Comet 67P Dichotomy and Morphology of the Southern Hemisphere from Rosetta/OSIRIS Images. M. R. El-Maarry[1], N. Thomas[1], M. Pajola[2], M. Massironi[3], S. Marchi[4], H.U. Keller[5], S. Besse[6], and the OSIRIS team, [1]Physikalisches Institut, University of Bern, Switzerland (mohamed.elmaarry@space.unibe.ch), [2]Center of Studies and Activities for Space (CISAS), University of Padova, Italy, [3]Geosciences Department, University of Padova, Italy, [4]Southwest Research Institute, Boulder, Colorado, USA.[5]Institute for Geophysics & Extraterrestrial Physics, TU Braunschweig, Germany, [6]Scientific Support Office, European Space Agency, Noordwijk, The Netherlands.

Introduction: The Rosetta mission has been in orbit around comet 67P/Churyumov-Gerasimenko since Aug, 2014 obtaining very high resolution images (down to ~17 cm/px) using the OSIRIS camera [1], particularly for the comet's northern hemisphere (NH). These images have shown the surface of the comet to be incredibly diverse in its texture and geology. A similarly detailed mapping of the comet's southern hemisphere (SH) was not possible before the comet's equinox (in May 2015), almost 80 days before perihelion (in Aug 2015). Nevertheless, the increased activity as the comet came closer to perihelion forced ESA to move Rosetta into larger orbits around the nucleus to protect the spacecraft. These measures, coupled with an excursion at ~1000 km away from the nucleus to carry out scientific investigations of the coma, limited geological investigation of the comet's SH, which has been fully illuminated since perihelion. However, since early Dec, 2015, Rosetta was put again into close orbits permitting detailed investigation of the SH. Here, we describe some of the morphological highlights, which clearly show a morphological dichotomy in 67P's nucleus.

Morphology of the NH: The northern hemisphere is morphologically diverse [2–4] including regions of consolidated, often fractured [5,6], materials of variable strength and cohesion [7], smooth terrains showing aeolian-like landforms [3,4] and seasonal variations [8], dust-covered areas suggestive of an air-fall-like mechanism [9], and irregular large-scale depressions suggestive of massive outburst activities [4]. Associated with these various terrains are a number of interesting features including active pits [10], boulders of variable sizes [11], some of them inferred to be ice-rich [12], pits suggestive of fluidized outflow processes [3,4,13], and numerous terraced outcrops suggestive of global layering [14].

New observations of the SH: The southern hemisphere shows a clear dichotomy with the North showing regionally rougher terrains with little or no smooth deposits. Similarly, dusty coatings that were observed in the northern hemisphere are generally lacking in addition to the absence of large depressions. Overall, the SH shows significantly less topographical variation and looks "flattened out" in comparison to the NH. For example, the steepest cliffs in the SH display a height

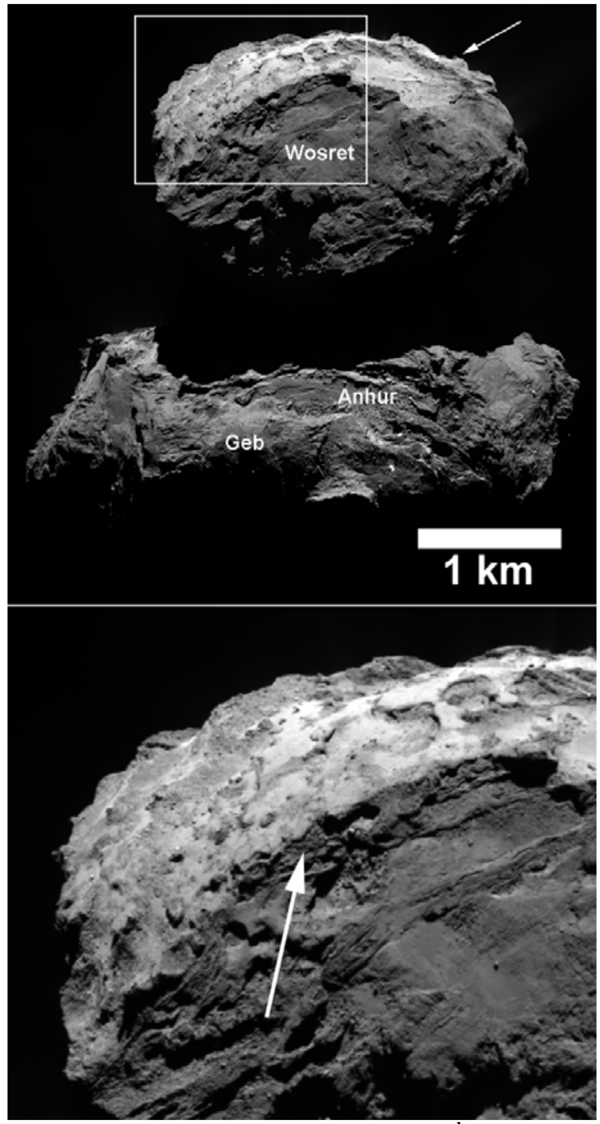

Fig. 1. OSIRIS image taken on May 5th 2015 of the southern hemisphere of comet 67P. [top] The small lobe (upper part) is casting a shadow over the southern neck region. The circular feature in the small lobe (arrow) is the Hatmehit depression [3,4], which is part of the northern hemisphere. The box shows the context for the bottom panel. [bottom] zoomed-in version of the top panel highlighting one of the locations showing the dichotomy between the northern and southern hemispheres (arrow) and the sharp morphological transition.

of ~450 m with respect to the neck region, which is nearly half the height of the opposite cliffs in the NH. On the other hand, the surface of the SH shows numerous textural unconformities possibly indicative of the primordial accressional processes (Fig. 2).

Overall, the general morphology of the SH most closely resembles the NH's consolidated regions. Talus deposits and boulder fields are apparent in localized regions, particularly the neck and parts of the cliffs in the large lobe. While large depressions are markedly absent, there are numerous irregular pits, niches, and alcoves, especially in the cliffs as well as localized fractured areas. One of the most significant fractured regions in the SH is the Wosret region (Fig. 1), which shows long quasi-parallel sets of fractures typically ~300 m-long cross-cut by shorter fractures in a number of locations. The SH displays a neck region (Fig. 3) similar to the NH yet is less obvious due to the lower elevation differences and morphological similarity with surrounding cliffs on both lobes highlighting the fact that no smooth deposits similar to the ones observed in the northern neck region are present. The Khonsu region is another notable region situated in the southern near-equatorial/ mid-latitude region (Fig. 2). It displays a number of irregularly shaped outcrops, which could possibly represent primordial accressional aggregates (arrow in Fig. 2).

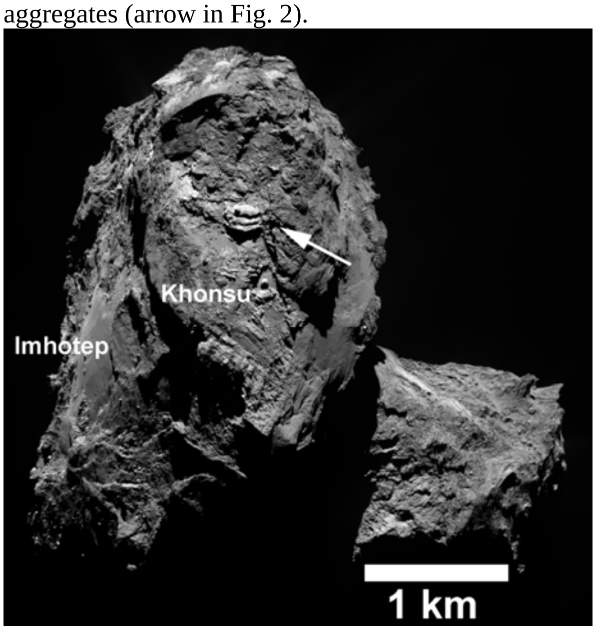

Fig. 2. Another view of the comet's southern hemisphere taken on May 2nd, 2015, showing the Khonsu region. Note the prominent landform (arrow) "sticking out" of the region.

Dichotomy and further insights: The difference in relief between the NH and SH may be explained by the differences in erosional extent between both hemispheres. The SH has a shorter yet more intensive summer (close to perihelion), which could result in levels of erosion in the SH that are up to a factor of 3 higher than that of the NH [15], which could offer an explanation for the observed dichotomy. Another notable difference between both hemispheres is the absence of smooth deposits and dust coatings in the SH. Particle ejection calculations based on gravitational potential models show that the dust coating distribution in the north can be reasonably produced through activity mainly generating from the northern neck region [11]. While the presence of dust coatings in the northern hemisphere appears to be consistent with the dust activity early in the mission that was mainly concentrated in the northern neck, the absence of similar deposits in the south needs further analysis to test a number of hypotheses regarding the morphological differences between the comet's hemispheres.

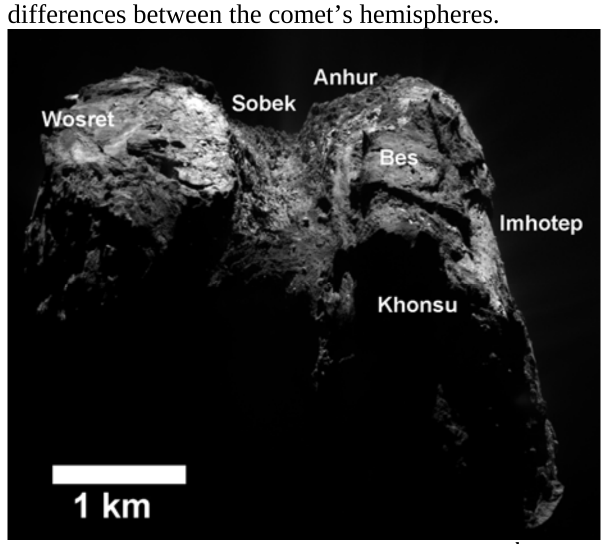

Fig. 3. OSIRIS images taken on July 29th, 2015 showing the southern hemisphere including the neck region (Sobek).

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