Distinct Purine Distribution in Carbonaceous Chondrites

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Carbonaceous chondrite meteorites are known to contain a diverse suite of organic compounds, many of which are essential components of biochemistry. Amino acids, which are the monomers of proteins, have been extensively studied in such meteorites (e.g. Botta and Bada 2002; Pizzarello et al., 2006) . The origin of amino acids in meteorites has been firmly established as extraterrestrial based on their detection typically as racemic mixtures of amino acids, the presence of many non-protein amino acids, and non-terrestrial values for compound-specific deuterium, carbon, and nitrogen isotopic measurements. In contrast to amino acids, nucleobases in meteorites have been far less studied. Nucleobases are substituted one-ring (pyrimidine) or two-ring (purine) nitrogen heterocyclic compounds and serve as the information carriers of nucleic acids and in numerous coenzymes. All of the purines (adenine, guanine, hypoxanthine, and xanthine) and pyrimidines (uracil) previously reported in meteorites are biologically common and could be interpreted as the result of terrestrial contamination (e.g. van der Velden and Schwartz, 1974.) Unlike other meteoritic organics, there have been no observations of stochastic molecular diversity of purines and pyrimidines in meteorites, which has been a criterion for establishing extraterrestrial origin. Martins et al. (2008) performed compound-specific stable carbon isotope measurements for uracil and xanthine in the Murchison meteorite. They assigned a non-terrestrial origin for these nucleobases; however, the possibility that interfering indigenous molecules (e.g. carboxylic acids) contributed to the ^{13}C-enriched isotope values for these nucleobases cannot be completely ruled out. Thus, the origin of these meteoritic nucleobases has never been established unequivocally.

Here we report on our investigation of extracts of 11 different carbonaceous chondrites covering various petrographic types (CI, CM, and CR) and degrees of aqueous alteration (1, 2, and 3) and one ureilite. Analysis via liquid chromatography coupled with electrospray triple-stage mass spectrometry or orbitrap mass spectrometry employed a targeted approach for analysis focused on the five canonical RNA/DNA nucleobases as well as 14 non-canonical pyrimidines and purines, which have been observed under plausible prebiotic reactions.

References

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