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A depleted Hadean signature recorded in a present-day ocean island volcano

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The ^{146}Sm-^{142}Nd isotope system is a powerful tool to study early silicate differentiation processes occurring before the Archean eon, during the lifetime of ^{146}Sm radionuclide ($T_{1/2}$ = 103 Ma). Hadean differentiation processes have long been tracked in Archean crustal rocks that display large ^{142}Nd anomalies. However, these terrains remain scarce as plate tectonics efficiently recycled most of the most ancient lithosphere. In contrast, evidence of the presence of Hadean materials in modern volcanic products is unclear. Indeed, the potential ^{142}Nd anomalies would be most probably diluted and difficult to identify given the current analytical precisions. Nevertheless, rare occurrences of ^{142}Nd isotope anomalies are reported for isolated samples from Samoa and Reunion Island [1, 2].

A novel analytical method based on a 5-line multi-dynamic acquisition scheme on a Nu TIMS [3], makes possible to achieve a routine reproducibility of 3.0 ppm for ^{142}Nd/^{144}Nd ratios of synthetic standards. Capitalising on this innovative method, we present the first high-precision ^{142}Nd isotope measurements of Fani Maoré lavas.

Fani Maoré is a new submarine volcano discovered in 2019 50 km East of Mayotte in the Comoros [4]. Its lavas have remarkably homogeneous Sr-Nd-Pb isotope compositions intermediate between HIMU and EM-I compositions [5] but the trace element contents are peculiar with large Ba enrichment and Pb depletion interpreted to be due to a exceptionally carbonated mantle source [5]. Our new measurements of high-precision Nd isotope composition of Fani Maoré reveal another peculiarity in their chemical composition. These samples display resolved excesses in ^{142}Nd up to +6.5 ±1.9 ppm, relative to the reference isotope composition of the Earth. Our results suggest a significant contribution in the mantle source of a component tracing back a depletion event that occurred in the Hadean. These new results demonstrate that the modern mantle preserves >4 billion years-old isotope heterogeneities.

[1] Peters et al. (2018), Nature **555**, 89–93; [2] Horan et al. (2018) EPSL **484**, 184–191; [3] Luu et al. (2022) Chem. Geol. **611**, 121078 [4] Feuillet et al. (2021) Nature Geoscience **14**(10), 787–795; [5] Chauvel et al. (2024) EPSL **626**, 118529