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

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The tectonic units of Crete are generally considered to consist of a Lower- and an Upper Nappe System, that are separated by a major tectonic contact. Based on the suggestion that the Upper Nappe System was not affected by Alpine metamorphism it has been proposed that the tectonic contact represents a low-angle extensional shear zone referred to as the ‘Cretan Detachment.’ However, the paucity of consistent and convincing kinematic indicators has been attributed to either bivergent extension or a strong component of coaxial deformation. Moreover, recent data on calcite twinning, Raman spectroscopy of carbonaceous material and illite crystallinity from rocks above and below the tectonic contact of the Upper and Lower Nappe System indicates that the fault was active in the Miocene as thrust at upper crustal conditions.

In this work, we investigate fault rocks of the ‘Cretan Detachment’ exposed in Eastern Crete, where the Tripolitza Unit is juxtaposed against the Tyros Unit. The Tripolitza Unit in the hanging wall consists of Upper Triassic platform carbonates and the Tyros Unit in the footwall is composed of Norian/Rhaetian violet slates, which are part of the Toplou Beds. Major displacement is localized in an almost horizontal detachment with up to 1 m thick (foliated) ultracataclasites and fault gouges, which record a pervasive SCC’ fabrics indicating top-to-N displacement. The material is mainly derived from the violet slates in the footwall that are strongly folded with subvertical limbs overprinted by a subhorizontal axial plane slaty cleavage, which is parallel to the main detachment plane. The low-grade marbles of the overlying Tripolitza Unit are cut by parallel steeply S-dipping antithetic normal faults with cohesive and non-cohesive cataclasites forming bookshelves, which are tilted towards the north. Numerous injection dykes filled with cemented cataclasites suggest overpressured fluids during slip along the detachment. New (U-Th)/He zircon ages are dispersed and as old as 130 Ma, but a significant population of the dates are ca. 17 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 ± 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 this part of the ‘Cretan Detachment.