NITROGEN ISOTOPE ANALYSIS OF AMINO ACIDS IN CARBONACEOUS CHONDRITES YAMATO 980115 AND ALLAN HILLS A77003.

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Introduction: Carbonaceous Chondrites (CC) are primitive meteorites that have not experienced extensive planetary differentiation. They also contain carbon up to 5% by weight, most of which is organic in nature. It is speculated that these extraterrestrial materials might have contributed to a source of organic compounds in the early-Earth. Among the wealth of organic materials in CC, soluble compounds such as amino acids demonstrate a crucial evolutionary significance as they are also the monomers of protein and enzymes that are indispensable to life on Earth. Like their terrestrial counterparts, some meteoritic amino acids also display chiral asymmetry [1, 2] and these abiotic compounds may have biased Earth's prebiotic organic inventory with left-handedness that predated life's origin.

The CCs CI (Ivuna) Yamato (Y) 980115 and CO (Ornans) Allan Hills (ALH) A77003 respectively collected in Antarctica in 1998 and 1977, were provided from the National Institute of Polar Research (NIPR) in Japan. In this study we determined amino acid contents and stable nitrogen isotopic compositions of individual amino acids. The nitrogen isotopic compositions of amino acids are indicative of their synthetic origins. This is a particularly important tool for determining the synthetic origins of achiral amino acids as enantiomeric analysis is not applicable for these molecules.

Results and Discussion: The distribution and enantiomeric composition of amino acids in the meteorites were determined using a gas chromatography/mass spectrometry (GC/MS) and a gas chromatography combustion isotope ratio mass spectrometry (GC/C/IRMS). The amino acid extraction and derivatization procedures employed in this study were based on a method described in Takano et al. [3].

The result suggests that the meteorites are generally depleted in amino acids, while only the terrestrial amino acid glycine was detected in Y-980115. Amino acids in extraterrestrial materials are known to be enriched in ^{15}N (higher than +60‰) relative to terrestrial counterparts (–10 to +20‰) [2, 4-5]. The $\delta^{15}N$ value of glycine in Y-980115 was as high as +145‰, which is clearly extraterrestrial. Therefore, although glycine is a common terrestrial amino acid, this exceptionally high stable isotope value indicates that the glycine in Y-980115 is indigenous to the meteorite.

In short, despite the low amino acid abundance, it is determined that the meteorite Y-980115 may contain organic matter that is of an extraterrestrial origin, and share the view that meteorites may have delivered abiotic compounds to the organic inventory of the Earth. The results also agree with previous studies that some amino acids in Ivuna and Ornans are indigenous [6-7].

References: [1] Cronin, J. R. and Pizzarello S. 1997. *Science* 275:951–955. [2] Engel, M. H. and Macko S. A. 1997. *Nature* 389:265–268. [3] Takano, Y. et al. 2009. *Anal. Chem*. 81:394–399. [4] Epstein, S. et al. 1987. *Nature* 326:477–479. [5] Sephton, M. A. and Gilmour I. 2001. *Mass Spectrometry Reviews* 20:111–120. [6] Ehrenfreund, P. et al. 2001. Proceedings of the National Academy of Sciences. 98:2138–2141. [7] Chan, H.-S. et al. 2012. *Meteoritics & Planetary Science* 47:1502–1516.