VESTA COLLISONAL HISTORY REVEALED BY DAWN: BUILDING A VESTA GLOBAL CRATER CATALOG.
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Introduction: Vesta is a 530 km diameter differentiated rocky body in the main asteroid belt that accreted within the first few million years after the formation of the earliest solar system solids [1,2,3]. These circumstances, along with the fact that Vesta's surface is probably sampled in meteorite collections, make Vesta one of the best targets for studying the early evolution of the main belt.

According to current dynamical models [4,5,6,7], Vesta early evolution took place in an environment where collisions with other asteroids were much more frequent than today. While these models can inform our interpretations of Vesta's history, detailed studies of its impact record are necessary to discriminate between these different models and determine to what extent its surface has been reworked by cratering.

Dawn observations of Vesta confirm and extend the range of geologic and impact processes seen on smaller asteroids. One of the obvious features emerging from these observations is that the surface of Vesta is dominated at all scales by impact craters. The lack of many of the obliteration processes that may occur on larger bodies (e.g., erosion on Mars, Venus; lava emplacement on the Moon and Mercury) allows for greater preservation of craters on Vesta. Observed crater sizes range from the resolution limit (10s of m for the low-altitude mapping orbit) to the largest ~500-km impact basin at the south pole, called Rheasilvia. Craters excavate and expose layers of different materials, drive regolith formation, and induce mass-wasting.

Here we present the first attempt to develop a global crater catalog for Vesta that can be used to assess some of the above mentioned processes.

Vesta global crater catalog: The Framing Camera on the Dawn spacecraft extensively imaged Vesta during its Survey phase, at an altitude of about 2700 km. These data have been used to build a global mosaic with a scale of 260 m/px, covering about 85% of Vesta's surface. The global mosaic and a Digital Terrain Model (DTM) [8] are used to map craters larger than ~4 km diameter. A number of large, shallow topographic depressions visible in DTM are inferred to be degraded impact structures (see Figure 1). Additional high- and low-altitude mapping orbit data have been used to refine the crater counts on small regions of the surface, reaching a limiting crater size of about 1-2 km. At the moment of writing, we have identified and cataloged 3457 craters ≥2 km, of which 1872 are ≥ 4 km, and 12 are ≥50 km. The work is in progress as more and more data become available.

Discussion: The overall shape of Vesta is largely determined by the roughly 500 km diameter Rheasilvia crater [9,10]. The formation of this structure obliterated the older cratering record over most of Vesta's southern hemisphere, including half of a ~400 km diameter basin (see Figure 1).

The cratering record shows that the northern hemisphere largely escaped such resetting, and the crater density increases from the Rheasilvia rim to northern latitudes. The crater density has a distinctive pattern, reaching maximum values in two heavily cratered terrains (HCTs) centered at about (12° W, 17° N) and (110° E, 17° N) (see Figure 2). Finally, HCTs have a higher crater density by a factor of 5-6 than the Rheasilvia floor.

The overall crater density in the north and the extent of the HCTs appear to have been shaped by the formation of large craters that obliterated preexisting craters. The best examples are two nearby young craters having diameters of about 50 and 60 km and located at (165° W, 10° N) in the Marcia quadrangle (see inset in Figure 1). These craters produced ejecta blankets that, along with other processes like impact-induced seismic shaking, apparently obliterated the previous cratering record up to a distance of about one crater radius from their rims. The northward extension of the HCTs is presently unmapped, as the north pole is currently in shadow. It is therefore possible that the highest crater density has yet to be discovered.

The equatorial region is characterized by high-relief terrains (HRTs). Interestingly, the local topography seems to be correlated with the crater areal density, and HRTs generally have intermediate crater densities with respect to the HCTs and the low crater density seen on Rheasilvia floor. This suggest that these terrains may have been partially reset by the formation of Rheasilvia. Although the crater retention age of Rheasilvia may not necessarily correspond to its formation age, it appears that most of the mass-wasting processes on Rheasilvia's floor occurred shortly after its formation as a consequence of complex crater collapse. This would indicate that Rheasilvia is much younger than HCTs.

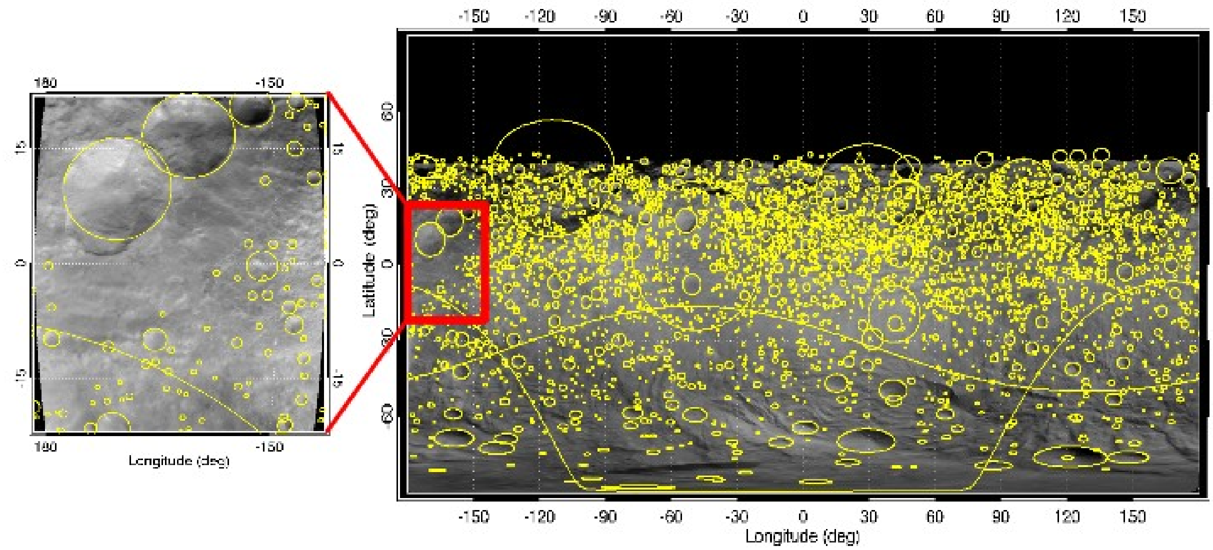
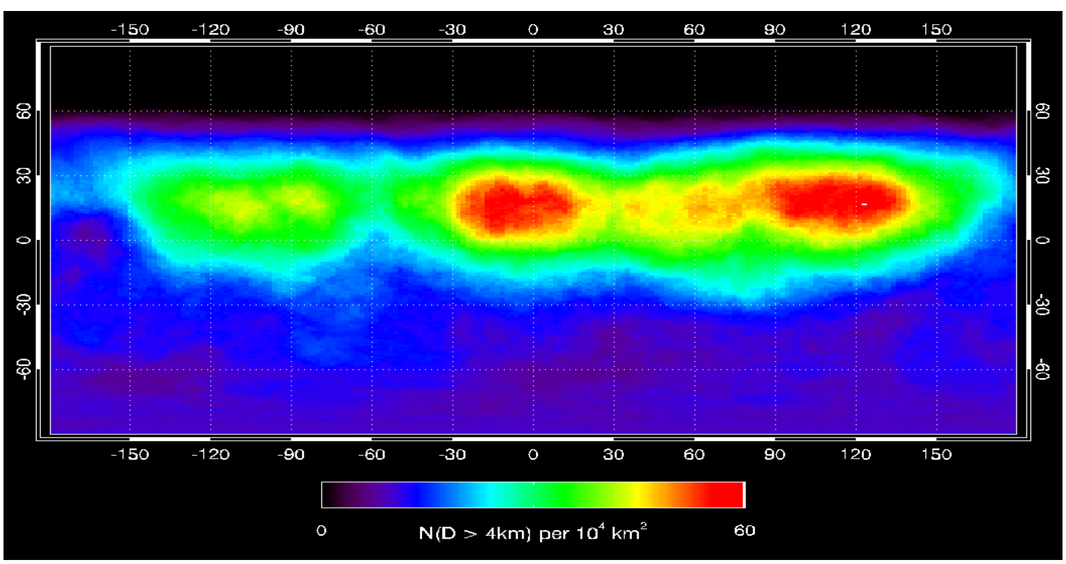


Figure 1 (top panels): Global distribution of craters larger than 2 km superposed on the 260 m/px survey phase global mosaic (left panel). The right panel indicates a portion of the Marcia quadrangle where two large and young craters are located (named Marcia and Calpurnia).

Figure 2 (bottom panel): Global crater areal density (D≥4 km). Crater density is derived by averaging over a radius of 80 km. The highest crater density is reached in the northern hemisphere in the so-called heavily cratered terrains (indicated in red). Note that latitudes higher than 40° N are not mapped.



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