MOLECULAR ISOTOPIC CHARACTERIZATION OF THE ALH 85013.50 METEORITE: DEFINING THE EXTRATERRESTRIAL ORGANIC COMPOUNDS. M. Fuller[1] and Y. Huang, [1]Brown University (Box 1846 Providence, RI 02912, Megan_Fuller@brown.edu).

Introduction: The Antarctic Meteorite Program has returned over 16,000 meteorites from the ice sheets of the Antarctic. This more than doubles the number of preexisting meteorite collection and adds important and rare specimens to the assemblage. The CM carbonaceous chondrites are of particular interest because of their high organic component. The Antarctic carbonaceous chondrites provide a large, previously uninvestigated suite of meteorites. Of the 161 CM chondrites listed in the 'Catalogue of Meteorites' 138 of them have been recovered from the Antarctic ice sheets [1], [2]. However, these meteorites have typically been exposed to Earth's conditions for long periods of time. The extent of terrestrial organic contamination and weathering that has taken place on these carbonaceous chondrites is unknown. In the past, stable isotope analysis was used to identify bulk organics that were extraterrestrial in origin[3]. Although useful, this method could not exclude the possibility of terrestrial contamination contributing to the isotopic measurement. Compound specific isotope analysis of organic meteorite material has provided the opportunity to discern the terrestrial contamination from extraterrestrial organic compounds on the molecular level.

In this work we examine both the water and solvent soluble organic compounds found in ALH 85013.50 meteorite using both compound-specific δD and $\delta^{13}C$ analysis in order to determine the presence of extraterrestrial organic compounds and delineate those from the terrestrial compounds. Our goal is to validate the use of Antarctic carbonaceous chondrites as sources for organic information about parent bodies and provide insight into abiotic organic synthetic pathways.

Experimental: A 6.3g sample of the ALH 85013.50 meteorite was ground to a fine powder using an agate mortar and pestle after the outermost exterior of the stone was removed in order to reduce the possibility of terrestrial contamination. The powder was placed into a reaction vessel with 30ml of triple distilled DI water and evacuated of atmosphere. The powder/water solution was heated to ~100 ºC for 22 hours. The water extract was removed and separated into basic and neutral fractions using cation exchange resin. The neutral water fraction contained the hydroxy acid and dicarboxylic acids. These compounds were extracted from the water using continuous ether reflux [4]. The ether fraction was dried using a rotary evaporator and derivatized using acidified isopropanol [5]. The derivatized hydroxy acids and dicarboxylic acids were then analyzed using gas chromatography mass spectrometry (HP 6890N GCMS) and gas chromatography-isotope ratio mass spectrometry (GC-IRMS- Finnigan Delta XL^+).

The ALH powder was freeze dried and extracted with a 9:1 DCM:methanol mixture to obtain the solvent soluble organics. The powder/solvent mixture was placed in a reaction vessel, evacuated of atmosphere, and heated to ~100 ºC for 22 hours. The solvent extract was removed and dried using a rotary evaporator. The residue was redissolved in hexane and separated into four fractions using silica gel chromatography. The four fractions that were eluted were hexane, 1:1 hexane:DCM, DCM, and methanol. Each of these fractions was concentrated using a rotary evaporator and analyzed by both GCMS and GC-IRMS.

Restults:

Dicarboxylic Acids. The dicarboxylic acid fraction of the water extract of ALH 85013.50 yielded the GC-MS chromatogram shown in Fig. 1. The most abundant diacids present were identified by their mass spectra and are labeled in Fig. 1. The $\delta^{13}C$ data for succinic, 2-methyl succinic, glutaric, and 2-methyl glutaric acids indicate that they are extraterrestrial in origin (See Table 1). These values agree well with previous carbon data of other CM chondrite dicarboxylic acids [3]. Preliminary hydrogen isotope analysis was done for these compounds, however they were not present in concentrations necessary to achieve a reproducible response. Although the prelimary δD data support the $\delta^{13}C$ results that these compounds are extraterrestrial. Some of the terrestrial compounds (compounds 5 and 6) present in the extract are shown in Fig.1 and Table 1 to demonstrate the ability of compound specific stable isotope to discriminate between terrestrial and extraterrestrial compounds.

Solvent Soluble Compounds. The four fractions of the hydrocarbon extract were analyzed using compound specific hydrogen isotope measurement. The fractions showed measurable terrestrial contamination, however heavy compounds, indicative of extraterrestrial origins, were observed. The compounds ranged in δD values from +17‰ to +122‰. These values are heavier than terrestrial compounds, however not as

heavy as previously reported numbers for other hydrocarbon extracts [6]. However, the values reported previously by Krishnamurthy et al. were bulk fraction values rather than compound specific values. This suggests that the bulk fractions of compounds may contain significant amounts of unresolved compounds with heavier δD values than the individual compounds that we analyzed. Finer-scale separation methods (e.g. thin layer chromatography, HPLC) should be applied to obtain more resolved mixtures for isotopic study.

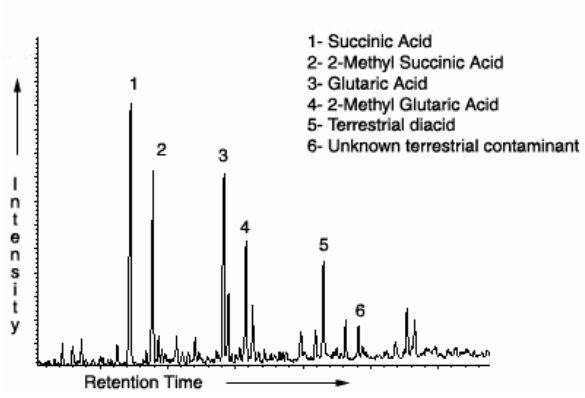

Figure 1- GCMS chromatogram of the dicarboxylic fraction of the ALH 85013.50 CM chondrite.

	Measured $\delta^{13}C$ (‰)	Corrected $\delta^{13}C$ (‰)	σ
Succinic Acid	-9	25.1	0.9
2-Methyl succinic Acid	-15.5	3.94	0.5
Glutaric Acid	-6.6	23.52	0.6
2-Methyl glutaric Acid	-2.1	27.5	0.6
5	-28.1		1.8
6	-25.1		0.9

Table 1- Measured and corrected values for extraterrestrial dicarboxylic acids. Also, measured values for terrestrial compounds.

Conclusions: Compound specific isotope analysis, both $\delta^{13}C$ and δD, is a crucial tool for identifying individual extraterrestrial compounds from terrestrial compounds present in meteoritic extracts. Because of this molecular resolution, the technique allows us to study even the most terrestrially exposed meteorites. The study of organic compounds on meteorites has long been focused on the study of the Murchison meteorite, and other stones like it, because they were fresh falls which were exposed to the Earth's conditions for a short while and stored in low-contaminant environments. However, compound specific isotope analysis now allows the study of any carbonaceous chondrite. With the rapidly growing collection of Antarctic meteorites, there are orders of magnitude more stones available for molecular and compound-specific isotopic analysis. New information on organic composition, synthetic pathways and implications for the origin of life will be revealed by the study of carbonaceous chondrites using combined molecular and isotopic studies.

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