Origin(s) of the local structures at the Philae landing site and possible implications on the formation and evolution of the 67P nucleus

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Abstract
The in situ images of the 67P/Churyumov-Gerasimenko nucleus acquired by the CIVA cameras on-board PHILAE revealed a rough, irregular and inhomogeneous terrains dominated by fractures and agglomerates of consolidated materials. While the composition of these materials is unknown, they provide unique structures to constrain the conditions prevailing at the surface of a comet and also possibly to the nucleus formation. A quantitative analysis of some microscopic structures (namely fractures and grains that look like pebbles) will be presented using a manual extraction from the CIVA data set with the software ArcGIS. Fractures/cracks are rather ubiquitous at various spatial scales with network and size (from sub-cm to 10 cm) well correlated to the texture of the landscape. The pebble size distribution are reasonably well fitted by power-laws having different cumulative indexes. The nature of the landscape of the landing site will be then discussed in relation to both endogenic and exogenic processes that could have sculpted it. The block seen in CIVA#1 is interpreted to be a close-up of fractured boulders/cliff belonging to the boulder field identified from the orbit near Abydos, this boulder field being itself the result of gravitational regressive erosion due to sublimation (Lucchetti et al. 2016). The observed fractures are best explained by thermal insolation leading to thermal fatigue and/or to loss of volatile materials (e.g., desiccation). This surficial fragmentation (up to >10 cm length) could generate macroscopic erosion that is also visible at larger scale from the orbit. While the pebbles are difficult to be formed by any current physical processes, there is at least an intriguing possibility that they are remnants of primordial accretion processes, as there are several lines of evidence that the nucleus could be primordial (Davidsson et al., 2016), and not a collisional rubble piles of a large body (Morbidelli and Rickman A&A, 2015). We thus speculate that the Abydos landscape could be in favour of pebble accretion model instead of runaway coagulation model with a formation location in the outer region of the Solar System.