Hot early intra-oceanic subduction beneath the Troodos ophiolite: Rutile petrochronology of the Agia Varvara formation, western Cyprus

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Rare metamorohic rocks (Agia Varvara formation, W Cyprus) are caught in a serpentinite shear zone juxtaposing the Turonian (92 Ma) supra-subduction zone (SSZ) Troodos ophiolite against a Triassic continental margin sequence (the Mamonia complex). A pressure-temperature section calculated for the chemical composition of a rutile- and titanite- bearing Agia Varvara amphibolite indicates that at Zr-in-rutile temperatures of 610 ± 40°C, this assemblage is stable at pressures of 6.5-9 kbar. It follows that the Agia Varvara formation is neither a metamorphic sole of the ophiolite nor the product of dynamic-thermal metamorphism along an oceanic transform zone, as previously thought. Instead, it most probably represents a piece of subducted hot and young oceanic slab exhumed from a depth of 20-25 km. Rutile U-Pb geochronology indicates that peak metamorphism occurred coevally with short-lived SSZ sea-floor spreading in the overlying Troodos micro-plate (92 Ma). The Agia Varvara formation thus provides a rare glimpse on the nascent slab, prior to the establishment of cold, 'self-sustained' subduction. At T_{25km}=600°C, the Agia Varvara amphibolites record a slab-mantle interface temperature, which is much higher than that modeled for the present-day Nankai trough, where young (≤ 15 Ma) and hot oceanic lithosphere is subducted. It follows that the cold Triassic rocks of the Mamonia complex cannot be the protoliths of the Agia Varvara formation. Instead, a pre-Troodos Cretaceous spreading center should have been active between the African and Tauride continents, and subduction initiation had to be driven by a much smaller density contrasr than in the western Pacific.

[(U-Th)/He] rutile and apatite thermochronology indicates that the rocks rapidly cooled below 220ºC at ~ 85 Ma, possibly by accretion to the extended overriding plate, and below ~70ºC at 75 Ma along a strike-slip shear zone accommodating the counterclockwise rotation of the Troodos microplate and then sealed by a Masstrichtian olistostrome.