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Intense Morphological Changes in a dust bank situated at the Khonsu region of 67P/Churyumov-Gerasimenko

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Abstract

Situated along a latitude band of -11 to -30 degrees, the dust bank in the Khonsu Region is an area that experienced dramatic morphological changes during the 67P/Churyumov-Gerasimenko's perihelion passage of July to September 2015 [1], the maximum period of activity [2]. Through the colors sequences obtained by the OSIRIS Narrow-Angle Camera (NAC) on-board the Rosetta/ESA mission, Deshapriya et al. [3] showed many ice-enriched spots appearing and surviving several months after and before perihelion. Using same instrument, Vincent et al. [4] detected two bright outbursts rising from the bank during same period.

Therefore, to study the relationship among the location, ejected mass and morphological changes, we further analysed the full rotational NAC color sequences of August 1st 2015 and December 13th 2015 that shows an impressive amount of outgassing happening on the dust bank and proximities. In total, it revealed 33 events of varied intensity. Most of them are clustered on the equatorial reach of the bank (Fig. 1). In particular, two bright events, one rotation apart, released an instantaneous mass of 3-4 tons during cometary night from same area in August 1st 2015. Finally, in December 13th 2015, we detected the strongest outburst, 23-30 tons were released from a ice-enriched terrain (8-9%/100 nm) very close to the origin of "jumping boulder" detected by El-Maarry et al. [5]. All mass were calculated applying the grain-size distribution estimated by Agarwal et al. [6].

Once these mass ejection events were located and identified, we searched through OSIRIS database to look for morphological and/or spectrophotometric counterparts. After perihelion passage, the spacecraft went to inscursion of low altitude and obtained the

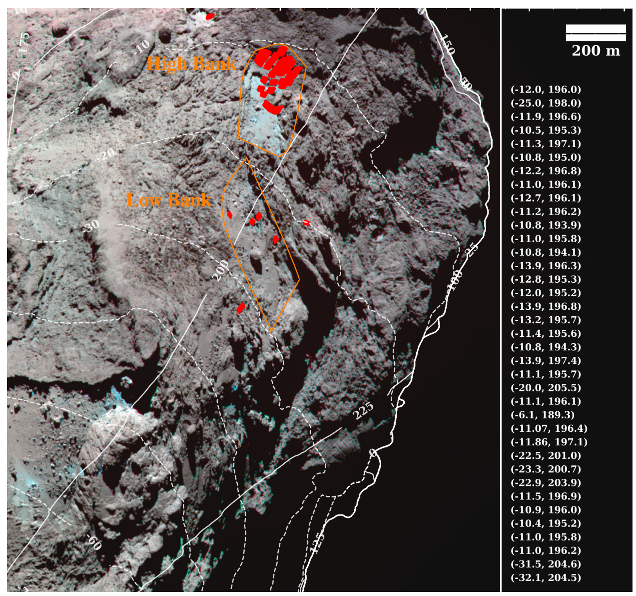

Figure 1: **All jet sources projected onto NAC image of January 28th 2016, 01:48.** Positions for events #7 $(-12, 196)$ & #33 $(-25, 198)$ of Vincent et al., 2016 are also included there. Most of the documented events cluster on the equatorial outskirts of Khonsu cliff, with sparse sources located in the southern reach.

highest-resolution images during the "Target of Opportunity observations" between June and July 2016. Conversely, before perihelion, only a couple of images were taken at low altitude on January 16th 2015 01:27 (30 km). Comparing both sets, we identified 8 features related to mass loss and a new displaced boulder of 50-meter size El-Maarry et al. [5]. Among these features we have 6 shallow cavities of 1.6 to 16.4 meters depth and 20 to 100 meters length, one retreating scarp of 25 meters height and 100 meters length and one mound of 16 meters height and 30 meters length. After the perihelion passage, the mound gave space to a 2.6-meter depth cavity and two cavities appeared, of 2.7 and 5-to-16 meters depth each. Looking precisely on the location of the previously identified events, we unveil an evident heterogeneity, the source points cluster in 5 morphological changes: the new "jumping boulder", the retreating scarp of $8.8 \cdot 10^7$ kg, a thick dust missing layer of $3 \cdot 10^7$ kg and one cavity in an extended bright patch. The 50-meters "jumping boulder", in particular, had escavated a mass of $2.8 \cdot 10^7$ kg, and corresponds to the two bright events and several other smaller ejections of August 1st 2015.

Except for the one bright patch and the few parts of the scarp borders, all mass ejection sources are apparently dry after 9 months of southern "summer fireworks" in late 2015. This is different from January 16th 2015 when the equatorial reach of the bank was fully ice-enriched, probably by recondensation, due to large casting shadows from Apis wall.

To conclude, we estimate an ejected mass for a single perihelion passage, in respect to the global density of 533 kg/m3 (7; 8), of $1.7 \cdot 10^8$ kg, which correspond to 1.7-3.4% of the total ejected mass estimated by Paetzold et al. [9] or Thomas et al. [10], respectively. The minimum gas flux to lift the new "jumping boulder" is estimated at $2.85 \cdot 10^{24}\ m^{-2}s^{-1}$ according to El-Maarry et al. [5] (Supp. Mat.) formulation. The characteristic features' depth and apparent violence of several events advocates for very energetic sub-surface storage mechanism [6] instead of a predominance of cliff collapses as raised by Vincent et al. [4] and exemplified in Pajola et al. [11].

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