EPSC Abstracts
Vol. 9, EPSC2014-701, 2014
European Planetary Science Congress 2014

Investigating Vesta's Marcia crater with Dawn data

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1. Introduction

The orbital observations of the asteroid Vesta by the Dawn mission have enabled the characterization of the asteroid geology [e.g., 1, 2]. Global and regional geologic maps have been produced, and have revealed that the Marcia impact is a complex impact structure on Vesta with unique features in terms of morphology, mineralogy and composition [1, 2]. The crater (190°E, 10°N; 68 x 58 km) is a relatively fresh structure (post-Rheasilvia) and is the largest of three adjacent impacts, Marcia (youngest), Calpurnia, and Minucia (oldest). Here we present new geological investigations of the Marcia region using the highest spatial resolution data acquired by the Framing Camera, VIR spectrometer, and GRaND instrument, and discuss possible processes related to the history and evolution of the Marcia impact.

2. Geologic map

We produced a morphologic map of the Marcia region using a 20m/pixel FC mosaic (Figure 1). The morphologic units predating the Marcia impact are the cratered highlands material *(c)* and the Capurnia crater materials, including ejecta *(Cr)*; wall material *(Cw)* and mass wasting material *(Cl)*. The interior of the Marcia crater contains smooth *(Ms)* and pitted *(Mp)* terrains, onlapping the crater wall material *(Mw)* and supersposed by mass wasting materials *(Ml)*. Mass wasting morphologies are described in details in [3]. A scarp separates the crater floor from an elevated bench located at the southern crater interior wall, interpreted as a collapsed crater rim. Two main distinct terrains characterize the ejecta of Marcia. The *(Mr)* unit has a rough morphology and usually forms hills. We interpret this unit to represent the primary thick ejecta of Marcia. A smooth terrain, often located in topographic depressions and with buried impact craters, is identified as unit *(Ms)*. The contact between the two units can be diffuse or relatively sharp. In the latter case, unit *(Ms)* is found to onlap unit *(Mr)*. On the eastern side of the Marcia ejecta, the smooth unit is darker (unit *Msd*). On the western side are located relatively small occurrences of smooth terrain with higher albedo *(Msb)*. In a few occurrences associated lobes and levees *(Mle*) were observed. Pitted terrain (*Mp)* is scattered throughout the units mentioned above and is superposing them. Mineralogical and compositional maps [4, 5] indicate that while Marcia crater is located in a broad region of elevated H and OH abundances, the immediate vicinity of the crater is actually not as strongly enriched in these species than areas east and west of Marcia. In addition, Marcia and the terrain around it are characterized by fresh/unmixed pyroxene of eucrite-like mineralogy and elevated iron abundances [5,6]. Williams et al. [7] have argued that the morphologies of unit *(Ms)* and *(Mle)* are consistent with impact melt ponds, as observed, for example, on the Moon [e.g., 8]. Impact melt pools, however, cannot explain the gradual boundaries of *(Ms)* with unit *(Mr)*.

3. Crater counts

To gain further insights into the detailed stratigraphy of our geomorphologic units, additional investigations using crater size-frequency distribution (CSFD) measurements have been performed. Crater size-frequency distribution (CSFD) measurements have been performed on 18 counting areas within units *Mr*, *Ms/Msd/Msb*, and *Cr*. Absolute model ages for unit *Mr* span between 175 and 198 Ma, and ages for units *Ms/Msd/Msb* are between 40 and 62 Ma. For unit *Cr* an age of 821 Ma has been derived with large uncertainties (+/- 470 Ma) due to superposition/mantling by younger units.

4. Discussion

On the basis of our investigation we find Marcia crater to be geologically very complex. There are still numerous open questions related to Marcia crater, including, among others, the detailed structure of the crater, the nature of the volatile-rich material associated with Marcia, the relative low abundances of OH and H compared to surrounding regions, the origin of the low albedo, the detailed thermo-physical properties of the materials in and around Marcia, as well as the gravity anomaly associated with Marcia crater. We have generated a detailed geologic map that will serve as basis for the interpretation of the available compositional, mineralogical, and geophysical data.

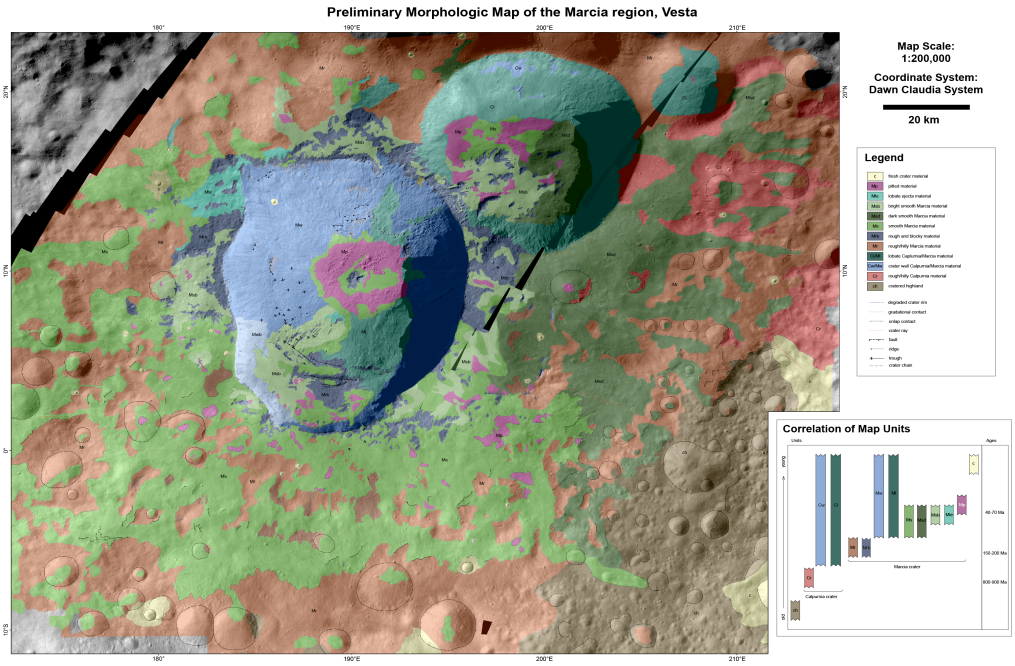

Figure 1: Morphologic map the Marcia region

References

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