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Insights into subduction channel exhumation of high-pressure metamorphic rocks by using stable isotopes and solid inclusion barometry

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Constraining the pressure-temperature (PT) evolution of metamorphosed continental and oceanic crust is fundamental to understanding mechanisms that control the burial and exhumation of rocks. Specifically, retrograde metamorphic rocks are a key record of tectonic processes because they are one of the few rock types that can capture the PT history of rocks throughout exhumation. However, studying these rocks has historically proven challenging for petrologists. We use solid inclusion barometry and stable isotope thermometry to constrain the PT evolution of retrograde metamorphic rocks of the Cycladic Blueschist Unit (CBU), an exhumed Eocene subduction complex exposed on Syros island, Greece. Our work utilizes both the well-established quartz-in-garnet and the recently calibrated quartz-in-epidote barometers to constrain pressures of garnet and epidote crystallization near peak subduction and during exhumation, respectively. We use oxygen isotope thermometry of quartz and calcite precipitates within necks of boudinaged epidote to calculate temperatures during exhumation and to refine our solid inclusion pressure estimates. Three distinct pressure groups are related to different metamorphic events and textural fabrics: high-pressure garnet-growth at $\sim$ 1.4 - 1.5 GPa and 500 °C, retrograde epidote growth recorded by foliation parallel epidotes at $\sim$1.3 - 1.4 GPa between 500 - 400 °C, and a second stage of retrograde epidote growth recorded by epidotes in a fold-hinge at $\sim$1.0 GPa and 400 °C. Our results are consistent with three stages of deformation inferred from field and microstructural observations: prograde subduction to blueschist-eclogite facies conditions, closely associated with garnet growth and N-S oriented mineral lineations (Ds), retrogression under blueschist-greenschist facies conditions (recorded by foliation parallel epidotes) while mineral lineations swing to the NE-SW (Dt1), and continued retrogression under greenschist facies conditions (recorded by a second stage of epidote growth) associated with mineral stretching lineations that trend E-W and boudinage of foliation parallel epidotes parallel to stretching (Dt2). Our results indicate that the CBU on Syros experienced cooling during decompression after reaching maximum high-pressure/low-temperature conditions and evolved under a cold geothermal gradient. The determined PT conditions and structural observations are consistent with exhumation in a subduction channel configuration in the proximity of a refrigerating subducting plate, prior to core-complex capture.