CORRELATION OF COMET 67P/CG'S MORPHOLOGY WITH THE OCCURRENCE OF EXPOSED WATER ICE PATCHES

G. Arnold[1,2], D. Weller[1,2], G. Zeilinger[2], D. Kappel[1], S. Hviid[1], E. Kührt[1], L. V. Moroz[1,2], K. Markus[1,3], D. Henckel[1], F. Capaccioni[4], G. Filacchione[4], S. Erard[5], C. Leyrat[5], D. Bockelee-Morvan[5], and the VIRTIS Science Team
[1]German Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin, Germany, Gabriele.Arnold@dlr.de, [2]Institute of Earth and Environmental Science, University of Potsdam, Karl-Liebknecht-Str. 24-25, 14476 Potsdam, Germany, [3]Institute of Planetology, University of Münster, Wilhelm-Klemm Str. 10, 48149 Münster, Germany, [4]INAF-IAPS, Via Fosso del Cavaliere 100, 00133 Rome, Italy, [5]LESIA, 5 place J. Janssen, 92195 Meudon, France.

Introduction: Comet 67P's surface is quite homogeneously covered by dark refractory materials rich in organics [1,2]. Rare water ice exposures on the surface, most likely originating from sub-surface layers, have recently been discovered [3,4]. Such H_2O ice patches on 67P’s Imhotep region in the pre-perihelion phase were examined and related to the local morphology to understand the exposure mechanisms [5].

Methods: H_2O ice was identified in two study areas using characteristic H_2O spectral features observed by the VIRTIS-M instrument [1]: absorption bands at 1.04, 1.25, 1.52, 2.02, 2.96 µm, and the VIS spectral slope (0.5-0.8 µm). Corresponding normalized spectral indicators were projected onto a 3D digital shape model (DSM) of 67P [6], along with high spatial resolution images acquired by OSIRIS [7] for morphological context.

Results and conclusions: The 2.0-µm absorption band proved to be the most sensitive H_2O indicator in the IR. Flat (bluer) normalized VIS slopes correlate very well with depths of H_2O ice absorption bands. The DSM projections show a significant spatial correlation between spectral H_2O indicators and morphological features. H_2O ice deposits were identified in two areas, each extending over hundreds of square meters. Both are located at the bases of steep-sloped (>60°) walls of Consolidated Cometary Material (CCM) on debris falls that came to rest on moderately inclined (20°-30°) terrain, pointing towards gravitational lows. Both deposits are located in poorly illuminated areas due to shadowing from close-by steep walls. The morphological and photometrical properties of these deposits appear to be stable over months. Spectral modeling [3,4] indicated the presence of large (mm-sized) H_2O ice grains. Such grains form through vapor diffusion in ice-rich colder layers or by sintering and are exposed by erosion [3]. The CCM in both study areas was fractured and weakened by thermal fatigue and sublimation, leading to the collapse of overhangs in one single event or in small steps over a longer time. For study area 1 this interpretation is supported by a small remnant H_2O ice patch in the upper part of the steep wall indicating the original location of the collapse overhang.

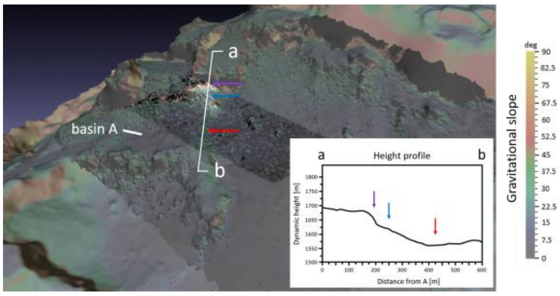

Fig. 1. Combination of DSM and gravitational slopes for study area 1 of exposed H_2O ice [5].

Sinkhole-structures on the CCM in study area 2 indicate sub-surface activity connected to ice sublimation, thermal stress, and occasional outbursts. Even though the nucleus structure probably is mostly homogeneous and primordial, the variable size and irregular distribution of sinkholes and erosional features strongly imply a highly active and heterogeneous sub-surface layer of at least tens of meters [8,9].

References: [1] Capaccioni F. et al. (2015) *Science, 347,* 628. [2] Quirico E. et al. (2016) *Icarus, 272,* 32-47. [3] Filacchione G. et al. (2016) *Nature, 529,* 368-372. [4] Barucci A. et al. (2016) *A&A, 595,* A102. [5] Weller D. (2016) *Master thesis, University of Potsdam*. [6] Preusker F. et al. (2015) *A&A, 583,* A33. [7] Keller H. et al. (2007) *Space Sci. Rev., 128(1),* 433-506. [8] Thomas N. et al. (2015) *Science, 347,* 440. [9] Vincent J.B. et al. (2015) *Nature, 523,* 63-66.