocks clearly indicate Miocene top-to-N normal slip along the eastern part of the ‘Cretan Detachment.’