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Evidence for Hadean mantle differentiation and Archean geodynamics preserved in granitoid rocks from the western Dharwar Craton, India

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The scarcity of well-preserved, exposed, ancient rocks has introduced controversies about how to obtain primary isotope compositions suitable to constrain the early silicate differentiation of the Earth. The ^{146}Sm-^{142}Nd chronometer is a powerful tracer of Hadean silicate differentiation [1, 2] that has the potential to overcome challenges related to post-emplacement metamorphism and the scarcity of well-preserved Hadean and Archean rocks. Such isotopic evidence can also provide direct information about chemical heterogeneities in Earth's ancient mantle composition [3]. However, radiogenic isotope systems are susceptible to recycling processes that are not always linked to Archean geodynamics [4]. To overcome these challenges, we also applied stable Si isotope system, which is less prone to recycling [5].

Archean rocks from the well-preserved western Dharwar Craton in southern India have been previously well-characterized geochemically and petrologically [6, 7], however, lack high-precision ^{142}Nd isotope data. Here, we present coupled ^{146,147}Sm-^{142,143}Nd isotope systematics of chemically diverse granitoids, including TTGs and granites. All granitoids define a trend in μ^{142}Nd vs ε^{143}Nd isotope space that extends from the primitive mantle composition up to μ^{142}Nd ≈ +10 ppm (±3 ppm, 2 S.D.) and ε^{143}Nd = +5. Significant positive ^{142}Nd anomalies are revealed in the oldest (~3.4-3.3 Ga) crustal rocks of the craton, whereas ^{142}Nd/^{144}Nd ratio in younger rocks (<3.2 Ga) is indistinguishable from that of the modern bulk mantle. The younger rocks formed by differentiation and reworking from a pre-existing mafic crustal reservoir [8]. These granitoids give δ^{30}Si =0.10-0.15‰ (95% CI) that are close to the values of marine or sedimentary cherts. This could be related to the close interaction with seawater, either by subduction or stagnant lid mode, during formation of these rocks.

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