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Detrital zircon U-Pb and trace element data from the North China Craton provide new constraints on Nuna supercontinent assembly and paleo-tectonics during the Proterozoic “Boring Billion”.

YUKE LI[1], RYAN MCKENZIE[2,3], ZIYI ZHU[1], JIAYUE WANG[4], LANG XUE[4] AND QING TANG[4]

[1]The University of Hong Kong
[2]Swire Institute of Marine Sciences
[3]University of Hong Kong
[4]Nanjing University

The paleogeographic position of the North China Craton (NCC) within the Nuna supercontinent during the "Boring Billion" (ca. 1.8 to 0.8 Ga), remains controversial, with competing models suggesting connections to India, Australia, Siberia, or Laurentia. Resolving this debate is critical for reconstructing the architecture of Nuna and understanding the tectonic drivers for prolonged environmental stability during the Boring Billion. Detrital zircon geochemical data can provide constraints on continental tectonic evolution and help test various paleogeographic models via provenance analysis. Here we present new detrital zircon U-Pb isotopic and trace elemental data from Proterozoic sedimentary successions in the Yongji area, located in the southern margin of the NCC, filling critical age and spatial gaps. Our U-Pb age spectra yield two dominant populations at ca. 2.5 Ga and 1.8 Ga, consistent with voluminous magmatism associated with Neoarchean cratonization and the Paleoproterozoic assembly of Nuna, respectively. In conjunction with U-Pb ages, zircon trace element data can inform magmatic source rock compositions and tectonic settings. Our new trace elemental data show that both LREE/HREE ratios and Eu/Eu* exhibit prominent high values at ca. 2.0 Ga, consistent with trends from global datasets, indicating that crustal thickening occurred before the broader assembly of Nuna. We compiled a stratigraphically-controlled database of detrital zircon U-Pb ages integrating our new analysis with existing data for Paleoproterozoic to Neoproterozoic strata across multiple sedimentary basins in the NCC. We apply quantitative comparisons including multi-dimensional scaling and machine learning clustering to detrital zircon age spectra between the NCC and other proposed neighboring key cratons in the Nuna supercontinent. Statistical similarity in provenance data provides evidence for shared paleogeographic positions, thereby testing and refining existing supercontinent reconstructions.