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Layering and geological inner structure of 67P Churyomov-Gerasimenko comet nucleus

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Abstract

Context The peculiar bi-lobe shape of 67P Churyumov-Gerasimenko (67P/CG) has soon raised the question if it is the expression of two distinct objects or the result of a well-localized excavation on the nowadays-active region in-between the two lobes. The widespread layering involving most of 67P/CG surface seems to give an unambiguous answer to this topic.

1. Introduction

Surface layering on cometary nuclei has been proposed for 9P/Tempel 1 and, possibly, both for 81P/Wild2 and 19P/Borrelly. Nevertheless the OSIRIS [1] images of 67P/CG comet, provide clear and unquestionable evidences of a layering extent never seen before. In this work we illustrate such evidences showing how such geomorphological features can provide fundamental clues to understand the nucleus inner structure.

2. Methods

We used both the OSIRIS NAC and WAC images acquired from 6 August 2014 up to 17 March 2015 with a spatial scale ranging between 0.5 m/px to 4.5 m/px depending on cometocentric distances and the derived shape models to infer presence, distribution and attitudes of layers throughout the entire comet surface. Layers where interpreted in ARC-GIS environment and their orientations derived from best fit planes reconstructed on the bases of shape models nodes of morphological terraces and cuestas-like features. 3D reconstructions were realized using Mesh-lab and Mat-lab soft-wares.

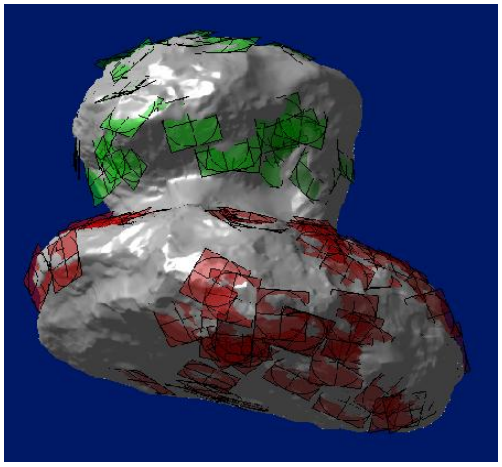

Figure 1: Planes referred to terraces on the 3d model with color depending by the lobe considered.

All the terraces are extracted from the 3D photo clinometric model (3.6M faces at 6m sampling). Best fitting planes are derived from the points clouds defined on the model.

These data allowed us to realize geological sections across the comet in order to infer the subsurface structure of the two lobes. In addition gravity vector

fields were calculated for the entire bi-lobe shape body as well as for the two isolated (and reconstructed) lobes.

Stereographic projections are then used to describe statistics of the orientation of planes in the relative reference system [5] of the gravity fields [2,3,4].

This enabled us to evaluate the angular relationship between the gravity vectors and the strata planes at different regions of the comet both considering the entire nucleus or two distinct objects.

2. Results

67P/CG layering form a nearly continuous (up to 150 m thick) envelop of the major lobe (the main body) which is independent for an analogues envelope of the minor lobe (the head). Thus the geo-structural analysis revealed that layers are neither continuous throughout the Hapi valley nor compatible between the two lobes[6]. Gravity vectors are nearly perpendicular to the layers considering the two separated lobes and diverge from perpendicularity considering the entire comet nucleus.

2. Conclusions

All the above mentioned evidences are in favour of 67P/CG being an accreted body of two distinct objects with onion-like layered envelopes formed before their aggregation.

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