LARGE SUB-SURFACE VOLATILE RESERVOIRS OF COMET 67P. N. Oklay[1] and The OSIRIS Team [1]DLR Institute for Planetary Research, Rutherford Str. 2, 12489 Berlin, Germany (Nilda.OklayVincent @dlr.de)

Surface regions enriched in H_2O ice – a key to sub-surface volatile reservoirs: Long-term high spatial resolution OSIRIS [1] observations of comet 67P/Churyumov-Gerasimenko allowed the detection of H_2O ice rich features surviving typically 10 months long on well illuminated areas. One icy feature, which survived the entire Rosetta mission, suggests the existence of a large sub-surface volatile reservoir and replenishment of exposed H_2O ice [2]. All those long-lasting H_2O ice exposures were detected in the first spatially resolved imaging of the comet's nucleus, indicating their exposure to the surface during the previous perihelion passage of the comet or earlier. The presence of H_2O ice on the surface for long timescale indicates large reservoirs with high ice/dust mixing ratios [2].

We presented the detection and investigation of several surface H_2O ice exposures and a sub-surface volatile reservoir in our earlier study [2]. As following, here we present the first time detection of a large volatile reservoir (Fig. 1, dashed circle), which is beneath a large round basin (~700 m in diameter) located in the big lobe of the comet. In this basin, we visually detected more than 20 transient activity events and characterized activity morphologies, source regions, morphologic and spectroscopic surface changes. We report detection of several activity events repeating from the same sources. We additionally present observations of two stages of an outburst. We detected two outbursts occurred in the same source location but 6 months apart. Both show the same outburst plume morphology. However, two stage observations of January 2016 outburst suggest that July 2016 outburst [3] was only the observation of the second stage.

How cometary activity works? Even after 2 years of observations of comet 67P by numerous instruments on board Rosetta spacecraft, the answer is still debated. Various theories and activity triggering mechanisms are still in discussion. With our work, we aim to put constrains on the activity triggering mechanisms by combining all information we could retrieve using OSIRIS images. When possible, we determine lifetime of the activity, multispectral properties, morphologic and multispectral changes of the source regions together with their vicinities before/after activity events, and outburst plume morphologies. We then evaluate our results in the context of various activity triggering mechanisms and discuss their plausibility.

Ongoing work: In order to investigate this large volatile reservoir in more details and understand the observed activity, Rosetta multi-instrument studies are necessary. Therefore, we are in discussion with several other Rosetta instrument teams. Our timeline of activity events and the source regions we detected provide guidance to other teams during re-visit of their data.

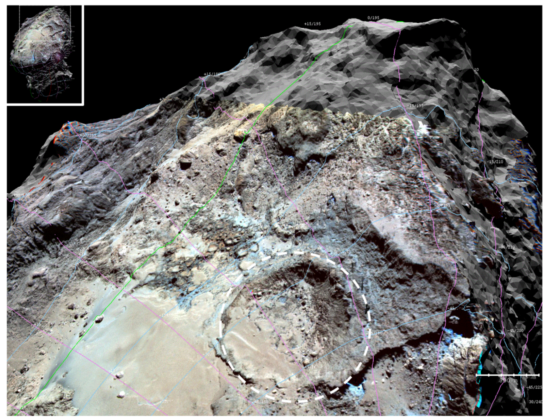

Figure 1: RGB color composite showing regions enriched in H_2O ice (blue) and the large round basin (white dashed circle). Top left corner shows the orientation of comet 67P as context. Dotted rectangle in the context image shows the location of the main figure. White scale bar at the bottom right indicates 300 m. OSIRIS narrow angle camera images taken at 882.1 nm, 649.2 nm and 480.7 nm are used in the RGB channels respectively (after co-registered in subpixel accuracy using USGS ISIS3 [4]). 2016-01-24T01:08:18 is the reference for the color set. The RGB color composite is projected onto 3D shape [5] using shapeViewer software [6, 7] to both orient the images consistently and have 3D map grid in 15° spacing. Pink lines indicate longitudes, blue are the latitudes, green is the zero latitude, and red (visible only on the context image) is zero longitude. Detailed geomorphologic analysis of this region at the arrival to the comet is in [8].

References:
[1] Keller et al., (2007) *Space Sci. Rev.,128,* 433.
[2] Oklay et al., (2017) *MNRAS., 469*, 582-597.
[3] Agarwal et al., (2017) *MNRAS*, *469*, 606-625.
[4] Anderson et al., (2004) *LPSC*, Abstract #2039.
[5] Preusker et al., (2017) *A&A*, *607*, L1 .
[6] http://www.comet-toolbox.com/shapeViewer.html
[7] Vincent et al., (2018) *LPSC*.
[8] Auger et al., (2015) *A&A, 583*, A35.

Acknowledgements: OSIRIS was built by a consortium of the Max-Planck-Institut für Sonnensystemforschung, Göttingen, Germany, CISAS University of Padova, Italy, the Laboratoire d'Astrophysique de Marseille, France, the Institutode Astrofísica de Andalucia, CSIC, Granada, Spain,the Research and Scientific Support Department of the European Space Agency, Noordwijk, The Netherlands, the Instituto Nacionalde Técnica Aeroespacial, Madrid, Spain, the Universidad Politéchnica de Madrid, Spain, the Department of Physics and Astronomy of Uppsala University, Sweden, and the Institut für Datentechnik und Kommunikationsnetze der Technischen Universität Braunschweig, Germany. The support of the national funding agencies of Germany (DLR), France (CNES), Italy (ASI), Spain (MEC), Sweden (SNSB), and the ESA Technical Directorate is gratefully acknowledged. We thank the Rosetta Science Ground Segment at ESAC, the Rosetta Mission Operations Centre at ESOC, and the Rosetta Project at ESTEC for their outstanding work enabling the science return of the Rosetta Mission.

This research has made use of the USGS Integrated Software for Imagers and Spectrometers (ISIS). We gratefully acknowledge the developers of SPICE and NAIF/PDS resources.

This research made use of the software shapeViewer, available at www.comet-toolbox.com