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More ion irradiated meteorites: expanding the space weathering view of dark asteroids

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Abstract

We performed ion irradiation of dark meteorites as a simulation of slow solar wind irradiation of dark asteroid surfaces. As a follow-up of the reflectance spectroscopy study of several ion-irradiated carbonaceous chondrites from different petrologic groups (CO, CV, CM, CI, C2) [1], we performed new ion irradiation of CK, CR, and CM meteorites to test composition effects. The results of these experiments are used to support current sample return missions Hayabusa2/JAXA and OSIRIS-REx/NASA.

1. Introduction

Space weathering (SpWe) processes such as micrometeorite bombardment or solar wind ion irradiation produce changes on the surface of airless bodies, impeding us to decipher their composition from their spectra. In order to understand the influence of SpWe on primitive asteroids, we perform ion irradiation of carbonaceous chondrites (CCs) as a simulation of solar wind irradiation of C-complex asteroids. We focus on carbonaceous materials as Hayabusa2/JAXA and OSIRIS-REx/NASA are currently studying and will bring back to Earth samples from two objects within the C- and B-type populations respectively [2, 3].

We previously studied several types of CCs [1] as they span a wide range of albedos (from 2-5% for CI/CM to 15-18% for CV/CO), initial composition (matrix- or chondrules-rich) and did not suffer the same thermal history (aqueous alteration or metamorphism). We proposed new insights on the effects of SpWe on low albedo asteroids based on these experiments. In the visible and near-infrared range (0.45-2.50 µm), a dichotomy behavior was observed as the "brightest" samples showed spectral darkening and reddening after 40 keV He^+ irradiation while the "darkest" ones showed brightening and blueing. In the mid-infrared range (up to 12 µm), an hyperspectral imaging technique highlighted a general shift of bands towards longer wavelength for both hydrous and anhydrous compounds [4].

2. Method

To test further our space weathering model on carbonaceous material and in particular to elucidate the SpWe spectral effects on aqueously altered objects, we performed new ion irradiations.

We analyzed two other types of CCs: a CK4 (NWA 5515-1498) and a CR2 (EET 92159). Two CM having two different lithologies — one aqueously altered with Mg-rich phyllosilicates (MET 01070) and the other (QUE 97990) poorly altered and Fe-rich [5] — have also been irradiated. We used He^+ ions with flux ~10^{13} ions/cm^2/s, fluence up to 6.10^{16} ions/cm^2, and energy at 40 and 15 keV to investigate energy regimes. VISNIR reflectance spectra are acquired in situ under vacuum (INGMAR setup) while MIR imaging micro-spectroscopy is performed ex situ at room pressure and temperature (at the Synchrotron SOLEIL).

3. Results

Preliminary results in the VISNIR show that the CK follows the reddening/darkening trend like CO and CV, whereas both CM get brighter and bluer. The CR does not have strong spectral change upon irradiation. We will analyze the MIR spectra and present results at the time of the conference.

4. Summary and Conclusions

The irradiation of CCs, and in particular the hydrated ones, aims at understanding the SpWe effects observed on the surface of Ryugu and Bennu, both having spectral indications of hydrated minerals [6,7]. We performed spectral analyses in the range of the NIRS3 (Hayabusa2), OVIRS and OTES (OSIRIS-REx) instruments. We will discuss our

results in the context of the spectral interpretation of Ryugu and Bennu IR observations.

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References

[1] Lantz, C., Brunetto, R., Barucci, M.A., et al.: Ion irradiation of carbonaceous chondrites: A new view of space weathering on primitive asteroids, Icarus, 285, pp. 43-57, 2017.

[2] Watanabe, S., et al.: Hayabusa2 arrives at the carbonaceous asteroid 162173 Ryugu — A spinning topshaped rubble pile, Science, 364, pp. 268-272, 2019.

[3] Lauretta, D.S., et al.: The unexpected surface of asteroid (101955) Bennu, Nature, 568, pp. 55-60, 2019.

[4] Brunetto, R., Lantz, C., Dionnet, Z., et al.: Hyperspectral FTIR imaging of irradiated carbonaceous chondrites, Planetary and Space Science, 158, pp. 38-45, 2018.

[5] Garenne, A., Beck, P., Montes-Hernandez, G., et al.: The abundance and stability of "water" in type 1 and 2 carbonaceous chondrites (CI, CM and CR), Geochimica et Cosmochimica Acta, 137, pp. 93-112, 2014.

[6] Kitazato, K., et al.: The surface composition of asteroid 162173 Ryugu from Hayabusa2 near-infrared spectroscopy, Science, 364, pp. 272-275, 2019.

[7] Hamilton, V., et al.: Evidence for widespread hydrated minerals on asteroid (101955) Bennu, Nature Astronomy, 3, pp. 332-340, 2019.