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Photometry of the Occator faculae on Ceres

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Abstract

We study the photometric behavior of reflectance and band depths on the Occator faculae on Ceres and compare it with the Ceres average. The different photometry between Occator and the rest of Ceres indicates that Occator is peculiar not only for the composition, but also for physical properties.

1. Introduction

The NASA/Dawn mission [1] has been orbiting the Ceres asteroid since March 2015, taking hyperspectral images by means of the VIR imaging spectrometer [2], and revealing a homogeneously dark body (reflectance at 0.55 µm and 30° phase is 0.03 [3]), with two very bright faculae located in the Occator crater (10°N 240°E) and reaching a reflectance up to 0.25 [4].

VIR data detected a widespread distribution absorption bands located at 2.7 µm (Mg-phyllosilicates), 3.1 µm (ammonia), 3.4 and 3.9 µm (Mg-carbonates) [5]. However, in some specific locations other carriers could contribute to these bands, e.g. in the Occator crater the 2.7 µm band is caused by Al-phyllosilicates and the 3.4 and 3.9 µm are contributed by Na-carbonates [6]. Moreover, organics could deepen the 3.4 µm band, as in the case of the Ernutet crater [7].

Here we apply a statistical analysis on VIR data aimed at obtaining the behavior of reflectance and band depths with phase angle. In particular, we compare the photometric behavior observed on the Ceres average and on the Occator faculae, respectively, and interpreted the observed differences in terms of optical and physical regolith properties.

2. Method

Retrieval of reflectance and band depth as function of phase angle is based on the approach already used for Vesta [8] and Churyumov-Gerasimenko [9], consisting in a statistical analysis of the dataset. In this case, median values of each spectral parameter at different phase angle bins are retrieved and fitted with a polynomial curve. To better describe the reflectance vs phase angle curve (phase function) we defined two parameters: R30, i.e. the retrieved reflectance at 30° phase angle, and PCS (Phase Curve Slope), i.e. the steepness of the phase function between 20° and 60° phase angle.

In the case of Occator, the analysis was performed only on observations where the 3.9 µm band center is longward of 4 µm, which is a peculiarity of the Occator faculae [6].

3. Results

***Albedo*.** The phase function of the Ceres average shows a low value of R30 and a high one of PCS. The location in the R30-PCS scatterplot is mainly driven by asteroids' taxonomy (Figure 1), and the location of Ceres is consistent with its C-type classification. Contrarily to what expected, the Occator phase function is as steep as the Ceres average one, whereas we should expect a PCS decrease in brighter regions (see the case of Vesta in Figure 1).

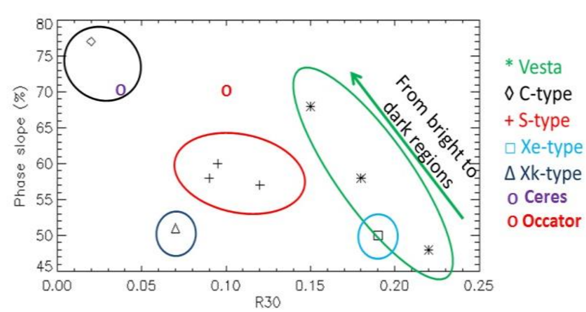

Figure 1: R30 vs PCS scatterplot for Ceres average, Occator and other asteroids [10].

Band depth at 2.7 μm. This band depth linearly increases with phase angle for the Ceres average, which is a common behavior of band depths (e.g. [8]). The increase with phase angle is two times larger for Occator.

Band depth at 3.0 μm. The increase with phase angle of this band is similar for the Ceres average and for Occator, but in the latter case the photometric behavior is strongly uncertain, due to the very weak band in the faculae.

Band depth at 3.4 μm. At increasing phase angle, this band depth increases for the Ceres average.

Band depth at 3.9 μm. This band depth is independent of phase angle for the Ceres average.

4. Conclusions

The obtained results for the Ceres average are somehow expected from its classification and from comparison with other asteroids. The different photometric behaviour of the two carbonate bands could be due to the fact that carriers other than carbonates contribute to the 3.4 μm band.

Different reasons may explain the different photometric behaviour of Occator with respect to the Ceres average:

- *Composition*. Occator includes a larger abundance of bright material (in particular, carbonates) and its carbonates and phyllosilicates are different from the rest of Ceres. However, this does not explain the high PCS, which, according to the Occator R30, should be comparable with S-type asteroids.
- *Granulometry*. A larger regolith grain size would increase PCS and the increase rate of band depth with phase.
- *Roughness*. A larger roughness increases the PCS [9]. In the Occator crater, the roughness increases due to the occurrence of many fractures. Carbonates form at lower topography [11], the observed behaviour of band depth could be affected by the fact that at low phase angles we observe lower heights and hence larger abundance of carbonates.

However, a combination of these hypotheses may occur.

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