Nitrogen isotopes as tracers of volatile sources in the inner Solar System

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The relative proportion of ^{14}N and ^{15}N shows outstanding variability across the Solar System. NASA's Genesis mission, which sampled the solar wind for 27 months, allowed to determine the isotopic composition of solar nitrogen, and to demonstrate that the protosolar nebula was highly depleted in ^{15}N compared to the reference $^{15}N/^{14}N$ ratio, that of Earth's atmosphere [1]. In contrast, laboratory analyses of terrestrial and extraterrestrial samples, together with spectroscopic observations, have revealed that all Solar System object – with the exception of the atmospheres of the giant planets [2] – are enriched in ^{15}N by several tens to hundreds of percent [3]. Given the distinct isotopic characteristics of solar, asteroidal, and cometary nitrogen, N isotopes have become the tracer of choice for investigating the origin of volatiles trapped in the interior and at the surface of planetary bodies.

The terrestrial N isotope signature can be explained by mixing between a solar and a chondritic component [4]. Carbonaceous chondrites also represent a suitable source for nitrogen trapped in the Moon's interior, indicating that volatile-rich chondritic material was delivered to the Earth-Moon system after the Giant impact [5]. Furthermore, studies of lunar regolith samples have revealed that the continuous influx of chondritic (micro-) impactors, together with solar wind implantation, has represented an important source of nitrogen and other volatiles for the lunar surface over the past ~1 Ga [6,7]. These findings demonstrate that the lunar geologic record constitutes a superb opportunity to investigate the nature and flux of matter and ions delivered to planetary surfaces through time, and will certainly receive further attention during future space missions. In this respect, it should be noted that the study of nitrogen (together with H, C, noble gases) is a major objective of ESA's PROSPECT package, which will drill, extract, and analyze samples of potentially ice-bearing regolith at the lunar South Pole as part of the Russian Luna-27 Moon lander mission in 2020.

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