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Dawn Framing Camera Color Mosaics of Ceres

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Abstract

We processed Dawn Framing Camera color filter images to produce global spectral mosaics of 1 Ceres. The mosaics allow analyses of compositional variations of the cerean surface. Moreover, we can derive statements about Ceres' surface absolute reflectivity using photometrically corrected FC data. During EPSC, we will show examples including global mosaics from Survey orbit images.

1. Introduction

The Dawn spacecraft entered orbit around Ceres in March, 2015 [1]. During approach and later science phases, several spectral datasets with global coverage were acquired using the Framing Camera (FC) onboard Dawn (Tab. 1). The FC is equipped with seven color filters covering the 0.4–1.0 µm wavelength region, plus one broadband filter [2]. The highest spatial resolution of FC color mosaics with complete spectral coverage of Ceres will be obtained during the High Altitude Mapping Orbit (HAMO) phase, yielding a spatial resolution of approximately 135 m/pixel.

Table 1: Dawn mission phases at Ceres with global coverage by all Framing Camera color filters.

Dawn phase	Date(s)	Resolution [m/pixel]	No. color stations*)
RC1#)	2015-02-12	~7,900	13
RC2	2015-02-19	~4,300	20
RC3	2015-05-04 – 2015-05-07	~1,260	45
Survey	2015-06-05 – 2015-06-28	~410	133
HAMO	2015-08-06 – 2015-10-11	~135	492

*) A station consists of 7 color images (all filters)
#) RC – Rotation Characterization

2. FC data processing

The FC color data is acquired in so-called 'stations' of seven images, i.e., all appendant color images are taken in the shortest possible time intervals. After calibration of the data to radiances and removal of the in-field stray light component (data level 1C), the subsequent processing is using the USGS Integrated Software for Imagers and Spectrometers (ISIS 3) [3]. Initially, every image is converted to I/F reflectance involving their respective heliocentric distances. Afterwards, every station is treated individually. At first, this comprises the precise co-registration of a single color image with the corresponding shaded relief map, which is based on the Ceres DEM. Subsequently, the remaining images of the station are co-registered with the single image. This ensures a consistent fit of all filters with the DEM, which is important for the accuracy of the following photometric corrections. These are based on individual Hapke Henyey-Greenstein model parameters for each FC filter. Finally, the spectral cubes of all stations are spatially mosaicked to create a global mosaic. Our approach yields maximum spectral integrity of the mosaic, as opposed to a separate processing and mosaicking of all images from single filters and subsequent stacking.

3. Ceres color mosaics

Figure 1 shows the low cerean surface reflectance exemplarily in the 0.55 µm filter. Considering the region between 50° N and 50° S latitude in Fig. 1 (in order to exclude areas of high incidence), nearly 99% of the pixels lie in between 0.03 and 0.04 reflectance at 0.55 µm. Only 0.2% of the pixels exhibit lower reflectances than 0.03, while 0.9% possess higher reflectances than 0.04. These reflectance values are consistent with most carbonaceous chondrite (CC) meteorites of CM type and some unusual aqueously altered and thermally metamorphosed carbonaceous chondrites (ATCC) as investigated by [4].

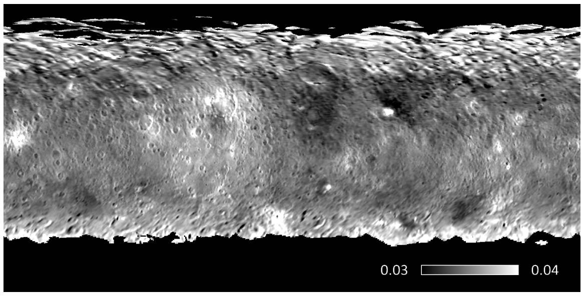

Figure 1: Global Ceres mosaic of reflectance in the FC 0.55µm filter from RC2 phase. Credits for all images: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

Despite the FC's limited wavelength range, even early color mosaics acquired during the RC1 and RC2 phase indicate a wide diversity of cerean surface materials if viewed as simple RGB displays (Fig. 2 and 3). For Figure 2, we preferentially used areas of low solar incidence and phase angles to create the mosaic. This yields a display free of most topographic effects (e.g., crater shadows), while intensifying color differences. In contrast, Figure 3 shows a mosaic where high incidence areas were favored, in order to emphasize topographic features.

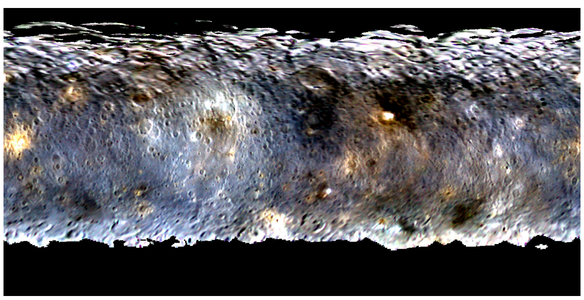

Figure 2: Global FC color image mosaic of Ceres from RC2 phase. Areas of low solar incidence have been used. R – 0.44 µm, G – 0.55 µm, B – 0.92 µm.

4. Scientific utilization (outlook)

We developed the aforementioned image processing and mosaicking approach for the FC data from Vesta, Dawn's first target. There, the spectral mosaics have proven crucial for a wide variety of geo– and mineralogical studies (e.g., [5, 6]). On Ceres, we intend to use them for the following investigations:

- Search for evidence of water ice on or near the surface.
- Investigation of the nature of the bright spots which appeared in Dawn observations during the approach phase.

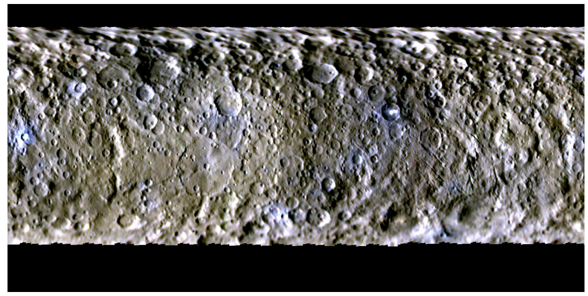

Figure 3: Global Ceres mosaic of FC color images from RC2 phase. Areas of high solar incidence have been used. R – 0.96 µm, G – 0.75 µm, B – 0.44 µm.

- Distribution of CC material on Ceres. For this, we will use FC-based spectral parameters that have been developed in [4] based on available CC laboratory spectra.
- The latter also includes the search for phyllosilicates, which are the main constituent in the matrix of aqueously altered CC meteorites (e.g., many CM). Using FC filters, [4] showed that it is possible to see both the 0.7 µm and the 0.9 µm absorption bands of Fe-bearing phyllosilicates.
- Exploration of possible cerean surface materials, e.g., serpentinization assemblages including serpentine group minerals, magnetite, carbonates and brucite. Besides, we also intend to search for salt-rich materials such as sulfate precipitates leached from CI and CM as found by [7, 8], or chloride-rich assemblages as suggested by [9].
- Signatures of exogenic materials delivered by impacts, more or less mixed with native material.
- Checking for possible temporal variations of the surface, e.g., in the case of near-surface ice.

References

[1] Russell, C. T. & C. Raymond, Space Sci. Rev., 163, 3-23, 2011. [2] Sierks, H. et al., Space Sci. Rev., 163, 263-327, 2011. [3] Anderson, J. A. et al.: ISIS Cartographic Tools for the Dawn FC and VIR Spectrometer. AGU Fall Meeting, abstract #U31A-0009, 2011. [4] Schäfer, T. et al.: Dawn FC color data: Carbonaceous Chondrites and Aqueous Alteration Products as Potential Ceres Analog Materials. Icarus, 2015, submitted. [5] Nathues, A. et al.: Detection of serpentine in exogenic CC material on Vesta from Dawn FC data. Icarus, 239, 222-237, 2014. [6] Nathues, A. et al.: Exogenic olivine on Vesta from Dawn FC color data. Icarus, in press, 2014. [7] Airieau, S. A. et al.: Planetesimal sulfate and aqueous alteration in CM and CI carbonaceous chondrites. Geoch. et Cosmoch. Acta, 69 (16), 4166-4171, 2005. [8] Izawa, M. R. M. et al.: Composition and evolution of the early oceans: Evidence from the Tagish Lake meteorite. Earth & Planet. Sci. Letters, 298 (3-4), 443-449, 2010. [9] Fries M. et al.: Do we already have samples of Ceres? 76th Annual Meteoritical Soc. Meet, abstract #5266, 2013.