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Carbon and nitrogen budget on iron meteorites: new constraints on their distribution during metal-silicate segregation and their origins

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Iron meteorites are mainly composed of metallic phases (kamacite, taenite), phosphides and sulphides, along with minor carbon- and nitrogen-bearing phases, such as graphite, carbides and nitrides [1]. They are classified into two main groups: magmatic iron meteorites, thought to derive from the core of differentiated asteroids [2], and non-magmatic iron meteorites, which are likely formed at the subsurface of chondritic parent bodies as a result of collisions [3]. A large part of carbon and nitrogen are expected to segregate into metallic cores during metal-silicate differentiation. During this process and the subsequent cooling, these elements can either be accommodated in metallic phases, phosphides and sulphides, or segregated as graphite, carbides and nitrides. This study aims to investigate the mineralogy and isotopic composition of carbon and nitrogen-bearing phases, in both magmatic and non-magmatic iron meteorites, in order to better constrain their origin, transport, storage and distribution processes.

Mineralogic characterisations of carbon- and nitrogen-bearing phases were conducted using scanning electron microscopy (SEM-EDS), electron probe microanalysis (EPMA) and, when required, by Raman spectroscopy and by atom probe tomography (APT). The N- and C-content of metallic phases and the isotopic compositions, expressed as $\delta^{13}C$ and $\delta^{15}N$, of both metallic and carbon- and nitrogen-bearing phases, were determined with a nanoscale secondary ion mass spectrometry (NanoSIMS).

The combination of mineralogical, chemical and isotopic compositions will be used to better constrain the mechanisms governing carbon and nitrogen segregation in the metal during planetary differentiation, and their origins in both magmatic and non-magmatic iron meteorites. The solubility limits of C and N and the ability to sequester them in thermally resistant phases will be discussed. The possible variations of isotopic signatures will help us to identify the different cosmochemical reservoirs and sources. This in turns will have drastic implications concerning the volatile budget, the ability to transport and deliver these atmophile elements during accretion and the revision of the degassing dynamics of large planetesimal interiors.

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