Latest results on Ceres from DAWN: ingredients for life ?

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1. Introduction

Ceres, the largest body in the main belt, has been the subject of extensive telescopic observation since its discovery on January 1, 1801. The arrival of Dawn mission at Ceres allowed to understand better this intriguing body. The Dawn mission has spent over two years orbiting Ceres, assessing the characteristics of its surface and interior [1]. Here we report about the main results of the mission, with particular care of the astro-biological implications.

2. Dawn discoveries

The Dawn data show that the crust is composed of an intimate mixture of rock and ice. Below ~50 km depth, the material weakens. The surface is cratered but very large craters are absent, indicating relaxa-tion. Ceres also has mountains, like very well preserved Ahuna Mons, that are likely cryovolcanic construct(s) [2].

Clearly, Ceres experienced extensive water-related processes and chemical differentiation. The surface is mainly composed of a dark and spectrally neutral component (carbon, magnetite), Mg-phyllosilicates, ammoniated clays, carbonates and salts. The observed species suggest endogenous, global-scale aqueous alteration [3,4,5]. The surface is uniform in composition at large scale with subtle but important variations in the abundance of the chemical species [5,6].

Water ice has been detected in localized small areas especially at high latitudes [7] in the North hemisphere but also in the southern hemisphere, in a crater not far from the equator [8], indicating ice on the surface and immediate subsurface. Global distribution of water ice shows strong latitudinal dependence [9]. Carbonates are ubiquitous in small abundance but very high concentrations of carbonates have been identified in several areas on the surface, notably in Occator bright faculae (fig.1) [3]. Many of the bright areas [10] that punctuate the surface of Ceres are compatible with the presence of sodium carbonates [5].

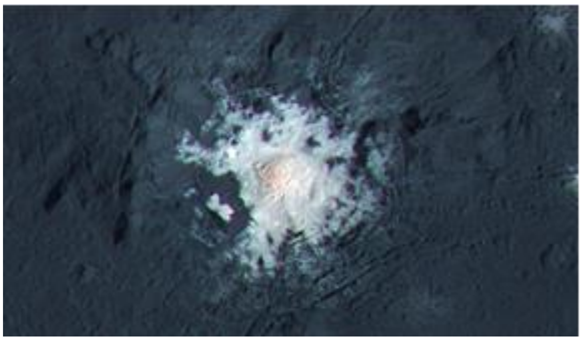

Figure 1. Cerealia facula on the dome of Occator crater. The dome is fractured as if it were pushed up from below. The bright material is mainly sodium carbonate.

The distribution of the material on the Occator crater suggests that this material was produced inside Ceres in brine-fed hydrothermal systems that brought this material to the surface [3]. Moreover, sodium and ammomium salts have been also identified [3]. Many if the compounds observed on Ceres are also identified in the Enceladus' plume suggesting some similarities between these bodies.

Some regions on Ceres show the presence of organics, identified by a strong absorption at 3.4 µm in the spectra [11]. The signature is extremely strong and clear indicating a high quantity of organics (fig.2). The main candidates for the 3.4 µm absorption are materials containing C-H bonds, including a variety of organic materials. The Ceres band at 3.3-3.5 µm shows marked similarities with the organic bands of terrestrial hydrocarbons, like asphaltite and kerite, considered to be analogues for asteroidal and cometary organics. It is also very similar to the organic 3.4 µm observed in Insoluble Organic Matter (IOM) extracted from the carbonaceous chondrites. The overall characteristics of the 3.3-3.5 µm band (shape, position, intensity) discovered on Ceres indicate unambiguously the presence of organic material on this dwarf planet.

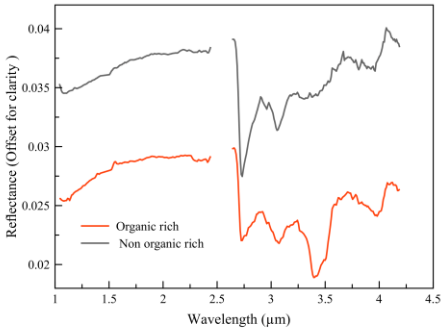

Figure 3. Red-line: Ceres organic-rich spectrum; gray-line: Ceres generic spectrum.

Liquid water is the first potential indicator of habitability on the Solar System bodies (planets and satellites). Ceres is very appealing in terms of habiltability. It has clear signs of fluids circulation in the recent past or even now, presence of acqueous alteration products, water ice and organic material. Moreover, Ceres experiences mild temperatures on the surface and resides in the habitable solar system region

3. References

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Short Summary

Ceres, is the largest body in the main belt, and the Dawn mission allowed to understand better this intriguing body. The mission has spent over two years orbiting Ceres, assessing the characteristics of its surface and interior. Here we report about the main results of the mission, with particular care of the astro-biological implications.