STUDYING HED METEORITES IN VIEW OF THE ANALYSIS OF THE VIR SPECTRA OF VESTA.

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Introduction: Asteroid 4 Vesta is one of the largest and the most massive bodies in the Main Asteroid Belt and it appears to have formed and differentiated very early in the history of the solar system, c.f.[1].
At present, observational evidence and constraints on the thermal evolution of the asteroid can be inferred for Vesta because of its connection to the Howardite, Eucrite and Diogenite (HED) meteorites, a class of achondrites thought to be derived from Vesta [2] that consist of material similar to terrestrial basalts and plutonic rocks. Detailed studies of these meteorites suggest that Vesta can be thought of as the smallest of the terrestrial-like dwarf planets, with a metallic core, an ultramafic mantle, and a basaltic crust.
If the HEDs are indeed impact ejecta from asteroid 4 Vesta [2], then combined spectra studies of Vesta and HED meteorites might reveal important information for understanding the geological history of the asteroid.
The objective of our study here is to improve our knowledge to interpret Vesta reflectance spectra acquired by the VIR instrument on board of Dawn, an imaging spectrometer mapping the surface of Vesta in the range between (0.25÷5.00) µm [3], in light of new laboratory measurements of HED spectra.

Data sets: In our terrestrial laboratory, we are collecting a database of reflectance spectra in the wavelength between visible and near infrared (VNIR) helpful for the analysis of composition of Vesta surface.
Bidirectional reflectance spectra of slabs of HED meteorites are taken in the range between (0.35÷2.50)µm, using a Fieldspec spectrometer. The Fieldspec, mounted on a goniometer, is in use at the Spectroscopy Laboratory (SLAB) at INAF in Rome. The spectra are acquired in standard conditions with a source angle $i=30^o$ and a detection angle $e=0^o$, measuring spots with a diameter of 5mm.
To date, the spectra of three Howardites, two Eucrites and one Diogenite have been mapped, taking numerous spots on the surface of each slab to characterize the spectral heterogeneity within each sample. We compared the spectral characteristic of samples in the same group to understand the nature of varying composition and to verify that they have Vesta-like spectral properties.

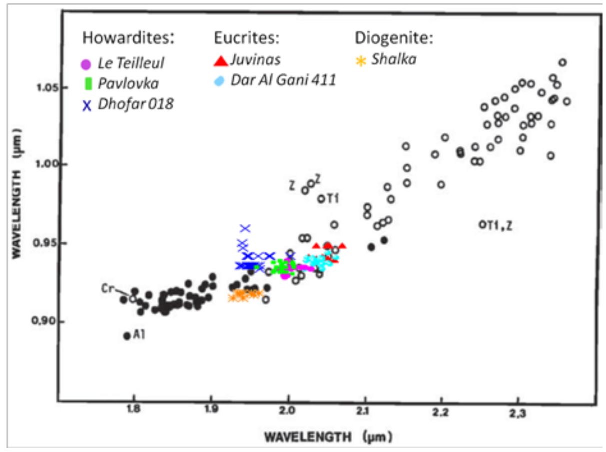

Figure 1*: Band I vs Band II minima of HED meteorites in this study, indicated by colored symbols, and literature pyroxene data (small circles) from [4]. Solid circles indicate <11% Wo samples, open circles >11% Wo samples. Points that deviate appreciably from this trend are invariably zoned or contain exolved phases (Z), >1 wt % TiO_2 (Ti), or Cr_20_3 (Cr), or in the case of low-calcium content samples contain > 4 wt % AI_20_3.*

We determined the position of the band minima for all reflectance spectra and we compared the variation, in band I and band II minima wavelengths with those measured by Cloutis and Gaffey [4]. The comparison is done between data relative to type B clinopyroxene and orthopyroxene, obtained with continuum removed, and the HEDs (Figure 1). There is a good correspondence between our results and the trend defined by pyroxenes. We also observe a consistent behavior within each meteorite class.
To compare Vesta's and the HEDs' reflectance spectra we must take into account that the Vesta surface is not a slab but a solid rock covered by a layer of regolith: dust, soil, broken rock, and other related materials. For this reason we have analyzed spectral modifications caused by different grain sizes of the same material. Although the spectral slope is different above 1 µm, neither band center is affected, which implies that slab spectra can be used to characterize the mineralogical composition. This is shown in Figure 2.

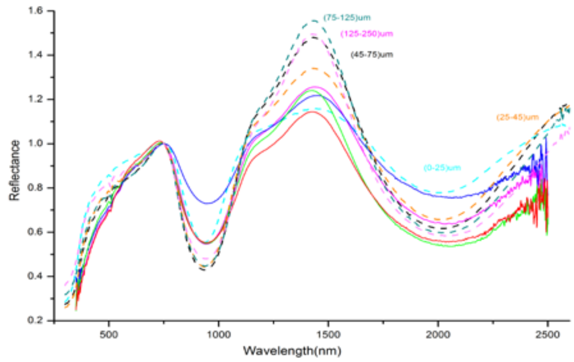

Figure 2: *Differences in reflectance shape for samples of the Juvinas meteorite depending on the grain size of particulate. Powdered samples are shown as dotted curves; the grain sizes are indicated in the same color as the corresponding curve. The slab spectra are given as solid lines. Data for the powders come from the Relab library [5], while the slab spectra were acquired in our lab. Reflectance values are normalized to 1 at wavelength 750nm.*

We will discuss how spectral properties differ between powders and slabs, and between terrestrial and extra-terrestrial material, comparing the profile of the reflectance spectra of terrestrial materials such as basalts and pyroxenes, and extraterrestrial materials such as the HEDs and lunar meteorites.

The information inferred about band minima, band center, bandwidth, band depth and reflectance level of HEDs will allow us to understand the surface composition and texture of the material present of Vesta's surface. All of this information could represent an important task for further comparison between the reflectance spectra of Vesta's surface measured by Dawn and the spectra of its impact ejecta represented by our HED sample. Following up in a more systematic way those by Hiroi et al.[6].

Acknowledgements The spectral data catalogue of the HEDs meteorites has been assembled using meteorites from the Vatican Observatory and the Planetary Science Museum of Prato. The authors wish to thank the Italian Space Agency (ASI) for supporting this work and the Planetary Science Museum of Prato for their generous access to their meteorites.

References: [1] Lugmair G. W. and Shukolyukov A. (1998) *Geochim. Cosmochim. Acta, 62,* 2863–2886. [2] Keil K. (2002) *Asteroids III*, 573-584, [3] De Sanctis M. C. et al., (2010) *Space Sci Rev*, 329–369. [4] Cloutis E. A. and Gaffey M. J., (1991) *JGR*, 96(E5),22,809-22,826, [5]*http://www.planetary.brown.edu/relabdocs/relab_disclaimer.htm,* [6] Hiroi T., Pirters C., Takeda H., (1994), *Meteoritics*, 29(3), 394-396.