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Identification and Characterization of the landing site of Philae from OSIRIS-NAC Images

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Abstract

On 12 November 2014, Philae rebounded from its first touchdown at the selected Agilka "J" site on the nucleus of Comet 67P/Churyumov–Gerasimenko, an event captured by the Rosetta's OSIRIS narrow-angle camera (NAC [1]). Following two additional bounces, Philae finally landed at the "K" site later named Abydos. Finding its exact location has been a major challenge and could only be indirectly constrained. Thanks to CONSERT measurements, it was finally possible to bound it by an ellipse of approximately 16 x 160 meters. Complementary analyses were performed at CNES-SONC allowing narrowing down the location of Philae to an area of approximately 10 m radius based on illumination conditions and times of contact between Orbiter and Lander during operations. A more precise localization is however hampered by the uncertainties affecting the present 3-dimensional reconstruction (DTM) of the area, presently at the limit of the illuminated part of the nucleus (Figure 1).

Spotting Philae on the images of the nucleus has been even more challenging. The highest resolution images of the region of interest after Philae's landing were obtained by the OSIRIS-NAC in mid-December 2014 at a distance of approximately 20 km, the image scale implying that Philae would at best appear as a few bright pixels. Bright "spots" are however ubiquitous on the surface of the nucleus, from glittering rocks or from local icy patches [2]. After meticulously scanning the region of interest, several candidates were spotted but the ambiguity could only be removed when a pre-landing image of the OSIRIS- NAC collection was identified whose geometric conditions (illumination and viewing) were very similar to one of the post-landing images of 12 December 2014. Although taken at different spatial resolutions, all topographic details match, except for one bright spot present on the post-landing image as shown in Figure 2.

A false detection or an artefact have been ruled out as this candidate was successfully identified on other images taken in mid-December (Figure 2). A local change in the surface is highly unlikely as no activity has been detected on this presently poorly illuminated part of the nucleus. The determined location is remarkably close to that resulting from the indirect constraints, within approximately 10 m, a further validation of the probable detection of Philae. In fact, this solution satisfies all known constraints, taking into account the present uncertainties affecting the DTM.

The Abydos area appears extremely rough with numerous rocks and boulders scattered around, possibly resulting from the local degradation of the rim of the Hatmehit depression. The roughness is confirmed by the large values of the local slopes determined on the present DTM although they are probably underestimated. It is further dramatically illustrated by several anaglyphs constructed from all suitable NAC images of the landing area, thus allowing a stereo view of the local relief.

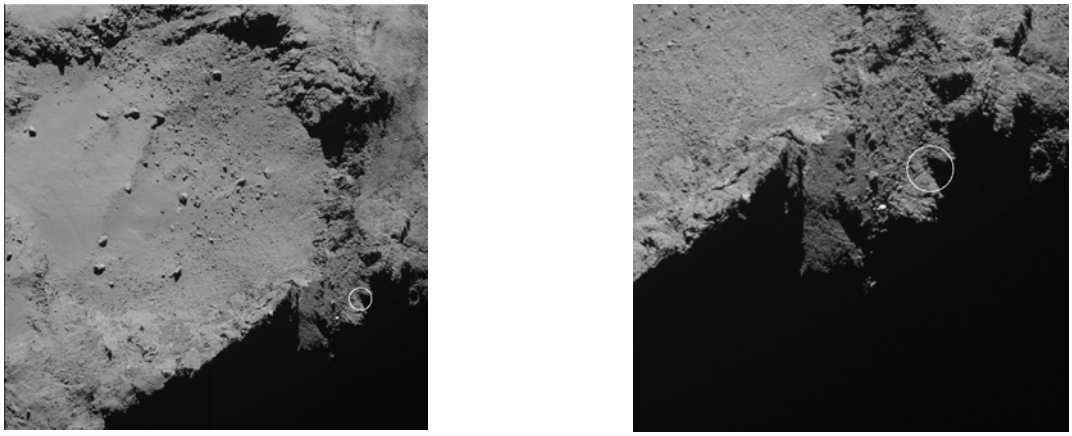

Figure 1: An OSIRIS-NAC image of the small lobe of the nucleus of comet 67P/Churyumov–Gerasimenko showing the large Hatmehit basin and the probable landing zone of Philae best seen on the zoomed sub-image (right panel). The white circles have a diameter of 60 m.

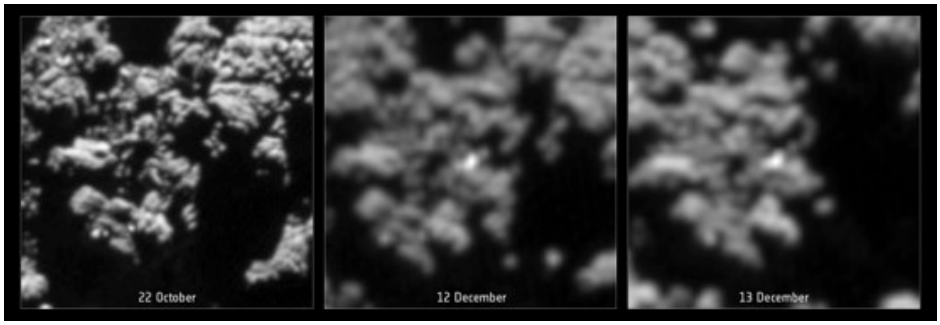

Figure 2: Pre- and post-landing OSIRIS-NAC images illustrating the likely detection of the Philae lander on the surface of the comet. The illumination and viewing conditions, nearly similar on 22 October and 12 December 2014 have already changed on 13 December but still many topographic details can be connected. The original images have been resampled to the same spatial scale. The square images are 20 x 20 m.

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