PROMINENT IMPACT CRATERS IN THE AV-13 QUADRANGLE TUCCIA ON VESTA - MORPHOLOGY, DEGRADATION, AND AGES OF TUCCIA, EUSEBIA, VIBIDIA, GALERIA, AND ANTONIA

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Introduction: The relatively lightly-cratered floor of the ~500 km-diameter Rheasilvia basin [1] provides a promising basis for the investigation of mid-sized impact craters on Vesta's surface. In contrast to craters on the heavily-cratered terrains in the northern hemisphere of Vesta, craters on the floor of Rheasilvia show clear super-positional relationships and, thus, allow for relatively unambiguous analyses of crater morphologies and formation ages. In this work we focus on prominent impact features in the mapping quadrangle Av-13 Tuccia, as this quadrangle offers a rich variety of different crater morphologies and features, e.g., dark and bright ejecta blankets, rayed-craters, impacts on slopes, or intense mass-wasting processes in the interior of craters. The Av-13 Quadrangle covers the region between 21°-66°S latitude and 180°-270°E longitude and represents the transition between Vestalia Terra and the Rheasilvia floor.

Data and methods: Detailed geologic mapping has been achieved on Framing Camera (FC) imagery (20 m/px.) derived during the Low Altitude Mapping Orbit (LAMO) of the Dawn spacecraft [2]. Here, we used standard map units and symbols from the global geologic map of Vesta [3]. Multispectral data from FC color-filter images have been used in form of Clementine ratio maps in order to map unit boundaries of ejecta blankets. Topographic analyses, e.g., the measurement of rim heights and slopes or the creation of topographic profiles, have been done using a digital terrain model (DTM) derived from stereo imagery [4]. The lateral resolution of the DTM amounts 92m/px and it is referenced to a two-axial ellipsoid with radii of 285 * 229 km. In order to determine relative and absolute ages, we measured crater size-frequency distributions (CSFDs) on individual LAMO images using the CraterTools extension for ESRIs ArcGIS [5]. CSFDs have been analyzed utilizing the software CraterStats [6]. In order to derive absolute ages we made use of the revison-3 chronology and production functions provided by [7].

Results:

Tuccia (D = ~9-10 km) is located at 40° S and 197° E. The bright-rayed crater on its rim has a diameter of ~3.4 km. Tuccia is located on top of a heavily degraded impact crater which has a diameter of ~14 km. The eastern rim of Tuccia coincides with the degraded eastern rim of the underlying crater. In contrast to Eusebia, all parts of the rim of Tuccia are sharp and more or less at the same elevation level confirming that the rim has not been displaced downwards and, thus, that the degraded crater rim in the west belongs to an independent impact structure. CSF measurements indicate a formation age of Tuccia ~150 Ma – 185 Ma.

Eusebia (D = ~26-29 km) is located in the east of Tuccia at 42.5° S and 204.5° E. The arrangement of scarps and slopes at the southern rim indicates that the former southern rim has slid crater-inwards forming a terrace whose planar surface is even visible in the topographic profile in figure 1B. Since the southern rim of Eusebia was displaced, the true diameter of Eusebia can only be measured in east-western direction (~26 km). However, the crater floor of Eusebia is mostly covered by lobate material which is interpreted to be mass-wasting material from the crater walls. Thus, even the east-west extent of the today's crater does not necessarily reflect the original diameter of the crater. The formation age of Eusebia is in between ~210 Ma - 261 Ma ago.

Vibidia (D = ~7-8 km) is located at 27° S and 220° E on the south-western edge of the Vestalia Terra highland on a moderate slope (~10°-15°). Nevertheless, Vibidia is a so-called "bi-modal" crater with a sharp, pristine crater rim at the uphill side of the crater and a degraded/covered rim at the downhill side [8]. In contrast to most of the craters in the Tuccia quadrangle, a large number of blocks/boulders can be found on the crater floor and close to the crater rim (within ~1 crater diameter). Vibidia is a bright-rayed crater, which, however, also excavated small amounts of dark material. This led to the deposition of complex crater ray material on the floor of Vibidia and in close vicinity to the NW crater rim. CSF measurements on the ejecta blankets of Vibidia indicate a formation age of Vibidia between ~8 Ma – 10 Ma ago.

Galeria (D= ~22-23 km) is located at 30.1° S and 228.2° E on the edge of the scarp bounding Vestalia Terra. Almost the complete southern and western rim of the bimodal crater is heavily affected by erosion and/or asymmetric crater ejecta emplacement. Only the north-eastern part of the rim provides intact morpholo-

gies. Comparable to Vibidia, Galeria shows outcrops of dark material on the crater wall escarping Vestalia Terra. The dark material is located in lenses or layers approximately 500 – 1300 m below the north-eastern crater rim, which is in agreement with the global average found by [3]. A CSF measurement on the north-eastern part of the ejecta indicates an age of ~190 Ma.

Antonia (D = ~17-18 km) is located at 60° S and 200° E, close of the region with the lowest elevation on Vesta (approx. 21 km below ellipsoid). Antonia is a bimodal crater, where the loose material covering the southern rim has a lower albedo than the surrounding material. Following [8], this material consists of ejecta emplaced asymmetrically due to an impact on a steep slope. A possible source of this dark material is the top-most part of the northern crater wall which consists of a ~400 m thick layer of dark material (dm). The floor of Antonia, i.e. the lowest parts of the crater wall, is covered by two different types of crater floor materials (cfm) that also cover segments of the crater rim. We interpret these deposits to be a second layer of asymmetrical ejecta, deposited below the dark ejecta material (dem) on the southern crater rim. In contrast to the western portion of the cfm unit, which is relatively smooth and bright (mapped as bright crater floor material (bcfm)), the eastern part of the crater floor material has a lower albedo, a rougher texture, and lobe-shaped structures indicating movement (mapped as dark crater floor material (dcfm)). CSFs on Antonia's ejecta indicate a formation age of ~21 – 25 Ma.

Conclusions:

- All investigated impact craters show very young crater retention ages in the range of 10 Ma – 260 Ma.
- Age differences between ejecta of Eusebia and the mass wasting deposits on its floor indicate ongoing mass wasting processes in the Rheasilvia region.
- Dark-material outcrops in Vibidia and Galeria indicate that dark material is existent in layers or lenses in the subsurface of Vestalia Terra.

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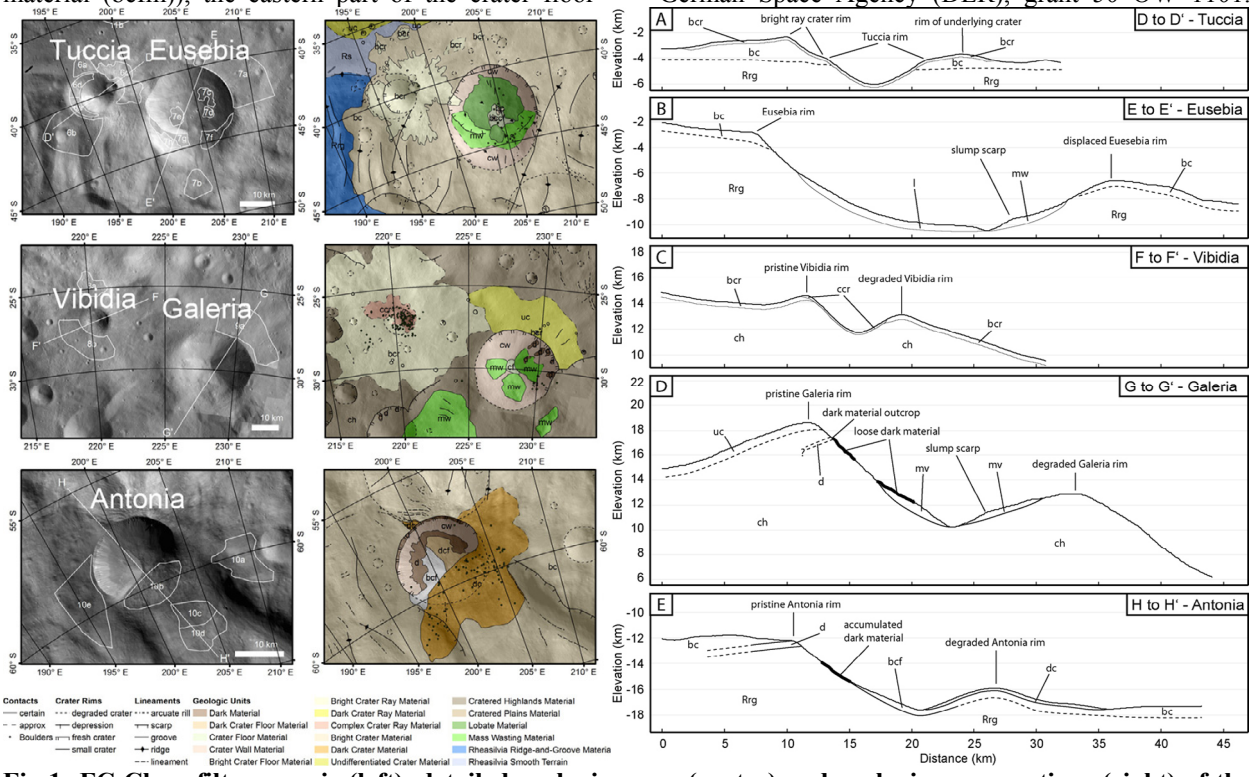

Fig 1: FC Clear-filter mosaic (left), detailed geologic maps (center) and geologic cross-sections (right) of the Tuccia (A), Eusebia (B), Vibidia (C), Galeria (D), and Antonia (E) impact craters. Locations of topographic profiles as well as areas used for crater size-frequency measurements mentioned in the text are shown in the FC Clear-filter images on the left. All profiles shown are not vertically exaggerated.