RESULTS FROM SPECTRAL CLUSTERING ANALYSIS APPLIED TO OSIRIS-REX COLOR IMAGES OF (101955) BENNU. J. de Leon[1,2], J. L. Rizos[1,2], J. Licandro[1,2], H. Campins[3], M. Popescu[1,2], E. Tatsumi[1,2,4], D. N. DellaGiustina[5], D. R. Golish[5], B. Rizk[5], D.S. Lauretta[5]; [1]Instituto de Astrofisica de Canarias, Tenerife, Spain (jmlc@iac.es), [2]Departamento de Astrofisica, Universidad de La Laguna, Tenerife, Spain, [3]University of Central Florida, Orlando, FL, USA, [4]University of Tokyo, Tokyo, Japan, [5]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA.

Introduction: NASA's OSIRIS-REx spacecraft is currently orbiting primitive near-Earth asteroid (101955) Bennu. The spacecraft is acquiring thousands of images using the OSIRIS-REx Camera Suite (OCAMS;[1]), which includes SamCam, PolyCam and MapCam. Color images are obtained with MapCam, equipped with four filters based on the Eight-Color Asteroid Survey (ECAS;[2]), *b*', *v*, *w*, and *x*, centered at 473, 550, 698, and 847 nm respectively. These filters permit measuring spectral slopes that can be used to constrain surface composition and identify the effects of space weathering. We have recently validated a spectral clustering methodology to analyze color images based on an unsupervised machine learning tool [3]. In this work we will present the first results obtained after applying this technique to the color images of Bennu, including the highest spatial resolution images (~ 7cm/pix) obtained during the Recon phase.

Methodology: The first step is to photometrically correct the images. To do so, we use the images taken during the Approach, Preliminary Survey, Orbital A, and Detailed Survey mission phases in the four color filters. Photometric angles for each pixel are obtained using ISIS software and the shape model developed by the OSIRIS-REx Altimetry Working Group [4]. We implemented the most commonly used empirical photometric models (Akimov, Minnaert, Lommel-Seeliger and Lambert) with several empirical phase functions [5]. Once the images are photometrically corrected we apply an equirectangular projection to create mosaics. In the case of the global mosaic we will use the photometric corrections following the methodology described in [6]. We run our spectral clustering method on both normalized (at 550 nm) and not normalized color images. We remove from our analysis those pixels that: have reflectance values lower than 0.001 (shadows), are out of the linearity limit of the CCD, and have emission and incidence angles larger than 80°. For the latter case, the photometric model does not work properly.

Results: We have applied our clustering technique to several global mosaics obtained during different flybys, and to specific regions of interest selected as potential sampling sites on the surface of Bennu. As an illustration of our method, we show in Fig. 1 the results obtained for one of the candidate sample sites (24 lat, 330 lon).

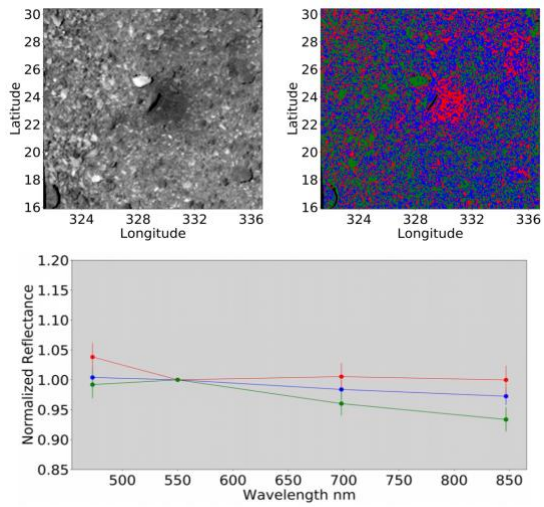

Figure 1. An example of the clustering analysis carried out using images from Detailed Survey Baseball Diamond Flyby 2 (~ 25 cm/pix). *Top panel, left*: *v* filter color image of the selected region for study; *Top panel, right*: location of the identified clusters over the analyzed area (black pixels are out of the defined limits); *Bottom panel*: the three representative spectral clusters with their corresponding error bars (standard deviation), using the same color code as in the top panel.

For this particular example we find three distinct clusters in normalized reflectance (at 550 nm) clearly consistent with the albedo variations and the morphology of the terrain. Regions of lower albedo tend to present redder spectral slopes, a behavior that has been observed throughout the entire surface of the asteroid [7]. The clustering technique is particularly sensitive to the presence of shallow absorption features, better identified in the normalized images, once the dominant contribution of the albedo is removed. We will apply this technique to the highest spatial resolution images obtained during the last flyby (Recon phase), including the images of the final four candidate sites for sample collection.

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