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Comparison between layers stacks of 67P/CG comet and spectrophotometric variability obtained from OSIRIS data

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Abstract

The Rosetta/OSIRIS cameras unveiled the layered nature of comet 67P/Churyumov-Gerasimenko, suggesting that the comet bilobate shape results from the low-velocity merging of two independent onion-like objects [1]. Several physiographical regions of the southern-hemisphere *big lobe* show stacks of layers forming high scarps, terraces and mesas [2]. A spectrophotometric analysis of OSIRIS images based on multispectral data classifications was conducted in order to identify possible morphological, textural and/or compositional characters that allow to distinguish regional stacks of layers.

Method

Multiple NAC image sequences were selected in order to cover the largest landscape of the selected regions as long as the broadest range of available filters (9 to 11). Such sequences meet comparable spatial resolutions and phase angles and include filters frequently used in previous 67P/CG studies [3,4,5]. Since potential diurnal and seasonal changes are expected to homogeneously occur along the same stack of layers, no constrain on a specific survey period was done, picking both pre- and post-perihelion sequences. Geomorphological domains were identified and mapped on each image set. Fine material and deposits were firstly discerned by outcropping consolidated material, which is expected to be meaningful for textural and spectral characters of layers' stacks. The outcrop domain was then distinguished in relatively unaltered consolidated material and degraded outcrops (e.g., *in-situ degraded material* rather than *polygonal consolidated material*).

NAC sets were used to generate several multispectral images, which represent different views of the selected regions. The illumination and topographic effects were corrected using Akimov photometric model [6], which was used and tested in previous analysis of the same body [4]. The 7th stereo-photoclinometry shape model (SPC) [7] was used, combined with the most recent NAIF-SPICE kernels and relative IDL code toolkit to produce high-resolution synthetic images and derive the illumination angles.

Multispectral data were then processed applying combinations of supervised and unsupervised classifications using ENVI software. The *fine material* class was extracted through specific training sites identified by geomorphological mapping, then obliterated on each multispectral image.

A linear interpolation of the multispectral data allowed to produce spectral slope maps between green (535 nm) and near-IR (882.1 nm) filters, which are comparable with global and local spectral slope overviews of the large lobe [3,4,5].

Reworked multispectral images were finally processed proposing two or more classes clustering similar spectra behaviour (Fig. 1). Image class distributions were compared to the geomorphological domains distributions, and class spectral properties were discussed to identify possible trends of the regional stacks of layers. Class distributions were also analysed as a function of incidence and emergence angles, verifying the photometric correction improvement.

Subsequently the classes were compared to the overall geometrical arrangement of the layers, as predicted by the Ellipsoidal Model (EM, Fig. 1) [8]. Furthermore, class distributions were evaluated as the elevation of the big-lobe onion-like structure changes, using values provided by the EM (Fig. 2).

Conclusions

Several classifications suggest a relationship between the spectral properties of the outcrop and the elevation of the EM. An overall comparison of all multispectral-image classification results could shed a light on the spectophotometrical variability of CG's big-lobe layers.

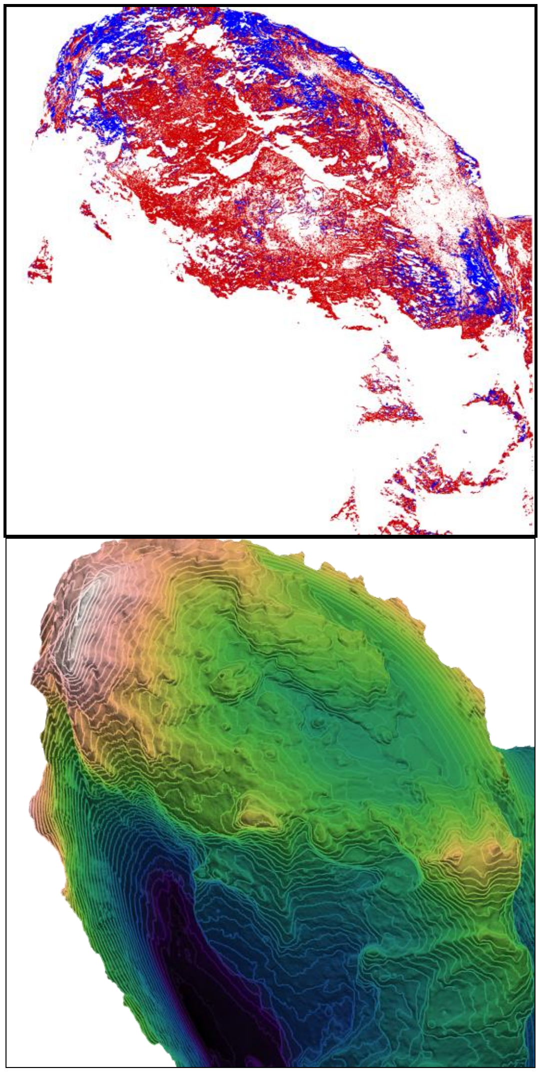

Figure 1. Khonsu region: above an example of supervised classification of the corresponding multispectral image (Maximum Likelihood classification, 2 classes, good separability of the training sites), and relative average spectra; below, the corresponding shape model, where contour lines represent the intersections of a set of spaced ellipsoidal shells defined by the Ellipsoidal Model.

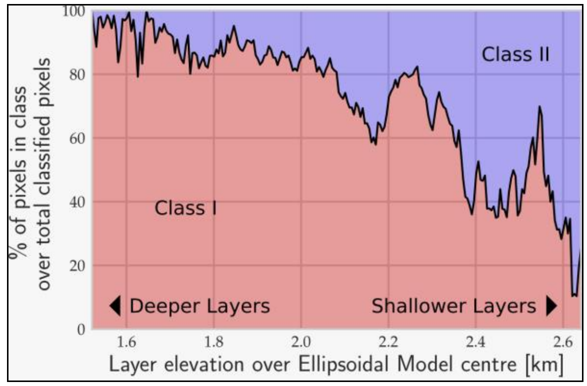

Figure 2. Classes of Fig. 1 are shown in relative percentage in function of their elevation with respect to the EM centre.

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