**MEGA-IMPACTS INTO PLANETARY BODIES: GLOBAL EFFECTS OF THE GIANT RHEASILVIA IMPACT BASIN ON VESTA.**

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**Introduction:** One of the great revelations of the Space Age is the role of impacts in reshaping planetary surfaces, especially large impact events of the type that may have formed the Moon or broken the asteroids. The giant Rheasilvia impact basin on Vesta [1] is the largest impact feature with respect to planetary size that has been observed to date. Here we report on the nature of this impact basin and its role in reshaping Vesta. Study of this event may have implications for our understanding of how planetary bodies react to such mega-scale, near-shattering events.

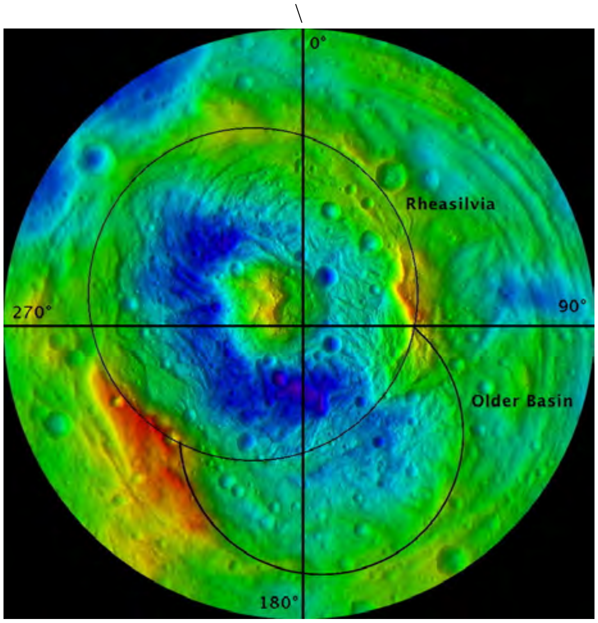


Figure 1: Shaded topographic map of entire southern hemisphere of Vesta, outlining the two major impact basins preserved there. Stereographic projection; blue is low and red is high with total range of 30 km.

**Basin Morphology:** Rheasilvia (Fig. 1) is ~500 km across (compared to Vesta's mean diameter of ~530 km), and forms a broad depression ~25 km deep. It is characterized by a narrow asymmetric rim, a large mound-like central complex 22 km high, and a floor extensively scarred by spiral (arcuate) and radial scarps and ridges (Fig. 1). Valley floor striations between ridges within Rheasilvia may be melt flows or regolith creep. Age dating based on crater counts suggests an age of formation of 1-2 Gyr [2].

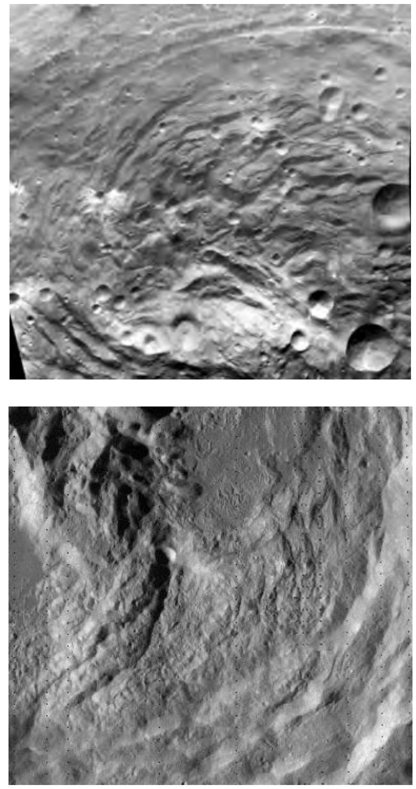

Figure 2: Arcuate ridge and scarp pattern across the floor of Rheasilvia (top – central complex is at bottom center) and within King crater on the Moon (bottom – central peak at upper left). King crater is 75 km wide.

Arcuate ridges and scarps on the basin floor (Fig. 2) are of special interest. These features are likely folding and fault scarps. Coriolis forces may have influenced basin floor movement during collapse [3]. Alternatively, they may be floor uplift structures made visible by the absence of extensive impact melt deposits (the naked floor hypothesis). Arcuate structures are recognized on the floors of other large craters, such as Inktomi (Rhea) and King (Moon) (Fig. 2). They are also visible in terrestrial complex craters and experimental simulations [e.g. 4] and may be a straightforward consequence of radial compression.

**Other Basins:** A surprise from Dawn's topographic mapping of Vesta was the presence of a second large basin partially preserved beneath and predating the formation of Rheasilvia. This 400-km-wide semi-circular depression (Fig. 1) is half truncated but retains a depth of 10-15 km despite the disruptive effects of Rheasilvia superposed on it. The centers of these two basins lie within 20° of the south pole and less than 200-km apart. That Vesta is still essentially intact after receiving two independent major strikes essentially on top of each other implies that Vesta has considerable strength. At least 4 additional basins between 150 and 250-km diameter have also been identified to the north [2], implying a robust history of large impacts, many of which probably provided source material for the Vestoids and HED meteorites.

**Melt and Ejecta:** Observations of ejecta at smaller fresh craters on Vesta [e.g. 5] are consistent with expectations that the giant Rheasilvia basin produced ejecta across much of Vesta [e.g. 6]. Although Dawn has not yet found evidence for the predicted massive 10-15 km thick ejecta deposit [6], it now appears that significant ejecta material did blanket much of Vesta. A region of smoothed striated material (Fig. 3) has been mapped adjacent to the rim. Although heavily cratered, much of the equatorial region of Vesta also has a strongly mantled appearance at high resolution (Fig. 3). Localized smooth lineated terrains (Fig. 3) are also now apparent across cratered terrains to the north, and some of these features are similar to ejecta units at Orientale on the Moon. Even further north (above ~25° N) Dawn has observed several dozen short grooves oriented radially to Rheasilvia (Fig. 3) and which might be secondaries.

Shallow crater depths in the mantled areas [7] are consistent with ejecta deposition, as is lower crater densities in some of these areas [2]. Global mapping at 20 m scales is just beginning but should lead to a global map of ejecta distribution for Rheasilvia.

**Fracturing of Vesta:** One major question prior to Dawn arrival concerned whether the Rheasilvia impact had fractured Vesta. Two sets of major equatorial troughs were discovered in equatorial and northern areas, each with centers of curvature coincident with the two largest basins [9]. These troughs are >25 km wide and several km deep but appear to be mantled by Rheasilvia ejecta. Their orientation to the large basins suggests a link although the mechanisms of fracturing remain obscure. Hundreds of short narrow E-W trending linear grooves have also been identified across equatorial and northern regions (Fig. 4). Any link between these narrow grooves and basin formation and stresses within Vesta is under investigation.

**Discussion:** It appears likely that Vesta's surface geology was extensively though not completely reset by both the Rheasilvia impact itself and the ejecta and fracturing produced. Extensive ejecta deposits cover large areas and global scale fractures formed. Seismic shaking may have affected the surface for hours [E. Asphaug, pers comm. 2011]. Despite the intense bombardment, however, Vesta remained intact, fractured and beaten but not defeated.

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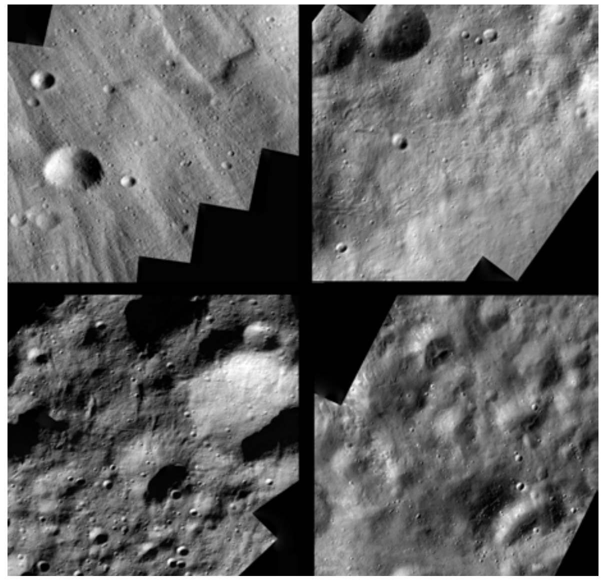

Figure 3. Apparent ejecta units associated with Rheasilvia. Clockwise from upper left (and also with increasing distance from the rim): Smooth striated rim unit, smooth unit transitioning to mantled crater units, mantled crater unit, and N-S trending linear grooves. Largest crater at bottom is ~10 km across for scale.

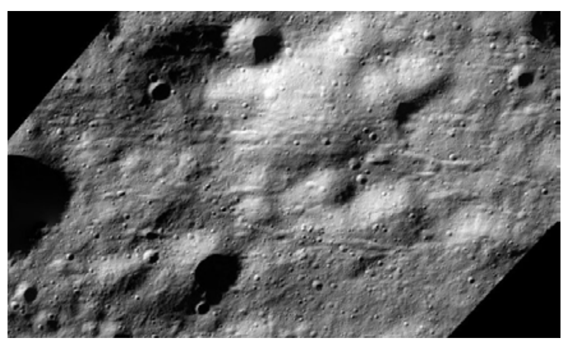

Figure 4. Narrow E-W trending troughs observed throughout equatorial and northern regions of Vesta. Scene width is ~25 km.

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