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Fresh impact crater ejecta on asteroid 4 Vesta – a geological and compositional fingerprint

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1. Introduction

As part of the analysis of Vesta's surface composition and geology in the region of the prominent impact crater Sextilia (~39°S/146°E) [1, 2] small (< 3km in diameter) morphologically fresh impact craters with distinct ejecta blankets become apparent. The ejecta either represent excavated subsurface material without significant spectral changes due to space weathering or at least partly remnants of the impactor itself. A detailed analysis of the geological and spectroscopical properties of these impact craters and their ejecta has been performed in order to: 1) characterize the spectral properties of the impact ejecta and 2) investigate the sub-surface composition of the regolith.

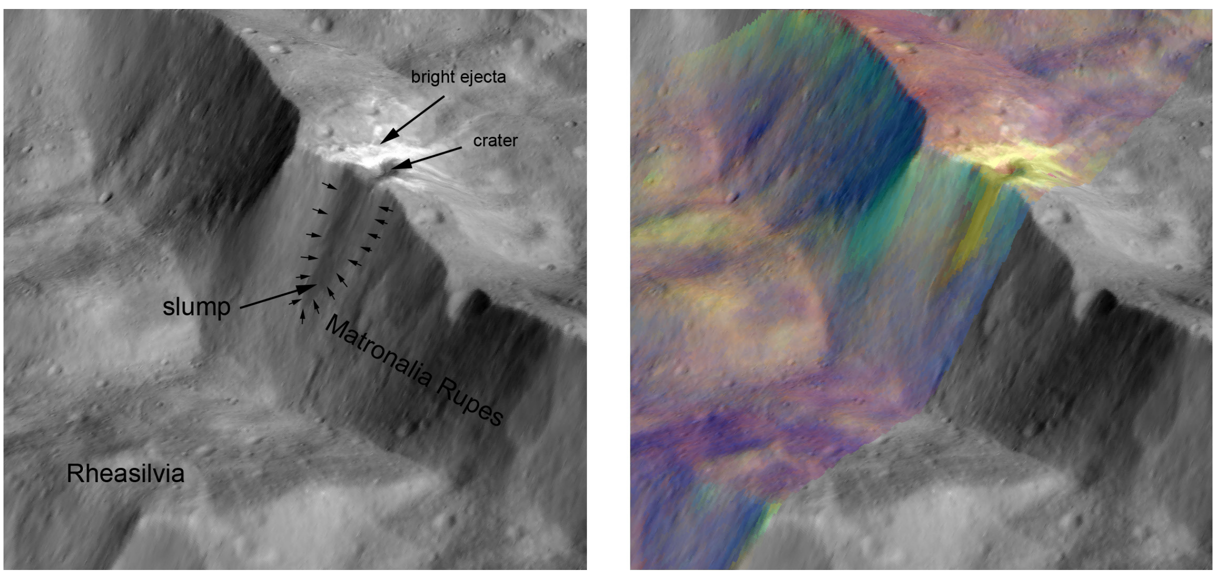

Figure 1: Small fresh impact crater as seen (a) by the FC CLEAR filter and (b) using a ratio color composite of the VIR channels at 749/438nm (Red), 749/917nm (Green), and 438/749nm (Blue) on top of the digital terrain model (DTM).

2. Spectral indicators:

Different surface materials are identified by their visible albedo, the position and depth of prominent absorptions and covariance statistics as well as by combining ratios of different spectral channels into color images (Fig. 1), which are known to be sensitive to the content of mafic minerals as well as its relative freshness [3].

3. Spectral ejecta properties and geological implications:

The ejecta blankets of small fresh craters appear bright or dark in the visible light with a sharp contrast to the surrounding region. Mostly, the crater itself is characterized by a similar albedo. Only a few impact craters show bright ejecta and a dark crater floor, which might be interpreted as two different surface layers. One of these craters is directly located at a huge scarp named Matronalia Rupes, which is known to mark the rim of the Rheasilvia impact basin (Fig. 1). Especially in the ratio color composite shown in Figure 1 fresh surface materials are known to appear yellow/green [3]. Intriguingly, both types 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. Both materials also show a pronounced pyroxene signature, even if they have different albedos.

Usually, bright material corresponds to a strong pyroxene signature with deep absorptions near 1 and 2µm [2,4], whereas this signature is normally surpressed, where the visible albedo is low. However several locations on Vesta deviate from this general trend [4]. The spectral variations mirror the global trend [4] with stronger pyroxene signatures concentrated in the Rheasilvia basin and weaker ones in the geologically older densely cratered equatorial region as well as pyroxene absorptions centered at slightly shorter wavelengths. Finally, VIR spectra indicate a possible slight shift in the position of the 1µm-pyroxene absorption toward shorter wavelength when moving from the crater and the slumping material to the bright ejecta.

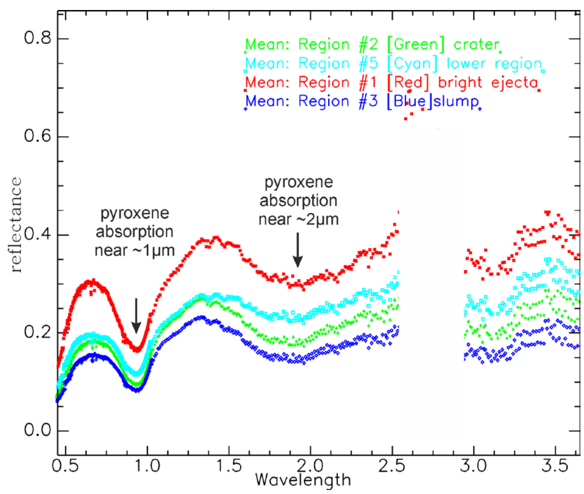

Figure 2: Average VIR spectra of the geological and geomorphological surface units shown in Fig. 1 and 3).

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 possibly representing an additional upper surface layer of newly excavated former ejecta of the Rheasilvia impact event.

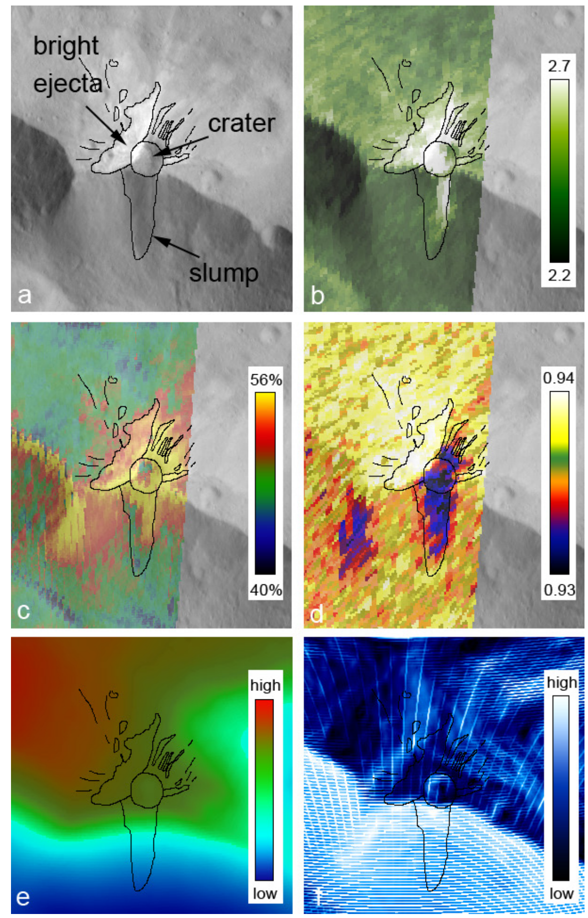

Figure 3**:** Small fresh impact crater as seen (a) by the FC CLEAR filter, (b) VIS-UV slope, (c) depth of the pyroxene absorpion near 1µm, (d) position of the pyroxene absorption near 1µm, (e) DTM-derived elevation and (f) DTM-derived local slope.

References

[1] Krohn, K. et al. (2012) LPSC *XXXXIII*, #1788. [2] Stephan, K. et al. (2012), *EGU* #EGU2012-11533. [3] Tompkins, S. & Pieters, C.M. (1999) *Meteor. & Plan. Sc*., 34, 25-41. [4] De Sanctis, C. et al. (2012) *LPSC XXXIII*, Abstract #1902.