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DAWN Framing Camera results from Ceres orbit

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1. Introduction

Having completed its investigation of Vesta in late 2012, the NASA Dawn mission [1] reached its second target, the dwarf planet Ceres on March 6, 2015. During its operational phase, Dawn is scheduled to fly four polar orbits, each with a different distance to the target. The Framing Cameras (FCs) onboard the Dawn spacecraft are mapping the dwarf planet Ceres in seven colors and a clear filter [2], covering the wavelength range between 0.4 and 1.0 µm. The FCs also conduct a number of sequences for purposes of navigation, instrument calibration, and have already performed satellite searches and three early rotational characterizations (RCs) of Ceres in February and May 2015. During the EPSC conference we intend to present the most intriguing results obtained from the Survey orbit (resolution ~400 m/pixel) as well as the first results from HAMO orbit (~140 m/pixel) focusing on the analysis of FC color data.

2. Potential water ice

FC data have been obtained during the RC phases and during several periods of optical navigation. These observations led to a number of intriguing discoveries. One of these is the detection of bright spots, especially on the floor of the 89.5 km diameter crater located at 22.6°N/239.4°E. The brightest of these spots has a geometric albedo of more than 0.4 and was not spatially resolved until RC2. Its high geometric albedo and spectral shape in VIS are consistent with water ice, but further investigations are required to rule out other potential analogue materials. One of the questions Dawn intends to answer is whether Ceres harbors a substantial subsurface reservoir of water ice. During the late approach phase, FCs spatial resolution was already sufficient to identify surface morphologies, which are dominated by the effect of relaxation. Deserving particular mention is a basin structure (Ø 260 km) centered at 13.1°S/122.7°E showing a much smoother surface compared to the rougher terrains indicated in Figure 1. Also, the determined minimum size of central peak craters is more consistent with the icy outer satellites than rocky bodies [3].

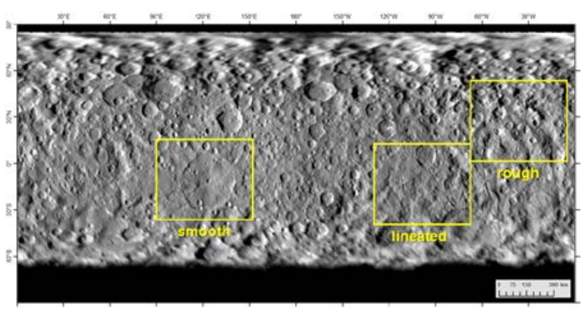

Figure 1: Clear filter mosaic of Ceres acquired by Dawn FC during RC2. Terrains of different roughness are marked. Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

3. Hunting for water vapor

Near-surface water vapor was detected before arrival of Dawn at Ceres [4]. This water vapor could arise from a variety of processes including cryovolcanism, recent impacts, and sublimation-induced outgassing activity. These should be colorimetrically distinguishable from the relatively flat and dark spectral background of the average Ceres surface. The water vapor emission observed by [4] requires surface exposures of water ice over small areas that are expected to be clearly resolved in FC images. Because the water vapor emissions seem to be episodic [4, 5], time-resolved color maps of the entire surface may reveal a history of emissions and insights into the mechanism(s) giving rise to them. Thus, the FC color data will provide an important complement to topographic and clear-filter albedo investigations to identify current and past surface processes, as well as other investigations returned by Dawn's payload instruments, to identify current and past surface processes.

4. Identifying native materials

Dawn’s first target, Vesta, revealed a surface with remarkable color heterogeneities that even increased over small spatial scales [6, 7, 8]. Given Ceres’ larger size, a surface similarly contaminated by exogenic material was expected but not identified so far. The color mosaics derived from RC2 show an unexpectedly high contrast across the Ceres surface (Fig. 2). The low reflectance surface units could be analogous to carbonaceous chondritic material with its low albedo and typical spectral shape [9]. Carbonaceous chondrite meteorite groups (CI, CM), containing hydrated minerals and water, show a very low overall reflectance of less than 0.1 in the visible and near-infrared range. Besides ice, we also consider evaporites, such as carbonates, sulfates and brucite as potential contributors to the brightest surface units on Ceres. These materials show overall reflectance values of more than 0.6 for relatively pure phases. Those minerals have been found in CI and CM [10] meteorites and could be derived from CI- or CM- like precursor material under aqueous conditions. Cryovolcanism or any other kind of surface or subsurface activity could cause those materials to be locally concentrated.

FC color parameters have been identified in order to discriminate the major carbonaceous chondrite groups and to narrow down ambiguities to other potential materials [9]. The FC filters are also suitable for the detection of phyllosilicate absorptions at 0.7 µm and 0.9 µm [9]. These minerals are common products of aqueous alteration of olivine and pyroxene precursor materials and are primary constituents in carbonaceous chondrites.

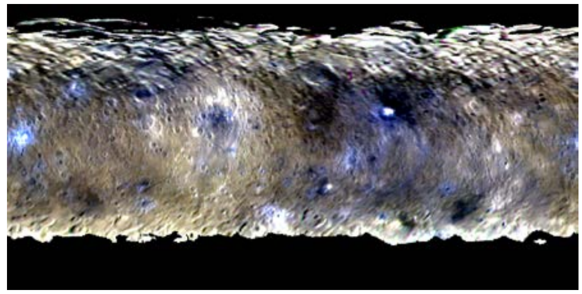

Figure 2: False color image mosaic of Ceres obtained during RC2 (same extent as Fig. 1, R – 0.96 µm, G – 0.75 µm, B – 0.44 µm). Credit: NASA/JPL-Caltech/UCLA/MPS/DLR/IDA

6. Summary and Conclusions

As of the editorial deadline, Dawn FC has acquired imagery with a spatial resolution of up to ~2 km/pixel. Color mosaics from RC2 show a world that is spectrally more diverse than expected. The geomorphology of surface features is, over large areas, consistent with surface relaxation. The discovery of the bright spots and the exploration their nature is very fascinating but requires higher resolution data, which will be on-ground by September 2015.

Acknowledgements

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References

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