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Putative volcanic landforms on Ceres

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Abstract

In the first RC2 and OpNav7 images of Dawn's approach at Ceres a number of intriguing landforms are observed, which potentially have formed by volcanic activity. These and subsequently discovered features will be monitored and validated on higher resolution datasets as acquired later in 2015.

1. Introduction

On March 6, 2015 the Dawn spacecraft was captured by Ceres' gravity field. Several optical navigation (OpNav) and rotation characterization (RC) observations were acquired during approach phase by the Framing Camera (FC) [1, 2]. In this preliminary study we used images of RC2 and OpNav7 campaigns taken on February 19, 2015 and April 15, 2015, respectively. We present and describe landforms that may have formed by volcanism. Pending further high-resolution image surveys, tentative comments are made regarding the nature of volcanism.

2. Data and methods

At the Max Planck Institute for Solar System Research RC2 and OpNav7 images have been processed and were resampled to resolutions of 2 km/px and 1.5 km/px, respectively. Of particular interest are those images acquired at low solar elevation (i.e., high incidence angle). Individual images are analyzed using USGS ISIS and ESRI's GIS environments. Elevation data are derived from the shape model provided by Nickolaos Mastrodemos (JPL).

3. Morphology

The surface of Ceres shows a variety of landforms including impact craters and basins, lineaments, and smooth and rough textured terrains. Current geological activity is manifested by bright spots, where presumably water sublimates [3].

At low solar elevation, a number of intriguing positive relief features are observed resembling cones and/or low-relief shields and domes. Three examples are provided below.

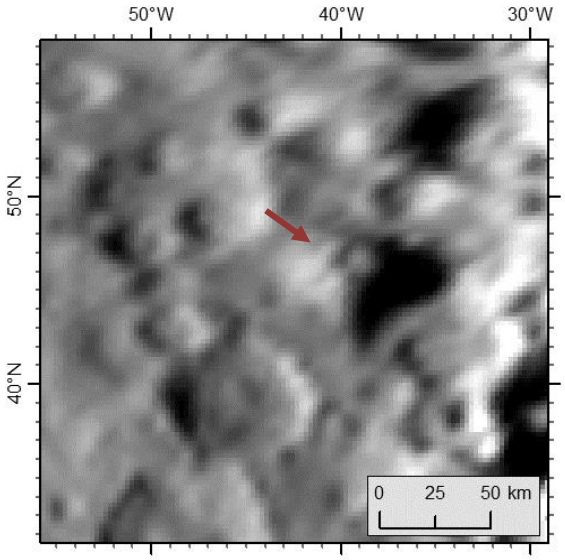

Figure 1: Site 1 – isolated, up to 4 km high mountain.

At 47.5°N/319.3°E[1] (site 1) an isolated mountain with a basal diameter of ~40 km and a height of up to 4 km is observed (height estimate is based on the shadow cast method [4, 5]). Near the summit a crater exits (Fig. 1). At site 2 (15.8°S/5.8°E[1]) two landforms are observed. At the lower centre a c.50-

km diameter flat-topped dome is present. About 50 km to the north, a broad S-shaped, flat-topped ridge with steep margins is observed (Fig. 2). Site 3 shows the largest impact basin observed so far on Ceres. The c.273-km diameter basin has a pentagonal outline with the northwestern rim being partially buried and dissected (Fig. 3). The basin interior and exterior (particularly to the west) is characterised by smooth-textured infill. The basin centre is marked by a c.26-km diameter pit. The basin floor shows a high-relief with the lowest point at the centre located approx. 5-6 km below elevated portions of floor materials. At the western rim a set of five small domes or cones is present.

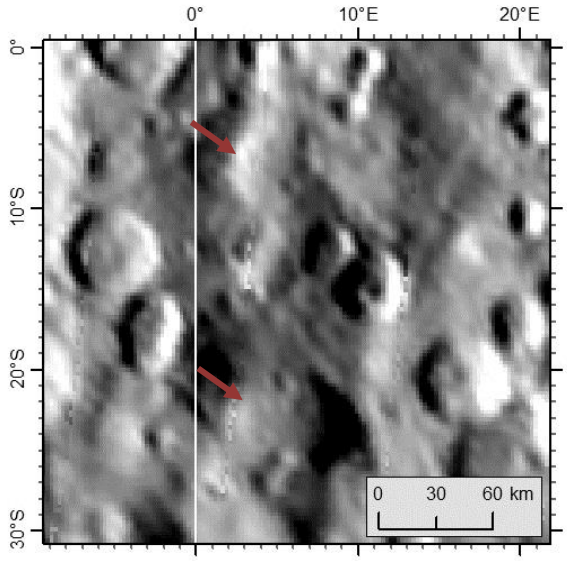

Figure 2: Site 2 – flat-topped dome (lower arrow) and ridge (upper arrow) near the prime meridian (white vertical line).

4. Preliminary conclusions

Ceres experienced a complex resurfacing history indicated by smooth-textured terrains in the vicinity of the c.273-km diameter basin. These smooth terrains lack mid-sized impact craters when compared to the overall crater population suggesting portions of this population were erased or buried. Though impact-related resurfacing could be the primary process, observed landforms, however, also suggest an endogenous process. At present, available imagery cannot resolve detailed morphological features, and therefore, cannot clearly link described landforms to a volcanic origin. The overall morphometry (i.e., height and slopes) of landforms, however, points to an endogenous formational process. If a volcanic origin is substantiated following higher resolution Survey, HAMO, and LAMO image analyses, the type of volcanism—silicate/carbonaceous, mud and/or cryovolcanism—need to be assessed. At the EPSC we present new data and results from Survey and HAMO campaigns.

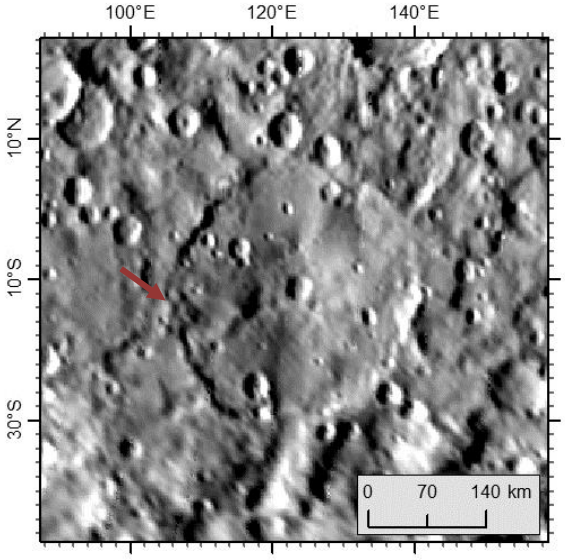

Figure 3: Site 3 – large infilled basin. Arrow points to a group of cones.

5. References

[1] Russell, C.T., and Raymond, C.A., 2012, Space Sci. Rev., 163, 3–23. [2] Sierks, H. et al., Space Sci. Rev., 163, 263–328, 2012. [3] Nathues, A. et al. EPSC 2015, #60115. [4] Pike, R.J., Geophys. Res. Lett., 1, 291–294, 1974. [5] Pike, R.J., 11th Proc. Lunar Planet. Sci. Conf., 2159–2189, 1980.

[1] provisional coordinates