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Exhumation and cooling of the Serifos metamorphic core complex, western Cyclades: extensional surging or continuum since the Early Oligocene?

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The western Cycladic island of Serifos lies within the active tectonic setting of the Aegean region where southward retreat of the subducting Hellenic slab and associated back-arc crustal block rotation has led to progressive extensional collapse of the lithosphere. Widespread exhumation has regionally exposed mid-crustal metamorphic and plutonic rocks through low-angle detachments associated with metamorphic core complex development. On Serifos, bedrock lithologies consisting of calc-silicates, schists, gneisses, and marbles metamorphosed under greenschist- to lower amphibolite- facies conditions are intruded by a largely undeformed, Late Miocene I-type granodiorite pluton that dominates the southeast portion of the metamorphic dome. Project ACCEL (Aegean Core Complexes along an Extended Lithosphere) documented that this pluton crosscuts a crustal-scale anastomosing shear zone consisting of (ultra) mylonitic marbles and orthogneisses that record consistent SSW-directed shear. These intensely sheared orthogneisses, yielding a preliminary U-Pb zircon rim crystallization age of c. 37 Ma, represent an earlier S-type granitoid that syn-kinematically intruded to mid-crustal levels during Late Eocene deformation. Additional thermochronometric constraints presented here elucidate the timing of extension and exhumation of the Serifos metamorphic core complex through mid- to shallow-crustal levels. Moderate temperature constraints from Ar-Ar analysis of white micas reveal two distinct cooling age populations separated by a steep age gradient that is coincident with the high-strain mylonitic shear zone. The micas define the rock's foliation in most cases with notable mica fish from shear zone samples and geochemical analysis via electron microprobe confirms that all micas are of a similar muscovite composition. Micas from southern portions of the island, within the shear zone and adjacent to the granodiorite pluton, yield Late Miocene cooling ages of 8-9 Ma, indicating exhumation and cooling through mid-crustal levels that was coeval with intrusion of the granodiorite. Structurally higher but lower metamorphic grade units from northern Serifos suggest Early Oligocene cooling at 28-34 Ma. Lower temperature timing constraints from zircon and apatite (U-Th)/He analysis reveal Late Miocene cooling ages across the bulk of the dome that are between 5 and 8 Ma with little clear spatial pattern. Similar relationships present on Naxos show that magmatism has little to no influence on the cooling history if intrusion occurred into a rapidly exhuming footwall. Thus, our results demonstrate two episodes of exhumation and rapid cooling commencing in the Late Eocene or Early Oligocene initially with extrusion of Cycladic Blueschist Unit-equivalent rocks and culminating in the Late Miocene with development of a metamorphic core complex. Both exhumation events were tentatively coeval with magmatic activity. Our results suggest rapid exhumation of the western Cyclades during south-directed kinematics and illustrate the notably protracted nature of extensional deformation in this region since at least the Early Oligocene.