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Lessons from Vesta and Ceres

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Abstract

When first discovered, the bodies in the asteroid belt were considered the missing planet(s) between Mars and Jupiter. When their small size and large number become realized, they were deemed to be minor planets and then asteroids. They soon were considered to be simply airless bodies, consisting mostly of rocky material, some having iron cores. When Dawn reached Vesta, this picture was initially largely reinforced by the extensive southern basin and the battered northern hemisphere. A more accurate picture arises, using the color filters of the Framing Camera, in coordination with the near-infrared spectrometer, revealing a diverse surface with different minerals and processes affecting regions on the surface in various ways. The variegated light and dark material and varying thermal properties indicate a complex surface. The water (OH) content of the surface is far from uniform. Examinations of the floors of Marcia and Cornelia revealed pits, and their crater walls have possibly water-carved gullies. The parent craters appear to have been formed in a wet surface, possibly ice melted in the crater-forming event. Figure 1 shows the latest mosaic of the vestan surface with the currently approved names for the surface features.

It had been expected that olivine would be excavated in the southern basin but it was not to be found there. Surprisingly, patches of olivine-rich material were discovered in the north. Doubts arose as to whether a magma ocean hypothesis applies to Vesta, in spite of quantifying the mass of its core, and new ways to explain Vesta's petrogenesis were developed. Closer examination of the surface suggested more interesting scenarios, possible excavation of early volcanic materials, odd craters that seemed impossible to form with simple impacts, and a long ribbon of material stretching diagonally across the surface, possibly originating in the Marcia ejecta blanket. The relative youth of some of these features (ca 50 Ma) suggest Vesta has had planetary processes acting over much of its history and is very much a small terrestrial planet worthy of participating in the comparative planetology that aids our ability to understand these diverse family members.

Ceres has yet to be visited by our spacecraft, but it too tells a story of active planetary processes. Ceres does not have meteorites or a family of small ceroids accompanying it in space, so we know little about its origins with any certainty. However, because it is large and has a low density, we believe it accreted late after the short-lived radionucleides had time to decay. It also seems to have continued to devolatize until the present. There were early 1 AU reports from observations at 1 AU of activity that have continued through the recent Herschel plume report.

Dawn followed a simple mapping scenario at Vesta with initial low-resolution measurements in a Survey orbit followed by a High-Altitude Mapping Orbit which gave complete stereo imagery and extensive moderate resolution VIR IR and Framing Camera color data. A later Low-Altitude Mapping Orbit provided data on GRaND's elemental composition, gravity and localized high-resolution imagery and spectra. A second HAMO orbit completed the needed stereo data and other data over the northern quadrangles.

The same mapping philosophy is planned for Ceres. There will be Survey, HAMO, and LAMO orbits, but once in Ceres orbit, Dawn is not expected to leave. Dawn has sufficient resources to achieve its science objectives but does not carry a large reserve for extended exploration.

Figure

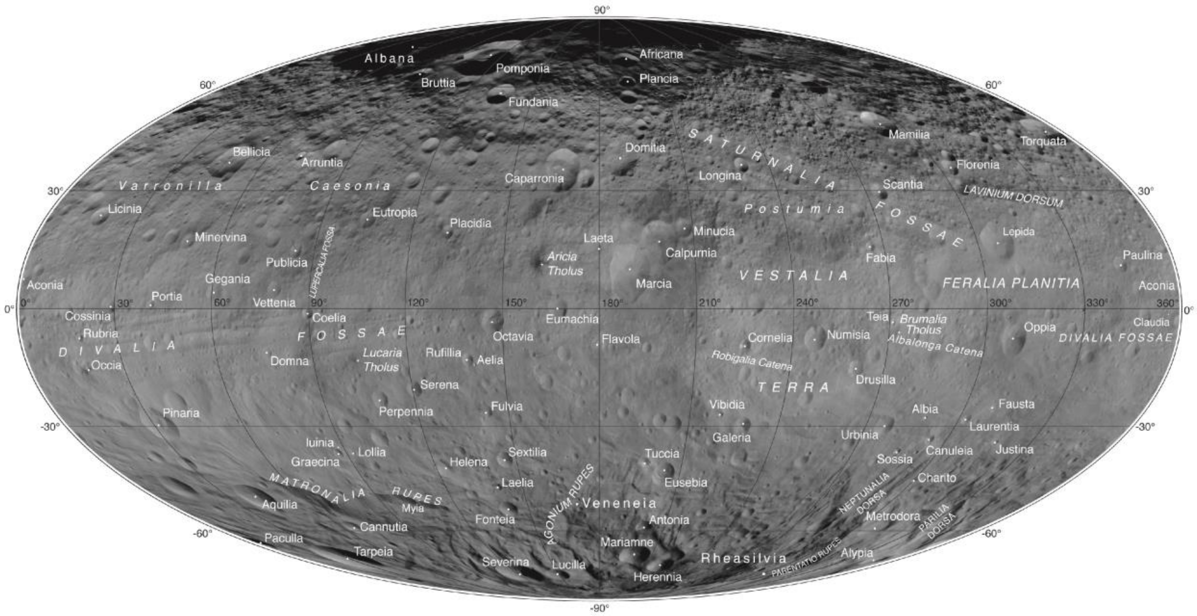

Figure 1: Mosaic of the vestan surface.