EPSC Abstracts
Vol. 13, EPSC-DPS2019-555-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Spectrophotometric characterization of the Philae landing site Abydos with the OSIRIS cameras

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1. Introduction

On 12 November 2014, the Philae lander onboard the Rosetta spacecraft made its historic touchdown on the surface of comet 67P/Churyumov-Gerasimenko (67P), at previously selected site called Agilkia, however the failure of the anchoring system caused the lander to bounce on the surface three more times during about two hours [1] before coming to rest at a location approximatemy one kilometer away from the original location [2]. After four extensive search campaigns that involved multiple instruments onboard Rosetta [3], Philae was unambiguously identified on the nucleus from 2 September 2016 observations with the NAC camera of the OSIRIS imaging system. The final landing site of Philae was called Abydos and it is located at -1.6° longitude and -8.4° latitude [2].

2. Methods

Throughout the length of the mission, the NAC instrument [4] has taken over 1000 images of the Abydos site as well as its neighbourhood, acquired with 1-11 colour filters that cover the 250-1000 nm wavelength range. The images used for our analysis were processed with the OSIRIS standard pipeline up to level 3B, including conversion in radiance factor [5]. When at least 3 different wavelengths were available in a sequence, the images were stacked together in order to create colour cubes.

3. Results

We computed the spectral slope values in the 535-882 nm wavelength range. Per the classification of [6], the terrain of Abydos can be considered averagered as the spectral slope values acquired at phase angles $\sim 50°$ varies between 16.5 and 17.5%/(100 nm). Phase reddening was observed both before and after the 2015 perihelion passage. Through comparisons of spectral slope values obtained at similar phase angles, we found that the Abydos site became spectrally bluer during perihelion and reddened again as the comet moved away from the Sun. This behaviour was also observed in other regions, and was attributed to the seasonal cycle of the comet: the surface dust was removed during the perihelion activity, exposing the more volatile-rich layers below [7].

Bright patches of volatiles were frequently observed around Abydos, a few survived for several months. Some spots are 3-6 times brighter than an average dark terrain depending on wavelength. Frosts residing on shadowed surfaces were also observed, but only in post-perihelion images in May 2016, as similarly observed in other regions of the comet. The frost asymmetry may be attributed to the thermal lag that followed the perihelion passage, and may indicate that the dust fall after the perihelion passage still preserved some water ice [8].

Cometary activity appeared to be scarce in Abydos and its surroundings, and only one cometary jet was clearly identified from this area.

4. Summary and Conclusions

OSIRIS/NAC observations of the Abydos site reveal a moderately red terrain that experienced color variations as the comet approached perihelion in 2015. This area showed some volatiles exposures, however it was not particularly active compared to other regions. In the future months, we will continue the research on Abydos looking for possible morphological changes and to characterize its photometric properties.

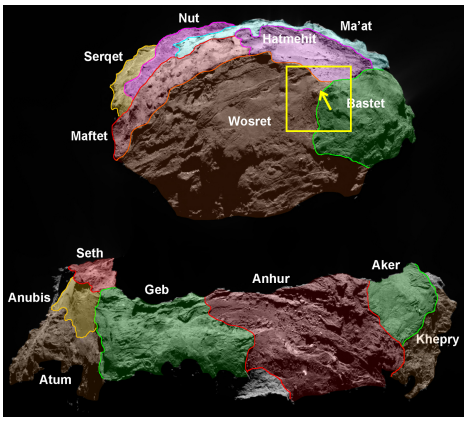

Figure 1: The southern hemisphere of comet 67P superposed with regional boundaries. The box covers the 5° radius around the Abydos site, which is indicated by the arrow. The base image is from [9].

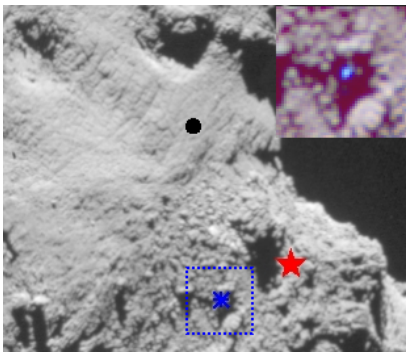

Figure 2: A portion of the 5° neighborhood of the Abydos site as captured by the NAC/F22 filter on 27 January 2016, 21h22. The red, black and blue symbols respectively represent Abydos, a reference dark terrain and a bright spot (shown in the inset, which is a 2x magnification of a color composite of the area inside the blue dotted square). Spatial resolution: 1.3 m/px.

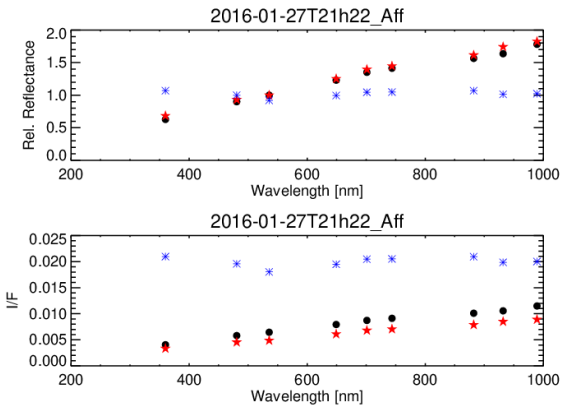

Figure 3: Spectra of the regions of interest shown in Fig. 2. The radiance factor was acquired at a phase angle of 62.7°, and it has been corrected with the Lommel-Seelinger law.

Acknowledgements

OSIRIS was built by a consortium led by the Max-Planck- Institut für Sonnensystemforschung, Goettingen, Germany, in collaboration with CISAS, University of Padova, Italy, the Laboratoire d'Astrophysique de Marseille, France, the Instituto de Astrofísica de Andalucia, CSIC, Granada, Spain, the Scientific Support Office of the European Space Agency, Noordwijk, The Netherlands, the Instituto Nacional de 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 Universitat 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. The authors acknowledge the financial support from the France Agence Nationale de la Recherche (programme Classy, ANR-17-CE31-0004).

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