PRISTINE CRUST EXPOSURE IN MARCIA CRATER ON VESTA: NEW SPECTRAL AND GEOMORPHOLOGICAL EVIDENCE. T. Giebner[1], R. Jaumann[1,2], S. E. Schröder[1], K. Krohn[1], K.-D. Matz[1], K. Stephan[1], T. Roatsch[1], F. Preusker[1]. [1] German Aerospace Center (DLR e.V.), Rutherfordstr. 2, 12489 Berlin, Germany (tanja.giebner@dlr.de), [2] Freie Universität Berlin, Malteserstr. 74-100, 12249 Berlin, Germany.

Introduction: Vesta is globally covered by a regolith layer with varying thicknesses and compositions, as shown by previous studies (e.g., [1], [2]). This is due to two major impacts in the past as well as ongoing flux of different types of asteroids/meteorites in the asteroid belt. In this study, we investigate an interesting spectral feature of Marcia crater, which indicates that in the northern/northwestern part of the crater, the original eucritic crust is exposed and that the corresponding impactor was likely volatile-rich in composition.

Marcia has always been of special scientific interest due to its anomalous crater shape, intriguing geomorphologies associated with the crater as well as its spectral dichotomy (e.g., [3], [4] and [5]). [5] have already indicated that eucritic remnants are likely present in the Marcia area. In this study, we show new evidence supporting the theory that the Marcia impactor hit the pristine crust which is still exposed today, mostly in the northern wall of the crater. Additionally, we suggest that the dark material associated with the impact (foremost east and inside the crater) likely originates from the impactor itself and is a thin layer of viscous ejecta material, mixed with crustal rocks and diminishing their pristine spectral characteristics.

Methods: Framing Camera (FC) color filters are utilized to identify the different spectral characteristics of Marcia crater and its surrounding (i.e., the reflectance ratios 750/917, 965/830 and 965/917 [nm]). These data are then compared with different meteorite spectra (downloaded from the RELab database at Brown University, http://www.planetary.brown.edu/relabdocs/relab_disclaimer.htm) in order to identify the material composition. Additionally, high-resolution LAMO images (Low Altitude Mapping Orbit, ~ 20 m/px) are analyzed to reveal the local geomorphological settings associated with the Marcia impact crater.

Spectral Results: Marcia and its surrounding show diverse spectral characteristics (Fig. 1). The most eucritic spectral characteristics are found most prominently in the northern/northwestern wall, on the western rims and at some isolated sites around the crater and in the walls of Calpurnia (consistent with VIR results by [4]), in cases associated with pitted terrain. The area extending east of Marcia belongs to the spectrally darkest occurrences on the whole asteroid, among which this area is even the most continuous feature according to our observations. The spectral characteristics of this material plot most closely to ordinary and carbonaceous chondrite data points for the given color ratios, but possibly are a mixture between HED and carbonaceous chondrite endmembers [5].

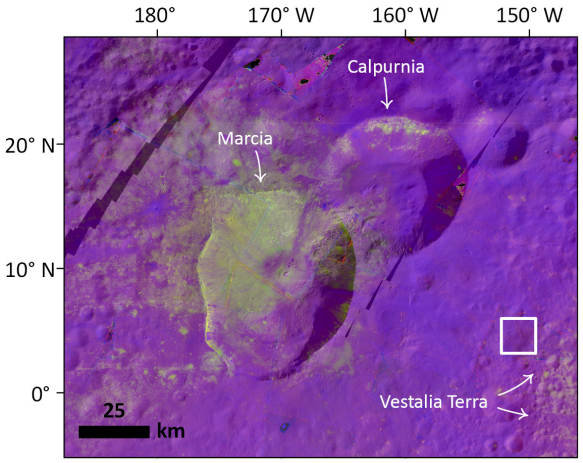

Fig. 1: RGB image composed of R=F5/F4 (965/917 nm), G=F3/F4 (750/917 nm) and B=F5/F6 (965/830 nm), superposed on a LAMO mosaic. Greenish colors indicate stronger pyroxene absorption bands; purple/bluish colors indicate much less prominent absorption features. White box displays location of Fig. 2.

Geomorphological Analyses: On LAMO-resolution images, prominent flow-features within the crater (in the north- and southeastern part) as well as distinctive flow fronts on the western slopes of Vestalia Terra indicate that the planar dark material around and inside Marcia might be the remnants of viscous ejecta. As seen at the rims of the crater, the thickness of this ejecta material is probably very small. Eucritic crust seems to be present just underneath. This observation is supported by results from [6], as GRaND, which penetrates deeper into the surface, observes a symmetric distribution of eucritic-rich material around Marcia.

The flow fronts seen on the western slope of Vestalia Terra (Fig. 2) are situated ~ 10 km above the eastern rim of Marcia. They most likely represent the margins of the first high energy jets during impact, which spread symmetrically around the impact site, later covered in the proximate surrounding by excavated eucritic crustal material. However, this jetted material probably was unstable on the slope of Vestalia Terra and "flowed back" towards Marcia, covering eucritic ejecta and flowing inside the crater (as seen at several rim locations). This inflow, recognizable by the prominent

flow features inside the crater and on the crater walls, seems to be the reason why pitted terrain and curvilinear systems can be observed ([7], [8]). A further indication for a "backward flow" of the ejecta are the strongly diminished rims of older craters in this area, indicating a much thicker layer on top of these old craters than in other parts surrounding the crater.

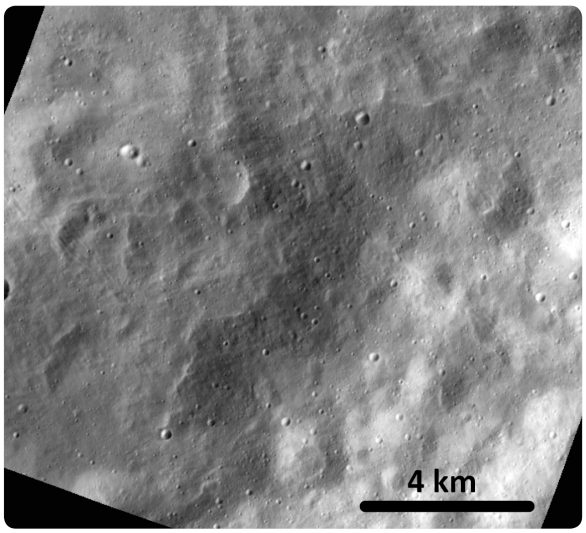

Fig. 2: Prominent flow fronts on the slopes of Vestalia Terra (LAMO image). Location: 209.3° E, 4.6°N.

Conclusions: We propose that the Marcia impactor delivered the dark, volatile-rich material seen foremost east of Marcia as there is no indication of a thick regolith layer that could account for these amounts of dark material. Furthermore, pristine crust (not regolith) is likely exposed in Marcia's northern wall, exhibiting slightly diminished pyroxene absorption features due to natural space weathering processes on Vesta, described by [9]. The most prominent absorption features are associated with mass wasting events at the steepest scarps of the rims, which reveal eucritic material just underneath the dark ejecta layer. The spectrally darker areas inside Marcia are probably the result of post-impact inflow, seen as prominent flow features within the crater.

Future work: West of Marcia, intriguing superposition features can be observed. In the northwestern surrounding, the impact Laeta reveals very dark material underneath eucritic material, while just a few kilometers south, eucritic material is revealed underneath a layer of dark material. Furthermore, the spectral features of pitted terrain, which generally exhibit more prominent absorption features than their surroundings (Fig. 3), certainly need more attention. They might display the remaining material after degassing. All these observations might provide further hints to the formation history of Marcia and its ejecta patterns. [3] suggested that the southern part of the crater might have collapsed later than crater formation, so a scenario before the southern collapse should also be considered in future work. Also, the obvious presence of volatiles might play a major role in the appearance of the flow fronts and the rheology controlling the movement of the ejecta and its possible backward flow.

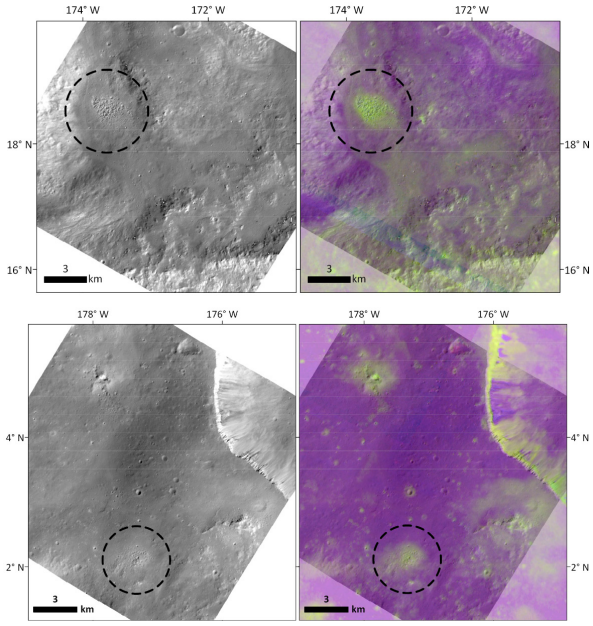

Fig. 3: Spectral differences for two pitted terrain locations around Marcia. Dashed circles indicate pitted terrains. Right: LAMO images, left: superposed RGB images (50%, composition as in Fig. 1).

References: [1] Jaumann et al. (2014) Icarus 240, 3-19. [2] McCord & Scully (2015) Icarus 259, 1-9. [3] Williams et al. (2014) Icarus 244, 74-88 [4] De Sanctis et al. (2015a) Icarus 248, 392-406. [5] De Sanctis et al. (2015b) Icarus 259, 91-115. [6] Prettyman et al. (2013) Meteorites & Planetary Science 48, 2211-2236. [7] Denevi et al. (2012) Science 338, 246-249. [8] Scully et al. (2015) Earth and Planetary Science letters 411, 151-163. [9] Pieters et al. (2012) Nature 491, 79- 82.