EPSC Abstracts
Vol. 13, EPSC-DPS2019-1395-1, 2019
EPSC-DPS Joint Meeting 2019
© Author(s) 2019. CC Attribution 4.0 license.

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Volatile related mass-wasting features on Ceres and Vesta

R. Parekh(1,2), K.A. Otto (1), R. Jaumann (1,2), K.D. Matz(1), T. Roatsch(1), E. Kersten(1), F. Preusker(1), Carol Raymond(3)
(1) DLR Institute of Planetary Science, Berlin, Germany, (2) Freie University of Berlin, Germany,(3) Jet Propulsion Laboratory, California, USA. (rutu.parekh@dlr.de)

Abstract

Various mass wasting features have been identified on Vesta and Ceres with prominent slumping regions, lobate materials, concentric ridges, and curvilinear edges. In this study we present a common classification of these features based on their morphological signatures. Our aim is to relate the mass wasting processes of the two bodies given their different surface compositions but similar environmental conditions.

1. Introduction

With high resolution data availability, it is possible to assess and analyse the geological features of various planetary bodies accurately. NASA's Dawn mission is one of the most successful missions which enabled us to carry out scientific analyses of the surface of Vesta and Ceres. Although Vesta and Ceres are compositionally and dimensionally different (e.g. Vesta is dry while Ceres possesses water in the interior, Vesta's diameter is 500 km while Ceres diameter is 950 km), they have some attributes, such as heliocentric distance (~2.5 AU) and surface acceleration (~0.25 m/s²) in common. These properties affect the dynamics and morphology of mass wasting features and give us the unique opportunity to analyze the influence of volatiles in the regolith on the mass wasting process. Using HAMO (resolution: 70 m/pixel for Vesta, 120 m/pixel for Ceres) and LAMO (resolution: 20 m/pixel for Vesta, 70 m/pixel for Ceres) data sets, we aim to assess the influence of the volatiles on material mobility and mass-wasting morphologies.

In this study we report on the mass-wasting features on both asteroids at a global scale. For Vesta, mass wasting has been reported for the southern regions [1,4] and for Ceres, global mapping of mass-wasting features has been carried out [3], however, with the help of recently available datasets we are able to identify a few more mass-wasting features.

2. Method

For the identification of mass movements, low resolution HAMO mosaics (~90-130 m/pixel) have been used for Vesta and Ceres. For the detailed investigation of the morphology of mass movements and classification the LAMO mosaics (~20-70 m/pixel) were considered. Several researchers have contributed to landslide classifications, however, in our study we used mass movement classification system developed by European research group[1], which divides mass wasting process into 7 classes, namely: Fall, topple, transitional slide, rotational slides/slump, lateral spreading, flow and complex movements [1]. Due to limitations in the resolution and sometimes inadequate acquisition angles of images some of the areas were tagged as probable mass wasting regions.

3. Results

Out of 7 classic examples, we could identify 3 different types of mass wasting movements on Vesta and Ceres. Most of these mass-wasting features are related to impact craters, where the steep crater walls provide low stability conditions. Both the bodies show the following types of landslides, however, in the case of Vesta a number of slumping features are larger compared to Ceres.

3.1 Translational slide: Transitional slides are features with well-preserved signatures of spurs/gullies at the crater rims and talus material spread at the bottom of the rim and the crater floor (Fig.1B). They are the most common type of landslides on Ceres.

3.2 Rotational slide/slump: These are one of the most prominent mass movement type

identified on Vesta. A minor scarp with a crown of dropped material creates a step like profile (Fig.2B). When taking topographic profiles, they show notable step-like topography.

3.3 Flow-like slides: This type of movement is sub classified into sheet spreading and lobate of tongue formation. On Ceres and Vesta, both types were successfully identified [2,3], however, they are most prominent in the southern part of Vesta. In our investigation of Vesta, we also identified similar sheet spread flow features nearby crater rims, which may, however, be related to ejecta blankets and ejecta deposition.

4. Discussion

Although Vesta and Ceres have similar surface accelerations, mass wasting processes appear in different forms and morphologies on the two bodies. This difference in morphology is most likely caused by the diverse surface material properties, with Ceres being relatively wet and Vesta a dry asteroid. Slumping is most likely to occur with cohesive material [1] whereas; transitional slides are common in the case of granular material [2]. Thus, we plan a detailed investigation of surface properties and physical parameters (e.g. H/L value, spreading coefficient) of both asteroids. Envisaged measurements of landslide morphologies for Vesta and Ceres and will enable us to correlate these values to the regolith volatile abundance.

5. References

[1] Dikau, R.., Brusden, D., Schrott, L., Ibsen, M-L (eds): Landslide recoganisation, identification, movement and causes, Wiley, 1996.

[2] Otto, K et al.: Mass-wasting features and processes in Vesta's south polar basin Rheasilvia, JGR:Planet, Vol. 118, pp. 2279-2294, 2013.

[3] Schmidt, et al.: Geomorphological evidence for ground ice on dwarf planet Ceres, NatureGeoscience, Vol. 10,pp.338-343,2017.

[4] Krohn, K et al.: Mass movement on Vesta at steep scarps and crater rims, Icarus, Vol. 244, pp. 120-132, 2014.

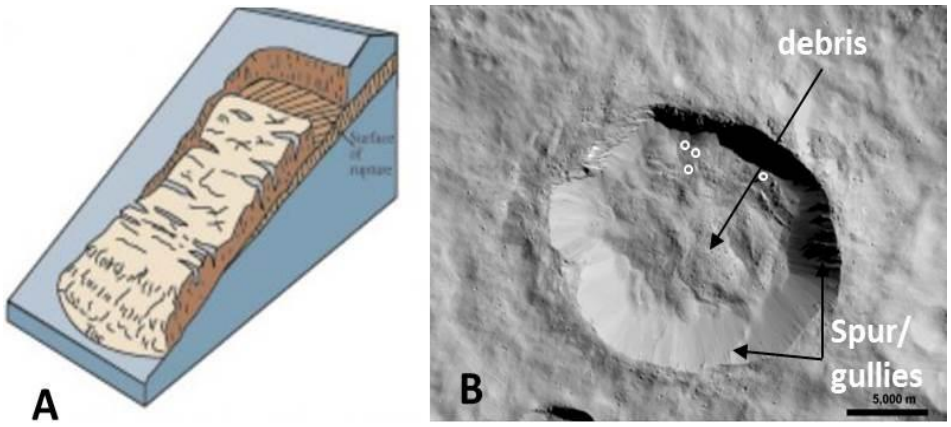

Figure 1: A. Schema of a transverse slide where material moves downward. The fresh deposit surface is distinguishable from the detached surface. (https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html)
B. Transverse slide on an unnamed craters (lat: 23°S, lon: 279°E) on Ceres where a bulge of material has covered the crater floor. Moreover, some of the boulders (white circles) were also identified at the bottom of the crater wall and in the deposit area.

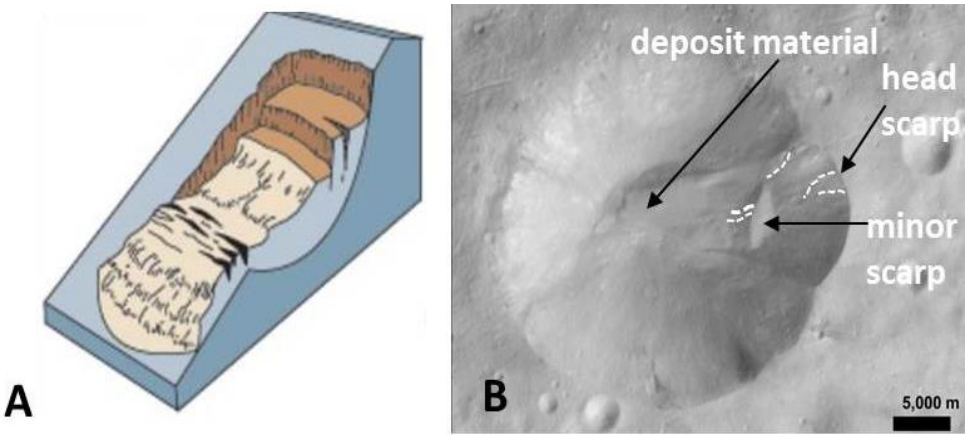

Figure 2: A. Schema of a rotational slump. Detached material is roughly circular at the toe and a step-like topography has formed. (https://pubs.usgs.gov/fs/2004/3072/fs-2004-3072.html)
B. Rotational slide on Octavia (lat:2°S, lon:146°E) on Vesta. The head of the dispatched material is clearly visible with a minor scarp between the failed part and the main terrain, material travelled and deposited in the center of the crater; striations (white lines) are parallel to the material movement direction.