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Ejecta of small fresh impact craters on asteroid Vesta

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1. Introduction

In order to further understand the composition of the upper as well as lower parts of Vesta's crust, small impact crater (< 10km in diameter), which show distinct ejecta and thus represent unweathered surface areas, have been identified and their spectral properties investigated with respect to their geological and geomorphological context [1]. The study was performed based on data acquired by the Visual and Infrared Spectrometer (VIR) [2], which observed Vesta's surface between 0.25 and 5.1µm with a pixel ground resolution of ~60 m/pixel. The geological and geomorphological context is provided by images acquired by the Framing Camera (FC) with a pixel ground resolution up to 20 m/pixel [3].

2. Spectral properties and geo-logical implications

The ejecta blankets of small fresh craters appear bright or dark in the visible light with a sharp contrast to the surrounding region. Bright ejecta are dominated by howardite-like material as expected for Vesta's crust and/or ejecta of the southern impact basin Rheasilvia, which cover most of Vesta's southern hemisphere. Dark ejecta associated with dark impact craters do not show a different pyroxene composition than the bright ejecta but an additional strongly absorbing, spectrally neutral compound, supporting an origin from carbon-rich impactors.

Mostly, the crater itself is characterized by a similar albedo such as the ejecta. Only a few impact craters show bright ejecta and a dark crater floor. Few of these impact craters could be identified to contain material that resembles diogenites, which are expected to exist in the deeper parts of Vesta's interior. One of these impact craters is directly located at Matronalia Rupus (Fig. 1) allowing a direct view into the subsurface. This scarp is known to mark the rim of the Rheasilvia impact basin.

Intriguingly, both type of materials, i.e. the bright ejecta as well as the darker slumping material extending from the crater floor appear yellow in the ratio color composite classifying them as fresh (Fig. 1). Both materials also show a pronounced pyroxene signature (Fig. 2), which is contrary to the variations in the spectral properties elsewhere on Vesta's surface. Usually, bright material corresponds to a strong pyroxene signature with deep absorptions near 1 and 2µm, whereas this signature is surpressed, where the visible albedo is low. Finally, VIR spectra show a possible slight shift in the position of the 1µm-pyroxene absorption toward shorter wavelength. This points a diogenitic composition of the material in the crater and the slump (Fig. 2).

The spectral variations mirror the global trend with a more diogenitic composition in the Rheasilvia basin and an eucrite-/howardite-like composition in the geologically older densely cratered equatorial region. This points to the interpretation that the bright ejecta might be related to the Rheasilvia basin whereas the darker material resembles excavated in-situ subsurface material. This interpretation is strengthend by the fact that the bright ejecta were formed only in the western part of the small impact crater in the direction of slightly higher elevation (Fig. 3) possibly representing an addional upper surface layer of former ejecta of Rheasilvia newly excavated.

References

[1] Stephan, K. et al. (2013) A compositional and geological view of fresh ejecta of small impact craters on asteroid 4 Vesta. submitted.

[2] De Sanctis et al. (2011), The VIR Spectrometer, Space Science Reviews, 163, 329-369.

[3] Sierks, H., et al. (2011), The Dawn Framing Camera, Space Science Reviews, 163, 263-327.

3. Figures

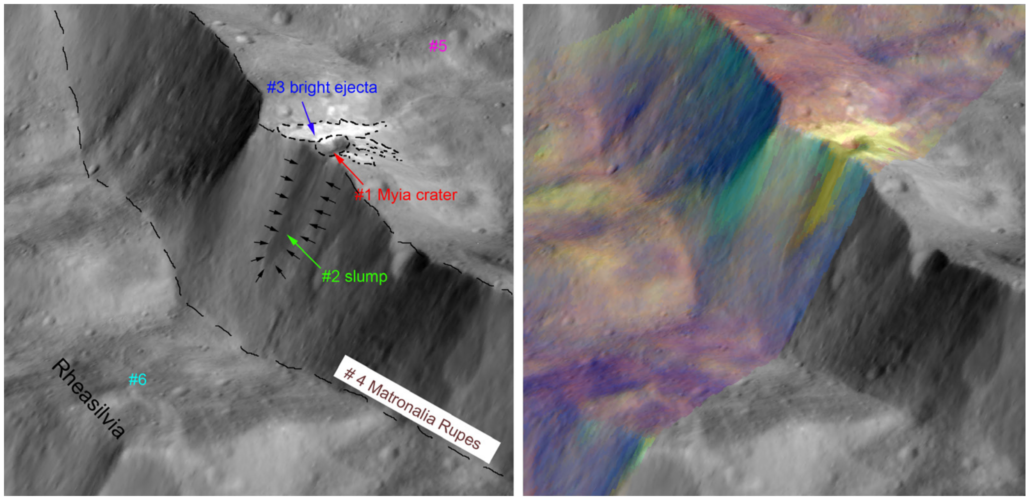

Fig. 1: Small fresh impact crater as seen (a) by the FC CLEAR filter and (b) using a ratio color composite of the VIR channels at 749/438nm (Red), 749/917nm (Green), and 438/749nm (Blue) on top of the DTM derived topography.

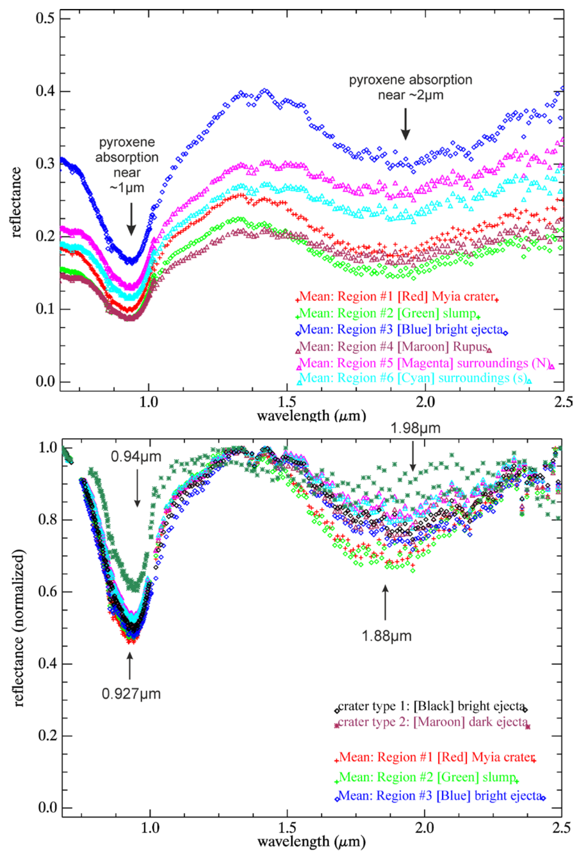

Fig. 2: Average VIR spectra of the geological and geo-morphological surface units (see Fig. 1).