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Untangling the Crustal Composition of the Hadean and Mesoarchean Earth: Trace Element Investigations of Zircons from the Singhbuhm Craton

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While the chemistry of Hadean and Archean zircons has been studied for decades, most information gleaned about Earth's first eon is from a single site in western Australia. Here, we expand our knowledge of earliest Earth through investigations of Pb-Pb age distributions and zircon trace and rare earth elements (TREE) from the Older Metamorphic Tonalitic Gneiss in the Paleoarchean Singhbuhm Craton of northeastern India [1].

Of the ~483 Pb-Pb measurements taken via LA-ICPMS which passed selection criteria, 21 are older than 3.8 Ga. We observe a small age peak at ~4.0 Ga and find a lack of zircons with ages between ~3.7 and ~3.8 Ga. Among zircons younger than ~3.8 Ga, we observe an age peak at ~3.4 Ga. 45 TREE analyses passed our selection criteria.

TREE from zircons > 3.8 Ga indicate a mantle-like source with both low U/Nb and Sc/Yb. This indicates that the long-lived protocrust from Hf isotopes by [2] was derived from the mantle and not from arc-like processes. Later-formed (< 3.8 Ga) zircons have a broader range of Sc/Yb concentrations, including those derived from more arc-like sources and those from mantle sources. This transition corresponds to a shift in Hf isotopes to more CHUR-like values [2]. Another possible crustal transition is indicated by an increase in both average zircon Th/U and indicators of middle rare earth depletion at ~3.4 Ga, potentially indicating a change in magma water content or mineral fractionation.

In addition to adding 15 new Hadean zircons to an extremely limited catalog of Hadean zircons outside of Western Australia, these results provide a clearer picture of the crustal composition of early Earth and indicate potential geodynamic changes and/or crustal transitions at ~3.8 Ga and ~3.4 Ga. The shift at ~3.8 Ga provides support for previous arguments of a geodynamic change supported by Hf isotopes [2] in India as well as other Archean terranes [3].

[1] Mukhopadhyay D. (2001) *Gondwana Res.* **4**, 307–318.

[2] Chaudhuri T. et al. (2018) Sci. Rep. 8, 1–12.

[3] Bauer A. M., et al. (2020) *Geochemical Perspect. Lett.*, 1–6.