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Enstatite achondrites as a potential candidate for the terrestrial nitrogen source

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Volatile light elements (H, C, N) are essential to build a habitable planet like Earth. However, the origin and evolution of nitrogen on Earth remain highly controversial **[1]**. Based on 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 potential candidates for Earth's building blocks, and their N isotopic compositions have been inferred to resemble Earth's primitive mantle [5]. However, it is likely that Earth mostly accreted from differentiated planetesimals **[6]**, necessitating a thorough understanding of the volatile budget of achondrites. Aubrites are enstatite achondrites that formed under similar very reducing conditions and within the same isotopic reservoir as ECs **[7],** but they have not yet been considered as a nitrogen source for Earth due to the limited data available **[8-10]**. Here, we conduct a comprehensive investigation of N isotope compositions and abundances of aubrites to determine their potential link with Earth's N budget.

We measured the Ne, Ar, and N contents and isotopic compositions of 12 aubrites. The Ne and Ar isotope data are used to correct the $^{15}N/^{14}N$ ratio for production of cosmogenic ^{15}N by cosmic rays during space exposure. Our results reveal that aubrites are substantially more N depleted than ECs. The aubrites with the highest N contents are also ^{15}N depleted, whereas N-poor samples generally have higher $^{15}N/^{14}N$ ratios. This observation could be due to both degassing on the parent body as well as cosmogenic ^{15}N production. Furthermore, the lower $^{15}N/^{14}N$ ratios are consistent with the observed N isotope composition range of ECs. Overall, our data suggest that ECs and aubrites may have contributed to the N budget of Earth.

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