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VMT, the DAWN/VIR Mineralogy Tool to retrieve Vesta compositional properties

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Abstract

VIR-MS, the VIS and IR Mapping Spectrometer [1] aboard Dawn mission [2], has started the exploration of 4 Vesta in may 2011. The instrument generates hyperspectral cubes in which spatial (up to 256 samples of 250 µrad each) and spectral (864 bands spanning the 0.25-5 µm range) data are combined together. Since the amount of available information for each pixel is very large, for a mineralogical interpretation of the results it becomes necessary to reduce the data space by adopting some derived spectral quantities able to identify the most significant compositional units. For this reason we have realized VMT, the VIR Mineralogy Tool, an automatic data processor, able to return different spectral indicators (continuum levels, absorption bands properties, spectral slopes and their mutual correlations) from Vesta's observations and to compare these results with references retrieved from laboratory measurements and ground-based observations of HED meteorites. This tool shall allow us to map the spatial distribution of each spectral indicator and corresponding mineralogical composition across Vesta's surface.

Spectral Indicators

VMT uses several spectral indicators to retrieve mineralogy information from VIR calibrated (level 1b) hyperspectral cubes of Vesta. The following are those that are widely used:

a) *Bands properties*, e.g. center and minimum wavelength, FWHM, band depth, band area, band asymmetry. These parameters are returned for each absorption band detected by VIR instrument. In particular we foresee to apply this method to Band I (0.95 µm) and Band II (2.0 µm). If other clear bands will be present (as pyroxene at 0.505 µm) they could be characterized as well;

b) *Spectral slopes*, defined as the angular coefficient of the best fitting line in the ranges I (0.4-0.55 µm), II (0.55-0.67 µm), III (0.67-0.95 µm), IV (continuum at 0.67-1.3 µm).

c) *Continuum levels* at 0.44, 0.55, 0.7 µm (for true color visible RGB image reconstruction) and at 1.45 and 2.6 µm.

These indicators are selected and tuned on the average properties of eucrites, howardites, diogenites reflectance spectra shown in Figure 1.

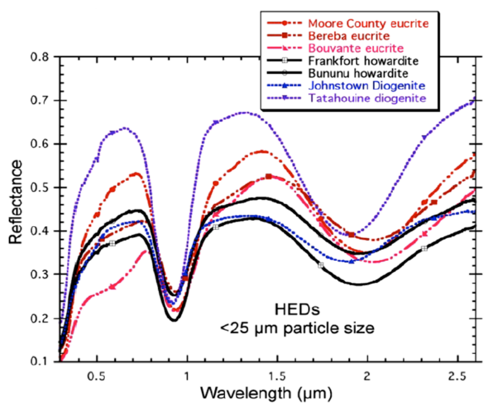

Figure 1: Reflectance spectra of different eucrites, howardites, diogenites samples measured in laboratory [3].

Several methods are widely used to determine the crustal basaltic composition thanks to different combinations of the previous quantities:

-The ratio of Band I/II areas gives the Band Area

Ratio (BAR) that is function of the relative abundance of olivine/orthopyroxene [4].

-The value of the Band I Vs. Band II depth is an indicator of the composition, allowing to discriminate among Howardites, Eucrites and Diogenites [4].

-The amount of Fs, Wo and Mg can be retrieved from the Band I and Band II centers [5, 6].

-The alteration of the surface, caused by space weatering, induces the reddening effect with consequences on I, II and IV slopes values [7].

Conclusions

Thanks to this tool is possible to identify mineralogical composition and units distribution from Vesta's hyperspectral cubes and to compare such as results with Framing Camera (FC) images and laboratory measurements. Finally the tool has enough flexibility to be adapted to still unknown absorption features in the thermal emission regime (4-5 µm).

References

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