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WATER AND CARBON DIOXIDE ICES-RICH AREAS ON COMET 67P/CG NUCLEUS SURFACE

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ABSTRACT: So far, only two ice species have been identified by Rosetta/VIRTIS-M *[1]* on the surface of 67P/Churyumov-Gerasimenko during the pre-perihelion time: crystalline water and carbon dioxide ice. Water ice has been spectroscopically identified in three distinct modalities: 1) On the active areas of Hapi region where water ice changes its abundance with local time and illumination conditions, condensing during the night hours and sublimating during daytime *[2]*; 2) On recent debris fields collapsed from two elevated structures in the Imhotep region where more fresh and pristine material is exposed *[3]*; 3) On eight bright areas located in Khonsu, Imhotep, Anhur, Atum and Khepry regions *[4]* where single or multiple grouped icy patches with sizes ranging between few meters to about 60 m are observed. Carbon dioxide ice has been detected only in a 60×80 m area in Anhur region while it was exiting from a four year-long winter-night season *[5]*. This ice deposit underwent a rapid sublimation, disappearing in about one month after its initial detection. While water and carbon dioxide ice appear always mixed with the ubiquitous dark material *[6,7]*, there are no evidences of the presence of water and carbon dioxide ices mixed together in the same area. If observed, ices always account for very small fraction (few percent) with respect to the dark material. Moreover, the surface ice deposits are preferentially located on the large lobe and the neck while they are absent on the small lobe. Apart from these differences in the spatial distribution of ices on the surface, a large variability is observed the mixing modalities and in the grain size distributions, as retrieved from spectral modeling *[8]*: 1) very small μm-sized water ice grains in intimate mixing with the dark terrain are detected on Hapi active regions *[2]*; 2) two monodispersed distributions with maxima at 56 μm and at 2 mm, corresponding to the intimate and areal mixing classes, are observed on the Imhotep debris fields ice grains *[3]*; 3) different combinations of water ice and dark terrain in intimate mixing with small grains (tens of microns) or in areal mixing with large grains (mm-sized) are seen on the eight bright areas discussed in *[4]*; 4) the CO_2 ice in the Anhur region appears grouped in areal patches made of 50 μm sized grains *[5]*. While the spectroscopic identification of water and carbon dioxide ices is made by means of diagnostic infrared absorption features, their presence cause significant effects also at visible wavelengths, including the increase of the albedo and the reduction of the spectral slope which results in a more blue color *[9,10]*. In summary, thermodynamic conditions prevailing on the 67P/CG nucleus surface allow the presence of only H_2O and CO_2 ices. Similar properties are probably common among other Jupiter family comets.

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