GEOPHYSICS OF VESTA.

C. A. Raymond[1], S. W. Asmar[1], A. S. Konopliv[1], R. S. Park[1], R. Jaumann[2], F. Preusker[2], C. T. Russell[3], D. E. Smith[4], M. J. Toplis[5], P. Tricarico[6], and M. T. Zuber[4], [1]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA (carol.a.raymond@jpl.nasa.gov), [2]DLR, Inst. of Planetary Research, Berlin, Germany, [3]UCLA, Los Angeles, CA, USA, [4]MIT, Cambridge, MA, USA, [5]Uni. de Toulouse, France, [6]Planetary Science Institute, Tucson, AZ, USA.

Introduction: Dawn's yearlong stay at Vesta allows comprehensive mapping of the shape, topography, geology, mineralogy, elemental abundances, and gravity field using its three instruments and high-precision spacecraft navigation. In the current Low Altitude Mapping Orbit (LAMO), tracking data is being acquired to develop a gravity field expected to be accurate to degree and order ~20 [1, 2]. Multi-angle imaging in the Survey and High Altitude Mapping Orbit (HAMO) has provided adequate stereo coverage to derive a shape model accurate to ~10 m at 100 m horizontal spacing. Accurate mass determination combined with the shape yields a more precise value of bulk density, albeit with some uncertainty resulting from the unmeasured seasonally dark north polar region. The shape and gravity of Vesta can be used to infer the interior density structure and investigate the nature of the crust, informing models for Vesta's formation and evolution.

Shape of Vesta: A Digital Topographic Model (DTM) with a lateral spacing of 100 m/px and a vertical accuracy of about 5 m has been generated from multi-angle HAMO images [4]. This DTM covers approximately 80% of Vesta's surface. Above ~35°N the illumination conditions in HAMO did not permit retrieval of heights; Survey data provided heights to 45°N at lower resolution. The shape of Vesta is dominated by the large Rheasilvia impact basin at the south pole, and the high topography (terrae) surrounding the Rheasilvia basin and associated with its ejecta. Also apparent are many other large impact basins [3], as well as a marked difference in the dynamic range of the topography between the northern and southern hemisphere, likely due to Rheasilvia.

Gravity Field: A degree and order 8 gravity field has been determined from tracking data through HAMO, and a higher-order field is currently being derived using LAMO tracking data. Major features of the gravity signal are the large positive anomalies associated with the northern polar cap, high topography near 30°S and 245°E, the central mound of the south polar Rheasilvia basin, and negative anomalies over the deep portion of the Rheasilvia basin and several putative large impact basins in the north. Weaker positive anomalies are correlated to the equatorial cratered and equatorial trough terrains that appear to be influenced by Rheasilvia's ejecta blanket. Many anomalies remain after Bouguer correction indicating there are significant density anomalies within Vesta's crust. Positive bouguer gravity over the Rheasiliva basin is correlated with the high terrain along the crater rim, and the central mound. The higher density implied for the central mound is in agreement with the presence of diogenitic material identified in VIR data [5]. The low over the second, older impact basin is consistent with the signatures apparent in the northern hemisphere.

Vesta's Core: The bulk density estimate has been combined with Dawn's measurement of 0.03178 for the gravitational moment $\bar{J}_2$ to explore the range of models of Vesta's interior that are consistent with the geophysical and geochemical constraints. The $\bar{J}_2$ predicted from Vesta's shape for a homogenous density is 0.0350, thus the measured $\bar{J}_2$ confirms the presence of a central mass concentration. We investigate a range of two-layer models of Vesta's internal structure to obtain constraints on the size of the core. Core and bulk silicate densities, and core radii, were varied within geochemically constrained ranges to derive the range of expected core size. The core size and silicate (mantle + crust) density that fits $\bar{J}_2$ is narrowly constrained for core densities between 6000 and 8000 kg m^{-3}. The range of core densities associated with the iron meteorites (7000-8000 kg m^{-3}) yields an average core size (equivalent spherical core size) of 105-114 km, resulting in a core mass fraction (~18%) similar to that deduced from the meteoritic data [5, 6]. The core size and shape are only weakly dependent on the core density; rather the density of the silicate fraction controls the fit. The core size constrained by the densities of iron meteorites, the HEDs, and petrogenetic models of the Vesta's interior evolution indicate an iron core of size 105-114 km, that is consistent with a magma ocean scenario. Modeling of Dawn's higher-order gravity field will help constrain Vesta's crustal thickness and crust and upper mantle density, providing further constraints on Vesta's interior structure.

References: [1] Asmar, S. W. et al. (2012) *LPS XLIII.* [2] Konopliv A. S. et al. (2011) *Space Sci. Rev.,163,* doi: 10.1007/s11214-011-9794-8. [3] Marchi S. et al. (2012) *LPS XLIII.* [4] Preusker F. et al. 2012) *LPS XLIII.* [5] De Sanctis, M. C. et al., (2012) *LPS XLIII* [6] Ruzicka A. et al. (1997) *Meteor. Planet. Sci. 32,* 825-840. [7] Righter, K. and M. J. Drake, (1997) *Meteor. Planet. Sci.*, *32*, 929-944.