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The low strength of 67P: evidence for a primordial nucleus?

O. Groussin (1), L. Jorda (1), A.-T. Auger (1,2), E. Kührt (3), R. Gaskell (4), C. Capanna (1), F. Scholten (3), F. Preusker (3), P. Lamy (1), S. Hviid (3), J. Knollenberg (3), U. Keller (3,5), C. Huettig (3), D. Romeuf (6), H. Sierks (7) and the OSIRIS team
(1) Aix Marseille Université, CNRS, LAM (Laboratoire d'Astrophysique de Marseille) UMR 7326, 13388, Marseille, France
(2) Laboratoire GEOPS (Géosciences Paris Sud), Bat. 509, Université Paris Sud, 91405 Orsay Cedex, France
(3) Institute of Planetary Research, DLR, Rutherfordstrasse 2, 12489, Berlin, Germany
(4) Planetary Science Institute, Tucson (AZ), USA
(5) Institute for Geophysics and Extraterrestrial Physics, TU Braunschweig, 38106, Germany
(6) Université Claude Bernard Lyon 1, France
(7) Max-Planck-Institut für Sonnensystemforschung, 37077 Göttingen, Germany

Abstract

Rosetta is orbiting comet 67P/Churyumov-Gerasimenko since August 2014. The OSIRIS camera [1] onboard this spacecraft has acquired hundreds of images of the nucleus surface, with a spatial resolution down to the decimeter scale [2]. The images reveal a complex nucleus surface made of smooth and hummocky terrains, covered partially or entirely by dust or exposing a consolidated material, pits, cliffs and fractures from the hundred meter scale to the decimeter scale [3]. The nature and origin of these terrains and geomorphological features are far from being understood but remain of paramount importance to better constrain the formation and evolution scenario of the nucleus of 67P and comets in general.

This study focuses on the link between the nucleus gravitational slopes and surface morphology, to provide constraints on the nature of the cometary material and its mechanical properties in particular (tensile strength, shear strength and compressive strength). The derived strengths can also be used to constrain the origin of the nucleus of 67P.

We derive a low tensile strength for the nucleus, typically from a few tens to a few hundreds Pa [4]. Our results tend to favour a formation of comets by pebble accretion in a region of higher concentration of particles like a vortice [5, 6, 7], which implies a gentle formation process by accretion at low velocity on the order of 1 m s^{-1} or less. On the contrary, the hierarchical accretion model with velocities up to 50 m s^{-1} for particles larger than 1 m [8], or the collisional scenario between two large bodies of tens of km or more with an internal compression by gravity larger than 10 kPa [9], although not excluded, are less favored. This points towards a primordial nucleus, which might have not been strongly affected by collisions since its formation.

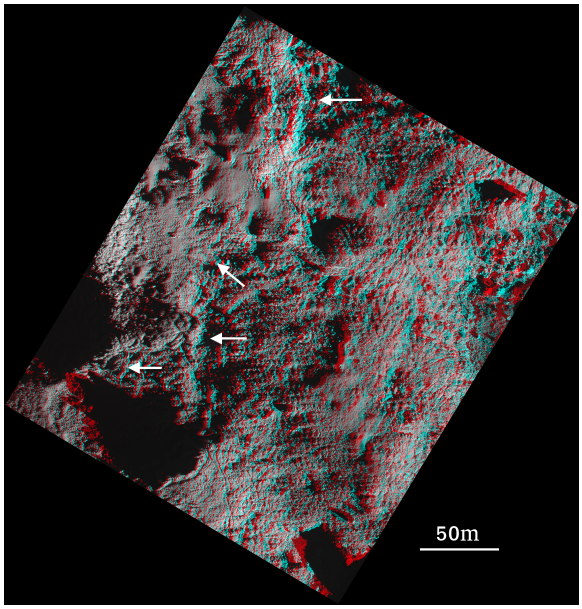

Figure 1: Red/blue anaglyph of overhangs (white arrows) at a high spatial resolution of 18 cm per pixel, in the Maftet region. Image NAC_2014-10-19T13.18.55.

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References

[1] Keller, H. U., Barbieri, C., Lamy, P., et al. 2007, Space Sci. Rev., 128, 433

[2] Sierks, H., Barbieri, C., Lamy, P. L., et al. 2015, Science, 347

[3] Thomas, N., Sierks, H., Barbieri, C., et al. 2015, Science, 347

[4] Groussin, O., Jorda, L., Auger, A.-T., et al. 2015, submitted to Astronomy & Astrophysics

[5] Johansen, A., Blum, J., Tanaka, H., et al. 2014, Protostars and Planets VI, 547

[6] Barge, P. & Sommeria, J. 1995, Astronomy & Astrophysics, 295, L1

[7] Blum, J., Gundlach, B., Mühle, S., & Trigo-Rodriguez, J. M. 2014, Icarus, 235, 156

[8] Weidenschilling, S. 2004, Comets II, 745, 97

[9] Davis, D. R. & Farinella, P. 1997, Icarus, 125, 50