EPSC Abstracts
Vol. 7 EPSC2012-192-1 2012
European Planetary Science Congress 2012

IR reflectance spectra of pristine Antarctic CM chondrites to characterize Marco Polo-R mission target

J. M. Trigo-Rodríguez (1), C.E. Moyano-Cambero (1), J.Llorca (2), J. Alonso-Azcárate (3), S. Fornasier (4), I. Belskaya (4), R. Binzel (5), and A. S. Rivkin (6). (1) Institute of Space Sciences (CSIC-IEEC), Campus UAB, Facultat de Ciències, 08193 Bellaterra (Barcelona), Spain, (trigo@ice.csic.es / Fax: +34-935814363), (2) Institut de Tècniques Energètiques i Centre de Recerca en Nanoenginyeria. Universitat Politècnica de Catalunya, Diagonal 647, ETSEIB. Barcelona, Spain., (3) Universidad de Castilla-La Mancha, Campus Fábrica de Armas, 45071 Toledo, Spain., (4) LESIA, Observatoire de Paris, 5 Place Jules Janssen, 92195 Meudon, France., (5) Department of Earth, Atmospheric, and Planetary Sciences, Massachuseeetts Institute of Technology, Cambridge, MA, USA., (6) John Hopkins University Applied Physics Laboratory, Laurel, MD, USA.

Abstract

The hydrated groups of carbonaceous chondrites (hereafter CCs) exhibit different degrees of aqueous alteration. Primary minerals were transformed in their parent bodies by the action of the water. Most of the water was probably accreted as ice or bounded in hydrated minerals. Moderate heating associated with residual radioactivity or collisional compaction released that water to soak temporarily the materials forming these asteroids. Evidence for static and dynamic aqueous mineral products has been described [1, 2], at the same time that the different degrees of alteration exhibited for members of the CM group were characterized [3, 4]. We apply here a new IR spectroscopic technique that allows to assess the amount of adsorbed water present in minerals forming carbonaceous chondrites.

1. Introduction

Mid-IR spectra of primitive asteroids provide valuable information on the surface mineralogy of these fascinating objects [5]. Most of the km-sized asteroids that are forming part of the NEO population are fragments of larger objects that experienced collisional or tidal disruption in late stages of their past. An example is probably the binary asteroid 1996FG3 that is the current target of Marco Polo-R mission [5, 6]. The CM chondrites are meteorites exhibiting different degrees of aqueous alteration [3]. It is probably consequence of the different availability of water in their parent asteroid. We previously proposed that such differences could have been originated at different burial depths in the progenitor asteroid [3]. In such a picture every CM chondrite could sample a different region. Reflectance spectra of CMs are dominated by their aqueously altered minerals. Glassy chondrules are transformed into phyllosilicates, while metal grains are transformed into troilite and pentlandite [7], and other secondary aqueous phases participate as opaques. The variability and extent of all these chemical transformations in the components and the matrix of CM chondrites are the reasons for their astonishing reflectance diversity.

2. Experimental setup

We have analyzed pristine carbonaceous chondrites from the Antarctic meteorite collection of NASA. Here we compile a representative number of them, belonging to the CM group. Small chips of each meteorite were grinded using an agate 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.

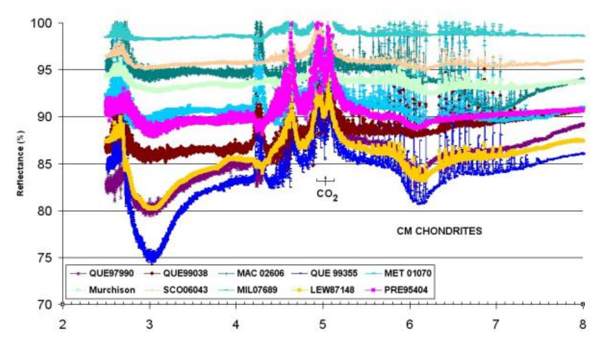

Figure 1: ATR spectra of the sample of CM chondrites analyzed by our team showing the main absorption bands in mid-IR.

3. Discussion

In Fig. 1 are plotted 9 Antarctic CM chondrites together with Murchison that, due to its availability, is usually considered a reference. Aqueous alteration seems to be directly associated with meteorite reflectance. Note for example that the less reflective LEW 87148, QUE 97990, and QUE 99355 are also exhibiting the deepest water absorption bands. For example, the 3 μm OH band was identified in the IR spectrum of 1996FG3 that is the current target of Marco Polo-R mission (see e.g. Fig. 1 in ref. [8]). The band was also identified in other NEO: 1992 UY4 [8]. The most representative bands and features identified are listed in Table 1, where some are associated with water and organics' bonds (Fig. 1).

4. Summary and Conclusions

IR Attenuated Total Reflectance spectra of 10 CM carbonaceous chondrites are presented. We have found that CM chondrites exhibit a significant reflectance diversity as consequence of different degrees of aqueous alteration. At the same time, some distinguishable features found in mid IR could be used to remotely characterize the surface of primitive C-type asteroids.

Acknowledgements

We thank NASA Meteorite Working Group for providing the Antarctic CCs. We acknowledge support from the Spanish Ministry (project AYA2011-26522) and CSIC (grant #201050I043).

References

[1] Hanowski, N.P. and Brearley, A.J.Iron-rich aureoles in the CM carbonaceous chondrites, Meteorit. Planet. Sci. 35, pp. 1291-1308, 2000.

[2] Trigo-Rodríguez, J.M. and Rubin, A.E. Evidence for parent-body aqueous flow in the MET 01070 CM carbonaceous chondrite. LPS XXXVII, Lunar & Planetary Institute, abstract #1104, 2006.

[3] Rubin, A., Trigo-Rodríguez, J.M., Huber, H. et al. Progressive aqueous alteration of CM carbonaceous chondrites, Geoch. Cosm. Acta 71, pp. 2361-2382, 2007.

[4] Trigo-Rodríguez, J.M., Rubin, A.E., and Wasson J.T. Non-nebular origin of dark mantles around chondrules and inclusions in CM chondrites, Geoch. Cosm. Acta 70, pp. 1271-1290, 2006.

[5] Barucci, M.A., Cheng, A.F., Benner, M.P. et al. Marco Polo-R near Earth asteroid sample return mission. Experim. Astron. 33, pp. 645-684, 2012.

[6] de León, J. et al. New observations of asteroid (175706) 1996 FG3, primary target of the ESA Marco Polo-R mission, Astron. Astrophys. 530, L12, 2011.

[7] Brearley, A.J., and Jones R.H. Chondritic meteorites, In *Planetary Materials*, J.J. Papike (ed.), Rev. Mineralogy #36, Mineralogical Society of America, pp. 3-1 to 3-398, 1998.

[8] Rivkin, A.S., Howell, E.S., DeMeo, F.E. et al. New Observations and Proposed Meteorite Analogs of the MarcoPolo-R Target Asteroid (175706) 1996 FG3. LPS XLIII, Lunar & Planetary Institute, abstract #1537, 2012.

Mineral or feature	**λ (cm^{-1})**	**λ(μm)**	**Notes**
OH stretching hydroxyl groups	3,450	2.9	Montmorillonite, smectite, etc…
CH stretch band	3,000	3.3	Organics
CC double bond stretch	1,650	6.1	Organics, distinctive in CMs.
CH_2 & CH_3 bend bands	1,450 & 1,400	6.9 & 7.1	Organics, distinctive in CMs
Al/Si-OH libration bands	930-950	10.8-10.5	Variable location
Peroxo groups (O-O)	~865	~11.6	Evident in some CMs
Al-O and Si-O, out of plane	~610	~16.4	Variable location

Table 1. Main distinctive features of the IR spectra of CM carbonaceous chondrites.