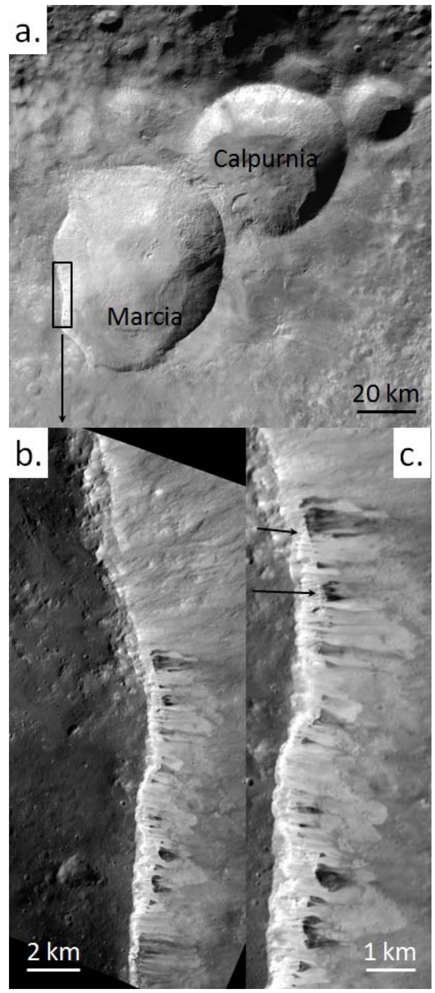
GEOLOGICAL STRUCTURES IN THE WALLS OF VESTAN CRATERS. D. W. Mittlefehldt[1], A. Nathues[2], A. W. Beck[3], M. Hoffmann[2], M. Schaefer[2],and D. A. Williams[4], [1]NASA/Johnson Space Center, Houston, TX, USA (david.w.mittlefehldt@nasa.gov) , [2]Max Planck Institute for Solar System Research, Katlenburg-Lindau, Germany, [3]Smithsonian Institution, Washington, DC, USA, [4]Arizona State University, Tempe, AZ, USA.

Introduction: A compelling case can be made that Vesta is the parent asteroid for the howardite, eucrite and diogenite (HED) meteorites [1], although this interpretation has been questioned [2]. Generalized models for the structure of the crust of Vesta have been developed based on petrologic studies of basaltic eucrites, cumulate eucrites and diogenites. These models use inferred cooling rates for different types of HEDs and compositional variations within the clan to posit that the lower crust is dominantly diogenitic in character, cumulate eucrites occur deep in the upper crust, and basaltic eucrites dominate the higher levels of the upper crust [3-5]. These models lack fine-scale resolution and thus do not allow for detailed predictions of crustal structure. Geophysical models predict dike and sill intrusions ought to be present, but their widths may be quite small [6].

The northern hemisphere of Vesta is heavily cratered, and the southern hemisphere is dominated by two 400-500 km diameter basins that excavated deep into the crust [7-8]. Physical modeling of regolith formation on 300 km diameter asteroids predicts that debris layers would reach a few km in thickness, while on asteroids of Vesta's diameter regolith thicknesses would be less [9]. This agrees well with the estimated ≤1 km thickness of local debris excavated by a 45 km diameter vestan crater [10]. Large craters and basins may have punched through the regolith/megaregolith and exposed primary vestan crustal structures. We will use Dawn Framing Camera (FC) [11] images and color ratio maps from the High Altitude and Low Altitude Mapping Orbits (HAMO, ~65 m/pixel; LAMO, ~20 m/pixel) to evaluate structures exposed on the walls of craters: two examples are discussed here.

Marcia Crater: Marcia is a young crater 68×58 km in size centered at latitude, longitude 9º, 190º [12] (Fig. 1a). Formation of Marcia partially obliterated the rim of 53 km diameter Calpurnia crater. Topographic prominences forming semi-continuous layers are visible at many locations high on Marcia crater walls. On the western wall where illumination was most favorable, semi-continuous layers of bright material overlie a discontinuous layer and/or scattered blocks of dark material (Fig. 1b). In one area bright material layers meet the underlying dark material layer at acute angles and appear to be truncated (black arrows, Fig. 1c). However, talus obscures the underlying structure below the dark band.

Fig. 1 FC images of Marcia crater. a. Portion of HAMO global mosaic showing the general region. b. Portion of a LAMO image showing discontinuous dark layer and blocks topographically below semi-continuous bright layers. c. Region showing angular junctures between bright and dark materials (arrows).



Rubria Crater: Rubria is a young crater ~10 km in diameter centered at latitude, longitude -7.5º, 18.5º within the Divalia Fossa, a region of troughs engendered by the Rheasilvia basing-forming impact [13] (Fig. 2a). Rubria crater was formed on a slope. The upslope northern crater wall has numerous prominences of bright material with some areas showing semi-continuous bright material bands (Figs. 2b-d; yellow arrows). Locally scattered within the bright material prominences are 100-400 m patches and short bands of dark material. Some are below bright material prominences suggesting they may be resistant to mass wasting and possibly supporting the prominences (black arrows; Figs. 2c, d). None of the boulders ejected onto the rim or mass-wasted to the south appear to be dark material (Fig. 2b) as might be expected if that material was mechanically strong.

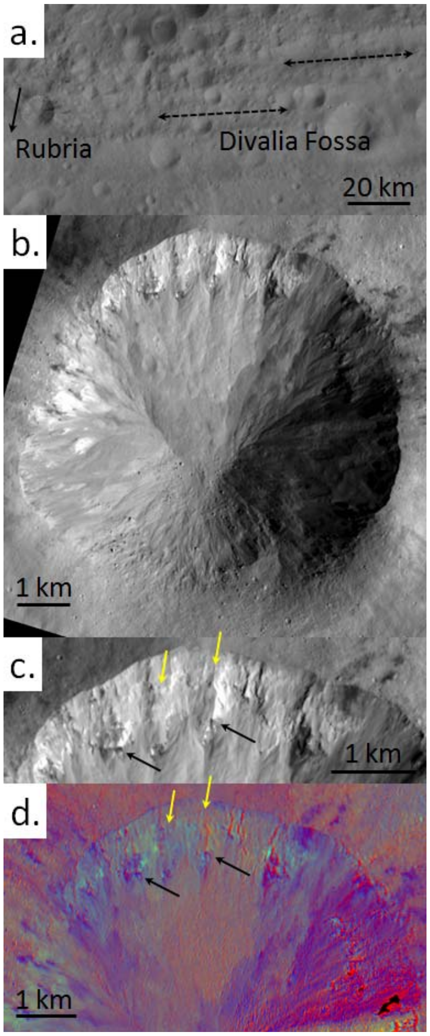


Fig. 2 FC images of Rubria crater. a. Portion of HAMO global mosaic showing the relationship between Rubria crater and equatorial troughs (dashed arrows) and the general downslope direction (solid arrow). b. Portion of a LAMO image. c. Expanded view of the north wall showing dark materials below prominences (black arrows), and semi-continuous layers of bright material (yellow arrows). d. Portion of a LAMO Clementine color ratio mosaic showing lithologic diversity.

Discussion: In general, dark materials on Vesta are interpreted to be fragments of carbonaceous chondrite impactors [14] while bright materials have spectral characteristics indicating that they are the most pristine vestan lithologies [15]. The thin layer of dark material in Marcia crater may have a different origin. The crosscutting relationship with bright material layers suggests a possible sill-like intrusion. However, the dark material band is at a depth of <2 km from the rim, within the depth range of a megaregolith assuming asteroid regolith formation models [9] are accurate. Thus, the bright layers may be ejecta draped onto a surface of preexisting dark material. The morphology of the thin layer of dark material in Marcia crater (Fig. 1c) is not that expected of carbonaceous chondrite debris. These fragile rocks ought to be efficiently disrupted during impact and mixed within vestan ejecta as scattered blocks; this morphology is observed in other craters on Vesta [16]. The thin, ~1 km long layer of dark material in Marcia crater could represent ponded impact-melt or melt-breccia from an earlier impact. Melt-breccia clasts in HEDs are typically dark brown to black [e.g., 17]. The dark material that appears to form a thin band supporting a prominence in Rubria crater (left black arrow, Fig. 2c, d) may be another instance of impact-melt or melt-breccia.

At present, all of the structures examined in vestan crater walls are plausibly layers or blocks of ejecta material, impact-melts, melt-breccias and/or impactor debris from earlier impact events. If the dark layer in Marcia crater is in fact composed of chondritic debris, this only strengthens the conclusion that the structures are not primary. We have yet to find unequivocal evidence for primary crustal structures on Vesta.

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