Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.27788

Formation and Evolution of the Early Earth's Depleted Mantle

PENG LIU[1], GUILLAUME CARO[2], XIAHONG CUI[3], CHAOFENG LI[1], PENG PENG[1] AND JINGHUI GUO[1]

[1]Institute of Geology and Geophysics, Chinese Academy of Sciences
[2]Université de Lorraine, CNRS, CRPG
[3]Hebei GEO university

The mechanism and timing of crustal growth and differentiation on early Earth are hotly debated. From the perspective of the long-lived isotopic system such as zircon Lu-Hf system, no incontrovertible evidence of significant mantle depletion >3.8 Ga exists. However, given the possibility of potential systematic biases in zircon petrogenesis and the unique tectonic setting of early Earth, the non-depleted zircon Hf isotopes globally during early Earth may in verity imply the existence of ubiquitous depleted mantle domains at that time. The ^{146}Sm-^{142}Nd systematics of Archean rocks have been extensively studied to decipher chronological and compositional constraints on Hadean differentiation processes. However, the paucity of ^{142}Nd data on Meso- and Neoarchean mantle-derived rocks relative to earlier periods contributes to uncertainty about the ultimate fate of primordial silicate reservoirs in the convective system of the early Earth. Whole-rock ^{146,147}Sm-^{142,143}Nd analyses for Mesoarchean (3.0-3.1Ga) to Paleoproterozoic (2.45Ga) granitoids, amphibolites and sedimentary rocks of the eastern North China Craton (NCC) have well-resolved positive ^{142}Nd anomalies, suggesting that the Eo- to Mesoarchean continental crust of the eastern NCC is derived from a depleted Hadean mantle source. The model age of differentiation and the ^{147}Sm/^{144}Nd source ratio (0.211±0.002) estimated from the 3.1 Ga Caozhuang amphibolites are identical to those of the 3.8-3.6 Ga rocks from the North Atlantic Craton and the 2.7 Ga pyroxenites from the Abitibi Greenstone Belt, suggesting that these mantle-derived rocks originated from a common, moderately depleted reservoir that differentiated in the wake of the Moon-forming impact and evolved in closed-system until at least 2.7 Ga. These observations contradict the commonly accepted notion of progressive homogenization of ^{142}Nd anomalies in the Archean due to crustal recycling and convective mixing, and instead suggest that primordial differentiation produced a long-lived, depleted reservoir that remained largely isolated from convective mixing on a timescale of several billion years.

[1] Liou, P. *et al.* Long-term isolation of Hadean mantle domains revealed from coupled 147-146Sm-143-142Nd systematics in the eastern North China Craton (2024) *Earth Planet. Sci. Lett.* **638**, 118761 (2024)

[2] Liou, P. *et al.* Zircons underestimate mantle depletion of early Earth (2022) *Geochim. Cosmochim. Acta* **317**, 538-551