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# Exhumation of the western Cycladic metamorphic core complexes – An integrated thermochronometric and structural study

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The Cenozoic tectonic evolution of intra-arc and back-arc extension in the Aegean is largely based on constraints from the eastern Cyclades, while our understanding of the structural and temporal evolution of crustal extension in the western Cyclades is still only basic and incomplete. In particular, the lack of detailed structural, kinematic, and timing constraints on extensional faulting has made it difficult to evaluate and test different geodynamic models for the western Cyclades and how these models fit into a larger Aegean and Attica context. While most of the central and western Cyclades (e.g., Naxos and Paros) were dominated by top-to-the-NNE directed, large-magnitude extension in the middle to late Miocene, the eastern Cyclades accommodated opposite sense, top-to-the-SW-SSW crustal extension, resulting in the formation of low-angle normal faults on Kea, Kythnos, and Serifos. In order to constrain the thermal and exhumational evolution of these extensional complexes in the western Cyclades, we have collected more than 80 samples for zircon and apatite (U-Th)/He and 40Ar/39Ar mica thermochronometry. These high-density thermochronometric sample arrays in Kea, Kythnos, and Serifos constrain the timing, spatial distribution, and magnitude of extensional faulting and footwall exhumation since the early Miocene.

On the island of Serifos, structural, metamorphic, and thermochronometric constraints suggest multi-phase Miocene top-to-SSW middle to upper crustal extensional detachment faulting. Structurally the island is dominated by a domed top-to-the-S detachment fault. The lower plate is made of up intensely sheared epidote-chlorite schist, marble, amphibolite, and orthogneiss that are syn-kinematically intruded by the Miocene Serifos granodiorite. These lower plate rocks are characterized by ~5-7 Ma apatite and zircon (U-Th)/He ages; 40Ar/39Ar mica ages yield ~8-9 Ma ages within the intrusion and ~28-34 Ma ages in the country rock. Limited exposures of upper plate rocks yield 40Ar/39Ar mica ages indistinguishable from the lower plate, but distinct apatite and zircon (U-Th)/He ages that cluster at 14 Ma, suggesting an earlier, middle Miocene phase of cooling and exhumation unrelated to late Miocene detachment faulting.

The island of Kythnos, similar to Kea and northern Serifos, is composed of highly sheared (top-to-the-S) greenschist facies chlorite-epidote schist, quartzite, and marble, folded into open structural domes. More than 20 apatite and zircon (U-Th)/He ages from chlorite-epidote schists along N-S and E-W profiles across the island of Kythnos cluster at ~14-17 Ma, suggestive of rapid Miocene cooling and exhumation. (U-Th)/He ages from Kythnos are indistinguishable from upper-plate rocks in Serifos, suggesting that they likely shared a similar structural position and unroofing history. Preliminary apatite (U-Th)/He ages from Kea show ~14 Ma ages at higher structural levels along the spine of the island, and ~7 Ma ages below a sheared marble fault zone, implying a lower plate upper plate scenario similar to Serifos.

Integrated structural and thermochronometric studies of the western Cycladic domain have revealed that crustal extension occurred in multiple stages or in a protracted fashion during Cenozoic times similar to the rest of the Cyclades. The data show extensional unroofing accommodated by low-angle normal faults that crosscut earlier top-to-SSW mid-crustal high strain zones in middle and late Miocene times with opposite sense to the NNE-directed Hellenic nappe stacking and detachment kinematics of the central and eastern Cyclades.