OVERVIEW OF VESTA MINERALOGY DIVERSITY. M.C. De Sanctis[1], E. Ammannito[1], M.T. Capria [1], F. Capaccioni [1], F. Carraro [1], S. Fonte [1], A. Frigeri [1], G. Magni[1], S. Marchi[2], E. Palomba [1], F.Tosi [1], F. Zambon [1], T.B. McCord [3], LA. McFadden[4], H. McSween[5], D.W. Mittlefehldt[6], C.M. Pieters[7], C.A. Raymond[8], C.T. Russell[9]. [1]INAF, Istituto di Astrofisica e Planetologia Spaziale, Area di Ricerca di Tor Vergata, Roma, Italy, mariacristina.desanctis@iasf-roma.inaf.it, [2]NASA Lunar Science Institute, Boulder, USA [3]Bear Fight Institute, Winthrop, WA, USA; [4]NASA, GSFC, Greenbelt, MD, USA; [5]Department of Earth and Planetary Sciences, University of Tennessee, Knoxville, TN, USA; [6]Astromaterials Research Office, NASA Johnson Space Center, Houston, TX, USA, [6]Astromaterials Research Office, NASA Johnson Space Center, Houston, TX, USA, [7]Department of Geological Sciences, Brown University, Providence, RI 02912, USA, [8]Jet Propulsion Laboratory, Pasadena, CA 91109, USA, [9]Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90095, USA

Introduction: 4 Vesta is known to have a surface of basaltic material through visible/near-infrared reflectance spectroscopy (1). Vesta's spectrum has strong absorption features centered near 0.9 and 1.9 µm, indicative of Fe-bearing pyroxenes. The spectra of HED (howardite, eucrite and diogenite) meteorites have similar features (1). This led to the hypothesis that Vesta was the parent body of the HED clan (2,3) and the discovery of a dynamical Vesta family of asteroids (Vestoids) provides a further link between Vesta and HEDs (4). Data from the Dawn VIR (Visible InfraRed mapping Spectrometer) (5) characterize and map the mineral distribution on Vesta, strengthen the Vesta – HED linkage and provide new insights into Vesta's formation and evolution.

VIR data: VIR acquired data during Approach, Survey and High Altitude Mapping (HAMO) orbits that provided very good coverage of the surface (> 65% of the complete surface and nearly all the illuminated portion). Additional data are now being acquired in the Low Altitude Mapping Orbit. Data of high quality, from 0.2 to 5 microns, have been acquired for a total of about 8.5 million spectra in 864 spectral channels. The VIR nominal pixel resolution ranges from 1.3 km (Approach phase) to 0.18-0.15 km (HAMO). The coverage obtained, allows a near global study of Vesta's surface mineralogy.

Vesta global mineralogy: Dawn VIR spectra are characterized by pyroxene absorptions (fig.1). Thermal emission dominates Vesta's spectrum beyond 3.5 µm. Pyroxenes are everywhere on Vesta at the VIR pixel scale of hundreds of meters (6) and no clear evidence for abundant other minerals are observed at the scale of the present measurements.

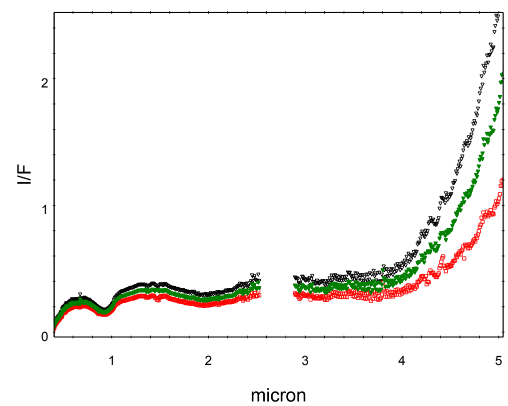

Figure 1. Vesta global mean spectrum (green) and other two extreme spectra obtained during the approach phase.

Even though Vesta spectra are dominated by pyroxenes, spectral variation at regional and local scales are evident and distinct color units are identified. Although almost all of the surface materials exhibit howardite-like spectra, some large units can be interpreted to be material richer in diogenite (based on pyroxenes band depths and band centers) and some others like eucrite-rich howardite units (6, 7).

In particular, VIR data strongly indicate that the south polar region (Rheasilvia) has its own spectral characteristics: deeper and wider band depths, average band centers at shorter wavelengths, quite uniform spectral behavior of the central mound. These spectral behaviors indicate the presence of Mg-pyroxene-rich terrains in Rheasilvia. On the contrary, the equatorial areas have swallower band depths and average band centers at slightly longer wavelengths. The mineralogical distinction between these two fundamentally different terrains are illustrated by their spectra in Fig.2.

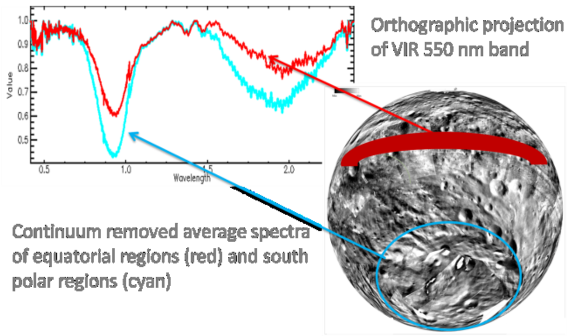

Figure 2: Upper left- Continuum removed average spectra of equatorial regions (red) and south polar regions (cyan). Lower-right- Orthographic projection of VIR 550 nm band

Vesta local mineralogy: Vesta surface shows considerable local diversity at local scales, in terms of spectral reflectance and emission, band depths and slopes. Figure 3 shows an example of local spectral diversity.

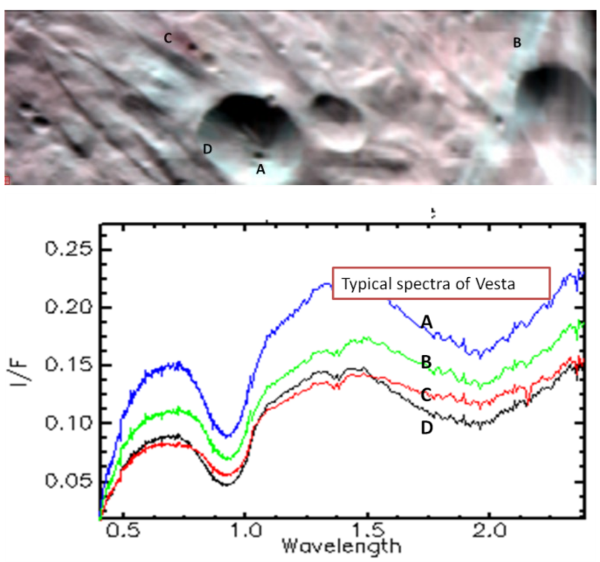

Figure 3: top-RGB VIR image of a region (40 x 180 km) of Vesta in RheSilvia basin; Bottom-some example of spectra from the area above. The features at 1.4 micron are calibration residua. The letters correspond to different locations as indicated in the image above.

Many bright and dark spots were identified on Vesta from VIR and FC (8, 9,10,11). The dark spots seen by VIR at visible wavelengths appear to have low reflectance while in thermal range have large emission (indicative of warmer material) (fig.4). This is consistent with dark material being warmer because it absorbs more solar radiation due to its lower albedo (12). Dark areas are spectrally characterized by shallower 1 and 2 micron bands with respect the surrounding terrains. The bright materials appear to have high reflectance and low thermal emission (cold areas) and are often spectrally characterized by deep pyroxenes bands (8).

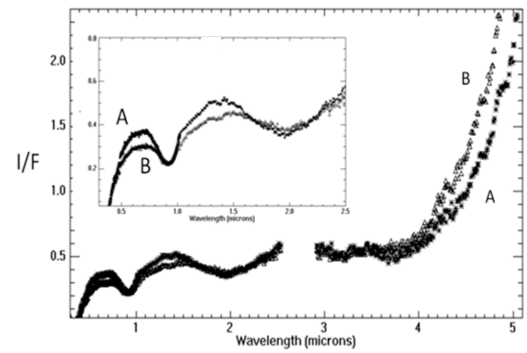

Fig. 4: VIR spectra of two areas on Vesta: A-Bright material, B-Dark material.

Vesta presents complex geology/topography and the mineral distribution is often correlated with geological and topographical structures. Ejecta from large craters have distinct spectral behaviors, and materials exposed in the craters show distinct spectra on floors and rims. VIR reveals the mineralogical variation of Vesta's crustal stratigraphy on local and global scales. Maps of spectral parameters show surface and subsurface unit compositions in their stratigraphic context [9].

Conclusion: The hypothesis that Vesta is the HED parent body is consistent with, and strengthened by, the geologic and spectral context for pyroxene distribution provided by Dawn. The stratigraphic locations of different lithologies on Vesta indicate the presence of a lower crust of diogenites (or diogenite in subsurface plutons) and of basaltic eucrites in the upper crust.

References: [1] McCord T.B. et al. (1970) Science 168, 1445-1447 [2] Consolmagno (1979). [3]Consolmagno and Drake (1977). [4]Binzel R.P. and Xu S. (1993) Science 260, 186-191. [5] De Sanctis et al., SSR, 2010. [6] De Sanctis et al., LPSC (2012). [7] Ammannito et al., LPSC, (2012). [8] Capaccioni et al. (2012), LPSC, [9] Li et al., (2012), LPSC. [10] McCord et al., (2012), LPSC [11] Palomba et al., (2012), LPSC. [12] Tosi et al., (2012), LPSC.