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Differences between the small and big lobes of 67P/Churyumov-Gerasimenko comet revealed from highly eroded regions analysis

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We have analyzed high-resolution images of the Wosret region acquired at different wavelength in the 400-1000 nm range with the NAC camera of the OSIRIS imaging system on board the Rosetta mission. This region is located on the small lobe of the 67P/Churyumov-Gerasimenko comet and it is subject to strong heating during the perihelion passage. It includes the two last landing sites of the Philae lander, and notably Abydos, the final one where the lander performed most of its measurements.

Wosret has unique geomorphological features among the 26 regions of comet 67P showing a high erosion level, a pervasive fracturing, and an overall lack of dust deposits compared to other regions. It is also one of the most active regions, showing the highest estimated water production rate [1] and originating about 40 activity events, including one of the brightest outburst caught by Rosetta observations.

We observed a few morphological changes in Wosret, related to local dust coating removal with estimated depth of about 1 m, and the formation of a cavity measuring 30 m in length corresponding to a total mass loss of 1.2×10^6 kg. The spectrophotometry of the region is typical of medium-red regions of comet 67P, with spectral slope values of 15-16 %/(100 nm) in pre-perihelion data acquired at phase angle 60^o. Few tiny bright spots are observed, but very small in size (1-1.5 m^2). One of them is very bright and we estimated a local water icy enrichment up to 60%. Morphological features like goosebumps/clods are widely present in Wosret, and they appear consolidated, highly irregular in shape and height. Their measured equivalent diameter ranges from 2 to about 12 m, with an average value of 4.7±1.5 m.

By comparing the physical ad mechanical properties of Wosret with those of Anhur and Khonsu [2,3], two southern hemisphere regions located in the big lobe, highly active, and that experienced the same high heating level than Wosret, we highlight some differences between the two lobes:

1) First of all, the water ice-enriched regions directly exposed at the surface of Wosret are less frequent and smaller in size than those observed in Anhur, where water ice rich area of several squared meters and up to 1600 m^2 were observed [4]. Also, the spectrally bluer area ice-enriched by frost, usually found close to shadows, are less frequently observed in Wosret.

2) All these three regions are highly active, but the activity results in different surface re-shaping. In fact important morphological changes were observed in Anhur and Khonsu (new scarps, dust bank removal up to 14m in depth, vanishing structures of several tenth of meters in length, boulders displacement and fragmentation, cavities formation) corresponding to a total mass loss in the order of 10^8 kg [2,3]. Conversely, no major morphological changes are observed in Wosret except for the formation of a new cavity, and the dust coating removal tentatively estimated in about 1 m depth, locally. We discard observation biases because these regions were observed under similar spatial resolution and illumination conditions pre- and post-perihelion.

3) Polygonal block in Wosret are, on average, two times larger than the goosebumps/clods found in different regions of the big lobe. These structures have been interpreted as being representative of the original cometesimals forming, by aggregation, cometary nuclei, or as result of fracturing processes caused by seasonal and diurnal thermal gradients.

Morphological analysis of the 67P regions alone also points to differences in the physical and mechanical properties of the material composing the two lobes of 67P nucleus [5]. The limited morphological changes and low exposure of volatiles observed in Wosret compared to Anhur/Khonsu indicate that the surface material on Wosret could be less fragile and more consolidated than the one composing the southern regions of the big lobe, and that the small lobe could have a lower volatile content, at least on its top layers, than the big lobe.

All these evidences support the hypothesis, formulated by Massironi et al. [6] from the analysis of the layering of two lobes, that comet 67P is composed of two distinct bodies that merged during a low-velocity collision in the early Solar System.

References: [1] Marshall et al., 2017, A&A 603, A87; [2] Fornasier et al., 2019, A&A 630, A13; [3] Hasselmann et al., 2019, A&A 639, A8, [4] Fornasier et al., 2016, Science 354, 1566; [5] El-Maarry et al., 2016, A&A 593, A110; [6] Massironi et al., 2015, Nature 526, 402