
First in situ nitrogen isotope analyses of melt inclusions in achondrites

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Résumé

In situ secondary ion mass spectrometry (SIMS) analysis is a powerful, quasi nondestructive technique that now permits to characterize the nitrogen content and isotopic composition of volatile-rich phases (e.g., melt inclusions) in extraterrestrial samples (1). It is particularly suitable for samples that may contain nitrogen from various reservoirs (i.e., solar, chondritic and cometary) with distinct $^{15}\text{N}/^{14}\text{N}$ ratios (2). To improve our understanding of the origin and evolution of nitrogen (and hydrogen) on planetary bodies in the inner solar system, we have applied this method, for the first time, to determine the N (and H) content and isotopic composition of melt inclusions and interstitial glass in differentiated meteorites with well-known ages - the angrites D'Orbigny and Sahara 99555 as well as the martian meteorite Chassigny. The most primitive (i.e., Mg-rich) melt trapped in olivine-hosted melt inclusions of D'Orbigny records $\delta^{15}\text{N}$ values between 0 ± 25 and $+56 \pm 29\text{‰}$ and δD values ranging from -348 ± 53 to $-118 \pm 31\text{‰}$. These results indicate that the angrite parent body mantle sampled by D'Orbigny contains isotopically CM-like volatiles, possibly with a contribution of hydrogen ingassed during the lifetime of the solar nebula, as indicated by the most D-depleted hydrogen isotope ratios (3). Preliminary results indicate that the martian mantle source sampled by Chassigny has slightly lower $\delta^{15}\text{N}$ values, which appear, nonetheless, also consistent with a chondritic source. Given the very old crystallization age of D'Orbigny, our findings imply that nitrogen- and water-rich material, presumably formed beyond the orbit of Jupiter, must have been present in the terrestrial planet-forming region within the first ~ 4 Ma after the formation of Ca-Al-rich inclusions (CAIs, the oldest materials in the solar system). References: (1) Füri et al. (2018) *Chem. Geol.*, 493, 327-337. (2) Füri and Marty (2015) *Nature Geosci.*, 8, 515-522. (3) Deligny et al. (2021) *GCA*, 313, 243-256.

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