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Nitrogen in aubrites: abundances, isotopic composition, and implications for Earth's nitrogen source

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Volatile light elements (H, C, N) are essential for the emergence of life on Earth. However, the origin and evolution of nitrogen on Earth remain debated **[1]**. Based on nucleosynthetic isotopic anomalies (Ca, Ti, Cr, Ni, Mo, Ru, Nd) **[2]** and stable isotopic compositions (H, C, N, O) **[3-5]**, enstatite chondrites (EC) are considered strong candidates for Earth's primary building blocks, with a N isotopic composition similar to that inferred for Earth's primitive mantle **[5, 6]**. However, growing evidence suggests that Earth accreted a substantial fraction of differentiated material **[7, 8]**, highlighting the need to better constrain the volatile budget of achondrites. Aubrites are enstatite achondrites that presumably formed from EC-like precursors and differentiated under highly reducing conditions **[9].** Therefore, they may represent valuable analogues for the physicochemical conditions prevailing during early stages of Earth's differentiation. Here, we present a comprehensive investigation of N isotopic compositions and abundances in aubrites to assess the behavior and fate of N during planetary differentiation under reducing conditions.

We measured the Ne, Ar, N contents and isotopic compositions of 14 aubrites. Neon isotopes were used to correct the $^{15}N/^{14}N$ ratios for cosmogenic ^{15}N produced by cosmic-ray exposure. Our results reveal that aubrites are substantially N depleted compared to ECs. However, aubrites and ECs display indistinguishable $^{15}N/^{14}N$ ratios ($d^{15}N \approx -30$ ‰), indicating that the N isotopic signature of the precursor material is preserved during differentiation under reducing conditions. Therefore, if portions of the primitive mantle survived throughout Earth's history **[10]**, the negative N isotope signature ($d^{15}N \approx -40$ ‰) observed in deep mantle diamonds could reflect that of Earth's accreting material **[5]**, consistent with EC-like precursors derived from the inner Solar System and characterized by an EC-like isotopic signature for nitrogen.

[1] Broadley et al. (2022) Nature. [2] Dauphas (2017) Nature. [3] Piani et al. (2020) Science. [4] Clayton et al. (1984) JGR. [5] Javoy et al. (1986) Chem Geol. [6] Grady et al. (1986) GCA. [7] Halliday and Canup (2023) Nat Rev Earth Environ. [8] Rubie et al. (2011) EPSL. [9] Keil (2010) Geochemistry. [10] Weis et al. (2023) Nat Rev Earth Environ.