A PRELIMINARY GLOBAL GEOLOGIC MAP OF VESTA BASED ON HIGH-ALTITUDE MAPPING ORBIT DATA. R.A. Yingst[1], S. Mest[1], W.B. Garry[1], D.A. Williams[2], D.C. Berman[1], R. Jaumann[3], C.M. Pieters[4], E. Ammannito[5], D.L. Buczkowski[6], M. De Sanctis[5], A. Frigeri[5], L. Le Corre[7], F. Preusker[3], C.A. Raymond[8], V. Reddy[7], C.T. Russell[9], T. Roatsch[3], P.M. Schenk[10], and the Dawn Team, [1]Planetary Science Institute, Tucson, Arizona, USA (yingst@psi.edu); [2]Arizona State University, [3]DLR, Berlin, Germany; [4]Brown University, Providence, Rhode Island, USA; [5]National Institute of Astrophysics, Rome, Italy; [6]JHU-APL, Laurel, Maryland, USA; [7]Max Planck Inst., Katlenburg-Lindau, Germany; [8]NASA JPL, California Institute of Technology, Pasadena, California, USA; [9]UCLA, Los Angeles, California, USA; [10]LPI, Houston, Texas, USA.

Introduction: Previous maps of the asteroid Vesta were derived from albedo and elevation (Hubble Space Telescope, 38-52 km/pixel), and color data and Earth-based spectroscopy were utilized to generate mineralogic and lithologic maps [1-6]. The Dawn spacecraft has acquired images of Vesta at resolutions up to 500x higher, allowing us to advance from simple identification of the largest spatial and spectral features to complex geologic mapping of morphologic units and features, including stratigraphic and structural relationships. We here report on a 1:500,000-scale preliminary global map of Vesta, based on data from the High-Altitude Mapping Orbit (HAMO). This map is part of an iterative mapping effort; the geologic map is refined with each improvement in resolution [e.g., 7].

Geologic Setting: Vesta is an ellipsoidal asteroid with an equatorial radius of ~283 km. It has been identified as the parent body for the Vestoids and the HED (howardite-eucrite-diogenite) family of meteorites. By dating HEDs, Vesta has been determined to be ~4.56 by old [8-10]. Previous data revealed that it has a surface composed of pyroxene-bearing minerals [e.g. 1-3]. Vesta has a heavily-cratered surface, with large basins evident in numerous locations. The south pole in particular is dominated by an impact basin so large it was identified before Dawn's arrival; this basin has been named Rheasilvia. The surface is also characterized by a system of deep, globe-girdling equatorial troughs and ridges, as well as an older system to the north. Troughs and ridges are also evident cutting across, and spiraling arcuately from, the Rheasilvia central mound [11].

Data and Mapping Procedure: We used a monochrome Framing Camera (FC) mosaic produced from the High Altitude Mapping Orbit (HAMO) data as our basemap. Images in this mosaic have an average spatial scale of ~70 m/pixel. This base was imported into ArcGIS (Geographic Information System software), and supplemented by a Digital Terrain Model (DTM) derived from Survey orbit image data [11, 12]. FC color ratio images from Survey orbit with a spatial scale of ~250 m/pixel and Visible and InfraRed (VIR) hyperspectral images from the Survey and HAMO orbits with spatial scales of 700 and 200 m/pixel, respectively, provided information on surface composition and were used to refine unit boundaries.

Geologic Units & Features: Vesta can be divided very broadly into three terrain types: heavily-cratered terrain; ridge-and-trough terrain (equatorial and northern); and terrain associated with the Rheasilvia basin. Smaller features include bright and dark material and ejecta (some defined specifically by color); and mass-wasting materials. Each of these is addressed below and shown in Figure 1.

Rheasilvia. The Rheasilvia formation is characterized by (a) bounding arcuate scarps; (b) a central mound with smoother, less cratered regions; (c) a linear set of ridges and troughs running through either side of the central mound; and (d) a more arcuate set swirling out from and around the central mound. Rheasilvia basin, centered at approximately the asteroid's south pole, stretches 60-120 degrees of latitude, and its formation undoubtedly influenced most of the geologic features on the surface and the overall shape of Vesta. [see abstracts for Av-6 to Av-14, this volume].

Ridge-and-trough terrain. Large-scale global troughs that occur at the equator cover an impressive percentage of the asteroid's 1765 km circumference and are 19 to 380 km long and up to 20 km wide. An older set of large-scale troughs is present in the northern hemisphere. The largest of these is 390 km long and 38 km wide, but shows evidence of degradation with shallower walls, rounded edges, and infilling. Mineralogical signatures of the troughs suggest the presence of howardite-eucrite, but the signatures are not homogeneous, and a region around 40°E displays shorter, deeper bands that suggest the possibility of a different composition [see abstracts for Av-2 to Av-10, this volume].

Heavily-cratered terrain. Impact structures dominate Vesta's surface. Crater morphology shows many similarities to other small, airless, rocky bodies. Small fresh craters, are characterized by sharp-crested, narrow rims and bowl shapes; larger fresh craters have flat floors and may display slumping of rim walls, some finer-textured floor fill, or visible ejecta material. All fresh craters are interpreted to be the youngest impact features on Vesta. Degraded craters, interpreted to be older, have subdued but distinct, continuous rims and varying internal shapes. Enclosed sub-circular or ovoid regions of lower topography also exist; many of these are interpreted to be the oldest craters. Basins like Rheasilvia are characterized by high-topography rugged hills and arcuate scarps forming partial rings.

Localized features. Localities with distinct geomorphologic characteristics include regions of bright and dark materials, and areas of mass-wasting. Bright materials occur as higher-albedo ejecta, often asymmetrically distributed. Several regions of localized dark material also exist [13]. These regions are commonly characterized by lower-albedo ejecta or dark streaks within crater walls. Ejecta is commonly asymmetrically-distributed and can sometimes be tied to discrete dark layers within crater rims. Mass-wasting was a local and regional process, associated with impact-driven slumping and possibly other processes that occurred subsequent to large impact-driven shaking.

Preliminary Stratigraphy: Differentiation, fractionation and crystallization of a primary crust were followed by the formation of impact basins and craters, including at least one basin near the south pole predating Rheasilvia (this basin may be the source of the older northern ridge-and trough complex [Buczkowski et al., this volume]). Formation of Rheasilvia followed, along with associated structural deformation that formed the major ridge-and-trough complex at the equator. Subsequent impacts and mass wasting events subdued impact craters, basin rims and portions of ridge-and-trough sets, and formed slumps and landslides, especially within crater floors and along basin rims and scarps. Subsequent to the Rheasilvia formation, discontinuous low-albedo deposits formed or were emplaced; these lie stratigraphically above the equatorial ridges that likely were formed by Rheasilvia. The latest features to be formed were craters with dark rays, and those with bright rays that also display thin layers of dark material in their walls and ejecta.

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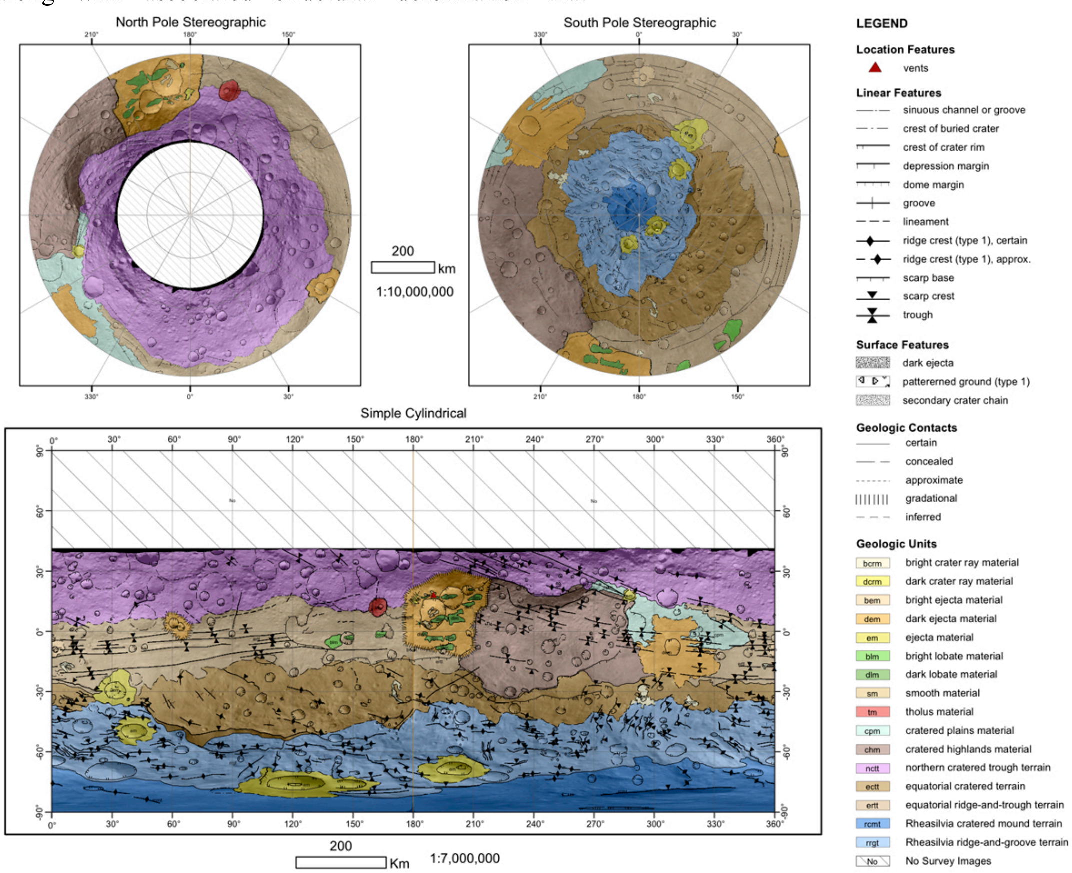

Figure 1. Geologic map of Vesta.