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Constraining Archean TTG and granitoid formation in Indian cratons using Lu-Hf, Sm-Nd isotopes and high-precision HFSE abundances

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Granitoids from Indian cratons were primarily studied for their Lu-Hf systematics from zircon grains (e.g., [1]), but lack comprehensive whole rock Lu-Hf and Sm-Nd isotope data that can fully elucidate the petrogenesis of these rocks. Additionally, the abundances of High Field Strength Elements (HFSE) and Heavy Rare Earth Elements (HREE) that are critical for discerning the processes involved in the formation of the granitoids (e.g., partial melting of residues; [2]), are often not available at sufficient accuracy.

This study presents whole rock Lu-Hf and Sm-Nd isotope as well as trace element data, also including HFSE (Zr, Nb, Ta and Hf) data acquired by isotope dilution. We studied Archean tonalite trondhjemite granite suites (TTGs), sanukitoids and granites from four different cratons in India (Dharwar, Singhbhum, Aravalli and Bundelkhand). The HFSE abundances align well in most cases with data obtained via ICPMS. The εHf_t (-6.5±0.4 to +13.8±0.4; n=25) and εNd_t (-6.3±0.9 to +7.6±0.4; n=25) values, with the exception of two samples from Aravalli-Bundelkhand cratons, follow the terrestrial array for sediments [3]. The εHf_t-εNd_t values of Dharwar TTGs [4,5] and Bundelkhand TTGs show significantly more depleted signatures compared to Singhbhum TTGs. Granitoids from all cratons show evidence for extraction from mafic protoliths close to ~3.8 Ga. Until ~3.2 Ga, no enriched crustal signatures are observed from measured ratios ($^{176}Lu/^{177}Hf$= 0.02, $^{147}Sm/^{144}Nd$= 0.157). This shows that previous evidence for early, enriched crustal signatures shown by short-lived isotope proxies [5][6] is not visible in the long-lived isotope systematics of Indian granitoids.

Trace element modelling including fractional crystallization allows to reproduce the compositions of juvenile TTGs from the Dharwar Craton from a garnet-amphibolite source.

[1] Ranjan et al. (2020) Precambrian Research 340, 105630
[2] Hoffmann et al. (2014) EPSL 388, 374-386
[3] Vervoort et al. (2011) GCA 75, 5903-5926
[4] Ravindran et al. (2023) Chemical Geology 615, 121196
[5] Ravindran et al. (2024) G-cubed 25, e2024GC011834
[6] Pakulla et al. (2025) EPSL 653, 119225