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Pre- and post-perihelion analysis of Seth's circular niches on comet 67P/Churyumov-Gerasimenko

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Abstract

We provide a detailed geomorphological and spectrophotometric analysis of the circular niches located on the Seth region of 67P using OSIRIS images (Fig. 1) [1]. The features can be related to landslide events that occurred on 67P and shaped its surface. After performing a geomorphological map of the area that allows us to identify different terrain units, we computed the boulders cumulative size frequency distribution (SFD) of the niches, before and after the perihelion passage. Then, we perform the spectrophotometric analysis of this region comparing pre- and post-perihelion results. The overall analysis has been performed making use of the gravitational slope map and the erosion and insolation model of the area, which have been calculated on the high resolution digital terrain model.

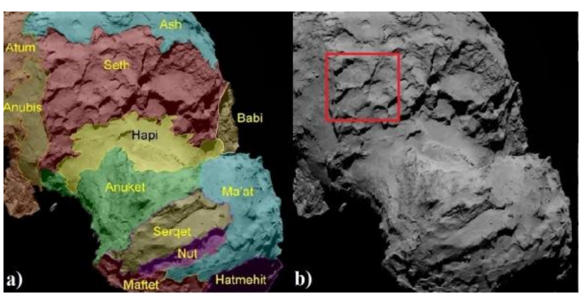

Figure 1: Geological context of the Seth region and the circular niches analysed in this work (NAC image acquired in 2014 August 6 with a scale of 2.2 m/px).

1. Geomorphological map

By means of the WAC image taken in 2016 August 24 with a scale of 0.31 m/px, we made a geomorphological map (Fig. 2) of the area identifying different terrain units. These niches are characterised by the presence of both gravitational accumulation deposits and talus deposits that can be separated on the basis of their texture. Such deposits cover the terrain outlined by the adjacent outcropping walls, which are defined as another geomorphological unit.

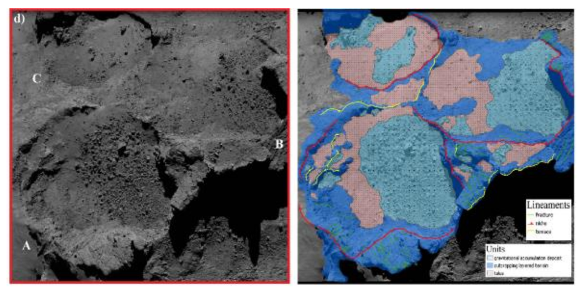

Figure 2: On the left the high resolution WAC image acquired in 2016 August 24 (scale of 0.31 m/px) which has been used to perform the analysis. On the right the performed geomorphological map.

2. Boulders counting

We identify boulders with different shapes with a diameter larger than 1 m through ArcGIS. We statistically analysed their distribution deriving a cumulative SFD [2] with similar power-law indices for niche A and B in post perihelion image (Fig. 3). The niche A is described by a power-law index equal to -2.3 for boulders diameter ranging from 1.8 m and 5 m and a power-law index of -5.0 for boulders larger than 5 m. The niche B is described by a similar behavior consisting in a power law index of -2.7 for boulders diameter ranging from 1.8 m and 5 m and a power-law index of -4.7 for boulders larger than 5 m. To detect if there have been any geomorphological changes, we used a NAC image taken before perihelion in March 2015 to compare the distribution of boulders within the niches finding similar pre/post results.

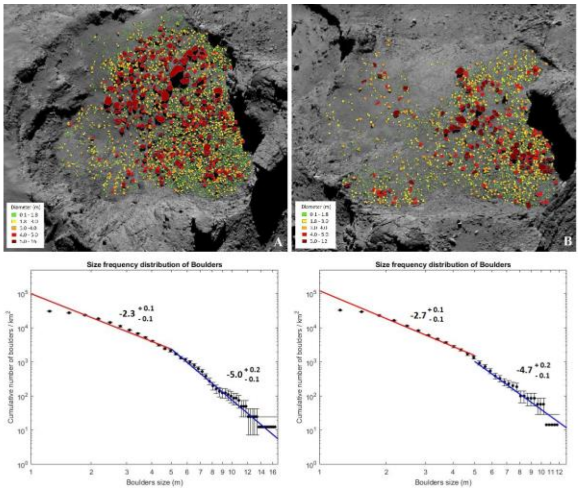

Figure 3: The spatial distribution of boulders on niches A and B counted on the WAC image acquired after perihelion. The lower panels show the cumulative size-frequency distribution of boulders larger than 5 px. The bin size is 0.31 m and vertical error bars indicate the root of the cumulative number of counting boulders (as from [3]).

3. Spectrophotometric analysis

We performed a spectrophotometric analysis on the NAC images acquired pre- and post-perihelion in order to study the colour changes after the Rosetta perihelion passage. The spectrophotometry performed on pre-perihelion images indicates a linear increasing of the reflectance with the wavelength, without any evidence of clear absorption bands, while the analysis computed on post-perihelion images reveals several bright and bluer regions close to or in the shadows, indicating a local enrichment in ice mixed to the refractory material (Fig. 4 for post-perihelion analysis).

Conclusions

The absence of boulders deposits changes suggest that the gravitational event that gave birth to these deposits is not related to the recent detected activity of 67P, thus the landslide that originated such deposits occurred in the past. This is also in agreement with [4], in which the analysis of detected surfaces changes imply a more active comet in the past. We found that the average spectral slope has not changed significantly after the *Rosetta* perihelion passage, but we observed bluer spots in images taken after perihelion indicating the presence of exposed water ice mixed to the refractory materials, in agreement with what previously observed in different nucleus regions [5, 6, 7].

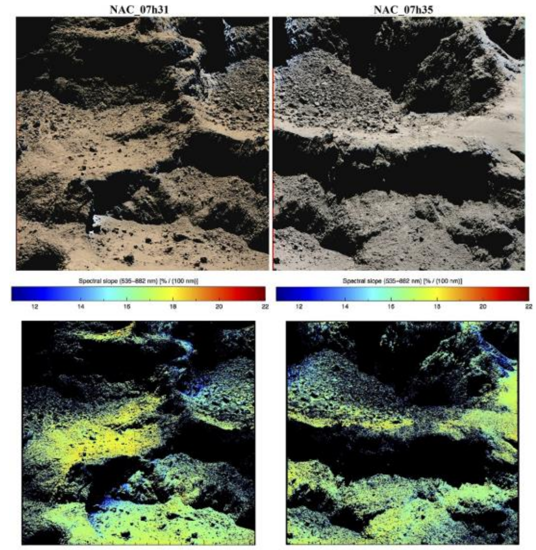

Figure 4: RGB images, in false colours, of the investigated region for images taken on 2016 July 23 with filters centred on 480, 649 and 882 nm (scale of 15 cm/px). Lower panel shows the spectral slope of the corresponding images at a phase angle of 89°. The slope is computed in the 535-882 nm range, after the normalisation at 535 nm and it is in %/100 nm

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