COMPOSITION AND MINERALOGY OF DARK MATERIAL DEPOSITS ON VESTA. E. Palomba[1], J.Ph Combe[2], T.B. McCord[2], M.C. De Sanctis[1], E. Ammannito[1], A. Longobardo[1], F. Tosi[1], F. Capaccioni[1], D.T. Blewett[3], R. Jaumann[4], H. McSween[5], C.A. Raymond[6], V. Reddy[7], D. Williams[8], C.T. Russell[9], and the Dawn Team. [1]INAF-IAPS, Via del Fosso del Cavaliere 100, I-00133 Rome, Italy, ernesto.palomba@ifsi-roma.inaf.it. [2]Bear Fight Institute, 22 Fiddlers Rd., Winthrop, WA, USA, [3]Johns Hopkins University APL, Laurel MD USA, [4]DLR Berlin Germany, [5]University of Tennessee, Knoxville, TN, USA, [6]JPL, Caltech, Pasadena CA USA, [7]Max Planck Inst. Solar System, Lindau, Germany, [8]Arizona State University, Tempe AZ USA, [9]UCLA, Los Angeles, USA.

Introduction: Differences in spectral albedo of the asteroid 4 Vesta were already observed by the Hubble multispectral images [1,2,3]. However, unusual regions of very low albedo on Vesta's surface were first discovered by the Dawn Mission [4]. These "Dark Material Deposits" (DMD) are non-randomly distributed onto the surface and often are associated with geological/morphological features [5,6].

DMD VIR catalogue: The VIR imaging spectrometer onboard Dawn encompasses a wide spectral range including solar reflected light and thermally emitted radiance [7]. Shadows, lighting conditions and photometric effects can complicate identification of DMDs. However, by combining visual and thermal IR a precise discrimination of DMDs can be done: a shadowed region would appear dark in the visual and will be colder than the surroundings. Conversely, a true DMD will be warmer or at similar temperatures. While VIR data are fundamental to discriminate DMD from shadowed regions, the higher spatial resolution images obtained by the Framing Camera (FC) [8] can help to understand the geologic context. This catalogue presents the result of our survey applied to the data obtained during the Survey orbit phase of the Dawn mission at ~2700 km altitude. In addition to a broad equatorial low albedo area located between 75°E to 150°W, 24 smaller DMDs with different degrees of darkness were found. For simplicity we divided the DMD's in two main families, Very Dark and Dark, depending on their I/F compared to the average value of the image (Table 1).

If VIR_{VIS} is the Lommel corrected I/F as measured by VIR (average @ 550-600 nm) and VIR_{IR} is the Thermal Radiance as measured by VIR (average @4.9-5 μm), then a Dark Material (DM) or a Very Dark Material (VDM) areas are found if the following conditions are satisfied: DM when $VIR_{VIS} \leq 85\% \overline{VIR_{VIS}}$ (Frame average) and $VIR_{IR} \geq \overline{VIR_{IR}}$ (Local average*), VDM when $VIR_{VIS} \leq$ 70% VIR_{VIS} (Frame average) and $VIR_{IR} \geq VIR_{IR}$ (Local average*). * local average means a 5°x5° area.

DMD types: As discussed above, DMD's show a lower albedo in the visible to near IR, while they have a larger radiance in the thermal IR (λ >3.5 μm). Here we limit our analysis to the 0.4-2.5 μm spectral interval, which is useful both for the presence of diagnostic absorption bands caused by iron-bearing pyroxenes and for the analysis of spectral slope effects (reddening). The majority of DMDs are associated with impact craters and are likely ejecta materials, both inside and outside craters. Another important family of DMD are associated with soil movements and mass wasting. A third class apparently is not linked to any geomorphologic feature.

Spectral behaviors: All the three classes are dominated by the 1 and 2 μm pyroxene bands (BI and BII, respectively). Their spectra have no other distinct spectral behaviours or signatures (Fig. 1). The spectral differences among the DMD's, when present, are only subtle and suggest a composition similar to the Vestan average "material", with a small amount of a moderate darkening agent. This opaque material would not change the main spectral parameter values, as is indicated by the analysis of the band centers and the band depths that shows only very slight variations [5]. In detail, all the analyzed DMD's show a general slight decrease in both the BI and BII band depth of 10-20%, on average (Fig. 2). The most variable parameter is the BAR (Band Area Ratio) [9], which decreases by as much as 50% relative to the average material value (i.e. 1.8-2.0) in some dark deposits. In other DMD's the BAR value remains unchanged or sometimes seems to increase. However, all the observed values are fully compatible with the BAR retrieved for a very large set of HEDs [10]. While the DMD's with low BAR are compatible with either an impact shock or space-weathering origin [11,12,13], the distinct trends observed for other Dark Material Deposits suggest different sources for their formation.

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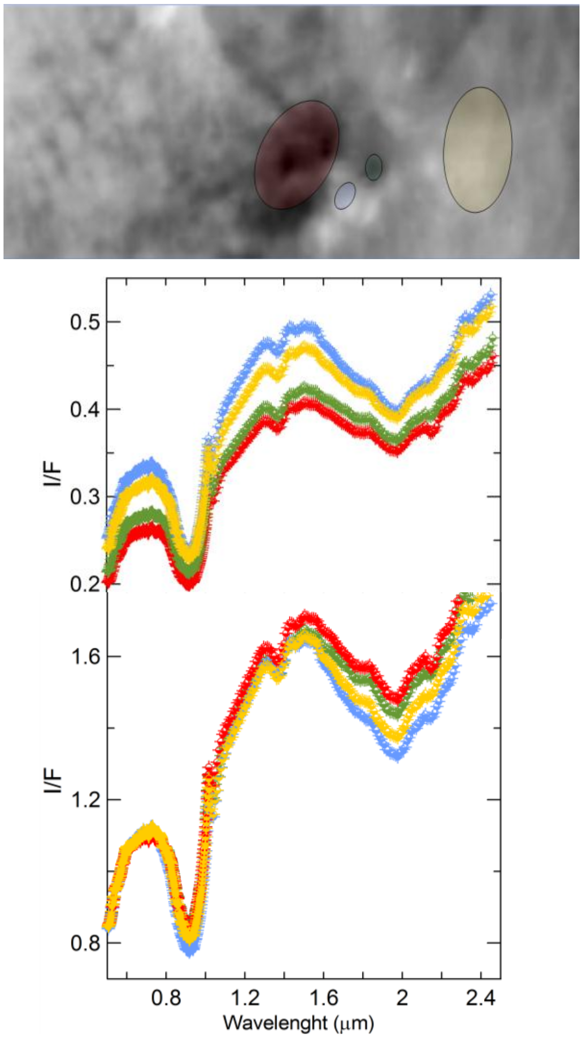

Figure 1. (Upper):VIR-VIS image of D10. (Middle):**s**pectra corresponding the largest DMD (red), a smaller DMD located in a crater floor (green), a brighter region (cyan) and an average albedo zone (orange). (Lower): same spectra normalized to 1 at 550 nm.

Label	Latitude	Longitude	description
D1	15/17	206/211	near crater
D2	15/16	178/180	ejecta
VD1	9/10	159/161	ejecta
D3	9	310/311	crater
D4	7 / 8	196/198	around crater
D5	1 / 10	203/208	near crater
D6	0	329/330	inside crater
D7	-1/0	148/149	wasted material
VD2	-5/0	246/247	crater
D8	-7	19	crater
VD3	-8	225/226	crater
D9	-10/-8	225/226	inside crater
D10	-14/-10	260/263	wasted material
D11	-15/-13	330/331	ejecta
VD4	-15	17/18	crater
D12	-25/-24	140/141	ejecta
D13	-30/-27	104/107	near crater
D14	-31	139	crater
D15	-34	127/129	around crater
D16	-36/-35	187/191	channel
D17	-44/-42	247/252	around crater
D18	-43/-39	125/134	between craters
VD5	-47/-46	140/142	inside crater
D19	-59/-58	280/282	inside crater

Table 1. The DMD's are listed for decreasing latitudes and are divided in Very Dark (VD) and Dark (D). The largest DMD's preference of southern occurrence is only apparent and depends onto the Survey phase observation geometry.

Figure 2. D10 as seen by FC (left), the BI (center) and the BII (right) band depths distributions (bluer = weaker).