EPSC Abstracts
Vol. 13, EPSC-DPS2019-796-1, 2019
EPSC-DPS Joint Meeting 2019

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

Mapping spectral slopes across (101955) Bennu

E. S. Howell (1), A. A. Simon (2), D. C. Reuter (2), V. E. Hamilton (3), B. E. Clark (4), H. H. Kaplan (3) S. M. Ferrone (4), X. Zou (5), K. J. Walsh (3), J. P. Emery (6), R. P. Binzel (7), M. A. Barucci (8), D. S. Lauretta (1), and the OSIRIS-REx Team.
(1) University of Arizona, Tucson, AZ, USA. (ehowell@orex.lpl.arizona.edu) (2) Goddard Space Flight Center, Greenbelt, MD, USA. (3) Southwest Research Institute, Boulder, CO, USA (4) Ithaca College, Ithaca, NY, USA. (5) Planetary Science Institute, Tucson, AZ, USA. (6) University of Tennessee, Knoxville, TN, USA. (7) Massachusetts Institute of Technology, Boston, MA, USA. (8) LESIA, Observatoire de Paris, PSL Research University, CNRS, Univ. Paris Diderot, Sorbonne Paris Cité, Meudon, France.

Abstract

The OSIRIS-REx spacecraft has been measuring the spectral properties of (101955) Bennu since November 2018. The OSIRIS-REx Visible and InfraRed Spectrometer (OVIRS) [1,2] is collecting spectra between 0.4 and 4.0 microns of the entire surface at a spatial resolution of 14 to 20 m.

1. Introduction

Lauretta et al. [3] and Hamilton et al. [4] showed that the disk-averaged photometry and spectrum obtained during the Approach phase is consistent with colors and spectroscopy measured from the ground [5]. The visible to near-infrared spectral region (0.4–2.5 microns) has a negative (blue) slope that varies somewhat across the surface. The spatial resolution of the spectral data planned during the equatorial stations of Detailed Survey (May 2019) will be about 20 m. These data will allow us to explore the spectral appearance of different terrains. Hamilton et al. [4] showed that the majority of the composition of Bennu is hydrated silicates with some spectral signatures of magnetite. At the current spatial resolution of the spectrometers, spectral differences are only just beginning to become evident across the surface.

2. Near-infrared Spectral Slope

The near-infrared spectral slope may be indicative of composition, particle size, space weathering effects, or some combination of all of these. Binzel et al. [6] suggested that the equatorial ridge area was not as blue-sloped as the region at higher latitudes, but the data quality was poor because Bennu was very faint when they observed it. Our initial assessment based on Detailed Survey Baseball Diamond Flybys 1 and 3 (March 7 and 21, 2019 UT) supports a variation in spectral slopes across the surface, but not over as large a range as seen by Binzel et al. [6] (see Figure 1). The 1-sigma uncertainty in the slope determination is ±0.003. We see no statistical difference in the spectral slope within 20 degrees of the equator from the region above and below that region. There is some longitudinal variability that is different from the albedo distribution seen at visible wavelengths.

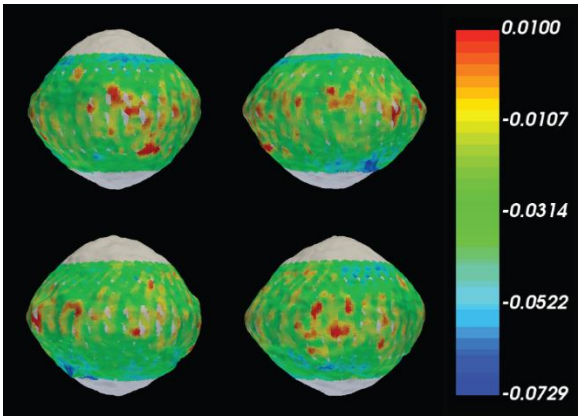

Figure 1: A map of the near-infrared spectral slope between 1 and 2 microns on Bennu. The center longitudes are 0, 90, 180 and 270 from top left to bottom right, respectively. The color scale bar ranges from slopes of -0.07 to +0.01 per micron, with a 1-sigma uncertainty of ±0.003. The blue slope is more prominent at higher latitudes between longitudes 0–40 and 220–360. The contrast is somewhat larger in the northern hemisphere than in the southern hemisphere, but nowhere is the slope as red as that seen by Binzel et al. [6] in 2012.

At the current resolution (~5 cm), the imaging does not indicate that the material near the equatorial ridge is noticeably finer-grained than at higher latitudes. The surface shows a variety of textures and local particle size distributions [7, 8], some of which are correlated

with albedo differences, but there is mixing at all size scales seen thus far. Presumably, the spectral slope in the 1- to 2-micron region would be strongly affected by micron-scale particles, if they exist. The spectral interpretation will become clearer as the data are combined at different local times of day to eliminate more of the geometric and thermal effects.

3. Summary and Conclusions

Upcoming spectral observations and higher-resolution imaging will lead to a better understanding of the distribution of the surface material properties on Bennu. The spectral properties along with thermal inertia and particle size distributions will help to differentiate between compositional, weathering, and other surface processes that can produce different spectral slopes. The tentative conclusion of Binzel et al. [6] that fine-grained material at the equator produces a dichotomy in the near-infrared spectral slope does not seem to be the most likely explanation at this time. This hypothesis was favored by Binzel et al. [6] to explain the color difference, but they suggest longitudinal variation as another possibility.

Acknowledgements

This material is based upon work supported by NASA under Contract NNM10AA11C issued through the New Frontiers Program.

References

[6] Binzel, R. P., et al.: Spectral slope variations for OSIRIS-REx target Asteroid (101955) Bennu: Possible evidence for a fine-grained regolith equatorial ridge, Icarus, 256, 22-29, 2015.

[5] Clark, B. E. et al.: Asteroid (101955) 1999 RQ36: Spectroscopy from 0.4 to 2.4 μm and meteorite analogs, Icarus, 216, 462-475, 2011.

[7] DellaGiustina, D. N., Emery, J. P., et al.: Properties of rubble-pile asteroid (101955) Bennu from OSIRIS-REx imaging and thermal analysis, Nature Astronomy, 3, 341-351.

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

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

[1] Reuter, D. C. et al.: The OSIRIS-REx Visible and InfraRed Spectrometer (OVIRS): Spectral maps of the asteroid Bennu, Space Science Reviews, 214, 54, 2018.

[2] Simon A. A. et al.: In-Flight Calibration and Performance of the OSIRIS-REx Visible and IR Spectrometer (OVIRS), Remote Sensing, 10, 1486, 2018.

[8] Walsh, K. J. et al.: Craters, boulders and regolith of (101955) Bennu indicative of an old and dynamic surface, Nature Geoscience, 12, 242-246, 2019.