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Meter-scale polygons on 67P/Churyumov-Gerasimenko as evidences of near subsurface water ice

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Abstract

Since August 2014, high spatial resolution images of the nucleus of 67P/Churyumov-Gerasimenko have been acquired by the OSIRIS camera on board the Rosetta spacecraft, enabling to identify meter-scale features on the surface. Among them, we identify polygons with a size from 2 to 20 meters. We define the polygons on 67P as high-centered thermal contraction polygons, which further evolve through preferential sublimation along the cracks. This kind of polygons are known on Earth and Mars as evidences of permanent water ice table in the near subsurface [1,2,3].

1. Introduction

Polygons are landforms associated with frozen environment that can be observed on Earth and Mars at high latitudes [1,2]. They formed when the thermal stress of the ground surface exceeds the tensile strength of the frozen ground, forming fractures [3]. This thermal contraction cracking produces episodic fracture expansion, which develops into a polygonal network. This process creates a population of proximal polygons with variable trough depths and sizes from typically a few meters to tens of meters [4].

We present here our detection of putative thermal contraction polygons on the surface of the nucleus of 67P [5], their morphological characteristics (size and shape) and how they are distributed on the nucleus surface.

2. Polygon identification and distribution

Using the morphological criteria defined by [4] and similarities with terrestrial and martian analogs, we identified putative polygons using OSIRIS images with a minimum resolution of 50 cm/px (Fig. 1). Polygons have elevated centers/sloping margins, with a few meters size. These morphologies are typical of sublimation polygons [2,3], which are formed by thermal contraction and evolve by preferential sublimation along the thermal cracks.

We mapped the polygons on the images in order to determine their size distribution, and we located them on the global shape model of the nucleus [6].

3. Results, discussions and conclusions

The global size distribution shows polygons with variable sizes from 2 m to 20 m, with a mean value of 7 m. The size and shape of thermal contraction crack polygons is determined by complex interactions between water ice content, cooling history and other mechanical properties of the soil [3]. Sublimation polygons form in a material that has water ice excess content in the subsurface [3]. [7] use a numerical model related to the martian environment and climate to evaluate the ice content and ice table depth from the polygon size.

In this paper, we will address the following questions:

- Is there a variability of the polygon shape and size depending on their location on the nucleus (e.g., illumination conditions, local inhomogeneities)?

- What is the ice table depth constrained by the observations?

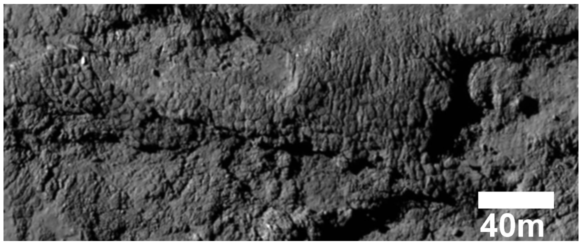

Figure 1: NAC image of the Apis region of 67P showing high-centered polygons [8].

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