Evolution of cometary surfaces. J.-B. Vincent[1] and the OSIRIS team, [1]DLR Institute of Planetary Research, Berlin, Germany, jean-baptiste.vincent@dlr.de

Introduction: Cometary surface evolution is mostly assumed to be driven by the sublimation of volatiles in the subsurface when the nucleus is in the inner Solar System. Rosetta has shown that evolution is more complex, with cometary surfaces changing through many different processes, epochs, time scales.

Large scale changes: Recent work based on the analysis of several comets visited by space missions suggests that the large scale topography of cometary nuclei is mostly controlled by events which took place in the Early Outer Solar System [1, 2]. Tall cliffs and deep pits are more likely to be the outcome of impacts in the primitive Kuiper Belt or large scale outbursts when the comet was in its Centaur phase, rather than being due to the current sublimation.

Indeed, water driven activity (<3AU) tends to not carve large features in the surface, but instead breaks apart the topography in smaller features, until the surface is dominated by a smooth layer of pebbles and dust (e.g. comet 103P/Hartley 2). Therefore, the large scale roughness of cometary nuclei provides a measure of how evolved the surface is, and can be used as a crude datation tool to assess how long a comet has been in the inner Solar System [2, 3].

Small scale changes: During its two years stay around comet 67P, Rosetta observed only a handful of large scale changes, with most modifications being very localized: cliff retreat, deflation of smooth terrains, transport of a few decameter-size blocks, expansion of a few fractures. This seems too little when compared with the observed activity.

Using a dedicated mapping tool and a new algorithm designed for automating the detection of surface changes [6], we are now able to extend our coverage of surface changes to the smallest scale (<1m) on the whole nucleus. Our technique reveals that while most of the large scale morphological features have remained unchanged, the small scale topography is completely different.

After processing OSIRIS[9]-NAC images acquired before and after, we are detecting several thousands changes, ranging from the redistribution of dust in local ponds, to the possibly thermally induced breaking of blocks, or the opening of small pits (10 m diameter) in conjunction with fracture expansion and/or outbursts.

We will present a review of the surface evolution at different scales. We will discuss what large scale changes tell us about the early life of comets, and how small scale changes inform us on the current physical processes.

References: [1] Vincent et al, *Nature* (2015); [2] Vincent et al, *MNRAS* (2017); [3] Birch et al, *MNRAS* (2017); [4] Thomas et al, *Icarus 222* (2013); [5] El Maarry et al, *Science* (2017); [6] Vincent et al, *LPSC* (2018); [9] Keller et al, *SSR 128* (2007)

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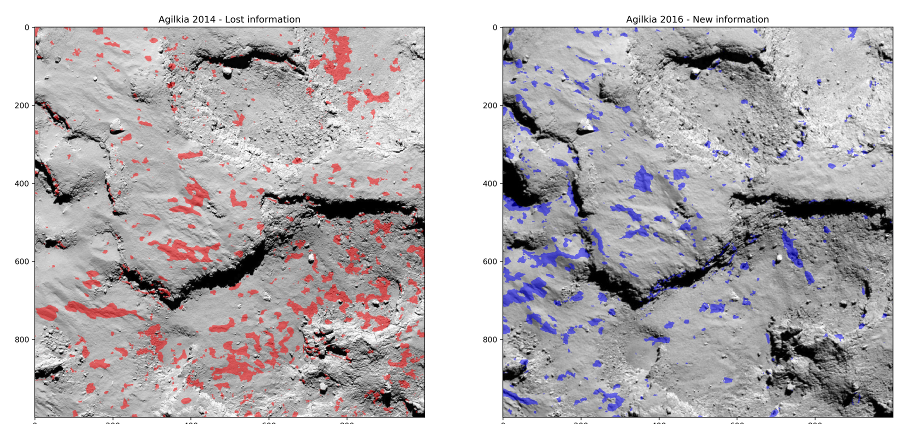

Automatic change detection on nucleus-referenced images of Agilkia region (comet 67P)