PARENT BODY INFLUENCES ON AMINO ACIDS IN THE TAGISH LAKE METEORITE

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Introduction: The Tagish Lake meteorite is a primitive C2 carbonaceous chondrite with a mineralogy, oxygen isotope, and bulk chemical composition intermediate between CI and CM carbonaceous chondrites [1]. However, in contrast to many CI and CM carbonaceous chondrites, the Tagish Lake meteorite was reported to have only trace levels of indigenous amino acids [2,3], with evidence for terrestrial L-amino acid contamination from the Tagish Lake meltwater [3]. The lack of indigenous amino acids in Tagish Lake suggested that they were either destroyed during parent body alteration processes and/or the Tagish Lake meteorite originated on a chemically distinct parent body from CI and CM meteorites where formation of amino acids was less favorable.

We recently measured the amino acid composition of three different lithologies (11h, 5b, and 11i) of pristine Tagish Lake meteorite fragments that represent a range of progressive aqueous alteration in order 11h < 5b < 11i as inferred from the mineralogy, petrology, bulk isotopes, and insoluble organic matter structure [4-6]. The distribution and enantiomeric abundances of the one- to six-carbon aliphatic amino acids found in hot-water extracts of the Tagish Lake fragments were determined by ultra peformance liquid chromatography fluorescence detection and time of flight mass spectrometry coupled with OPA/NAC derivatization [7]. Stable carbon isotope analyses of the most abundant amino acids in 11h were measured with gas chromatography coupled with quadrupole mass spectrometry and isotope ratio mass spectrometry.

Results and Discussion: We found that lithology 11h had a much higher total amino acid abundance (5,600 ppb) than 5b (900 ppb) and 11i (40 ppb), similar to recent GCMS measurements of the same extracts [8]. The abundance of α-aminoisobutyric acid in the most pristine fragment 11h was ~ 200 times higher than previously reported for a pristine Tagish Lake sample [2,3]. Glycine was the most abundant amino acid in 11h and had a carbon isotope value of $\delta^{13}C = +19‰$, consistent with an extraterrestrial origin. The enantiomeric ratios of alanine, β-amino-*n*-butyric acid, and isovaline in 11h were racemic (D/L ~ 1) indicating an extraterrestrial origin for these amino acids. Non-racemic isovaline (D/L = 0.87) was detected in 5b corresponding to an L-enantiomeric excess of 6.6%, but no L-isovaline excess was measured in the more pristine lithology 11h. No isovaline or any other five-carbon amino acids were detected in the extensively altered lithology 11i. We observed a distinct distribution of five-carbon amino acids in 11h and 5b compared to other CI, CM, and CR carbonaceous chondrites studied using this technique.

Conclusion: The results of this study challenge the previous held view that the parent body of the Tagish Lake meteorite was depleted in amino acids. Our data on fragments 11h, 5b, and 11i suggest that the total abundance of amino acids and the enantiomeric composition of isovaline in Tagish Lake is directly correlated with the varying degree of aqueous alteration on the parent body. The detection of excess L-isovaline in Tagish Lake 5b and other aqueously altered meteorites [7] supports the hypothesis that the origin of life on Earth and possibly elsewhere in our solar system was biased toward L- homochirality from the beginning.

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