EPSC Abstracts
Vol. 10, EPSC2015-244, 2015
European Planetary Science Congress 2015

OSIRIS observations of metre-size bright exposures of H_2O ice at the surface of comet 67P/C-G.

A. Pommerol (1), S. Fornasier (2), N. Thomas (1), M. R. El-Maarry (1), M. Pajola (3), O. Groussin (4), A. -T. Auger (4), N. Oklay (5), C. Feller (2), B. Davidsson (6), A. Gracia (1), B. Jost (1), R. Marschall (1), O.Poch (1), M. A. Barucci (2), J. –L. Bertaux (7), F. La Forgia (8), H. U. Keller (9), E. Kührt (9), S. C. Lowry (10), S. Mottola (9), G, Naletto (3,11,12), H. Sierks (5), and the OSIRIS Team.

(1) Physikalisches Institut, University of Bern (antoine.pommerol@space.unibe.ch) (2) LESIA, Obs. de Paris, CNRS, Univ Paris 06, Univ. Paris-Diderot, 5 place J. Janssen, 92195, Meudon, France (3) Centro di Ateneo di Studi ed Attivitá Spaziali, "Giuseppe Colombo" (CISAS), University of Padova, Italy. (4) Aix Marseille Université, CNRS, LAM, UMR 7326, 38 rue Frédéric Joliot-Curie, 13388 Marseille, France (5) Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg, 3, 37077, Göttingen, Germany (6) Department of Physics and Astronomy, Uppsala University, 75120 Uppsala, Sweden (7) LATMOS, CNRS/UVSQ/IPSL, 11 boulevard d'Alembert, 78280, Guyancourt, France (8) Department of Physics and Astronomy, University of Padova, vicolo dell'Osservatorio 3, 35122 Padova, Italy (9) Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Planetenforschung, Rutherfordstraße 2, 12489 Berlin, Germany (10) The University of Kent, School of Physical Sciences, Canterbury, Kent, CT2 7NZ, UK (11) Department of Information Engineering, University of Padova, Via Gradenigo 6/B, 35131 Padova, Italy (12) CNR-IFN UOS Padova LUXOR, Via Trasea, 7, 35131 Padova , Italy

1. Metre-size bright spots

Since the beginning of Rosetta's orbital observations, over a hundred small bright spots [1] have been identified in images returned by its OSIRIS NAC camera, in all types of morphological regions on the nucleus.

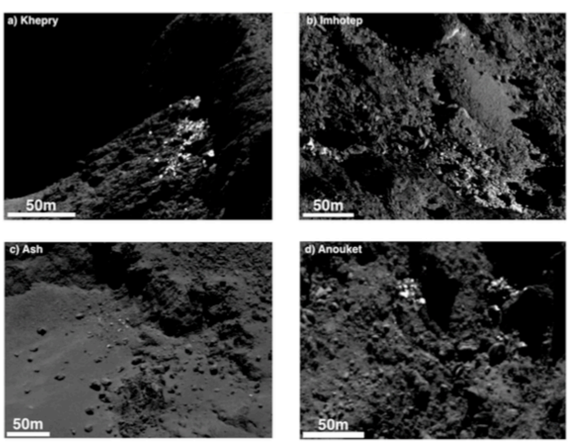

Figure 1: Example of clusters of bright spots in four different regions of the nucleus.

Bright spots are found as clusters of several tens of individuals in the vicinity of cliffs, or isolated without clear structural relation to the surrounding terrain. They are however mostly observed in the areas of the nucleus currently receiving the lowest amount of insolation and some of the best examples appear completely surrounded by shadows (Fig. 1).

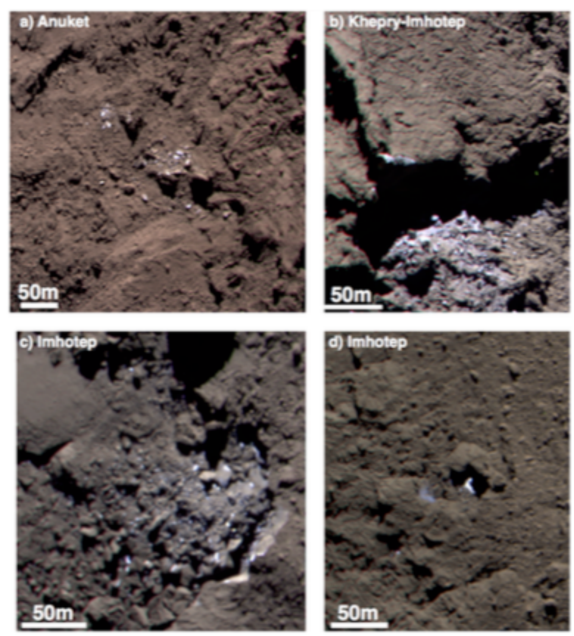

Figure 2: False-color RGB images assembled from frames acquired by OSIRIS in the near-infrared, visible and near-ultraviolet, respectively.

Their typical sizes are of the order of a few metres and they are often observed at the surfaces of boulders of larger dimension.

The brightness of these spots is up to ten times the average brightness of the surrounding terrain, reaching reflectance factor in the range of 0.10-0.15, and multi-spectral analyses show a significantly bluer spectrum over the 0.3-1µm range (Fig. 2) than the rest of the surface of the nucleus, which displays a steeper red slope [2]. Comparisons of images taken in September and November 2014 under similar illumination conditions do not show any significant change of these features

2. Laboratory experiments

Analysis of the results of past and present laboratory experiments with H_2O-ice/dust mixtures provide interesting insights about the nature and origin of the bright spots. In particular, recent sublimation experiments conducted at the University of Bern [3,4] reproduce the spectro-photometric variability observed at the surface of the nucleus by sequences of formation and ejection of a mantle of refractory organic-rich dust at the surface of the icy material.

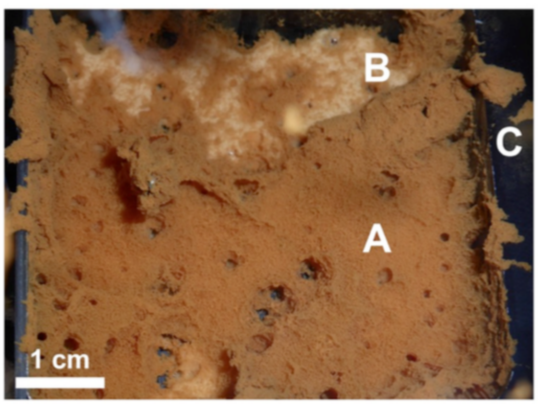

Figure 3: Picture of the surface of a sample initially prepared as a mixture of fine-grained water ice and tholins. After exposure to low temperature and pressure conditions for tens of hours, a surficial mm-thick very porous layer of tholins has formed (A). cm-size chunks of this mantle are regularly ejected (C), exposing the underlying brighter and less red ice-rich material (B).

The formation of hardened layers of ice by sintering/re-condensation below the uppermost dust layer can also have strong implications for both the photometric and mechanical properties of the

3. Interpretation and discussion

Based on the comparison between OSIRIS observations and laboratory results, our favoured interpretation of the observed features is that the bright spots are exposures of dusty water ice, resulting from the removal of the uppermost layer of refractory dust that covers the rest of the nucleus. Some of the observations of clusters of bright spots (Fig. 2b for example) are indicative of a formation process, which involves the breakage and collapse of brittle layers of ice to form fields of large boulders, some of them showing bright spots on part of their surface. Some of the isolated spots observed elsewhere on the nucleus might as well have been formed by similar processes and then have been transported over large distances by multiple bounces. These surface exposures of water ice must be more recent than the last passage at perihelion, as they would rapidly sublimate at short heliocentric distance. The hypothesis formulated here will thus easily be tested as the comet approaches the Sun, by checking if and how fast the bright spots vanish and disappear. The VIRTIS imaging spectrometer on-board Rosetta should also be able to detect the water ice spectral signatures over the largest of these bright areas.

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 Instituto de Astrofísica de Andalucia, CSIC, Granada, Spain, the Research and Scientific Support Department of the European Space Agency, Noordwijk, We thank the national funding agencies of Germany (DLR), France (CNES), Italy (ASI), Spain (MEC), Sweden (SNSB), and the ESA Technical Directorate

References

[1] Pommerol, A. et al., submitted to A&A. [2] Fornasier, S. et al., submitted to A&A. [3] Pommerol et al., PSS, in press. [4] Poch et al., submitted to Icarus.