RELATIVE AMINO ACID COMPOSITION OF CM1 CARBONACEOUS CHONDRITES. Z. Martins[1], O. Botta[1], P. Ehrenfreund[1,2], [1]Astrobiology Laboratory, Leiden Institute of Chemistry, P.O. Box 9502, 2300 RA Leiden, The Netherlands, z.martins@chem.leidenuniv.nl, [2]Astronomical Institute "Anton Pannekoek", University of Amsterdam, Kruislaan 403, 1098 SJ Amsterdam, The Netherlands.

Introduction: Carbonaceous chondrites contain up to 5 wt% of organic carbon. More than 80% of this material is locked into an insoluble macromolecule that is structurally complex and poorly understood. The remaining < 20% is comprised of a mixture of soluble organic compounds. Polycyclic aromatic hydrocarbons (PAHs) make up the majority (up to 80%) of this soluble fraction, followed by the carboxylic acids and fullerenes, which are about an order of magnitude less abundant [1].

More than 70 different amino acids have been identified in the CM2 carbonaceous chondrites Murchison, most of which do not occur naturally on the Earth, such as α-aminoisobutyric acid (AIB) and isovaline. Almost identical amino acid compositions have also been found in other CM2's, including Murray and the Antarctic meteorite LEW90500, although the total abundances in these meteorites are significantly lower (~7760 parts per billion (ppb) in LEW90500 and 11,600 ppb in Murray compared to ~ 15,300 ppb in Murchison) [2]. CI1 carbonaceous chondrites, such as Orgueil and Ivuna, have a distinctively different and simpler amino acid composition compared to CM2's [3]. While CM2 carbonaceous chondrites contain a wide variety of complex amino acids, the CIs display a more simple composition, with glycine and β-alanine present in significant abundances. Relative amino acid concentrations have been shown to be indicative for parent body processes with respect to the formation of this class of compounds [4]. It was concluded that while Strecker cyanohydrin synthesis is the most probable pathway for the formation of the amino acids in the CM2 parent body, a different formation mechanism was active on the parent body of CIs.

The composition of the macromolecular material also gives insight into parent body processes. Hydrous pyrolysis data obtained for Murchison, Orgueil and Cold Bokkeveld (CM2) are qualitatively very similar. However, quantitative differences regarding the ratios of one-ring and two-ring aromatics and phenols in the pyrolysates indicate that the structural differences in the macromolecular materials can be explained with different degrees of aqueous alteration on the parent body [5]. This is in contrast to the interpretation of the amino acid data that suggest that the composition in the CI1 is *not* produced by aqueous alteration.

CM1 carbonaceous chondrites show a higher degree of aqueous alteration than CM2's and therefore provide an important link between the CM2 and CI1 chondrites. If aqueous alteration is the main process that determines the composition of the organic material, the amino acid composition of these meteorites should be different than that of the CM2's in that they should show a trend to a simpler distribution, towards that of the CI's. We analyzed two CM1 chondrites, MET01070 and ALH88045, and compared their amino acid composition with that of Murchison, Murray, LEW90500, Nogoya, Orgueil and Ivuna.

Sample preparation. The Antarctic CM1 MET01070 was collected during the ½ ANSMET expedition and was provided by the Antarctic meteorite curator at the NASA Johnson Space Center. The Antarctic CM1 ALH88045 was collected during the EUROMET meteorite collection program and was provided by the EUROMET meteorite curator at the Open University, Milton Keynes, UK. Each sample was crushed into a fine powder, and 100 mg of each sample was then analyzed using the established procedure for amino acids, which includes hot water extraction followed by 6 N HCl acid vapor hydrolysis, desalting, OPA/NAC derivatization [6] and separation by high-performance liquid chromatography (HPLC) [1]. Amino acid abundances in the meteorite samples were determined by comparison of the chromatographic signals with those of known standards.

Results and Discussion. Figure 1 shows a comparison of chromatograms of the MET01070, ALH88045 and Murchison meteorites. Absolute amino acid abundances were measured and relative amino acids concentrations were calculated. Based on these, it is possibly to verify that the relative (glycine=1) concentrations of β-alanine and AIB of the CM1's ALH88045 and MET01070 falls between that of CM2 Murchison and the CI1 Orgueil [3], suggesting a link between CM2 and CI1 meteorites. The values for the β-alanine/glycine ratio are 0.764, 1.991, 1.258 and 2.902, and for the AIB/glycine ratio are 1.826, 0.431, 0.221, and 0.055, respectively for Murchison, ALH88045, MET01070 and Orgueil [3]. The most abundant D-amino acid in meteorites, D-alanine, could give us important information. Yet, D-alanine/glycine ratios of CM1's ALH88045 and MET01070 do not fit between this pattern.

We will discuss the processes which occured in the parent bodies of CIs and CMs carbonaceous meteorites. We will elucidate the link between these chondrites.

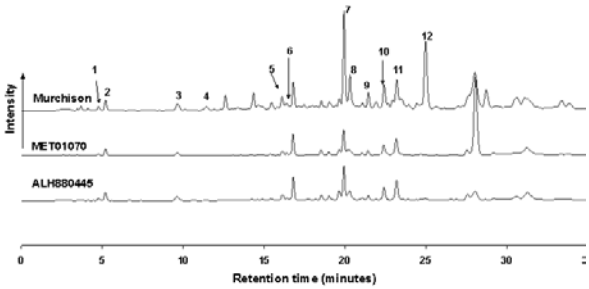

Figure 1. The 0 to 35 min. region of the HPLC chromatograms (no peaks were observed outside this period). OPA/NAC derivatization of amino acids in the 6 N HCl-hydrolyzed hot water extracts from MET01070, ALH88045 and Murchison meteorites are shown. The peaks were identified as follows: 1: D-aspartic acid; 2: L-aspartic acid; 3: L-glutamic acid; 4: D-glutamic acid; 5: D-serine; 6: L-serine; 7: glycine; 8: β-alanine; 9: γ-ABA; 10: D-alanine; 11: L-alanine; 12: AIB.

References: [1] Botta O. & Bada J. L. (2002) *Surv. Geophys.* 23, 411-467. [2] Botta O. & Bada, J. L. (2002). In *Lunar and Planetary Science XXXIII*, Abstract #1391, LPI, Houston (CD-ROM). [3] Ehrenfreund P., *et al.* (2001) *Proc. Natl. Acad. Sci. USA* 98, 2138-2141. [4] Botta O., *et al.* (2002) *Origins Life Evol. Biosphere* 32, 143-163. [5] Sephton M., *et al.* (2000) *Geochim. Cosmochim. Acta* 64, 321-328. [6] Zhao M. & Bada J. L. (1995) *J. Chromatogr. A, 69*0, 55-63.