EPSC Abstracts
Vol. 13, EPSC-DPS2019-1127-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

How do lunar space weathering effects and darkening agents affect the surface spectral properties of low albedo asteroids?

Faith Vilas and Amanda Hendrix
Planetary Science Institute, Arizona, US (fvilas@psi.edu)

Abstract

Ultraviolet (UV) C-complex asteroid studies of International Ultraviolet Explorer spectra are combined with spectra of main-belt C-complex asteroids obtained using the MMT 6.5-m telescope facility Blue Channel spectrograph, covering the 320- to- 640-nm wavelength range. These asteroids likely contain iron and phyllosilicates and vary in levels of aqueous alteration and space weathering. The results of our studies in the UV/blue spectral region address the questions (1) Are there UV/blue spectral attributes that suggest compositional information? (2) Can UV/blue data be used to discern space weathering effects on a C-complex asteroid's surface?

Introduction

During this past year, the two low-albedo - presumed primitive - near-Earth asteroids (162173) Ryugu and (101955) Bennu have been visited by the robotic space probes Hayabusa2 and Osiris Rex respectively [e.g., 1, 2]. To date, Ryugu has been sampled in preparation for returning materials to Earth; OREx is expected to obtain and return samples from Bennu. These are the first of the low-albedo asteroids to be sampled, and the orbiting space probes instrumentation show the surfaces to be dark containing aqueous alteration products, with rocky, rough surfaces [e.g., 1, 2]. Remote sensing, however, remains our primary means of studying the asteroid population of over 700,000 numbered objects. Future human exploration and utilization of primitive asteroids will be informed by both the results of these missions tied with the best Earth-based characterization we attain of similar-type asteroids. Our efforts probe the near-UV spectral range and couple the results with VNIR reflectance spectra of the low-albedo asteroids, in an effort to understand the processes affecting their compositions.

1. Data sets

We extend UV C-complex asteroid studies of International Ultraviolet Explorer spectra of 13 C-complex asteroids in the ~210- to- 320-nm wavelength range [3] to spectra of 6 main-belt C-complex asteroids (41, 54, 165, 253, 326, 3507) that were obtained using the MMT 6.5-m telescope facility Blue Channel spectrograph, covering the 320- to- 640-nm wavelength range. These asteroids likely contain iron and phyllosilicates and vary in levels of aqueous alteration, as well as space weathering due to exposure to ambient space. The results of our studies in the UV/blue spectral region address questions. Are there UV/blue spectral attributes that suggest compositional information, and are these coupled with VNIR information? Can UV/blue data be used to discern space weathering effects on a C-complex asteroid's surface?.

2. Spectral Differences

The UV dropoff is quite subdued for C-complex asteroid reflectance spectra compared to spectra of CI and CM meteorite types. The spectral absorption features identified in the VNIR of these asteroids are reduced in strength compared to laboratory spectra of terrestrial samples and meteorites. Carbon, iron sulfide, magnetite and other materials have been proposed as the darkening agent(s). Meteorites show evidence that the likely darkening agent present is iron sulfides. We also expect carbon (as graphite) to contribute to the composition of the C-complex asteroids. We note differences in the spectral properties at UV wavelengths for asteroids whose VNIR spectra appear the same at longer wavelengths. Significant differences in the absorption exist at

wavelengths lower than 400 nm; ground-based spectra sample part of this region. Separate work shows that the UV spectra potentially show the effects of increased carbon in the surface material [4].

3. Space weathering

We have shown that the effects of lunar-like (creation of SMFe) space weathering seen in the S-complex asteroids is evident in the UV/blue spectral region before it is apparent in the VNIR; this is an effect of the presence of iron in olivines [5, 6]. Our modeling supporting the S-complex research, based upon UV/blue observational data, suggests that the effect of adding small amounts of SMFe to particles from both a hypothetical mineral and a terrestrial basalt affects the reflectance at UV/blue wavelengths before the VNIR reddening and diminution of absorption features associated with space weathering [6]. Can space weathering be the root of the differences between C-complex asteroid and CI/CM meteorite reflectance spectra? Most CM2 carbonaceous chondrites have chondrules containing ~ 20 volume % olivines [e.g., 7]; no spectrum of the chondrule contents of CM2 meteorites has been obtained. We report our most recent results.

Acknowledgements

This research is supported by the SSERVI Center for Lunar and Asteroid Surface Science and SSERVI Toolbox for Research and Exploration.

References

[1] Sugita, S. et al.: The geomorphology, color, and thermal properties of Ryugu: Implications for parent-body processes. Science, Vol. 364, 252-252, 2019.

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

[3] Roettger, E. E., and Buratti, B. J.: Ultraviolet Spectra and Geometric Albedos of 45 Asteroids. Icarus, 112, 496, 1994.

[4] Hendrix, A. R., and Vilas, F.: Ultraviolet Characteristics of Low-Albedo Class Asteroids. LPSC 49th, 2845, 2018.

[5] Hendrix, A. R., and Vilas, F.: The Effects of Space Weathering at UV Wavelengths: S-Class Asteroids. AJ, 1396 – 1404, 2006.

[6] Vilas, F., and Hendrix, A. R.,: The UV/Blue Effects of Space Weathering Manifested in S-Complex Asteroids. I. Quantifying Change with Asteroid Age. AJ, 150, 64, 2015.

[7] Howard, K. T. et al.: Classification of hydrous meteorites (CR, CM and C2 ungrouped) by phyllosilicate fraction: PSD-XRD modal mineralogy and planetesimal environments. *GeochimCA*, 149, 206 – 222, 2015.