Bivergent extension in the overriding plate above a slab tear (Dodecanese, Greece)

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Tearing in the Hellenic slab below the transition between the Aegean and Anatolian plate is considered to have significantly affected Miocene tectonic and magmatic evolution of the eastern Mediterranean by causing a toroidal flow of asthenosphere and a lateral gradient of extension in the upper plate. Some studies suggest that this lateral gradient is accommodated by a distributed sinistral lithospheric-scale shear zone whereas other studies favor a localized NE-SW striking transfer zone. Recent studies in the northern Dodecanese demonstrate that the transition zone between the Aegean and Anatolian plate is characterized by Miocene extension with a constant NNE-SSW sense of shear accommodating the difference in finite extension rates in the middle-lower crust. Neither localized or distributed strike-slip faults nor rotation of blocks about a vertical axis have been observed.

In this work we focus on the geology Kalymnos located in the central Dodecanese. Based on our new geological map, three major tectonic units can be distinguished: (i) Low-grade, fossil-rich late Paleozoic marbles, which have been deformed into S-vergent folds and out-of-sequence thrusts. This fold-and-thrust belt is sealed by an up to 200 m thick wildflysch-type deposit consisting of low-grade metamorphic radiolarites and conglomerates with tens of meters-scale marbles and ultramafics blocks. (ii) Above this unit, amphibolite facies schists, quartzites and amphibolites are tectonically juxtaposed along a several meter-thick thrust fault with low-grade ultramylonites and cohesive ultracataclasites/pseudotachylites with top-to-N kinematics. (iii) At highest structural levels, a major cataclastic low-angle normal fault zone localized in Verrucano-type violet slates separates Mesozoic unmetamorphosed limestones in the hanging wall. The sense of shear of the normal fault is top-to-SSW. All units are cut by brittle high-angle normal faults shaping the geomorphology of Kalymnos, which is characterized by three major NNW-SSE trending graben systems.

New white mica Ar-Ar ages suggests that the middle units represent relics of a Variscan basement, which was thrust on top of a fold-and-thrust belt during an Eo-Cimmerian event. Zircon (U-Th)/He ages from the Variscan basement are c. 28 Ma, indicating that the lower units were exhumed below the Mesozoic carbonates during the Oligocene-Miocene. Since Miocene extension
in the northern Dodecanese records top-to-NNE kinematics, we suggest that back-arc extension in the whole Aegean realm and transition to the Anatolian plate is bivergent, and tearing in the Hellenic slab did not significantly affected the extension pattern in the upper crust.