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Diverse crust-forming mechanisms on early Earth from the Eoarchean–Hadean detrital zircon record of the Tanzanian craton

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The geological record of early Earth is sparse, making an understanding of the processes that operated at that time largely a matter of conjecture. Paleoarchean quartzites from the central Tanzanian craton contain a detrital zircon record spanning the Hadean–Eoarchean, offering an exceptionally rare opportunity to investigate early crust formation. However, this record has been remarkably understudied until now. Here we investigate these Hadean–Eoarchean detrital zircon using integrated U-Pb geochronology, trace element analysis, and Hf isotope geochemistry. Ti-in-zircon thermometry of concordant U-Pb ages yields crystallization temperatures ranging from 580 °C to 840 °C, consistent with magmatic temperatures from the granitic water-saturated solidus to intermediate magmatic temperatures. Trace element data (U-Yb-Y-Hf-Nb) suggest similarities to zircon from continental arcs and ocean islands but are distinct from other Eoarchean–Hadean zircon records (e.g., Jack Hills, Barberton, Acasta). Notably, zircon Hf isotopic data reveal predominantly chondritic sources throughout the ~400 million years of magmatism sampled by these Tanzanian quartzites, contrasting with the dominantly subchondritic Hf compositions observed in other similar age terranes. These findings shed new light on the diverse processes that contributed to crust formation on early Earth.