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500 Myr of thermal history elucidated by multi-method detrital thermochronology of North Gondwana Cambrian sandstone (Eilat area, Israel)

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Following the Neoproterozoic Pan-African orogeny, the Arabian-Nubian Shield (ANS) of North Africa and Arabia was eroded and then covered by Cambrian sandstones that record the onset of platform sedimentation. We applied K-feldspar $^{40}Ar/^{39}Ar$, zircon and apatite fission track and apatite (U-Th)/He thermochronology to detritus from Cambrian sandstones of southern Israel deposited at about 500 Ma. U-Pb detrital zircon ages from these sandstones predate deposition and record the earlier Neoproterozoic crustal evolution of the Pan-African orogens. $^{40}Ar/^{39}Ar$ ages from 50 single grains of K-feldspar yield a Cambrian mean of approximately 535 Ma. The $^{40}Ar/^{39}Ar$ age spectrum of a multi-grain K-feldspar aliquot displays diffusion behaviour compatible with $>$560 Ma cooling later affected by a heating event. Assuming that the high temperature domains of the K-feldspars have not been affected by subsequent (hydro)thermal events, and taking previously published K-Ar and Rb-Sr ages from other parts of the East African Orogen at face value, these ages apparently record Pan-African thermal resetting below a thick volcano-sedimentary pile similar to the Saramuj conglomerate in Jordan and/or the Hammamat in Egypt. Detrital zircon fission track (ZFT) ages cluster around 380 Ma, consistent with previous ZFT results from Neoproterozoic basement and sediments of the region, revealing that the Cambrian platform sequence experienced a middle Devonian thermal event and low-grade metamorphism. Regional correlation indicates that during Devonian time the sedimentary cover atop the Cambrian in Israel was never in excess of 2.5 km, requiring an abnormally steep geothermal gradient to explain the complete ZFT annealing. A basal Carboniferous unconformity can be traced from Syria to southern Saudi Arabia, suggesting that the observed Devonian ZFT ages represent a regional tectonothermal event. Similar Devonian ZFT ages were reported from ANS basement outcrops in the Eastern Desert, 500 km south of Eilat. The detrital apatites we studied all have extremely rounded cores suggestive of a distant provenance, but some grains also feature distinct euhedral U-rich apatite overgrowth rims. Authigenic apatite may have grown during the late Devonian thermal event we dated by ZFT, coinciding with existing Rb-Sr ages from authigenic clays in the same deposits and leading to the conclusion that the Devonian event was probably hydrothermal. Like the ZFT ages, the detrital apatite fission track (AFT) ages were also completely reset after deposition. Sixty single grain detrital apatite fission track (AFT) ages group at $\sim$270 Ma with significant dispersion. Inverse modeling of the AFT data indicate extended and/or repeated residence in the AFT partial annealing zone, in turn suggesting an episodic burial-erosion history during the Mesozoic caused by low-amplitude vertical motions. Seven detrital apatite (U-Th)/He ages scatter between 33 and 77 Ma, possibly resulting from extreme compositional zonation associated with the authigenic U-rich overgrowths. The $\sim$70 Ma (U-Th)/He ages are more likely to be accurate, setting 1-2 km as an upper limit (depending on the geothermal gradient) on the post-Cretaceous exhumation of the Cambrian sandstone and showing no evidence for substantial denudation related to Tertiary rifting of the Red Sea.