The Morphology and Albedo of Dark Material on Vesta

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Abstract

In this work we present the current state of dark material characterisation focussing on the morphology and relation of dark material distribution with other main features on Vesta, such as the prominent south pole impact craters. We include the information of digital terrain models (DTM) and photometrically corrected maps of Vesta and find that dark material is correlated to old impacts.

1. Introduction

The spacecraft DAWN, launched in September 2007, was designed to visit the two largest asteroids in the main belt: Vesta and Ceres. In July 2011 it reached Vesta and until August 2012 it is in orbit collecting data with three instruments on board: The Framing Camera (FC) [6], the Visible and Infrared Spectrometer (VIR) [5] and the Gamma Ray and Neutron Detector (GRaND) [2]. These instruments produce significant data which gives new insight to the characteristics of Vesta's surface composition and morphology.
One of the new discoveries is the occurrence of low albedo features, so called dark material. It was first detected by the framing camera [1, 4]. Here we concentrate on the FC data to investigate the reflectance and morphological properties of dark material to get a better understanding of its origin and deposition.

2. Types of Dark Material

In a first step, we divided the occurrence of dark material into five categories: dark material on hills, dark material exposed in crater rims, dark material exposed in crater walls, dark ejecta and dark spots. We also see dark material aligned in a linear pattern around the crater of Marcia and occurrence of dark and bright material in a common crater. Figure 1 shows examples of these types.

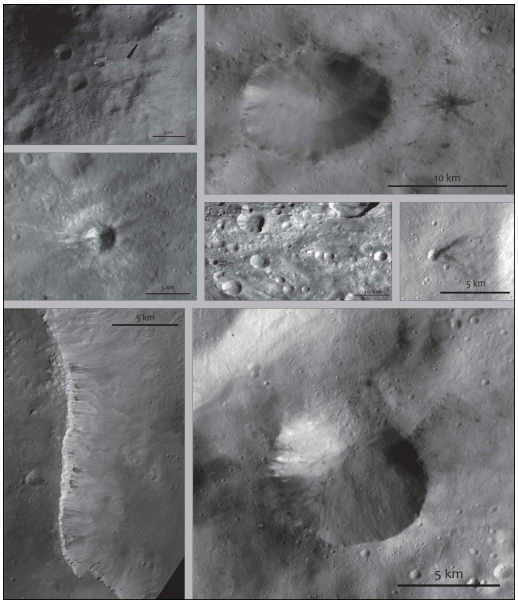

Figure 1: Examples of different types of dark material found on Vesta. The upper left picture shows dark material exposed on a hill. The upper right one is a crater with little dark spots around it and a bigger spot to the right. In the centre row the pictures display from left to right dark and bright material, linear features (higher contrast picture) and dark ejecta. The bottom left picture shows the crater wall of Marcia with dark material emanating from a subsurface layer. The bottom right picture exhibits dark material flowing down a crater from its rim. It also shows dark ejecta and spots.

3. Geomorphological Context

For information about the geomorphological context of dark material on Vesta, we marked the different types on two projections, an equidistant global and a stereographic south polar map. Additionally we underlaid a digital terrain model (DTM) [3] and added the outline of old craters. Figure 2 illustrates this.

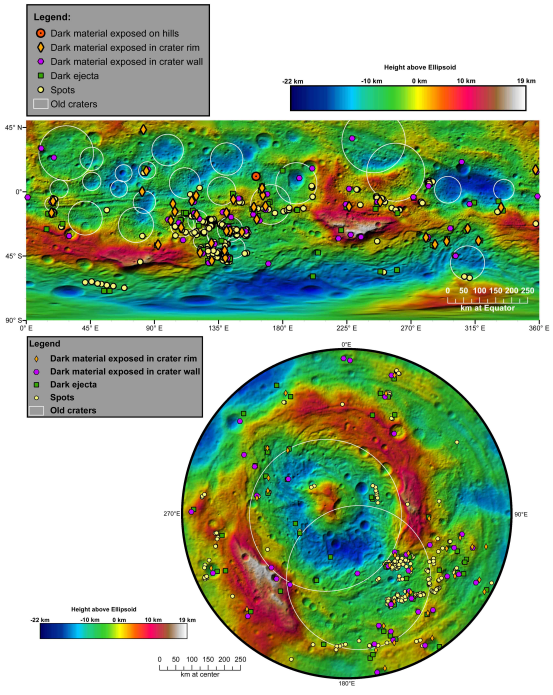

Figure 2: The distribution of types of dark material and old craters on an equidistant global (top) and a stereographic south polar (bottom) DTM.

Dark material to some extent clusters in regions around old craters suggesting an origin associated with impact events. This might be due to excavation processes of the impact or the projectile.

4. Albedo

For a more qualitative understanding of dark material we mapped different reflectance with the help of photometrically corrected maps of Vesta. They show that Vesta's mean albedo is given by 0.32.
The photometrically corrected maps show a correlation of dark material and impact events. Especially the northern rim of Veneneia has lower albedo and clustering of dark material. This, and the morphological mapping (Fig. 2), might suggest that the origin of dark material in the northern hemisphere is associated with Veneneia's impact event. However it is unclear whether it is excavated endogenous or distributed exogenous material.

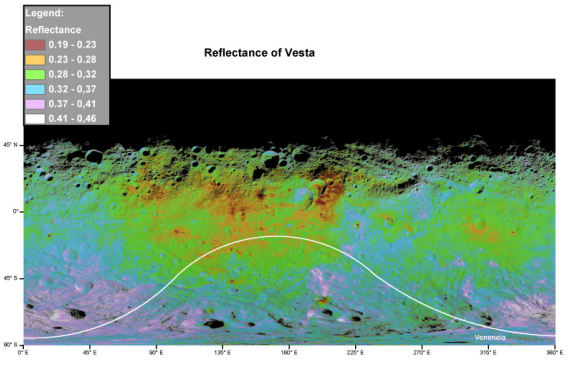

Figure 3: The distribution of dark material on Vesta on an equidistant map. The coloured steps are one standard deviation of Vesta's albedo. The outline of Veneneia's rim is sketched.

5. Summary and Future Work

We found a relation between the distribution of dark material and old craters on Vesta. Especially the ruined rim of Veneneia seems to be associated with dark material. This might suggest that it originates from the impact event as endogenous or exogenous material.
Upcoming high-resolution images will provide a better understanding of the correlation of dark material and surface features on Vesta and will help to analyse the origin of dark material.

References

[1] Jaumann, R. et al.: Vesta's Shape and Morphology, Science, Vol. 336, pp. 687-690, 2012.

[2] Prettyman, T. et al.: Dawn's Gamma Ray and Neutron Detector, Space Sci Rev, Vol. 163, pp. 371-459, 2011.

[3] Preusker, F. et al.: Topography of Vesta from Dawn FC Stereo Images, LPSC, 19–23 March 2012, The Woodlands, TX, USA, 2012.

[4] Reddy, V. et al.: Color and Albedo Heterogeneity of Vesta from Dawn, Science, Vol. 336, pp. 700-704, 2012.

[5] De Sanctis, M. C. et al.: The VIR Spectrometer, Space Sci Rev, Vol. 163, pp. 329-369, 2011.

[6] Sierks, H. et al.: The Dawn Framing Camera, Space Sci Rev, Vol. 163, pp. 263-327, 2011.