INVESTIGATION OF THE HYDRATION FEATURES OF ASTEROIDS WITH CARBONACEOUS CHONDRITES: EXPERIMENTAL ANALYSIS AND COMPARISON WITH ASTRONOMICAL OBSERVATIONS.

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Introduction: C-complex asteroids make for 2/3 of the total mass of the Main Belt Asteroids (MBAs) and their low reflectance value suggest a primitive composition, rich in carbon and volatiles elements [1].Two space missions are currently orbiting C-complex Near-Earth Asteroids (NEAs): OSIRIS-REx around (101955) Bennu [2] and Hayabusa2 around (162173) Ryugu [3]. While 50% of C-complex MBAs show signs of hydration features in their reflectance spectra [4], such hydration bands are detected on only a few percents of NEAs [5]. All small Solar System bodies have experienced heating in their lifetime [6] and temperature on the surface of NEAs is generally higher than MBAs because of their closer distance to the Sun [7]. We focus here on laboratory investigation of the effect of heating on the reflectance spectra of carbonaceous chondrites. Our results will be compared to telescopic observations of C-complex MBAs and NEAs.

Samples and methods: 13 carbonaceous chondrites (10 CM, 1 CR, 1 CV and 1 CI) have been selected for the experiment given their type and petrographic grade. After manual powdering, each sample is set in an environmental chamber and put under secondary vacuum to remove the adsorbed molecular atmospheric water. Reflectance spectra from the visible to near-infrared [8] are acquired inside the cell under vacuum and at room temperature, before and after having heated the sample up to 250°C for 1.5 hour.

Results: It is observed that heating results in *(i)* reducing iron-related bands at 0.7 and 0.9µm, *(ii)* modifying the spectral slope, and *(iii)* reducing the amplitude and broadness of the -OH 2.7µm signature. The shape of the -OH band is also modified, changing from round to sharp. Interestingly, the most acqueously altered chondrites show the smallest variations of the 2.7µm band along heating. Spectral fitting is performed to separate the different components of the hydration band: -OH groups in hydrated minerals like phyllosilicates, and/or molecular water adsorbed and/or strongly trapped in minerals [9]. The model shows that the varying shape of the 2.7 µm band is due to the removal of the free and coordinated water, leaving the sharp unaltered phyllosilicates component to appear. A deepening of the organics feature around 3.4µm is also observed along heating of each considered chondrite. Raman spectroscopy of the initial and heated samples testifies of a reorganization of the polyaromatic carbonaceous matter with heating.

Comparison with telescopic observations: The 2.7µm bands obtained on the heated carbonaceous chondrites are compared to astronomical observations of C-complex asteroids from the Main Belt with the AKARI space telescope [10]. Reflectance spectra of the two NEAs Ryugu and Bennu are also compared to our measurements. The band center and amplitude are consistent between the measured meteorites spectra and the observations, but differences are found when comparing the broadness and sharpness of the 2.7µm band. This effect could be assigned to the short heating time imposed by our experiment, and effects of long-term heating are currently under study.

Conclusion: Hydration features on the reflectance spectra of laboratory thermally altered carbonaceous chondrites are consistent with astronomical observation of MBAs and NEAs, though the effect of long-term heating is still to be studied in the laboratory. The procedure of spectral fitting used on the meteorites spectra is currently being applied to asteroids observations, with the objective to distinguish the type of hydration on the surface of the small bodies.

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