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Mapping Vesta: First Results from Dawn's Survey Orbit

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Abstract

The geologic objectives of the Dawn Mission [1] are to derive Vesta's shape, map the surface geology, understand the geological context and contribute to the determination of the asteroids' origin and evolution.

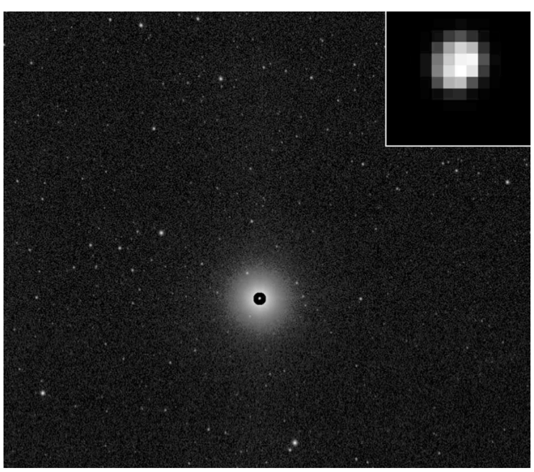

Fig. 1 First View of Vesta as seen by the Framing Camera May 3, 2011 from a distance of 1.2 10^6km (NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

Geomorphology and distribution of surface features will provide evidence for impact cratering, tectonic activity, volcanism, and regolith processes. Spectral measurements of the surface will provide evidence of the compositional characteristics of geological units. Age information, as derived from crater size-frequency distributions, provides the stratigraphic context for the structural and compositional mapping results, thus revealing the geologic history of Vesta. We present here the first results of the Dawn mission from data collected during the approach to Vesta, and its first discrete orbit phase – the Survey Orbit, which lasts 21 days after the spacecraft had established a circular polar orbit at a radius of ~3000 km with a beta angle of 10°-15°.

Mapping Approach

The surface of Vesta is basaltic in nature, geologically diverse [e.g. 2], chemically fractionated, and is the probable parent asteroid of the igneous meteorite suite, the howardites, eucrites and diogenites (HED) [e.g. 3]. Volcanism occurred in the early stages of Vesta's geologic history. Vesta's most dominant topographic feature known so far is a large basin near the south pole that averages about 460 km in diameter, with an average depth below the rim of 13±3 km, that is interpreted as a single crater [4]. Several other depressions, also interpreted to be craters [4], have 160-km diameter and 6±3 km depth located at 20° N, 70° W, and another of150 km across, 8±3 km depth, located at 10° N, 270° W, which are also reported to be a geologic features in spectroscopic ground-based data [5]. The overall relief of Vesta ranges from -12 km to +12 km. The surface topography is key for any mapping approach because it defines Vesta's shape, provides the base for georeferencing and opens a three-dimensional view. In particular, stereoscopic imagery will make a major contribution to topographic mapping and will be important for characterizing the geologic context of planetary bodies [e.g.6]. While photogeology provides the qualitative interpretation of two-dimensional images, the third dimension is needed for quantitative geological analyses. Information on the physical surface properties by the means of multi-phase angle observations additionally supports geologic context characterization. The lithology of geological units is based on spectral information that will be georeferenced [e.g. 7]. The Dawn mission is equipped with a framing camera (FC), a visible and infrared mapping spectrometer (VIR) and a gamma-ray and neutron detector (GRaND) [1].

The major geoscientific topics for mapping Vesta are:

- Impact cratering: the morphology of impact craters will provide access to surface properties such as target strength, the structure and physical state of surface materials, as well as erosion and volcanic processes. The crater size-frequency distribution enables age determination and thus defines the stratigraphic position of geologic units in time. Age determination of vestan cratering, in turn, will probe the violent history of the early Main Asteroid Belt
- Volcanology: According to the chronology of the howardite-eucrite-diogenite suite of meteorites, melting, fractionation, and volcanism occurred in the early stage of Vesta's geologic history, during which time the asteroid is thought to have completely differentiated [e.g. 8]. Eruptions of basaltic magmas may have buried the original surface at least partially; whereas impacts, in particular the impact crater on Vesta's south pole, excavated into olivine-enriched material of the upper mantle, providing stratigraphic evidence for the crustal structure.
- Tectonics: the surface expressions of crustal stresses are tectonic features that are either due to volcanic processes like ridges or graben induced by dikes, or disruption of the crust by impacts, or accretional and tidal processes.
- Regolith: Impacts produce ejecta layers. Degradation, alteration, erosion, and mass wasting on the surface are indicative of surface processes induced by space weathering that modify the debris layer on the surface which thus contains information about the surface alteration history.
- Lithology: the composition of surface units defines their mineralogical and geochemical state, and thus constrains their origin and thermal evolution.
- Stratigraphy of the crust: large impact craters and basins excavate deeply into the crust and thus reveal its vertical structure. [e.g. 9].
- Past rotation state: The morphology of an impact blanket associated with the formation of the south polar basin will constrain Vesta's original rotation pole and spin in addition to details of the impact direction and energy [9].

We will present here the first results of geological surface units identified on Vesta's surface by the means of geomorphology, topography and color variations as well as the crater size-frequency distribution of these units from Framing Camera images taken through different filters.

References: [1] Russell, C.T. et al., 2007, Advances in Space Research 40, 193-201. [2] Keil, K., 2002. In *Asteroids III, eds.* W. F. Bottke Jr., A. Cellino, P. Paolicchi and R. P. Binzel, 573-584. [3] Drake, M. J., 2001. Meteoritics & Planet. Sci. 36, 501–513. [4] Thomas et al., 1997, Science, 277, 1492-1495. [5] Gaffey, M.J., 1997, Icarus 127, 130–157. [6] Jaumann, R., et al., 2007, Plan. Space Sci. 55, 928-952. [7] Jaumann, R., et al., 2006, Plan. Space Sci. 54, 1146-115. [8] Mittlefehldt, D. W., et al., 1998, Rev. in Mineral., vol. 36, chapter 4. [9] Jutzi, M. and E. Asphaug, 2011, Geophys. Res. Lett., 38, L01102.