Geophysical Research Abstracts
Vol. 14, EGU2012-10447, 2012
EGU General Assembly 2012

Dark Material Deposits on Vesta: composition and mineralogy

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The albedo variability of the asteroid 4 Vesta has been recognised for many years but only recently was the Dawn mission able to identify specific regions of very low albedo on Vesta's surface. These regions contain "Dark Material Deposits" (DMD), and they are non-randomly distributed onto the surface and often are associated with specific geological features. Here we describe how we detected, catalogued and analysed the DMDs, using the VIR spectrometer and the Framing Camera (FC) observations.
VIR is an imaging spectrometer that senses in the visible (0.25-1 microns) and the infrared (1-5 microns) spectral regions. By combining visible and infrared data, it is possible to discern DMDs from shadowed regions: shadowed areas appear dark in both spectral regions, while a DMD will appear warmer than the surroundings. In the catalogue developed from VIR data, two families of DMDs have been defined: very dark material and dark material. Dark material is considered detected if the following two conditions are both satisfied: visible I/F (@ 550-600 nm and Lommell corrected) lower than 85% of the average I/F (70% for the very dark material) and infrared I/F (@ 4.9-5.0 microns) higher than the average I/F.
Applying these rules to the observations collected during the Survey orbit phase, (from an altitude of about 2700 km) led to the detection of 24 Dark Material Deposits.
The analysis of the FC images enabled most of the DMDs to be identified with geologic structures.. The majority of these are related to impact features (i.e. craters and/or ejecta). Only in four cases the Dark Material Deposits are associated with soil movements and mass wasting. A smaller group is not associated with geological/morphological features. The general spectral behaviour of the DMDs is very close to the average Vestan material, with the presence of the two prominent pyroxene bands, centered at 0.9 microns (BI) and 1.9 microns (BII) and a lower visible albedo. The BI and BII band depths are 10-20% shallower than the Vesta average. The band center values also show little variation. This behaviour suggests that the DMDs composition is similar to the Vestan average material, with a moderate darkening agent. The most variable spectral parameter is Band Area Ratio (BAR), which decreases down to 50% of the Vestan average value. These low BAR values are compatible with either an impact shock or space weathering.