AMINO ACIDS IN ANTARCTIC MICROMETEORITES

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Introduction: Deposition of organics to Earth from asteroids and comets, and their fragments, could have contributed to the origin of life on Earth. *In situ* studies of the coma of comet 67P/Churyumov-Gerasimenko [1] and laboratory analyses of meteorites suggest amino acids are present on asteroids and comets [2]. Amino acids are important target analytes when investigating extraterrestrial samples because the abundances, distributions, and enantiomeric and isotopic compositions of amino acids can infer information regarding parent body processing [2].

Meteorite organics have been heavily studied, yet, organics in micrometeorites (MMs) are poorly understood [3-6]. Responsible for ~30×10^6 kg/yr [7-8], MMs are the primary contributor of extraterrestrial material to Earth [7,9]. To illustrate, 100 – 250 µm MMs deposit ~1000× more mass than other sources of extraterrestrial material [10].

Large (100 – 400 µm) Antarctic MMs (AMMs) have been recovered from the South Pole Water Well (SPWW), Cap Prud'homme (CP), Dome Fuji, and Dome C (Concordia Station), Antarctica. Groups of dozens of AMMs from SPWW and CP have been analyzed, leading to the detection of α-aminoisobutyric acid (α-AIB), a non-protein extraterrestrial amino acid [3,6]. Yet, it is unknown if MMs possess a broader distribution of extraterrestrial amino acids, which would provide insight into parent body processes and potential MM amino acid contributions to early Earth.

Experimental: In this work, 6 AMM grains (~7 µg total mass) from the Concordia collection [11] have been analyzed for amino acids. The particles were subjected to pre-column derivatization using *o*-pthaldialdehyde/*N*-acetyl-L-cysteine [12] to enhance instrumental sensitivity to, and specificity for, primary amino groups, and to provide chromatographic separation of chiral amino groups. Subsequent to derivatization, sample analyses were executed with ultra performance liquid chromatography with fluorescence detection and time-of-flight mass spectrometry.

Results and Discussion: The present work detected numerous extraterrestrial amino acids, and used ~1000× less material than previous MM studies [6]. The amino acids detected possessed a distribution of abundant achiral, straight-chained *n*-ω-amino acids (Figure 1). Thermally altered CV3 and CO3 chondrites also contain elevated abundances of *n*-ω-amino acids. Interestingly, such a distribution is disproportionately not observed in the analyses of low temperature, aqueously altered CR, CI, and CM chondrites [13]. Based on the observed amino acid distribution, it is plausible that the MMs analyzed in this study originated from a thermally altered parent body. However, we cannot rule out the possibility that the amino acids were affected by atmospheric entry heating, which warrants further investigation.

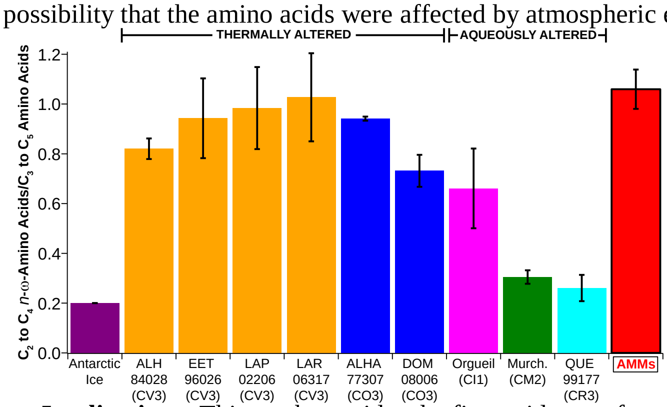

Figure 1. C_2 to C_4 *n*-ω-amino acids relative to C_3 to C_5 amino acids of **Antarctic ice**, thermally altered **CV3** and **CO3** chondrites [13], and low temperature aqueously altered **CI1**, **CM2**, and **CR3** chondrites [14], compared to the present analysis of 6 **AMM grains**.

Implications: This work provides the first evidence of extraterrestrial *n*-ω-amino acids in MMs, suggesting these compounds were formed at elevated temperatures. Additionally, while it was previously thought that the only indigenous extraterrestrial amino acid in MM grains was α-AIB [3,6], our new results indicate that MMs may have delivered a much broader range of amino acids to the primordial Earth than suggested by prior research in the field.

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