Aliphatic Amines from the Murchison Meteorite

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Carbonaceous chondrites represent some of the most primitive solid materials formed in the Solar System, therefore, the analyses of their organic content provide valuable insights into the chemical inventory for the primordial synthesis of organic matter [1]. The most thoroughly studied carbonaceous chondrite with respect to its organic chemistry is the CM2 type Murchison meteorite. Multiple organic classes have been identified from this meteorite including amino acids, a few of which have been found to contain an L-enantiomeric excess [2]. Furthermore, meteoritic amino acids possess enriched stable isotopic compositions (D, ^{13}C, ^{15}N), which can be used to unveil their primordial formation mechanisms and histories [3]. However, the enantiomeric distributions and isotopic ratios of meteoritic compounds besides amino acids are largely unknown [4].

Meteoritic aliphatic amines are organic compounds which may share similar synthetic histories with amino acids. We developed a novel chromatographic method which allowed us to invstigate the enantiomeric composition of *sec*-butylamine, and to quantify the $^{13}C/^{12}C$ of a suite of twenty other meteoritic aliphatic amines. We observed that *sec*-butylamine is racemic in Murchison, in contrast to isovaline, its structurally analogous amino acid. We also observed a substantial enrichment in ^{13}C for amines composed of one and two carbon atoms, with respect to their structurally analogous amino acids, but similar $\delta^{13}C$ values for amines composed of three and four carbon atoms relative to their amino acid analogs. We will discuss these results and evaluate the different synthetic routes involved in the formation of amines and amino acids in the early Solar System, and in the Murchison parent body.

[1] Cronin & Moore (1971) *Science* **172**, 1327-1329 [2] Glavin & Dworkin (2009) *Proc. Natl. Acad. Sci. USA* **106**, 5487-5492 [3] Elsila *et al* (2012) *Meteor. Planet. Sci.* **47**, 1517-1536 [4] Aponte *et al* (2014) *Geochim. Cosmochim. Acta.* **131**, 1-12