EPSC Abstracts
Vol. 12, EPSC2018-651, 2018
European Planetary Science Congress 2018

Unique light scattering at Occator's Faculae on (1) Ceres

A. Nathues (1), M. Hoffmann (1), J. Ripken (1), G. Thangjam (1), T. Platz (1), K. Mengel (2)
(1) Max Planck Institute for Solar System Research, Goettingen, Germany, (nathues@mps.mpg.de), (2) Clausthal Technical University, Clausthal-Zellerfeld, Germany

Abstract

Imagery of the central region of Occator crater obtained by Dawn's Framing Camera is photometrically analysed. The scattering behaviour of the floor faculae is confirmed to be consistent with the appearance of an optically thin near surface haze.

1. Introduction

A prime target of the Dawn mission at Ceres is the Occator crater, hosting the brightest cerean surface features [e.g., 1, 2, 3, 4, 5, 6, 7]. These features populate a portion of its floor and are composed mainly of carbonates, mixed with some dark ammoniated minerals [8]. The bright deposits at Occator's center are significantly younger than the impact crater itself and are likely of cryo-volcanic origin [2, 3]. The dome, located in the central pit, is possibly the outcome of a long lasting, periodic or episodic ascent of bright material from a subsurface brine reservoir. Originally triggered by an impact event, gases, possibly exsolved from a subsurface brine reservoir, enabled the bright material to ascend through fractures and deposited onto the surface [2, 3].

During Rotational Characterization 3 (RC3) orbit the Framing Camera (FC) obtained low spatial resolution images (~1.3 km/pix) of Ceres. This imagery led to the detection of an unusual light scattering behavior at the floor of Occator, which was attributed to a diurnal varying near surface haze [1], which was later on confirmed and detailed by [9]. However, [10] argued that there are no evidences for haze. We revisited the reported effect by [1] and [9] by using RC3 and more recent data from RC4 and CXO mission phases, which have been obtained at favorable observation geometries.

2. Results

We computed reflectance ratios between individual bright material sites belonging to the Occator faculae and nearby (dark) floor sites in order to identify differences in their reflectance behavior versus geometry. Figure 1 displays the ratio between one of the investigated site combinations versus cos *e* for three different mission phases. In all three data sets, the ratio max/median is a positive sloped function, i.e. with decreasing *e* the ratio increases. This effect is seen in each data set but different in degree of correlation. For each of the RC and CXO sets the phase angle kept virtually constant, and is not responsible for the trends in Fig. 1.

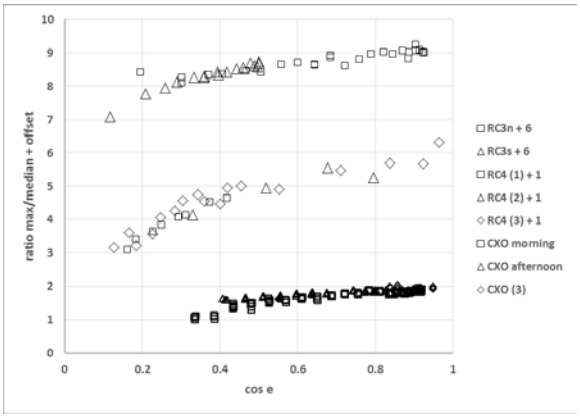

Fig. 1: *Reflectance ratio between a bright and a dark material site within Occator versus cos e. Results from three different mission phases (RC3, RC4 and CXO) are shown. RC3 and RC4 data has been offset for clarity. The reflectance ratio increases with cos e. Statistical errors are on the order of symbol size.*

In order to investigate whether the light scattering behavior of Occator's faculae is indeed unique or found elsewhere, we measured bright and dark sites at other localities for comparison. By contrast with the Occator findings, all ratios of reference sites exhibit approximately constant levels in reflectance after applying a global photometric correction; none is showing such a strong correlation with emission angle or a diurnal variation of reflectance. Approximately constant ratio levels for varying emission and incidence angles indicate that the light scattering behavior of bright and dark units outside Occator's floor are similar, i.e. these sites have

similar light scattering parameters than the global surface.

3. Discussion

[1] and [9] reported, based on RC3 data, a diurnally variable enhancement of light excess near the centre of the Occator crater, which was attributed to an optically thin haze. Our current work, using multiple datasets from different mission phases, obtained under different observation geometries, confirms the unique light scattering characteristic of Occator's faculae.

In order to discard or confirm the haze hypothesis two further potential explanations need to be discussed: 1) The unique light scattering being a result of a spatial resolution effect of a scene, which is optically shortened while moving towards the limb; and 2) The effect is a result of differential light scattering parameters of different planetary surface materials. We found that the potential explanations 1) and 2) are highly unlikely compared to the haze hypothesis since only the latter hypothesis allows us to explain the fact that the reflectance ratio of a faculae varies with emission angle while the phase angle is constant in the absence of shadows.

4. Summary and Conclusions

A thorough comparison of reflectance data from different mission phases resulted in a further confirmation of a light excess measured in the central region of Occator. This excess is unlikely to be caused by a unique facuale material. Although the available data sets do not allow a determination of all necessary free parameters, which are required to develop a unique quantitative model, a consistent qualitative explanation for the phenomenon in terms of an optically thin haze has been identified. Several different locations on Ceres with contrasts of reflectance do not follow similar dependencies. Thus, Occator as an outstanding location on Ceres is further manifested.

References

[1] Nathues et al. 2015, Sublimation in bright spots on (1) Ceres, Nature 528

[2] Nathues et al. 2017, Evolution of Occator Crater on (1) Ceres. The Astronomical Journal, Vol. 153, pp. 112–124.

[3] Nathues et al. 2018, Occator crater in color at highest spatial resolution. Icarus, in press.

[4] Ruesch et al. 2018, Bright carbonate surfaces on Ceres as remnants of salt-rich water fountains. Icarus, in press.

[5] Stein et al. 2018, The formation and evolution of bright spots on Ceres. Icarus, in press.

[6] Quick et al. 2018, A Possible Brine Reservoir Beneath Occator Crater: Thermal and Compositional Evolution and Formation of the Cerealia Dome and Vinalia Faculae, Icarus, in review

[7] Scully et al. 2018, Introduction to the special issue: The formation and evolution of Ceres' Occator crater, Icarus, in press

[8] De Sanctis et al. 2016, Bright carbonate deposits as evidence of aqueous alteration on (1) Ceres. Nature volume 536, pages 54–57.

[9] Thangjam et al. 2016, Haze at Occator Crater on Dwarf Planet Ceres, Astrophysical Journal Letters, Volume 833, Number 2.

[10] Schröder et al. 2017, Resolved spectrophotometric properties of the Ceres surface from Dawn Framing Camera images, Icarus, Volume 288, Pages 201-225.