INVESTIGATING THE LINK BETWEEN CARBONACEOUS AND ORDINARY CHONDRITES AND THEIR ASTEROIDAL PARENT BODIES.

J. Eschrig, L. Bonal, P. Beck, T. J. Prestgard - Institut de Planétologie et d'Astrophysique de Grenoble – Université Grenoble Alpes, CNRS (Grenoble - France) (jolantha.eschrig@univ-grenoble-alpes.fr)

Introduction: Reflectance spectroscopy is currently the only measuring method for the remote characterization of asteroidal bodies besides the characterization in laboratory of asteroidal samples collected through space missions. It is thus important to improve the understanding we have of the different spectral features observed in the asteroidal reflectance spectra. As these features are generally very faint [e.g., 1] in the 0.45 - 2.45 µm spectral region, this task becomes increasingly difficult. Analyzing the reflectance spectra acquired for different carbonaceous and ordinary chondrite types in the laboratory allows to further interpret the asteroidal spectra and establish some genetic links between meteorites and asteroids. This has been the subject of several papers in the past [e.g., 2]. Here we are taking advantage of a new spectro-radio goniometer available at IPAG [3] to measure a large set of samples with a well-constrained post-accretion history. Measurements under vacuum and at 80°C significantly improve the quality of the spectra. Our objectives are to *(i)* further our understanding of spectral features, *(ii)* understand if some are controlled by secondary processes such as thermal metamorphism, and *(iii)* establish some genetic link between asteroids and carbonaceous chondrites, that are in some cases only very faint.

Samples and Methods: In this work a total of 21 CV chondrites, 16 CO chondrites, 4 CR chondrites and 15 ordinary chondrites are measured with the SHADOWS instrument [3]. The measurements were done on powdered bulk material in the 0.4 – 4.2 µm spectral region, at 80°C and under vacuum ($P < 10^{-4}$ mbar). The selected samples feature a wide range of metamorphic grades, that were previously determined through Raman spectroscopy [4]. A set of well-defined spectral properties, including absorption band depths, positions and spectral slopes, are considered following previous works [e.g., 2] to describe the individual whole-rock reflectance spectra. Additionally, 12 mean reflectance spectra from the asteroidal belt [1] of the types A, K, L, O, Q, R, S, Sa, Sq, Sr, Sv, and V, 24 EOS family member spectra [5] and 8 CK chondrites (RELAB database (http://www.planetary.brown.edu/relab/)) were treated in the same way as the other chondrites and added for comparison purposes.

Results and Discussion: Generally, a large variability in the reflectance spectra of samples of the same chondrite group is observed. Nevertheless, there are clear differences in the reflectance spectra of different chondrite groups. Ordinary chondrites systematically exhibit deeper absorption features which are located at lower wavelengths in comparison to carbonaceous chondrites. Type 2 CR chondrites exhibit 1000 nm absorption features at even lower wavelengths than ordinary chondrites, thus clearly separating them from type 3 chondrites. On the other hand, independent of the spectral features, CO and CV chondrites do not plot appart which is not that surprising due to their comparable mineralogical composition [6]. Several spectral features appear to be controlled by the metamorphic grade of the samples. The depth of the 1000 nm absorption band becomes deeper with increasing metamorphic grade for CV chondrites. This was not previously observed [2] which might be related to the much higher number of CV chondrites considered here. To be noted, this correlation is not observed for the other chondrite groups. For CO chondrites the visual slope defined in the 340 to 520 nm wavelength range becomes steeper with bluer overall spectral slopes. Moreover, the visual slope seems to be linked to the peak reflectance value in the visible wavelength range located at approximately 700 nm and the 2000 nm absorption band feature. With increasing visual slope, the peak reflectance in the visible becomes higher and the 2000 nm absorption feature becomes deeper. Moreover, for CO chondrites, the 2000 nm absorption feature becomes deeper with increasing metamorphic grade of the samples. For ordinary chondrites, the visual slope becomes less steep with increasing metamorphic grade. Interestingly, two specific trends are observed for ordinary chondrites. The cause of this dichotomy is not understood yet, however, it does not seem to be related to the metal content in the sample or the weathering degree.

The comparison of spectral features of asteroids and chondrites led to a good match for a few of them. S-type asteroids have similar 1000 nm and 2000 nm absorption band depths as ordinary chondrite samples. This is expected [7], and validates our approach. The parent bodies of CK and CV/CO chondrites have previously been suspected to be K-type asteroids, particularly EOS family members [e.g. 8]. This genetic affiliation is confirmed here by our data for CK chondrites which exhibit similar 1000 nm and 2000 nm absorption features as K-type asteroids. For CO/CV chondrites the absorption band depths and 1000nm absorption band position match those of the EOS family but also those of L-type asteroids.

References: [1] DeMeo F. E. et al. (2009) *Icarus* 202: 160-180. [2] Cloutis E. A. et al. (2012) *Icarus* 221: 328 – 358. [3] Potin et al. (2018) *Applied Optics* 57 : 8279-8296. [4] Bonal L. et al. (2016) *Geochimica et Cosmochimica Acta* 189: 312–337. [5] Monthé-Diniz T. et al. (2008) *Icarus* 195 : 277-294. [6] Krot A. N. et al. (2014) *Classification of Meteorites and Their Genetic Relationships*, pages 1–63. [7] Nakamura T. et al. (2011) *Science* 333: 1113–1116. [8] Clark B. E. et al. (2009) *Icarus* 202 : 119-133.