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The appearance of Carbonaceous Chondrites on (1) Ceres from observations by the Dawn Framing Camera

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NASA's Dawn spacecraft reached dwarf planet Ceres in March 2015 and started data acquisition using three different instruments. These are the Framing Camera (FC; [1]), the Visible & Infrared Spectrometer (VIR; [2]), and the Gamma Ray and Neutron Detector (GRaND; [3]).

In our work we focus on the potential appearance of carbonaceous chondritic (CC) material on the cerean surface using Dawn FC color mosaics covering the VIS/NIR wavelength region. In preparation of the Dawn arrival at Ceres, a discrimination scheme for CC groups using FC color ratios was developed by [4] and is based on 121 CC laboratory spectra compiled from RELAB.

As the cerean surface material mainly differs by its spectral slope over the whole FC wavelength range (0.44–0.97 μm), we classified the color mosaics by this parameter. We applied the CC discrimination scheme only to those regions on the cerean surface (more than 90 %) which exhibit spectral slopes $\geq$ -1 % reflectance per μm to exclude the strongly negative sloped regions of large young craters such as Occator, Haulani, and Oxo. These are not likely to be similar to pure CC material as can be seen by their brightness and their bluish spectral slope [5].

We found that the surface material of Ceres is, among the suite of CCs, most similar to Ivuna samples artificially heated to 200 and 300°C [6] and unusual CCs, which naturally experienced heating. The latter ones comprise Dhofar 225, Y-86789 and Y-82162, which have been determined to have undergone aqueous alteration and subsequent thermal metamorphism (e.g. [7,8]).Our comparison with VIR data shows, that the spectra of Ivuna heated to 200°C and 300°C match well the OH-absorption at 2.7 μm but do not show the smaller 3.05-3.1 μm absorption observed on Ceres [9,10,11]. Nevertheless, the remarkably flat UV drop-off detected on the cerean surface may, at least spectrally, correspond to highly aqueously altered and subsequently thermally metamorphosed CC material. Further alteration of this material on a parent body like Ceres may produce spectral changes affecting the 3 μm region, while showing no additional modification in the VIS/NIR region.

Scenarios of thermal and geophysical evolution models allow Ceres' differentiation into a core of dehydrated silicates and a shell of hydrated silicates overlain by an icy shell [12,13]. The widespread occurence of material on the cerean surface, spectrally similar to thermally altered CC material, suggests that we possibly see the mineralogy of the hydrated-dehydrated boundary of Ceres exposed by impact gardening and simultaneous loss of the icy shell. Also differing recent models of a convecting mud ocean on Ceres, introduced by [14] and enhanced by [15], allow a lag deposit of aqueously altered fine material on the surface, spectrally corresponding to mildly heated Ivuna samples.

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