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21 Lutetia as the likely parent body of CH chondrites

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Abstract

The reflectance spectra of the different groups of carbonaceous chondrites (hereafter CCs) reflects a large compositional diversity. CC groups exhibit different components and distinctive abundance ratios that are the main reasons for a large spectral diversity [1, 2]. A precise visible reflectance spectra of asteroid 21 Lutetia was recently obtained by VIRTIS spectrometer on board the Rosetta (ESA) spacecraft [3]. All collected evidence suggests that 21 Lutetia is a primitive asteroid, but exhibiting far higher reflectance than the measured for the most common groups of CCs [3, 4]. In any case, Rosetta data can be compared with our recently taken laboratory spectra of rare CC groups from the NASA Antarctic collection. As a result we have found an excellent candidate to fit that reflectance pattern in the CH group of carbonaceous chondrites. We exemplify that presenting the UV to nIR spectrum of one of the most pristine CHs available in our collections: PCA 91467.

1. Introduction

Narrow-band spectrophotometry programs for the study of asteroids were initiated in the 1960s [5], which were able to identify clear absorption bands in the UV and visible, that were used later on in order to develop the first asteroid taxonomy [6]. Laboratory studies of meteorite reflectances give key clues to remotely characterize primitive carbonaceous asteroids from the Main Belt or NEO populations. It is also the best way to know the main sources of primitive meteorites Taking into account the parent bodies of primitive meteorites arriving to Earth. associate Reflectance spectra of CCs are dominated by their most abundant components. Chondrules vary in average size and proportions in each group, such as the Ca-Al rich inclusions (CAIs), other refractory oxides, and opaques. Metal grain abundances are also highly variable in CCs 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.

2. Procedure and experimental setup

A Shimadzu UV3600 UV-Vis-NIR spectrometer was used to get the reflectance of the meteorite sections. The standard stage for the spectrometer is an Integrating Sphere (ISR) with a working range of 200 to 2,600 nm. The spectrometer uses multiple lamps, detectors and diffraction grates to work over a wide range of wavelengths. The sample beam interacts with the sample at a phase angle of 8º. The reference beam interacts with the reference material and then goes to the same detector. 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 2×1 cm^2. More details were given in [7].

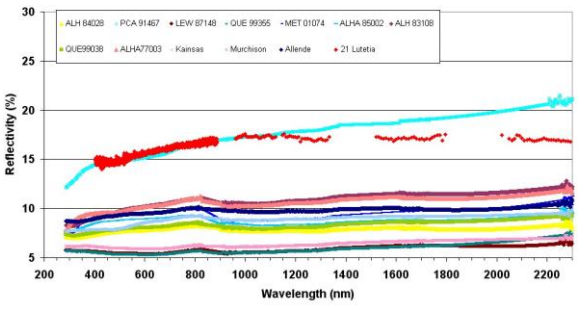

Figure 1: 21 Lutetia reflectivity compared with the measured for PCA 91467 (CH3) and several members of other CC groups. Note that the visible part of 21 Lutetia spectrum was obtained from ground based observations.

3. Discussion

In Fig. 1 Lutetia spectra was normalized for having a 1,000 nm similar reflectivity than PCA91467. It fits well with the picture that 21 Lutetia geometric albedo in the visible was ~19%. Both spectra are comparable because our meteorite reflectance measurements, performed at 8º of phase angle, are close to the 0º given by definition for Lutetia's derived albedo. However, it underestimates a little bit the reflectance of the asteroid in the 400 to 900 nm range, also supporting polarimetric results. The higher measured reflectance for PCA91467 after 1,400 nm is probably consequence of being a fresh section not affected by space weathering as is the case of Lutetia's surface. The abundance of metal grains in the matrix of CHs is the main reason for their higher reflectance compared with other CCs groups. Consequently, despite that other people has claimed for an enstatite nature for 21 Lutetia [8], our results clearly show that the CH carbonaceous chondrites are far better candidates to sample this asteroid. They are primitive in composition, and rich in metal so they can explain many of the fascinating properties of 21 Lutetia [9].

4. Summary and Conclusions

CH chondrites exhibit reflectance and mineralogical properties that suggest an origin in asteroid 21 Lutetia. CH chondrites are far more reflective than any other CC primitive groups due to the abundance of metal grains in their matrix.

Acknowledgements

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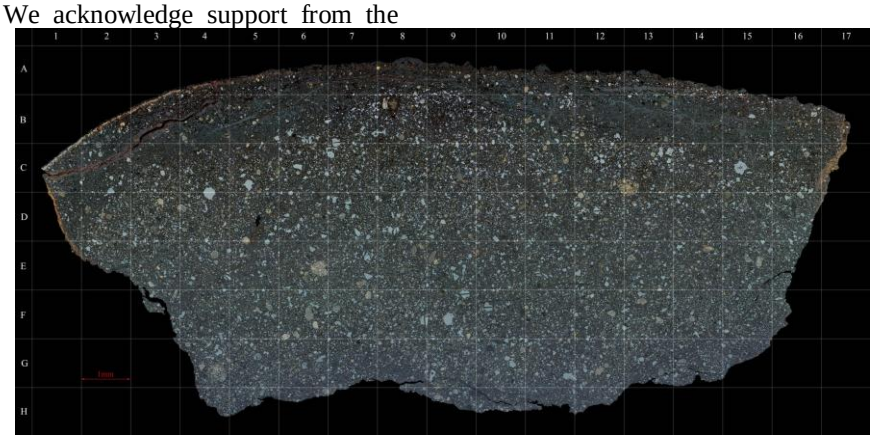

Figure 2. A mosaic of PCA 91467 section built from reflected light images taken with a Zeiss Scope petrographic microscope. Light blue inclusions are metal grains. The grid is 1 mm wide.