THE EFFECTS OF THERMAL METAMORPHISM ON THE AMINO ACID CONTENT OF THE CI-LIKE CHONDRITE Y-86029. A. S. Burton,[1] S. Grunsfeld,[2] J. E. Elsila,[3] D. P. Glavin,[3] and J. P. Dworkin[3]. [1]NASA Johnson Space Center, Houston, TX 77058; aaron.s.burton@nasa.gov, [2]River Hill High School, Clarksville, MD 21029; [3]NASA Goddard Space Flight Center, Greenbelt, MD 20771.

Introduction: Carbonaceous chondrites contain a diverse suite of amino acids that varies in abundance and structural diversity depending on the degree of aqueous alteration and thermal history that the parent body experienced [1 – 3]. We recently determined the amino acid contents of several fragments of the Sutter's Mill CM2 chondrite [4]. In contrast with most other CM2 chondrites, the Sutter's Mill meteorites showed minimal evidence for the presence of indigenous amino acids. A notable difference between the Sutter's Mill meteorites and other CM2 chondrites are that the Sutter's Mill stones were heated to temperatures of 150 - 400 °C [4], whereas most other CM2 chondrites do not show evidence for thermal metamorphism [5]. Because empirical studies have shown that amino acids rapidly degrade in aqueous solutions above 150 °C and the presence of minerals accelerates this degradation [6], a plausible explanation for the lack of amino acids observed in the Sutter's Mill meteorites is that they were destroyed during metamorphic alteration.

Fewer CI chondrites have been analyzed for amino acids because only a small number of these meteorites have been recovered. Nevertheless, indigenous amino acids have been reported in the CI chondrites Ivuna and Orgueil [7]. Here we report on the amino acid analysis of the CI-like chondrite, Yamato 86029 (Y-86029; sample size of 110 mg). Just as the Sutter's Mill meteorites were thermally metamporphosed CM2 chondrites, Y-86029 has experienced thermal metamorphism at higher temperatures than Orgueil and Ivuna (normal CI chondrites) experienced, possibly up to 600 °C [8]. The abundance, distribution and enantiomeric compositions of the two- to five-carbon aliphatic amino acids found in this meteorite were measured by ultra performance liquid chromatography fluorescence detection and time of flight mass spectrometry (LC-FD/ToF-MS) coupled with *o*-phthaldialdehyde / *N*-acetyl-L-cysteine (OPA/NAC) derivatization [1]. For comparison, a similarly sized sample of the Ivuna CI1 carbonaceous chondrite (92 mg) from the Natural History Museum of London was also analyzed using the same protocols.

Results and Discussion: The correlation between thermal metamorphism and very low amino

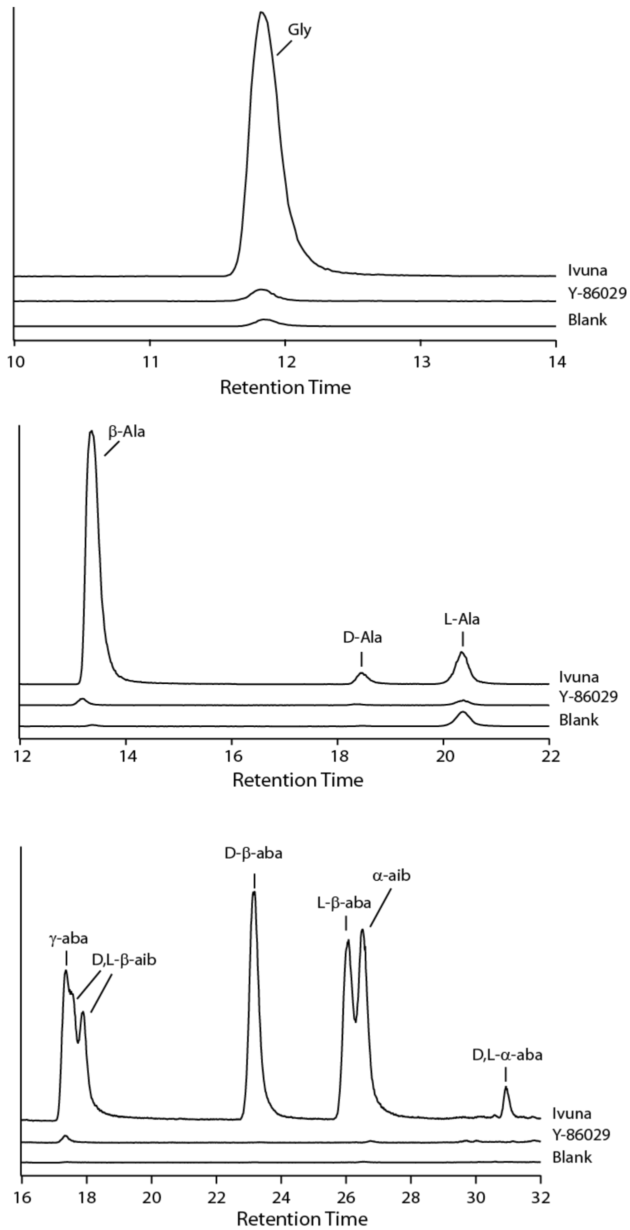

Figure 1. Representative LC-ToF-MS single-ion chromatograms of Y-86029, Ivuna, and an amino acid standard. A) The single-ion chromatogram for OPA/NAC-derivatized two-carbon amino acid glycine (Gly); B) single ion-chromatograms for the OPA/NAC-derivatized three-carbon amino acids β-alanine (β-Ala), D-alanine (D-Ala) and L-alanine (L-Ala); C) single ion-chromatograms corresponding to the OPA/NAC-derivatized four-carbon amino acids γ-amino-*n*- butyric acid (γ-aba), β-aminoisobutyric acid (β-aib), β-amino-*n*-butyric acid (β-aba), α-aminoisobutyric acid (α-aib), and α-amino-*n*-butyric acid (α-aba).

acid abundances previously observed for CM2 chondrites was also observed here with the CI chondrites. From a qualitative perspective, Y-86029 shows only low levels of the amino acids glycine and β-alanine that are both abundant in Ivuna (Figure 1). Many other amino acids found in Ivuna (and other aqueously altered meteorites) are virtually absent (Figure 1, ref 7). The most obvious difference between Y-86029 and Ivuna and Orgueil is the thermal metamorphism that Y-86029 experienced [8]. However, thermal metamorphism alone is not a sufficient explanation for the amino acid depletion observed in observed in Y-86029 because indigenous amino acids have been found in other thermally metamorphosed meteorites including CV and CO chondrites and ureilites [3, 9]. As was the case for the Sutter's Mill meteorites, then, the combination of thermal metamorphism *and* aqueous alteration that occurred on the parent body of Y-86029 appears to have been responsible for destroying and/or preventing the synthesis of amino acids. This finding, in addition to our previous results from the Sutter's Mill meteorite, places an important constraint on the on the range of impactors capable of delivering amino acids to the prebiotic Earth.

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