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Investigation of Vesta composition by Linear Spectral Mixing

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1. Introduction

With the 20 millions spectra of Vesta acquired so far [1], Dawn's Visible and Infrared spectrometer (VIR) allows us to investigate with good accuracy the composition of Vesta's surface. Vesta spectra are similar to those of the howardite-eucrite-diogenite (HED) meteorites and its spectra are characterized by the two strong iron-bearing pyroxene bands at 0.9 μm (band I) and 1.9 μm (band II) [2]. Our purpose is to find a good way to have a more exact evaluation of Vesta's surface composition. In this preliminary analysis we will apply the linear mixing method to a specific area of Vesta, i.e. the region of the Canuleia crater (Fig. 1). This area is particularly bright and contains three different type of bright deposits, (for the details see [3]). The band center locations, that gives information about the composition [4] of the main pyroxenes features are and are centered at approximately 0.93 μm and 1.97 μm, respectively. This area is dominated by howardite [5], but its spectra will be a mixture of different HED spectra.

2. Linear Spectral Mixing

Spectral mixing analysis is a very useful method to give an estimate of the amount of the different components of a surface. Hiroi at al. 1994 [6] applied this method to the ground observation of Vesta, finding a global howarditic composition with a grain size lower than 25 μm. Before using a linear mixing method, some assumptions have to be made. First of all, in the linear case we assume that the interaction between the radiation and the material occurs by single scattering [7] and that the investigated area consists of a discrete region of different materials [6]. We will choose the appropriate endmembers, in such a way that the final spectrum will be a linear combination of these endmembers [6].

3. Linear Spectral Mixing and the VIR data

In this work we want to apply a linear spectral mixing algorithm to VIR data of the Canuleia region (Lat -34°, Lon 296°). To investigate the composition of this area we have choosen several RELAB [8] samples of HED spectra, in particular: diogenite Y74013, eucrite Y74450, Juvinas and Millbillillie, and the howardite EET87503. In Fig. 2 we show the average spectrum of Canuleia's ejecta compared to these different HEDs with a grain size < 25 μm. The spectrum that better fits the VIR data will be a combination of those different HED spectra, which are our endmembers. We start our analysis by using a linear combination of this endmembers, to get a preliminary result. The mixing equation are [9]:

$$\mathbf{x}=\mathbf{Mf}+\mathbf{e}$$

where **x** is the reflectance extimated, **e** the vector error, **M** is the matrix containing the value of the expected signal coming from the pixels that contains just the ith class, while **f** is the vector that contains the proportion of each endmember with the constraint that [9]:

$$f1+f2+\ldots+fn=1.$$

Using these model, with the suitable value we will achive the spectrum that fits better with the VIR data. More improvements can be done by varying the samples and the grain size or considering a non-linear approach [9].

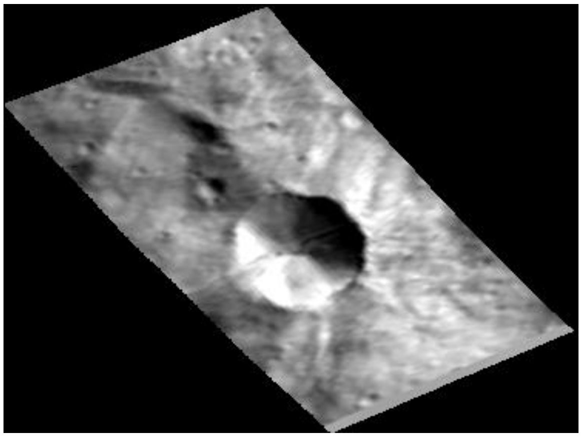

Fig 1: VIR image of the Canuleia crater at 0.5 μm.

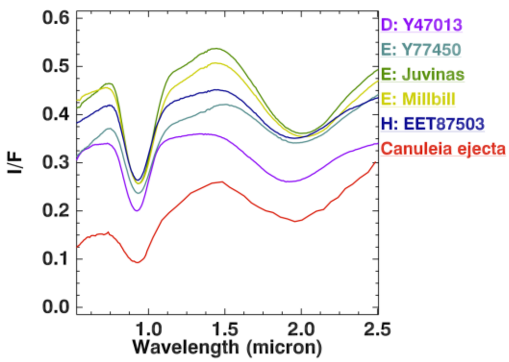

Fig 2: VIR spectrum of the bright ejecta of Canuleia compared to the HED spectra with a grain size < 25 μm. The average spectrum of the Canuleia ejecta is in the red colour, while the other colours represent the spectra of the different samples of HED.

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