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Mapping and changes of exposed bright features on the comet 67P/Churyumov-Gerasimenko

J.D.P. Deshapriya (1), M.A. Barucci (1), S. Fornasier (1), P.H. Hasselmann (1), C. Feller (1), H. Sierks (2) and OSIRIS team.

(1) LESIA, Observatoire de Paris, PSL Research University, CNRS, Univ. Paris Diderot, Sorbonne Paris Cité, UPMC Univ. Paris 06, Sorbonne Universités, 5 place Jules Janssen, 92195 Meudon, France, (2) Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg, 3, 37077, Göttingen, Germany
(prasanna.deshapriya@obspm.fr / Fax: +33-145077144)

Abstract

The Optical, Spectroscopic and Infrared Remote Imaging System (OSIRIS) [10], studied the Jupiter-family comet, 67P/Churyumov-Gerasimenko (67P), embarked on the Rosetta spacecraft from August 2014 to September 2016. Consisting of two scientific cameras: Narrow Angle Camera (NAC) and Wide Angle Camera (WAC), respectively optimised to observe the coma and the nucleus, OSIRIS contributed immensely to further the scientific know-how of comets. In this context, our study [5] focusses on the exposed features of volatile ices on the nucleus of the comet 67P.

Several studies [4],[8],[11],[12] have investigated the exposed bright features using OSIRIS data where, based on the spectrophotometric characteristics of the features, it was concluded that H_2O was present in those exposures. Apart from this, local exposures of H_2O [1],[3],[6] and CO_2 [7] have been spectroscopically identified on the nucleus by the spectro-imaging instrument VIRTIS-M [2] on-board ROSETTA. All these results indicate the presence of volatile ices on the nucleus of the comet, as predicted by the theories and they correspond to a restricted period of time (in-bound phase of the orbit as the comet was approaching its perihelion) throughout the orbit of the comet around the sun. In this study, we attempt to investigate data spanning in a wider time frame, which is from Rosetta's arrival near the comet in August 2014 up to the end of the extended mission in September 2016, which encompases more than two years, including a year of the in-bound orbit and a period more than a year in the out-bound orbit, as we explore the exposed bright features on the nucleus. As such, it is possible to constrain the evolution and morphologies of such features as the comet moves through its orbit.

We report the identification of 57 exposed bright features which are preferably located in the equatorial latitudes. Analysing the available spectrophotometric data for 51 of them, we are confident to interpret them to be exposures of H_2O ice. This is based on the flat reflectance curve of these features, which mimics the visible spectra of H_2O ice and the fact that their lifetimes are consistent with the sublimation rates of H_2O ice, unlike the other super-volatile ices like CO, CO_2 , SO_2, NH_3, etc that also share the flat visible spectra. We also show that the studied features can be morphologically categorised under 4 types :1) isolated patches on smooth terrains, 2) isolated patches close to irregular structures, 3) patches resting on boulders, 4) clusters of patches. Using the linear-exponential phase curve of bright features published by Hasselmann et al. [9], albedos are calculated for these features, which we interpret to have a correlation with the type of the feature as shown in the Fig. 1.

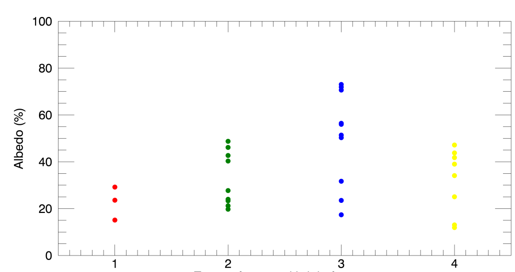

Figure 1: Albedos calculated for the explosed bright features, grouped according to their respective types.

Furthermore, we highlight the link with potential activity sources, responsible for resulting in the formation of two exposed bright features, belonging to the type 2. As such, the Fig. 2 illustrates a displacement of a boulder in the Bes region of the comet, that resulted in the appearance of an exposed bright patch on top of it, that was observed to stay for about 6 months with gradual decrease of its area due to sublimation.

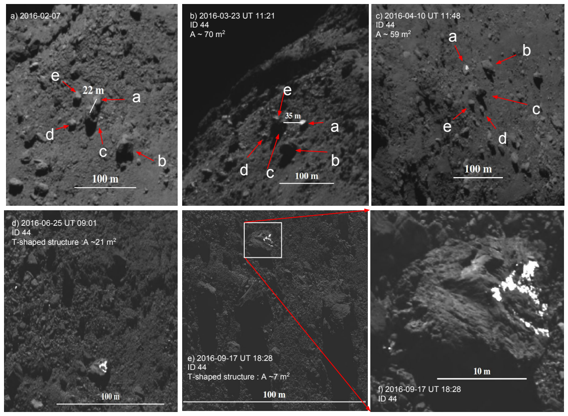

Figure 2: The field of boulders in Bes region, where a displacement of a boulder was observed, leading to the appearing of an exposed bright patch on it between February and March 2016. Its sublimation-driven evolution can be characterised by means of the diminution of its effective size calculated from pixels resolutions.

The results of the detected exposed bright features and their albedo distribution will be presented and discussed.

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