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Namibe Group detrital zircon U-Pb and Lu-Hf isotopes: a testimony of late-Orosirian (1.9–1.8 Ga) crustal growth in the Angolan Shield (Congo Craton)

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The Namibe Group represents the largest package of immature supracrustal rocks of the Angola Shield (Congo Craton), occupying an area of nearly 10,000 km^2 in the Namibe Zone (NZ). It is a folded, steeply dipping, meta-volcanosedimentary sequence essentially comprising immature micaschists and greywackes, felsic metavolcaniclastites, along with intercalated marbles and amphibolites. The metavolcanosedimentary sequence is intruded by ca. 1810–1790 Ma ultramafic to felsic plutonic rocks with magmatic arc geochemical signatures. Despite its importance, key aspects such as its maximum depositional age (MDA), sedimentary provenance, and the detrital zircon (DZ) record of crustal evolution remain unresolved. This study presents LA-ICP-MS U-Pb and Lu-Hf DZ analyses from nine NG samples.

The results reveal a dominant cluster of MDAs between 1840 ± 6 Ma and 1820 ± 5 Ma, with two samples yielding older MDAs of 1867 ± 15 Ma and 1880 ± 13 Ma. These findings establish a late-Orosirian age for the NG, refuting earlier proposals of an Archean age. The DZ age distributions are dominated by a prominent youngest peak, with most ages clustering near the MDA. These patterns resemble those of active magmatic arc basin deposits, indicating a convergent plate margin setting for NG deposition.

The provenance for all DZs can be explained by sources internal to the SW Angolan Shield, apart from a minor (8%) Rhyacian age fraction (~2.08 and ~2.14 Ga), for which no rocks of this age have been identified in the Angolan Shield. Approximately 63% of the DZs are late-Orosirian (1.82–1.90 Ga), with a predominant component at ~1.83 Ga and a minor one at ~1.87 Ga. These zircons were likely sourced from the extensive magnesian, calc-alkaline granitoids of the Epupa Metamorphic Complex (EMC: ~1.86–1.76 Ga), the Kamanjab Inlier (~1.88–1.80 Ga), the NZ (~1.83–1.79 Ga), and/or ~1.84–1.80 Ga plutons intruding the Central Eburnean Zone (CEZ: 2.04–1.95 Ga). Older DZ

populations comprise 23% early-Orosirian (Eburnean) ages (peaks at ~1.92, ~1.97, and ~2.01 Ga) and 6% Archean ages (2.50–3.52 Ga). These Eburnean and Archean DZs were likely sourced from the CEZ and/or Cassinga Zone in southern Angola, and/or the Sesfontein-Grootfontein-Tsumkwe-Quangwadum inliers in northern Namibia.

Archean DZs exhibit mostly subchondritic Hf compositions, indicating significant crustal reworking. This trend persisted during Rhyacian to early Orosirian times, with 88% of DZs displaying markedly negative $\varepsilon Hf_{(i)}$ values. In contrast, most late Orosirian DZs (86%) plot above the crustal evolution trend of older ones, reflecting a marked shift toward slightly subchondritic to suprachondritic $\varepsilon Hf_{(i)}$ values and younger TDM_2 model ages. This trend indicates a substantial increase in the contribution of juvenile material to magma generation in late-Orosirian times.

This isotopic shift is also observed in late-Orosirian granitoids of the NZ and EMC, likely reflecting a fundamental geodynamic transition from a period dominated by crustal reworking to juvenile accretion within this part of the Angolan Shield. Our data show that significant continental growth took place in the southwestern margin of the Angolan Shield (Congo Craton) in late-Orosirian times, during the assembly of Columbia.