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# Long-term survival of water-ice observed on comet 67P

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## Abstract

Numerous water-ice-rich features sizes from centimetres to tens of meters, mostly located in rough terrains, surviving more than several months on comet 67P/Churyumov-Gerasimenko were observed during the Rosetta mission (Oklay et al. 2016a; Barucci et al. 2016; Deshapriya et al. 2016). We present the first-time detection of areas enriched in water ice surviving up to two years since their first observation via narrow angle camera (NAC) of Optical, Spectroscopic and Infrared Remote Imaging System (OSIRIS Keller et al. 2007). Their existence on the nucleus of comet 67P at the arrival of the Rosetta spacecraft suggests that they were exposed to the surface during the comet's previous orbit. We investigated the temporal variation of large patches to understand the long-term sustainability of water ice on cometary nuclei on time scales between half a year, and two years i.e. until the end of the mission.

Large clusters are stable over typical periods of half a year and reduce their size significantly around the comet's perihelion passage, while smaller exposures disappear in shorter time scales (Oklay et al. 2017). By studying multispectral images taken by OSIRIS NAC, we characterized the multispectral signatures of features enriched in water ice. Individual features have low spectral slopes and flat spectra, while clusters show similar spectra to the average surface but with lower spectral slopes. Within the first ten months of observations, spectral slopes increase by about 3%/100 nm within large clusters, indicating the ongoing sublimation process. However, several small boulders enriched in water ice within the talus field still display typical low spectral slopes of ∼8%/100 nm. At the first detection, the large isolated features had spectral slopes typically ∼5%/100 nm but increased by 3-5%/100 nm in the next ten months.

We investigated the association of water ice features and activity. Most of the regions enriched in water ice are the sources of activity (Oklay et al. 2016b; Vincent et al. 2016). In large clusters, dust jets were detected, whereas in large isolated ones no associated activity was detected.

Our thermal analysis shows that the long-term sustainability of water-ice-rich features can be explained by the scarce energy input available at their locations over the first half year. However, the situation reverses for the period lasting several months around perihelion passage. Within one of the isolated patch, our two end-member mixing analysis estimates a pure water-ice equivalent thickness up to 15 cm and 0.9 cm in the cases of intimate and areal mixtures respectively. For the isolated one still observable through the end of the mission, the water-ice equivalent thickness could be up to 2 m and 0.5 m in the case of intimate and areal mixtures respectively .

Our spectral modelling of areal mixture of water-ice with the cometary material estimates up to 48% water-ice content for one of the large isolated feature, and up to 25% water ice on the large boulders located within clusters.

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