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Ceres' Yellow Spots – Observations with Dawn Framing Camera

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The Framing Camera (FC) onboard the Dawn spacecraft acquired several spectral data sets of (1) Ceres with increasing spatial resolution (up to 135 m/pixel with nearly global coverage). The FC is equipped with seven color filters (0.4–1.0 μm) plus one panchromatic ('clear') filter [1]. We produced spectral mosaics using photometrically corrected FC color filter images as described in [2]. Even early FC color mosaics obtained during Dawn's approach unexpectedly exhibited quite a diversity of surface materials on Ceres. Besides the ordinary cerean surface material, potentially composed of ammoniated phyllosilicates [3] or some other alteration product of carbonaceous chondrites [4], a large number of bright spots were found on Ceres [5]. These spots are substantially brighter than the average surface (exceeding its triple standard deviation), with the spots within Occator crater being the brightest and most prominent examples (reflectance more than 10 times the average of Ceres).

We observed bright spots which are different by their obvious yellow color. This yellow color appears both in a 'true color' RGB display (R=0.65, G=0.55, B=0.44 μm) as well as in a false color display (R=0.97, G=0.75, B=0.44 μm) using a linear 2% stretch. Their spectra show a steep red slope between 0.44 and 0.55 μm (UV drop-off). On the contrary to these yellow spots, the vast majority of bright spots appears white in the aforementioned color displays and exhibit blue sloped spectra, except for a shallow UV drop-off. Thus, yellow spots are easily distinguishable from white spots and the remaining cerean surface by their high values in the ratio 0.55/0.44 μm.

We found 8 occurrences of yellow spots on Ceres. Most of them (>70 individual spots) occur both inside and outside crater Dantu, where white spots are also found in the immediate vicinity. Besides Dantu, further occurrences with only a few yellow spots were found at craters Ikapati and Gaue. Less definite occurrences are found at 97°E/24°N, 205°E/22°S, 244°E/31°S, 213°E/37.5°S, and at Azacca crater. Often, the yellow spots exhibit well-defined boundaries, but sometimes we found a fainter diffuse yellow tinge around them, enclosing several individual yellow spots. Rarely, they are associated with mass wasting on steep slopes, most notably on the SE crater wall of Dantu. Recently acquired clear filter images with 35 m/pixel resolution indicate only a small number of yellow spots to be situated nearby craters. These craters could also be interpreted as pits probably formed by exhalation vents. More frequently, we found yellow spots linked to small positive landforms. Only a few of the yellow spots seem to be interrelated with crater floor fractures.

As with white bright spots, which were interpreted as evaporite deposits of magnesium-sulfate salts [5], the yellow spots appear to emerge from the sub-surface as a result of material transport, possibly driven by sublimation of ice [5], where vents or cracks penetrate the insulating lag deposits. However, in contrast to the white spots, a different mineralogy seems to have emerged at yellow spots. First comparisons of FC spectra with laboratory spectra indicate pyrite/marcasite as a possible component. The relatively strong UV drop-off may at least indicate some kind of sulfide- or sulfur-bearing mixture. As identifications of minerals based on FC spectra are often ambiguous, further investigations by high-resolution data yet to come from Dawn's VIR spectrometer may shed light into the compositional differences between yellow and white bright spots.

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