VESTA IN THE LIGHT OF DAWN. C.T. Russell[1], C.A. Raymond[2], H.Y. McSween[3], R. Jaumann[4], A. Nathues[5], M.C. DeSanctis[6], T.A. Prettyman[7], S. Marchi[8], N. Schmedemann[9], D. Turrini[6], J. Scully[1], M. Hoffman[10], K. Otto[4], D. Buczkowski[11], [1]Earth and Space Sciences/Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA, 90095-1567, USA, ctrussell@igpp.ucla.edu; [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena CA 91109-8099 USA; [3]University of Tennessee, Department of Earth and Planetary Sciences, Knoxville, TN 37996-1410, USA; [4]Deutsches Zentrum fur Luft-und Raumfahrt, Institute of Planetary Research, Berlin, Germany; [5]Max Planck Institut fur Sonnensystemforschung, Katlenburg-Lindau, Germany; [6]Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, Rome, Italy; [7]Planetary Science Institute, Tucson, AZ 85719, USA; [8]NASA Lunar Science Institute, Center for Lunar Origin and Evolution, Boulder, CO 80302 USA; [9]Freie Universitaet, Berlin, Department of Earth Sciences, Institute of Geosciences, Planetary Sciences and Remote Sensing, Berlin, Germany; [10]NASA Dryden Flight Research Center, Edwards, CA 93523-0273 USA; [11]Johns Hopkins University Applied Physics Laboratory, Laurel, MD 20723-6099 USA.

Dawn completed its observation of Vesta in September 2012, after nearly 14 months in orbit. What Dawn discovered ranged from the anticipated to the totally unexpected. Vesta is intact, almost complete, basaltic protoplanet, with the properties inferred from the study of the HED meteorites, including an iron core (Fig. 1).

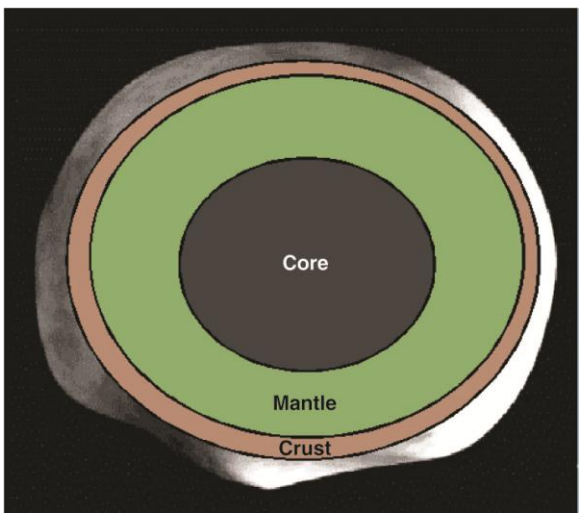

Figure 1. Vesta has a pyroxene crust of eucrite and diogenite with an olivine mantle and an iron core.

It has a pyroxene crust consisting of an outer eucritic component and an inner diogenitic layer overlying an olivine mantle. The VIR observations of the mineralogy of the crust reveal the expected diogenite, howardite, and eucrite composition revealed by comparing band centers observed on Vesta's surface with those observed in HED meteorites (Fig. 2). The fact that the eucritic crust is still quite extensive places important limits on the formation of Jupiter and its role in the evolution of the main belt. The crust in the southern hemisphere has been strongly excavated by the two events that formed the Veneneia and Rheasilvia basins.

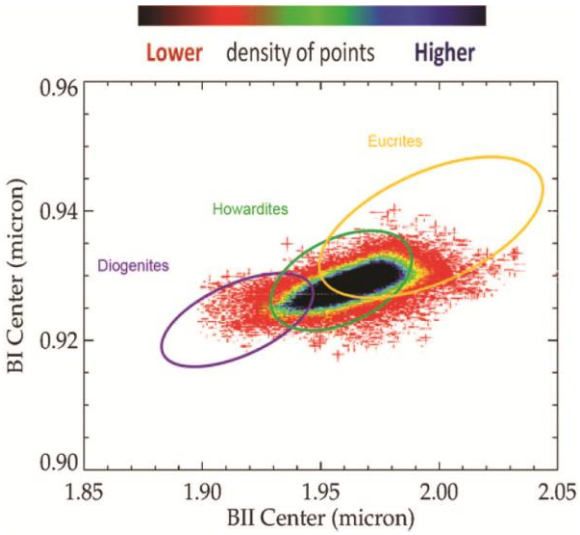

Figure 2. VIR-derived band centers compared with the expected band centers from terrestrial meteorite studies. A similar result has been obtained with GRaND elemental abundances.

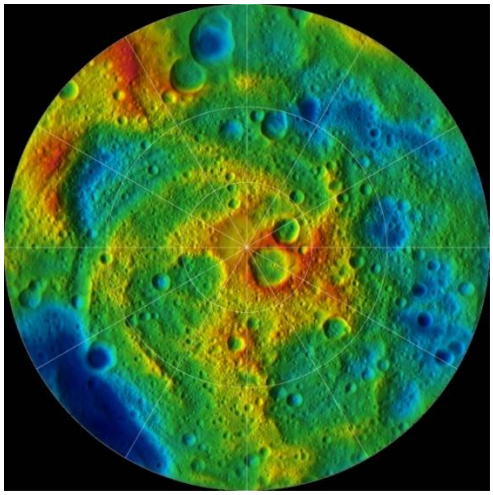

Figure 3. Northern hemisphere shape model (Gaskell, 2012).

Most of the northern crust is older than the southern basins but it appears to have received a partial resurfacing during the southern basin-forming impact events (Fig. 3). The cratering record has been found to be in production down to about 2 km crater size on ~3.8 Ga old surfaces, although crater frequencies are higher than the lunar equilibrium distribution (Fig. 4).

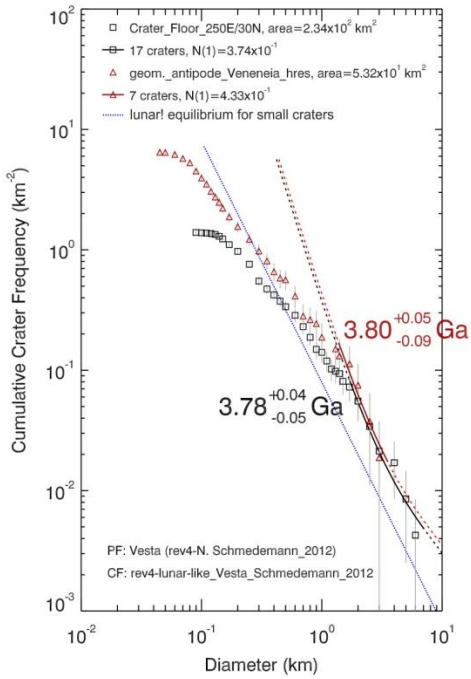

Figure 4. SFD near Veneneia antipode on north.

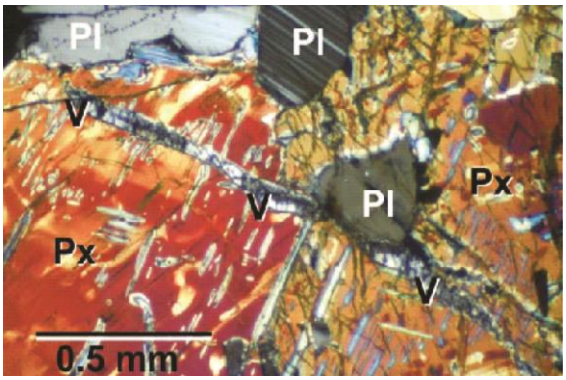

Figure 5. A quartz veinlet (Tremain et al., 2004).

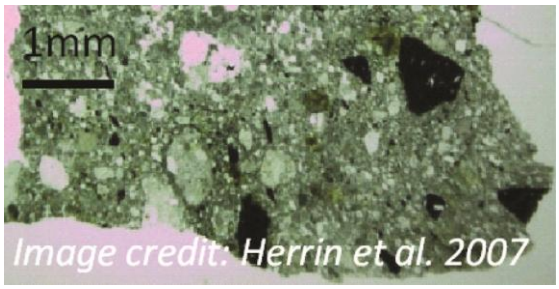

Figure 6. Carbonaceous clasts (Herrin et al., 2007).

The cratering record is consistent with some of the models of the evolution of the asteroid belt and planetary migration theory and puts important constraints on the history evolution of the solar system. The 110-km radius iron core may have aided Vesta's survival through its heavy bombardment early in its history. The surface shows evidence for the cross solar system transport of volatiles and carbonaceous material. The study of HED meteorites presaged those discoveries (Fig. 5, Fig. 6). The biggest surprises have come from a detailed high-resolution study of the surface; the discovery of pits as opposed to craters (Fig. 7); the different styles of gully formation (Fig. 8); and discovery of odd crater morphologies.

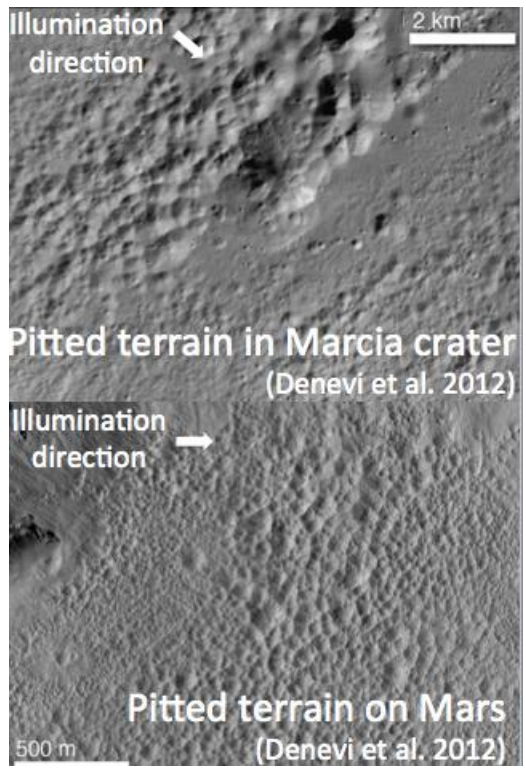

Figure 7. Pits on Mars (top) and Vesta (bottom).

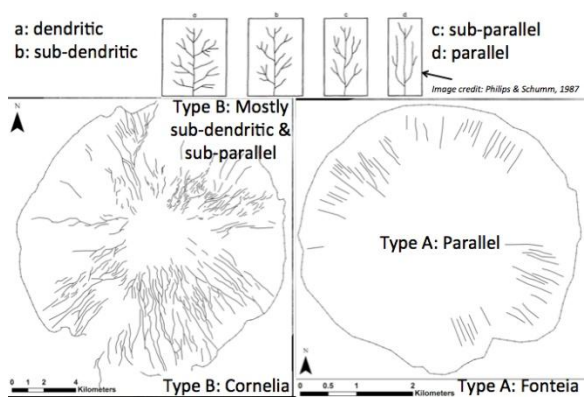

Figure 8. Two types of gullies found on Vesta.