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# In-situ Ar-Ar white mica ages reveal differences in mica crystallization behaviour in quartz-rich and calcite-rich rocks of the same shear zone

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Conventional Ar-Ar dating of tectonites can result in equivocal ages due to mixed mineral populations, excess 40Ar (decoupled from its parent 40K), or partial resetting of the K-Ar systematics. In-situ Ar-Ar dating was performed on white micas from footwall marbles and schists of the Western Cycladic Detachment System (WCDS) of the Aegean. These rocks are part of the Cycladic Blueschist Unit, which experienced HP conditions during the Eocene and strong extension during the Miocene. The rocks contain undeformed, kinked, and neocrystallized micas with the mica phases recording higher strain (elongated grains and mica-fish structures) in quartz-dominated rocks compared to the calcite-dominated assemblages. In both quartzitic and calcitic rocks, deformed white micas are chemically zoned. Two chemical populations were identified: (1) a high component of Al-celadonite in undeformed portions of grains that likely crystallized during high pressure metamorphism; (2) enrichment in muscovite in deformed portions of grains as a result of Tschermak substitution that took place during deformation-induced neocrystallization under shallow crustal conditions. Neocrystallization occurs preferentially in zones of localized deformation and in zones of enhanced fluid availability. The latter is supported by stable isotope (O, C, H) analyses of calcite, dolomite and white micas that suggest a moderate fluid-rock interaction resulting in a coupled depletion of $\delta$18O vs $\delta$13C and $\delta$18O vs $\delta$D. Recrystallized quartz exhibits planar indentation structures, also consistent with fluid-assisted deformation. Completely neocrystallized grains, in quartzitic rocks from Kea Island at the center of the WCDS yield Ar-Ar deformation ages of c. 18-21 Ma, which are interpreted as dating the timing of ductile extension along the detachment system. Undeformed (unkinked, prismatic) portions of white micas in calcitic rocks from Serifos Island at the southern end of the WCDS yield Ar-Ar ages of c. 40-45 Ma, whereas deformed (kinked or strained) portions of the same grains yield younger ages of c. 31-36 Ma. Calcitic rocks are intrinsically less permeable than quartzitic rocks, thus are less affected by fluid-induced recrystallization. Moreover, in calcite-muscovite aggregates, strain is accommodated in calcite (by dislocation creep) whereas in quartz-muscovite aggregates, strain is accommodated in mica (as mica-fish structures). Hence, ductily deformed and completely neocrystallized micas occur more often in quartzitic rocks, whereas calcitic rocks contain micas that are only partially neocrystallized due to a lack of deformation and fluid infiltration. Consequently, consistent with our empirical results, the minimum age of ductile deformation is more likely to be preserved in quartzitic rocks, such as the c. 18-21 Ma obtained on Kea. Similarly, inherited or partially reset ages are likely to be found in calcitic rocks, such as the c. 31-36 Ma from Serifos.