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Hadean bridgmanite sampled by a present-day ocean island volcano

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The samarium-neodymium isotope systems are powerful tools for investigating the silicate differentiation. In particular, ^{146}Sm decayed to ^{142}Nd ($T_{1/2}$ = 103 Ma) only during the Hadean eon, making it ideal to record the Early Earth differentiation events. Most ^{142}Nd anomalies occur in Archean crustal rocks, but these are scarce due to the efficient recycling of lithosphere by plate tectonics. On the other hand, the present-day mantle preserves ancient heterogeneities as recorded by several radiogenic systems. Several studies have focussed on Nd isotopes in modern volcanic products, in search of Hadean heterogeneities but only rare occurrences of ^{142}Nd isotope anomalies have been reported in few isolated samples from Samoa and Reunion Island [1, 2]. The isotopic variations are small, making it unclear whether Hadean remnants have been eradicated or are diluted and difficult to identify with current analytical precision.

By implementing a new 5-line multi-dynamic acquisition scheme on a Nu TIMS [3], we achieve a routine reproducibility of 3 ppm for ^{142}Nd/^{144}Nd ratios. This advance in analytical precision allowed us to perform the first high-precision ^{142}Nd isotopic measurements of Fani Maoré lavas.

Discovered in 2019 at about 50 km East of Mayotte [4], the submarine volcano Fani Maoré is an interesting target because its Sr-Nd-Pb isotopes are remarkably homogeneous, at values intermediate between HIMU and EM-I end-members but its trace element composition is characterized by strong Ba enrichment and Pb depletion, suggesting a carbonated mantle source [5]. Here we report new ^{142}Nd compositions for Fani Maoré lavas. They average at m^{142}Nd= +2.9 ±1.4 ppm (2se, n=12). Such positive value requires the preservation in the mantle of a depleted material formed during the Hadean. We suggest that the source of this material is bridgmanite formed during the earliest crystallisation stage of Earth's magma ocean.

[1] Peters et al. (2018), Nature **555**, 89–93; [2] Horan et al. (2018) EPSL **484**, 184–191; [3] Israel et al. (2025) Chem. Geol. **680**, 122686 [4] Feuillet et al. (2021) Nature Geoscience **14**(10), 787–795; [5] Chauvel et al. (2024) EPSL **626**, 118529