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Memories of Vesta/Hopes for Ceres

C.T. Russell (1), C.A. Raymond (2), E. Ammannito (3), U. Christensen (4), M.T. Capria (3), M.C. DeSanctis (3), R. Jaumann (5), A. Konopliv (2), T.B. McCord (6), L.A. McFadden (7), H.Y. McSween (8), A. Nathues (4), C. Pieters (9), T. Prettyman (10), D. Smith (7), M.V. Sykes (10), M.T. Zuber (11), D.L. Buczkowski (12), U. Carsenty (5), S. Marchi (13), D. A. Williams (14).
(1) University of California, Los Angeles, Earth and Space Sciences, USA; (2) Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA; (3) Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, Roma, Italy; (4) Max-Planck-Institut fur Sonnensystemforschung, Katlenburg-Lindau, Germany; (5) Deutsches Zentrum fur Luft- und Raumfahrt, Institute of Planetary Research, Berlin, Germany; (6) The Bear Fight Institute, Winthrop, WA, USA; (7) NASA Goddard Space Flight Center, Greenbelt, MD, USA; (8) University of Tennessee, Department of Earth and Planetary Sciences, Knoxville, TN, USA; (9) Brown University, Department of Geological Sciences, Providence, RI, USA; (10) Planetary Science Institute, Tucson, AZ, USA; (11) Massachusetts Institute of Technology, Department of Earth, Atmosphere and Planetary Sciences, Cambridge, MA, USA; (12) Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA; (13) NASA Lunar Science Institute, Center for Lunar Origin and Evolution, Boulder, CO, USA; (14) Arizona State University, School of Earth and Space Exploration, Bateman Physical Sciences, Tempe, Arizona, USA. (ctrussell@igpp.ucla.edu/ Fax: (310) 206-8042)

Abstract

Dawn, a solar-powered, ion-propelled mission, was launched on September 27, 2007, reaching its first target, Vesta, on July 16, 2011. Dawn orbited Vesta until September 5, 2012, and is now on its way to Ceres, where it will enter orbit in early 2015 [Fig. 1].

1. Vesta

The first target of the Dawn mission, the main belt asteroid Vesta, [Fig.2] made itself known in many ways. It showered the Earth with meteorites and it made no secret that Vesta was the source. These howardite, eucrite and diogenite meteorites established that Vesta was a basaltic body formed early in solar system history [1]. Measurements with the instruments of Dawn confirmed what the meteorites had foretold. Vesta had differentiated and formed an iron core, a [2] [3] mantle, probably containing olivine, and a crust rich in pyroxene. Its surface was found to be highly cratered and very hilly [4][5] . Large basins had been formed by giant impacts [6]. But not everything was foretold by the readings of the meteorites and from the telescopes of the Earth. The surface was pockmarked with dark material [7][8] and OH/H_2O-bearing minerals [9][10]. There were pitted terrains, [11] sinuous gullies, global troughs, crater chains, and gravity anomalies. These observations revealed that the smallest terrestrial body was surprisingly diverse with considerable complexity for a primordial body. The diversity of the surface and the gravity anomaly over Vestalia Terra in turn suggest that plutonic activity has played an important role in the history of Vesta. The correlation between pitted terrains in the bottoms of craters whose walls have sinuous gullies raises the question as to whether ice has remained in the Vestan crust for eons, perhaps from the time of formation of the crust. Vestalia Terra is also home to Brumalia Tholus that may be associated with early volcanic activity. Olivine is rare on the surface of Vesta despite the fact that its presence was once suggested by telescopic measurements from Earth. However, small patches of olivine have now been detected by Dawn, but the occurrences in the north and not in the south where the crust appears to be most deeply excavated. Vesta continues to surprise us.

2. Ceres

Ceres [Fig.3] has been quite secretive. It has not revealed itself through meteorites. It has a low density and a shape that appears to be in hydrostatic equilibrium. It is dark. Rather than being discouraging to the explorer, this lack of knowledge of what we will find tugs on our aspirations and makes us anxious to reach our second destination. Despite the differences between Vesta and Ceres, our exploration plans are quite similar and systematic. As we approach Ceres in 2015, we will do rotational characterization, staring at Ceres as it rotates "beneath us." The first mapping orbit is called Survey, with a near-polar inclination. This orbit is optimized for the Visible and Infrared Mapping Spectrometer which will evaluate the mineral composition of the surface. The spacecraft then moves closer to Ceres to a High Altitude Mapping Orbit, which is optimized for topography and visible

mapping with the framing camera, and which will enable the study of the geologic character of the surface. Then Dawn descends again to a Low Altitude Mapping Orbit, where the prime objectives are the Gamma Ray and Neutron Detector data for elemental composition and gravity's radiometric measurements. High resolution images will also be collected.

We were, in the end, very surprised by what we found at Vesta, but having so little insight into Ceres either from remote sensing or from the meteorite record ensures that the surprises at Ceres will be even greater.

Figures

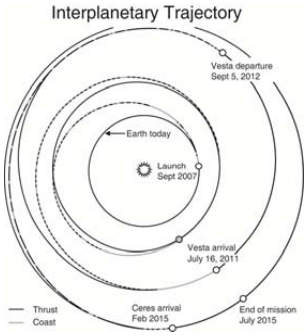

Figure 1: Dawn is a solar-powered, ion-propelled mission. It has left Vesta and is now on its way to Ceres.

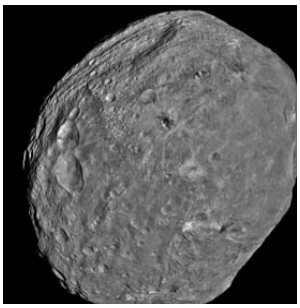

Figure 2: Clear filter framing camera image of Vesta taken during the pre-survey orbit phase from a distance of approximately 5,200 km showing craters Marcia (62 km diameter), Cornelia (15 km diameter) and Numisia (30 km diameter) containing closely juxtaposed bright and dark materials. Image courtesy of NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

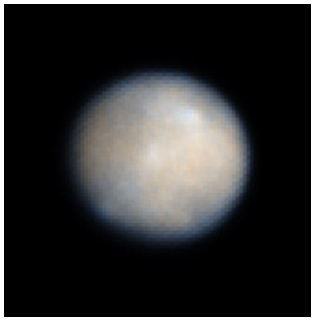

Figure 3: HST image of Ceres.

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