UV-NIR SPECTRA OF THE MOST REFLECTIVE CARBONACEOUS CHONDRITE GROUPS: CH, CR AND R

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INTRODUCTION

Reflectance spectra of primitive asteroids provide valuable information on the surface mineralogy, and clues on the plausible evolution of these objects. Narrow-band spectrophoto-metry programs for the study of asteroids were initiated in the 1960s [1], which allowed the identification of absorption bands in the UV and visible windows. Such features were used later on to develop the first asteroid taxonomy [2].

Laboratory studies of meteorite reflectances give key clues to remotely characterize primitive carbonaceous asteroids from the Main Belt or NEO populations. Most of the km-sized asteroids that are forming part of the NEO population are fragments of larger objects that experienced collisional or tidal disruptions during early stages of their past [2].

The carbonaceous chondrites (hereafter CCs) are samples arrived from these undifferentiated bodies that arrive naturally to Earth mainly through dynamical mechanisms associated with orbital resonances [3]. Among the 13 currently recognized chondrite groups [4], most contain dark matrix that significantly decreases the overall reflectivity of these materials in the UV to NIR region [5-7]. Consequently, the asteroids associated with those dark chondrite groups are among the darkest solar system materials with geometric albedos well below 0.1. It is commonly said that undifferentiated meteorites should be dark, but a few CC groups are not fitting such description. We focus this abstract in the CH, CR, and R groups, also primitive but with the highest reflectance found in CCs.

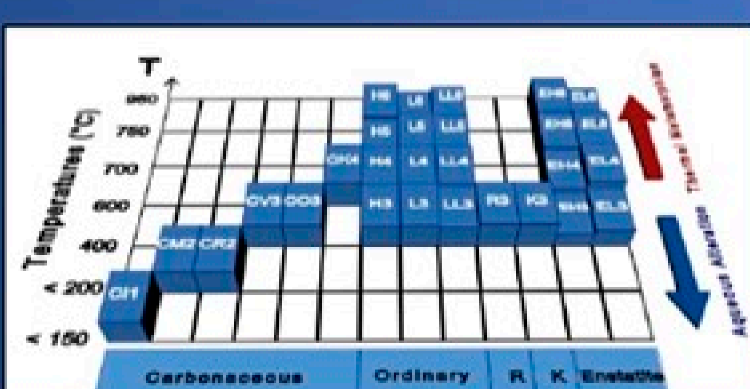

Figure 1: Petrologic types are defined by two main processes: thermal metamorphism, and aqueous alteration [8].

TECHNICAL PROCEDURE

We are currently analyzing pristine carbonaceous chondrites from the Antarctic meteorite collection of NASA. Here we compile a representative number of them, belonging to the CH, CR, and R CC groups. We have used a Shimadzu UV3600 UV-Vis-NIR spectrometer to obtain the reflectance spectra of the meteorite sections listed in Figure 1. The standard stage for the spectrometer is an Intregrating Sphere (ISR) with a working range of 200 to 2,600 nm. The sample beam interacts with the sample at a phase angle of 8º. For calibration of the detector a standard baseline was created using a conventional $BaSO_4$ substrate. The area sampled during the measurements correspond to a slot of 2x1 cm2.

RESULTS AND DISCUSSION

The UV-NIR spectra obtained for the samples discussed here (Fig. 2) are shown in Figure 3. CR and R spectra exhibit the characteristic red-sloped spectra going from about 5 to 20% maximum reflectance. These groups don't exhibit the absorption band in the 650 nm region characteristic of CMs attributable to Fe^{3+}-Fe^{2+} charge transfers as noted previously [6]. It suggests that CMs are richer in Fe^{3+} phyllosilicates and aqueous alteration was probably weaker in CRs. By studying the sections at the petrographic microscope and SEM we noticed that the largest reflectance of CR, R, and CHs compared to other chondrite groups is due to their major abundances of metal grains in volume. However, the relationship is not lineal as, for example, CR chondrites have a significant fraction of the metal inside chondrules while CH ones have them in the matrix (Fig. 4). We expect chondrules not to be perfectly cut by space weathering processes and consequently metal grains inside of chondrules are not contributing so much as they were in the matrix.

Meteorite	CC group /petrol. type	Weathering grade	Year of find
EET 92159	CR 2	B/C	1992
GRA 95229	CR 2	A	1995
LAP 02342	CR 2	A/B	2002
PCA 91467	CH 3	B/C	1991
PRE 95404	R3	A	1995

Figure 2: Table showing the Antarctic chondrites discussed in this work

CR, CH and CB chondrites are considered primitive meteorites forming a grouplet sharing similar characteristics and being particularly rich in metal [4]. The metal content was estimated to be respectively 5-8, 20, and 60-80 in vol.% for the above mentioned chondrite groups [4,9]. We have not included in the discussion here the CBs as they are probably formed by impact, but we have also measured the reflectivity of some CB members, ranging from 30% in the UV to about 60% in NIR. Due to the biased number of naturally sampled CCs arrived to Earth and the observed variability in their reflectance properties, our preliminary results points towards the existence of a continuous in the reflectivity of primitive asteroids as a function of their variable metal content. An example could be the recently visited by Rosetta spacecraft asteroid 21 Lutetia that we have recently identified as presumable parent body of CH chondrites [10]. We reached such temptative conclusion by comparing the reflectance spectra of 21 Lutetia with PCA 91467 a CH3 chondrite. We think that the CH chondrites are good candidates to be sampled from this asteroid, as they are primitive in composition, and enough rich in metal to explain most of their intriguing reflectance properties [11].

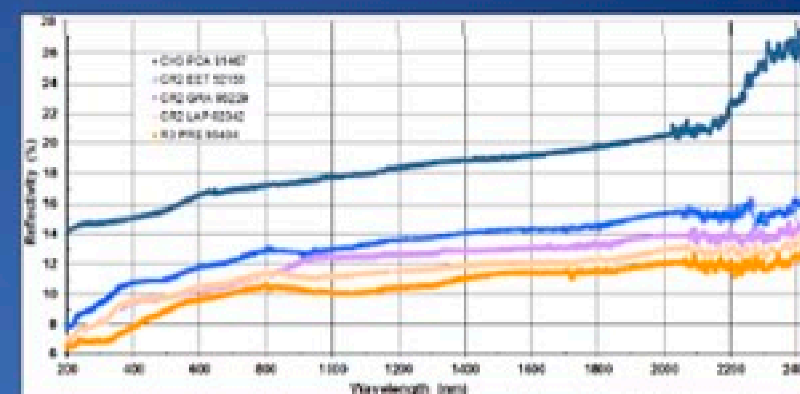

Figure 3: UV-NIR spectra of CH, CR, and R carbonaceous chondrites. A higher abundance in pyroxene-rich chondrules in the CHs is the likely origin of the NIR increase in reflectivity from 2.200 nm upwards [4].

CONCLUSIONS

Our results clearly demonstrate that some CC groups exhibit high reflectivity in the UV to NIR window. The main reason for such peculiarity is a progressive increase in the abundance of metal grains present in R, CR, and CH chondrites. We think that this result is quite relevant for future characterization of undifferentiated asteroids as the body primitivity is not directly associated with exhibiting a low albedo or an overall low reflective spectra.

Figure 4: A 1 mm2 window of three of the chondrites discussed here exhibiting increasing amounts of metal in this Zeiss petrographic microscope reflectance image: a) GRA 95229, b) EET 92159, and c) PCA 91467.

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