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Subduction dynamics and exhumation of eclogites and blueschists: The Cycladic Blueschist Unit (Cyclades, Greece)

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Located in eastern Mediterranean, the Hellenic subduction zone results from the convergence between Apulia and Eurasia plates since the late Cretaceous. The Cycladic Blueschist Unit (CBU) is a HP-LT metamorphic unit that was buried and exhumed in the Hellenic subduction zone. Famous for its excellent preservation of HP-LT metamorphic rocks and tectonic structures, the CBU is considered as a natural laboratory to study subduction dynamics. Our study, mainly conducted on Syros Island, combines field structural observations, P-T thermodynamic modelling and $^{40}\text{Ar}/^{39}\text{Ar}$ dating that provide a detailed P-T-t-d path of the CBU. Our results show that the CBU was exhumed by an overall top-to-the east shearing during exhumation from eclogite- to greenschist-facies depths, localized along several retrograde shallow-dipping shear zones. Thermobarometry shows that three events of garnet growth have been recorded in the CBU. A first prograde event is recorded in garnets from eclogites at 17 ± 2 kbar and 450 ± 50 °C and a second one at peak P-T conditions around 22 ± 2 kbar and 550 ± 50 °C. A last garnet growth event is recorded only in retrograded samples between 10-12 kbar and 500-570 °C. We interpret this retrograde garnet growth event as the result of an almost isobaric heating previously highlighted on Tinos and Andros islands. Finally, $^{40}\text{Ar}/^{39}\text{Ar}$ ages constrain the timing of peak pressure conditions at 52-49 Ma, which is consistent with previous U/Pb, Sm/Nd, Lu/Hf and Rb/Sr ages. Our $^{40}\text{Ar}/^{39}\text{Ar}$ ages then constrain exhumation through blueschist-facies P-T conditions between 47 and 35 Ma and the final ductile exhumation in the greenschist-facies at 18-20 Ma. Syn-orogenic exhumation of the CBU, from eclogite- to blueschist-facies P-T conditions, was accommodated in ca. 15 Ma within the subduction channel between a top-to-the E detachment above (Vari Detachment) and a thrust below. Then, a change of subduction dynamics and the settling of a faster slab retreat, coeval with the migration of the subduction front southward within the more external zones (Phyllite-Quartzite Nappe in Crete and Peloponnese), resulted in a break of exhumation of the CBU accompanied by isobaric heating during ca. 5 Ma. Retreat then induced large-scale back-arc extension leading to thermal re-equilibration of the lithosphere from a cold syn-orogenic regime in the subduction zone to a warmer post-orogenic regime in the back-arc domain. Post-orogenic exhumation in greenschist-facies P-T conditions was finally accommodated in a LP-HT environment by several detachments systems (e.g. NCDS, WCDS, NPEFS) acting during 10-12 Ma. During this 30 Ma long evolution, deformation progressively localized until the brittle detachments observed today.