IR REFLECTANCE SPECTRA OF ANTARCTIC CARBONACEOUS CHONDRITES TO BETTER CHARACTERIZE THE SURFACES OF ASTEROIDS TARGETTED BY SAMPLE RETURN MISSIONS.

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Introduction: Undifferentiated carbonaceous asteroids have experienced complex collisional histories, and a significant number are fragments of larger bodies. Meteorites arrived from these asteroids exhibit an amazing reflectance spectra diversity [1-3]. These asteroids are now in the focus of several sample return missions due to the astrobiological relevance of their exploration [4, 5]. In meteorite collections the rocks delivered from these fascinating asteroids are called carbonaceous chondrites (hereafter CCs). Impacts on these asteroids mixed together materials with different compositions and alteration histories. Due to their low bulk densities and porous nature the collisions with other bodies resulted in heavy fragmentation and brecciation of their surfaces. In fact, it is now being recognized that most of the identified CCs in terrestrial collections are breccias characterized by having clasts of different lithologies [6]. Carbonaceous asteroids delivered to the NEO region by dynamic resonances, as the selected targets of Marco Polo-R and Osiris-Rex missions, cannot be considered an exception. They evolved through the Main Belt as a consequence of non-gravitational effects, and in their long journey until becoming a NEO could have experienced space weathering processes changing significantly their reflectance properties. Chemical evidence indicates that the number of carbonaceous asteroids sampled is lower than twenty. Among them, some are represented by ungrouped and extremely rare CCs that are only available thanks to the Antarctic recovery effort made by different teams during the last decades. Due to this we have started a project to increase the number of high resolution reflectance spectra of CCs, with three main goals: 1) To identify the main features that could be used for remote characterization of their parent bodies; 2) To analyze the relevance of grain size in the reflectance spectra and exemplify its influence in regolith-covered carbonaceous asteroids, and 3) To perform experiments to simulate space weathering processes and their influence in the reflectance properties of primitive bodies.

Technical procedure: We have analyzed pristine carbonaceous chondrites from the Antarctic meteorite collection of NASA. So far we have received chips and thin sections that we are characterysing using different spectrometers from UV to IR. Here we discuss only the IR analyses. Small chips of each meteorite were grinded using an agata mortar. Powders were carefully located in between a diamond detector of a Smart Orbit ATR (Attenuated Total Reflectance) IR spectrometer. This instrument provides high resolution internal reflection spectra of meteorite powders following standard procedures [7].

Preliminary results and discussion: Significant differences in the reflectance spectra of CCs reflects a large compositional diversity. CC groups exhibit different components and distinctive abundance ratios. Chondrules are the most abundant ingredients, but they vary in average size and proportions, such as the Ca-Al rich inclusions (CAIs) and other refractory oxides [8]. Metal grain abundances are also highly variable from being almost absent to ubiquitous depending of the chondrite group, and their presence inside the chondrules or in the matrix has direct implications to reflectance. For instance, the abundance of metal grains is probably the reason for the uniformly red-sloped spectra of CRs. To complicate even more the interpretation, some water rich groups, (e.g. the CMs) exhibit secondary minerals formed by precipitation from a fluid. To exemplify the complexity and heterogeneity of aqueous alteration, we know that the mobilization of soluble elements by water was a local process in CMs. Probably the availability of heat and/or water was depth dependent. In consequence, reflectance spectra of CM exhibit different degrees of aqueous alteration and the extent of aqueous products is highly variable (Fig. 1). Each chondrite group exhibits distinctive absorption bands that support the notion that secondary variations in mineralogy have deep influence in the meteorite reflectance. CO, CH and CK reflectance spectra are plotted in Fig. 2.

Conclusions: IR reflectance spectra of CCs are presented. Detailed spectra were obtained for specimens belonging to the CM, CO, CH, and CK groups. Characteristic absorption bands of silicates and phyllosilicates dominate the spectra. Interestingly, for the CM several OH absorption bands characteristic of phyllosilicates exhibit different depths in agreement with previous studies using IR micro-spectroscopy [9]. The variable depth in OH bands exhibited by some of the selected CMs is probably consequence of the degree of aqueous alteration [10, 11]. Interestingly, we note that a couple of CMs (QUE99038 and PRE 95404) exhibit a CO-like spectra. These results are encouraging as a careful identification of absorption features and the location and relative depth of OH bands (e.g. features around 10, 17, 20 and 26 μm) could be used to distinguish pristine regions in the surface of targets selected for future spacecraft missions.

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References:

[1] Cloutis E.A. et al. (2011) Icarus 212, 180-209. [2] Cloutis E.A. et al. (2011) Icarus 216, 309-346. [3] Cloutis E.A. et al. (2012) Icarus 217, 389-407. [4] Lauretta D. et al. (2010) *Met. Plan. Sci.,* id. 5153. [5] Barucci A. et al. (2011) Experimental Astronomy, DOI: 10.1007/s10686-011-9231-8 [6] Bischoff A. et al. (2006) MESS II, 679-712, Univ. of Arizona, Tucson. [7] Thermo Fisher Scientific (2010), ATR handbook, WI, USA. [8] Rubin A. (1989) *Meteoritics* 24, 179-189. [9] Beck P. (2010) *GCA* 74, 4881-4892. [10] Rubin A. et al. (2007) *GCA* 71, 2361-2382. [11] Trigo-Rodríguez J.M. et al (2006) *GCA* 70, 1271-1290.

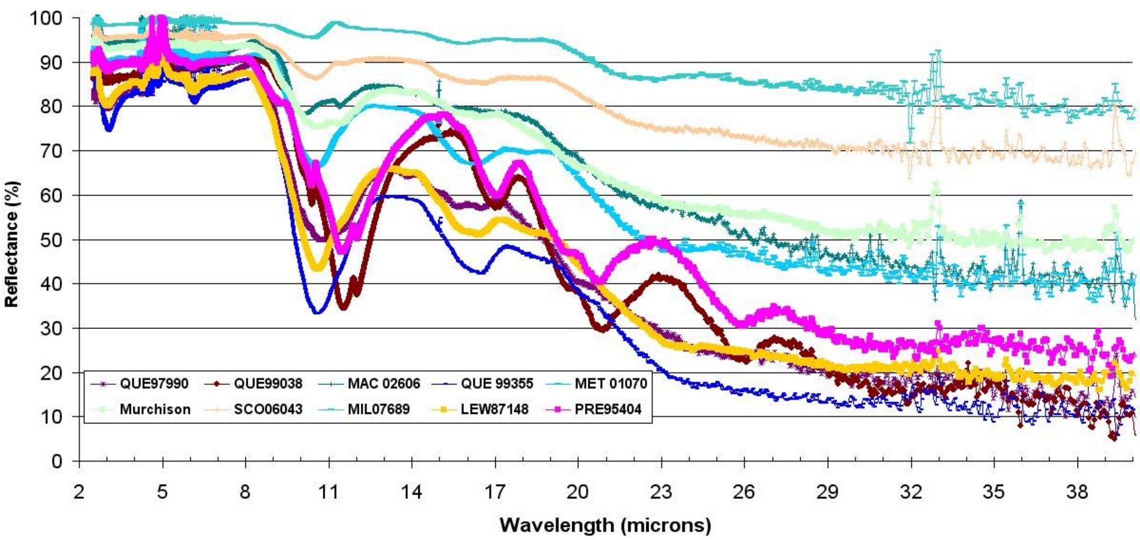

Figure 1. IR spectra of CM carbonaceous chondrites analyzed in this study.

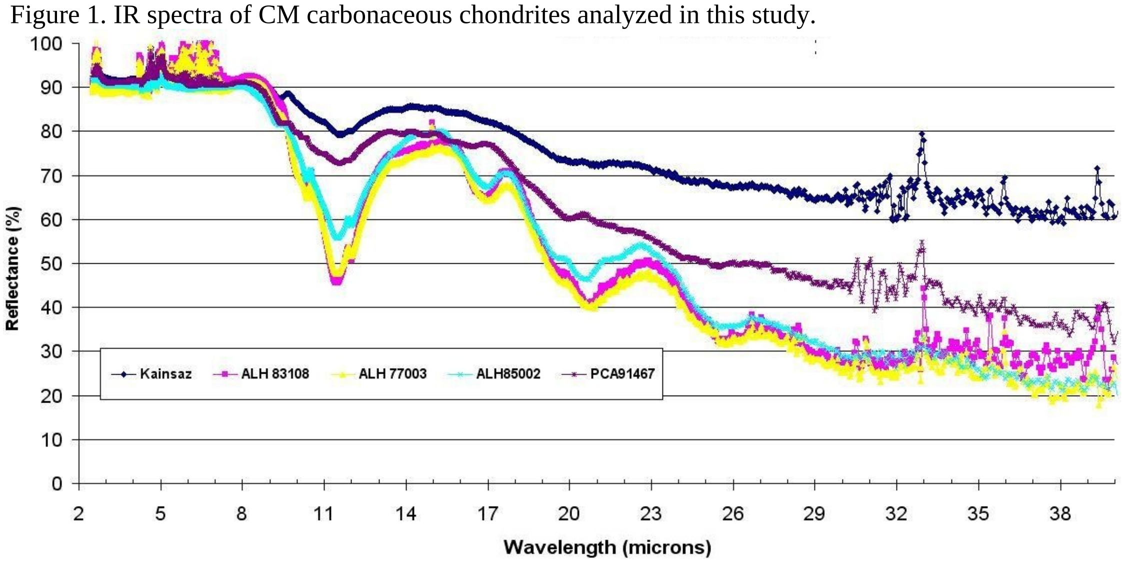

Figure 2. IR spectra of CO, CH and CK carbonaceous chondrites analyzed here. Kainsaz, ALH83108, and ALHA77003 are CO3 chondrites. ALH 85002 and PCA 91467 are CK4 and CH3 chondrites respectively.