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Geoscientific Mapping of the Asteroid Vesta by NASA's Dawn mission.

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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. 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 into the stratigraphic context and thus revealing the geologic history of Vesta. The surface of Vesta is of basaltic nature, geologically highly diverse [e.g. 2], and fractionated, and on which volcanism occurred in the early stages of Vesta's geologic history.

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 makes a major contribution to topographic mapping and is important for characterizing the geologic context of planetary bodies [e.g.3]. 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 to the high-resolution camera image mosaics [e.g. 4]. 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]. Science data will be collected during the approach to Vesta, and in discrete orbit phases - Survey Orbit, High Altitude Mapping Orbit (HAMO), and Low Altitude Mapping Orbit (LAMO). The Survey Orbit will last 17 days and will start when the spacecraft has established a circular polar orbit at a radius of 3000 km with a beta angle of 10°. HAMO-1, at 950 km radius (β=30deg), will primarily be used for optical mapping and reflectance spectroscopy. A second HAMO (HAMO-2) phase (β=45deg) will take place during departure to acquire images of areas that have become illuminated since HAMO-1 mapping, and to fill gaps in coverage. LAMO at a 460-km radius near-polar circular orbit (β=45o) is the penultimate science phase at Vesta and will primarily be used to collect gamma ray and neutron spectra and to determine the gravitational field, but will also collect imagery and visible and IR spectral data.

The Dawn FC will obtain images of Vesta in the clear filter and in at least 3 color filters (7 color filters are mounted) over at least 80% of the surface, with a resolution of better than 100 m per pixel, and a signal-to-noise ratio of better than 50. Stereo coverage of the FC will be used to obtain a topographic model of the surface of Vesta with an expected vertical accuracy better than 10 m. The spatial resolution of the FC will be up to 17 m/pixel per pixel in LAMO. Standard image maps of Vesta with a scale of 1:500,000 are planned. Vesta will be covered with 15 individual sheets in sinusoidal projection (spherical form with planetocentric latitude) and one sheet at each polar region in Lambert azimuthally equal-area projection that can be subdivided into smaller segments based on the regional and local mapping during LAMO. VIR image cubes will add spectral information in the 0.25-5 μm range.

Mapping will be related to major geoscientific topics such as impact cratering, volcanology, tectonics, regolith processes (e.g. gradation, alteration, erosion, and mass wasting), lithology, and the stratigraphy of the crust.

References:

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