Relationships Between Color & Morphology on Bennu

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Abstract

In September 2019, the OSIRIS-REx Camera Suite (OCAMS; Rizk et al., 2018) globally mapped asteroid (101955) Bennu in four broadband filters (b′, v, w, x) covering 0.44 to 0.89 microns. The multispectral images show complex relationships between color and morphology on Bennu's surface. These data indicate that Bennu's color has been influenced by primordial heterogeneity and space weathering.

Introduction

To evaluate relationships between color and morphology on Bennu, we radiometrically and photometrically corrected OCAMS images acquired by the MapCam instrument (Golish et al., 2020a, Golish et al., 2020b). Calibrated images were subsequently mosaicked to develop band-ratio and principal component analysis (PCA) maps. To establish statistically meaningful trends between color, reflectance, and morphological features, we mapped ~1600 boulders and ~700 craters, and extracted their average MapCam color indices.

Bennu's global average spectrum is blue (–1% per 0.1 μm) in MapCam data (0.44 to 0.89 μm), but spectral slopes can vary from blue (negative) to red (positive) at the meter scale. The diverse color and reflectance of boulders suggests primordial heterogeneity inherited from Bennu's

parent body and exogenic impactors (DellaGiustina and Kaplan et al., accepted). Spectral changes in craters as a function of radius indicate that color may also be influenced by space weathering on Bennu.

Boulders

On the basis of reflectance and color, we categorized Bennu's boulders into four types: 1) High-reflectance boulders (>4.9% normal albedo) are brighter than units having the average color of Bennu, texturally smooth, exhibit angular morphology, and have blue spectral slopes across the MapCam v to x bands. 2) Dark boulders (≤4.9% normal albedo) are subangular and have rougher, more undulating surface textures compared to the bright boulders. They encompass a wide range of sizes and include the largest boulders on the asteroid (25 to 100 m in diameter). 3) Boulders with very high reflectance (up to 0.26; ~1% in number) show evidence of an absorption at 1 μm (downturn in the x band). These boulders were spectroscopically identified to contain pyroxene using data acquired by the OSIRIS-REx Visible and InfraRed Spectrometer (OVIRS; Reuter et al., 2018). 4) About 2% of boulders surveyed have an absorption feature that is detectable above the radiometric uncertainty of OCAMS at 0.7 μm (absorption depth of 2 to 10%). This absorption has been observed in spectra of primitive asteroids and carbonaceous meteorites and has been attributed to the Fe^{2+}-Fe^{3+} intervalence charge transfer associated with hydrated clay-bearing phyllosilicates.

Craters

The color of the largest craters (>100 m) on Bennu is indistinguishable from that of the average terrain. However, many small (≤25 m) craters are redder than average across MapCam b′ to x filters, resulting in neutral to red spectral slopes. The size distribution of these small reddish craters implies that they are the youngest component of the global crater population.

References

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