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Vestalia Terra: An Ancient Mass Anomaly In The Southern Hemisphere Of Vesta

Carol A. Raymond (1), Ryan S. Park (1), Sami W. Asmar (1), Alex S. Konopliv (1), Debra L. Buczkowski (2), M. Cristina De Sanctis (3), Harry Y. McSween (4), Christopher T. Russell (5), Ralf Jaumann (6), and Frank Preusker (6)

(1) California Institute of Technology, Jet Propulsion Laboratory, Solar System Exploration Directorate, Pasadena, United States (carol.raymond@jpl.nasa.gov, 818-393-4445), (2) Applied Physics Laboratory, Johns Hopkins University, Laurel, MD, USA, (3) INAF, Istituto di Astrofisica e Planetologia Spaziale, Area di Ricerca di Tor Vergata, Roma, Italy, (4) Dep. of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN, USA, (5) IGPP, UCLA, Los Angeles, CA, USA, (6) DLR, Inst. of Planetary Research, Berlin, Germany

Dawn's yearlong stay at Vesta allowed comprehensive mapping of the shape, topography, geology, mineralogy, elemental abundances, and gravity field using its three instruments and high-precision spacecraft navigation. A gravity field accurate to degree and order $\sim$20 was obtained from high-accuracy data in the Low Altitude Mapping Orbit (LAMO). Multi-angle imaging in the Survey and High Altitude Mapping Orbits (HAMO-1 and HAMO-2) has provided adequate stereo coverage to develop a shape model accurate to $\sim$10 m at 100 m horizontal spatial resolution. 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. Significant Bouguer anomalies indicate density variations within the vestan crust and mantle, and considerable variation is seen in the crust/mantle density contrast that minimizes the major Bouguer anomalies in different regions of Vesta. Significant features of the southern hemisphere Bouguer gravity field are the large positive anomaly associated with the high topography of Vestalia Terra at the western intersection of the Rheasilvia and Veneneia basins, a weaker positive over the central mound of the Rheasilvia (RS) basin, and negative anomalies associated with the eastern rim of Rheasilvia and most of the Veneneia basin. A second large positive anomaly is seen over the equatorial troughs at the northeastern edge of the RS basin. The positive Bouguer anomaly over Vestalia Terra (VT) represents a significant mass anomaly relative to the average bulk silicate density of Vesta. The gravity data indicate that the RS ejecta are resting on a dense topographic rise that likely is composed of ultramafic mantle material. The density of the underlying rise also appears higher than the mantle elsewhere in the southern hemisphere. The high topography at VT pre-dates the Rheasilvia and older Veneneia impacts as these basins carve the edges of VT. Thus, the density structure of Vestalia Terra may be indicative of a more primordial state of the vestan interior. It is difficult to probe the nature of the bedrock beneath the mantling RS ejecta, but several small impact craters indicate at least localized presence of diogenitic material. The origin of VT could be the result of magmatic processes during Vesta's early evolution, or may be explained by variable impact gardening of the vestan crust and mantle.