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New Investigations of Colour Variation on Eros

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Abstract

The *Near Earth Asteroid Rendezvous* (NEAR) – Shoemaker mission performed an orbital investigation of the near-Earth asteroid 433 Eros from 2000-2001 [1] returning the first orbital images of an asteroid. While Eros harbours intriguing surface features, such as ponds [e.g. 2, 3] and boulders [2], it displayed seemingly few colour variations. The recent production of a high-resolution shape model for Eros has allowed us to re-examine color variations on the asteroid using photometrically corrected images from 5 of the colour bands. Our preliminary results indicate spectral variation both in the overall spectral shape, and also in the depth and location of the 1-μm mafic absorption feature, suggesting Eros may indeed hold more colour variations than initially recognized.

1. Introduction

The NEAR mission orbited the asteroid 433 Eros from 2000-2001 [1], and observed little evidence for colour variations, despite discovering a range of unusual geologic features [2, 3, 4]. The perception of colour blandness was reinforced by the limited spectral variation found in data from the NEAR Near-Infrared Spectrometer (NIS), which shows only very subtle variations in the centre or shape of the 1-μm (1000-nm) mafic mineral absorption band [e.g. 4]. However, the spatial resolution of the NIS footprints are quite large compared with the pixel dimensions of images obtained by the Multi-Spectral Imager (MSI), and thus the question of true colour variation on Eros is underexplored. A majority of previous MSI analyses only utilized two or three filters (primarily filters 1, 3, and 4, 550 nm, 760 nm, and 950 nm, respectively) [5, 6]. Therefore, there remains a set of unexplored colour data in the unexploited filters 5 and 6 (900 and 1000 nm), which we utilize in this analysis for a full five-band investigation.

2. Image Coregistration and Correction

R. Gaskell and colleagues have produced a high-resolution Eros shape model [7] using the technique of stereophotoclinometry [8]. We registered nearly all the MSI images of Eros to the Gaskell shape model, and produced a set of updated backplanes for geometric and geophysical parameters including incidence, emergence, and phase angles [9]. These backplanes allowed us to perform photometric normalization using the model of [10], adjusting the images to standard illumination and viewing conditions (incidence = phase = 30°, emergence = 0°), with improved fidelity compared with previous models.

The Small Body Mapping Tool (SBMT) [11] is an interactive tool for visualizing spacecraft data on small bodies. The SBMT is publicly available at http://sbmt.jhuapl.edu/. Among the capabilities of the tool is the ability to ingest custom images (in this case the photometrically normalized MSI images), project them onto the shape model, and to output these images as a cube file comprised of co-registered images. We have thus far identified 35 sequential images sets, and of these, 11 have high enough resolution for the study of small features (such as ponds).

3. Image Analysis

After generating our photometrically corrected image cubes, we import the images into ENVI for analysis. We utilized principal components analysis (PCA) to reveal broad spectral units and also to highlight features with anomalous spectral characteristics (Fig. 1, top). In the example analysis shown in Figure 1, we identify two crater wall regions, two background regions, and an anomalous "splotch" feature. We then extract the reflectance at each filter wavelength to obtain spectra for these regions (Fig. 1 middle and bottom). As expected, the two background regions show similar spectral characteristics. However, the two crater wall regions and the splotch feature all display different spectral characteristics, with the foreground splotch more closely resembling the midground crater wall. The limb crater wall shows a much lower relative reflectance at 1000 nm, suggesting possibly a broader mafic absorption (and therefore different composition) exposed on the crater wall.

We are currently performing similar investigations on the other 10 sequential image sets as a means of establishing the range of spectral variation. We will then use these five-band results to compare with previous MSI studies which used only three spectral bands to identify four colour units: bright streaks, dark soils, ponded material, and average regolith [e.g. 2, 3, 5, 6].

4. Figures

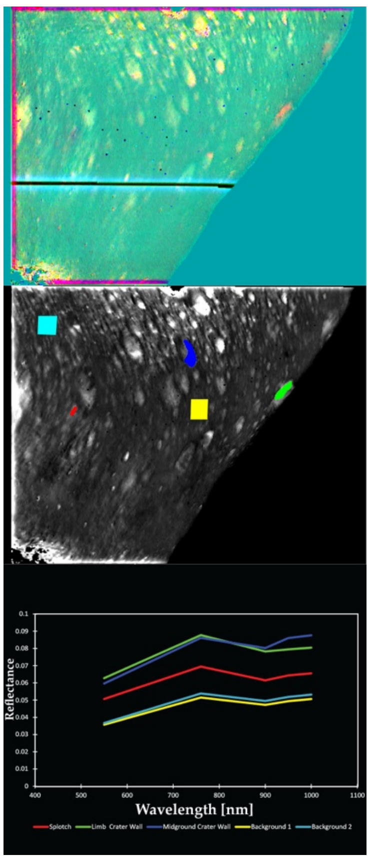

Figure 1: PCA analysis of MSI bands 1, 3, 4, 5, and 6. The top image shows PC1 in the red channel, PC2 in the green channel, and PC3 in the blue channel. The middle image shows the image regions of interest. The bottom image shows the extracted reflectance data from the regions of interest.

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