

Exhumation of Pan-African terranes and their linkage to the great Cambro-Ordovician sandstone of North Gondwana: Detrital zircon and rutile perspectives

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The final amalgamation of Gondwana by a series of orogens known collectively as the Pan African orogeny, during the latest Neoproterozoic to early Paleozoic, was followed by the deposition of a vast Cambro-Ordovician siliciclastic veneer that covers much of North Africa and Arabia. The origin of these early Paleozoic sandstones and their genetic linkage to Pan-African orogens are of broad interest because of the extraordinary sand volume that was generated and because they coalesced with important global environmental changes. We combine new detrital rutile U-Pb age data and previously obtained detrital zircon U-Pb-Hf data for Cambro-Ordovician sandstones in Israel, Jordan and Ethiopia to unravel the cooling and unroofing history of their Pan-African provenance. In contrast to zircons, which display a wide range of mainly Neoproterozoic (0.54 – 1 Ga) ages, detrital rutiles in the Cambrian of Israel and Jordan define a unimodal age concentration at 0.59-0.58 Ga, similar to that of the youngest zircons. This age concentration is interpreted as representing widespread cooling and exhumation associated with late to post-tectonic igneous activity in the northern sectors of the Pan-African orogeny. The rutile unimodal age spectra does not change significantly up the Cambrian sequence, implying that late Neoproterozoic exhumation cooled an ample amount of crustal material to below the rutile U-Pb closure temperatures (400 – 600°C) over vast areas. Consequently, the immense sand volume stored in the North Gondwana Cambrian strata represents secondary denudation of an already-exhumed Pan-African basement, rather than ongoing erosion of active, Cambrian-age orogenic belts. Alongside the 0.59-0.58 Ga detrital rutile population, which dominates the Cambrian sandstone sequence, 0.55-0.54 Ga detrital rutile first appear in the Ordovician of Jordan and locally dominates the Ordovician of Ethiopia, some 2000 km upstream the fluvial system, closer to its headwaters. It thus seems that the Ordovician drainage basin has been extended southwards to include Pan African terranes that were exhumed coeval with the final consolidation of Gondwana during the Cambrian. However, it appears that most of the rock carapace that has been eroded from these Cambrian orogenic sutures has been delivered to the eastern and southern (modern coordinates) margins of the supercontinent.