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Distribution of carbonates on Ceres

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Abstract

In this work we mapped the spatial distribution of carbonates using the VIR/Dawn spectrometer. The presence of the hydrated carbonates indicates that their formation/exposure on Ceres' surface is geologically "recent" and dehydration to the anhydrous form (Na_2CO_3) is still ongoing.

Introduction

After the success of the Dawn mission in the study of the asteroid Vesta, the spacecraft departed toward the dwarf planet Ceres and is currently in its orbit. In this work we investigate the nature, the formation and the distribution of carbonates on Ceres using the VIR spectrometer onboard Dawn mission. Carbonates are a components of chondritic meteorites (e.g., 1,2) and have typically been used to infer the occurrence of liquid water in their parent bodies (3). The carbonate signature in the Ceres spectrum was first detected from Earth (4,5) and then confirmed by Dawn observations (6), showing that Ceres' average surface is an assemblage of phyllosilicates, ammoniated species, absorbing dark materials, and carbonates (6,7). The distribution and chemical composition of the carbonates are indicators of internal evolution.

Data

VIR (Visible-Infrared Mapping Spectrometer, 8) is the imaging spectrometer on board Dawn spacecraft and it is acquiring hyperspectral images in the 0.25-5.1 µm spectral range [1] of Ceres. We measured the strength and position of the ~3.9 µm feature across Ceres that gives us the distribution of carbonates unambiguously. The maps discussed have global longitudinal coverage, latitudinal coverage from 66°S to 66°N, and a spatial resolution of ~1.86 km/pixel at the equator. We used the HAMO dataset. A few selected small areas have been also observed at higher resolution, at ~100 m/pixel.

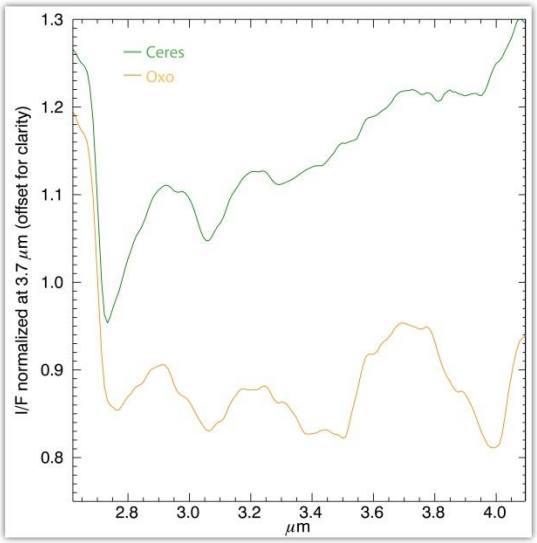

Fig. 1. Average spectrum of Ceres compared to the spectrum enriched in Na-carbonates located in Oxo crater. The spectra have been normalized to 1 at 3.7 µm and an offset has been applied for clarity.

Results

The VIR spectrometer mapped carbonates spatial distribution on the surface of Ceres. We found that carbonates are ubiquitous across the surface, but variations in the strength and position of their absorptions indicate variations in the composition and abundance of this mineral. The analysis of the band centers indicates that most of the surface is compatible with (Mg,Ca)-carbonates, being at about 3.96 µm. However, there are localized areas, such as

Occator central dome, that show band centers at much longer wavelengths (4.02 μm) typical of sodium carbonates (Fig. 1). Sodium carbonates occur mainly in the brighter areas of Ceres (9) and their geological settings suggest the upwelling, excavation and exposure of Na-rich species. The origin of sodium carbonate is different with respect the (Mg, Ca) carbonates, meaning that different processes have formed these chemical species.

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