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Disk-resolved investigation of (4) Vesta, target of the Dawn space mission

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Abstract

We used the NACO instrument at the ESO-VLT to observe the asteroid (4) Vesta, target of the NASA-Dawn space mission. Near-infrared high resolution imaging and spectroscopy have been obtained. Preliminary results confirm the presence of some inhomogeneities on the surface of Vesta, as suggested by HST data. In particular, we argue a dichotomy of the surface, with relevant abundance of olivine only in the eastern hemisphere. This result is in agreement with the lithological and geological maps of Vesta available in the literature.

1. Introduction

Asteroid (4) Vesta is the largest main belt object showing a basaltic crust. Its surface composition is very similar to that of Eucrite, Diogenite, and Howardite (HED) basaltic achondrite meteorites. The identification of a Vesta dynamical family whose members present spectra similar to those of Vesta and HED meteorites, and the detection of a large impact crater on Vesta, allowed to hypothesize a link between Vesta and HEDs, via basaltic fragments that reach the Earth through complex dynamical processes ([1], and references therein). Vesta will be visited by the NASA Dawn space mission from July 2011 to July 2012. Hence it is of straightforward importance to perform detailed ground-based studies of this asteroid. In this context, we performed ESO VLT-NACO observations, obtaining NIR high resolution imaging and spectroscopy of the asteroid.

2. Imaging

CCD images (J, H, Ks filters) were firstly pre-reduced with standard procedure and then deconvolved using the MISTRAL package [2]. The comparison of our results with images obtained with the WFPC2 instrument of the Hubble Space Telescope (HST), published by [3], is shown in Fig. 1. A general good match between our images and those obtained by HST is evident. The same surface characteristics are detected in images acquired at similar longitudes (using the reference system proposed by [4]), even if with different filters. In particular the *Olbers Regio*, a low albedo region with diameter ~ 200 km located at the origin of the coordinate system, can be clearly seen both in our dataset (image 16J2) and in the HST-WFPC2 one (images o, p). The diameter of this region, computed in our images taking into account the scale of the used camera and the distance between Earth and Vesta at the moment of the observation, is consistent with those available in the literature. A smaller (diameter ~ 80 km) low albedo zone is also visible in both datasets (images 16J3, 16H2, 17H1, 17Ks1 and v, w, x).

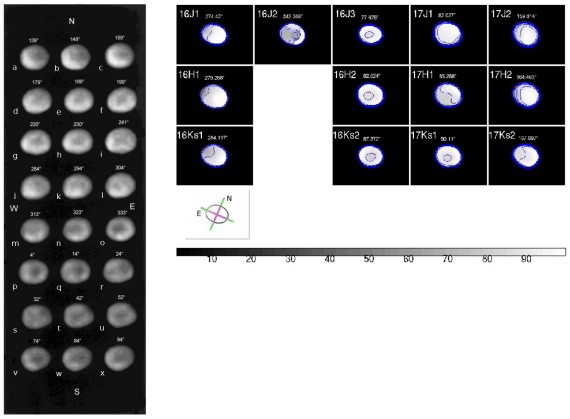

Figure 1: HST-WFPC2 (left) images of Vesta [3] compared to our observations (right). Above each image is the longitude of the centre of the body.

3. Spectroscopy

We combined our J+HK spectra of Vesta with visible data from the SMASS survey (http://smass.mit.edu). These NIR spectra have been acquired with NACO, in the northern hemisphere of the asteroid, at different rotational phases. Following the method by [5], we measured area and position of the 1 μm and 2 μm absorption bands (hereafter we will refer to these bands as BI and BII), to investigate the composition of the different surface regions we observed. We found a pyroxene composition with orthopyroxenes (Ca-poor pyroxenes) dominant respect to clinopyroxenes (Ca-rich pyroxenes).

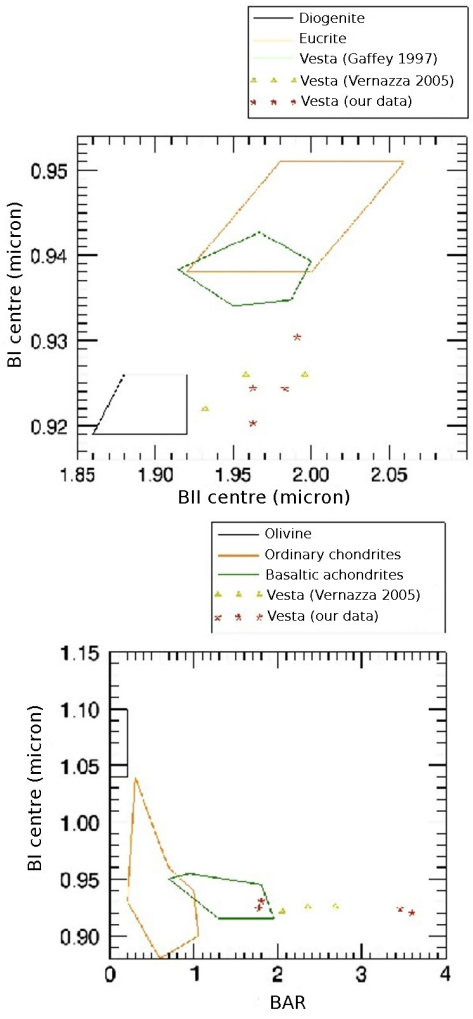

Figure 2 (up): BI centre vs. BII centre positions for Vesta, diogenites, eucrites. (down): Position of the BI centre vs. BAR for Vesta, olivines, ordinary chondrites, HEDs.

As shown in Fig. 2 (up) the positions of BI centre vs. BII centre in the Vesta spectra lie in the transition region between the Eucrite and Diogenite meteorites. Our results are in good agreement with those published by [6]. Fig. 2 (down) shows the values of the position of BI plotted against the ratio of BII area to BI area (BAR, Band Area Ratio). Since the BAR value is directly related to the ratio of pyroxene to olivine abundances [5], our results show a dichotomy of Vesta surface: for what concerns the two spectra taken in the western hemisphere (rightmost points), the content of olivine is almost null, while the two spectra taken in the eastern regions suggest a small but relevant content of olivine. This result is in agreement with lithological and geological maps of Vesta published by [7] and [8], which prompt the presence of several craters in the eastern hemisphere, where olivine has probably been brought to the surface by impacts.

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