EPSC Abstracts
Vol. 13, EPSC-DPS2019-401-2, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Occator Crater on Ceres: Recently Active Cryovolcanism?

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Abstract

Ceres is a partly differentiated body in the main asteroid belt that experienced cryovolcanic, and potentially brine-driven activity throughout its history [1-9]. The young Occator crater, perhaps the most striking surface feature on Ceres, displays bright deposits across its floor that possibly originated from brine reservoirs at depth involving endogenic forces [2,7,8,10,11].

1. Introduction

Dwarf planet Ceres is the largest and most massive object in the main asteroid belt. NASA's Dawn spacecraft investigated the origin and evolution of Ceres. One of the most astonishing discoveries of Dawn is the cryovolcanism within the Occator crater that was triggered by the impact itself, unleashing endogenic forces [1,2]. Cryovolcanism has been found before exclusively on icy planetary moons of the outer solar system as a consequence of tidal forces. During its final orbit, Dawn's Framing Camera (FC) obtained several thousand high resolution images of the Occator region. This imagery is suited to shed further light on the origin and evolution of the crater and Ceres itself.

2. FC and Dawn's final orbit

The FC used one panchromatic and seven colour filters, covering the wavelength range 0.4 to 1.0 µm. In June to August 2018 the FC obtained the highest resolution surface images ever. The whole Occator crater was imaged with pixel scales ≤ 25 m (Fig. 1A), selected areas even with pixel scales 3 – 5 m, and thus about 10-times higher resolved than before (Fig. 1D/E).

3. Cryovolcanism on Ceres

Cryovolcanism on Ceres was associated with the young giant dome-like feature Ahuna Mons [2]. Similar elevations have been identified and studied by [3], suggesting a more widespread presence of these features. Ahuna Mons, the youngest of these domes, is dated to be less than ~200 Ma old [2, 4]. Even younger cryovolcanic features, as young as ~4 Ma, have been reported by [1, 5] on the floor of Occator. This crater (Ø 92 km, ~4 km deep) is one of the most intriguing surface features on Ceres because of its bright material deposits (faculae). Previous studies revealed that the faculae (cf. Fig. 1) are compositionally enriched with sodium carbonate [7, 8] and are suggested to be significantly younger than the impact crater itself [1, 5]. However, FC imagery from the Low Altitude Mapping Orbit (LAMO) was too coarse for a reliable age determination of the faculae and other floor units. As will be shown during the presentation, the new high resolution imagery is suited to determine ages of individual geologic units of Occator, including the faculae. The measured ages and morphological characteristics of the floor features are consistent with a long lasting, periodic or episodic ascent of brines from a deep subsurface reservoir or a combination of a shallower and a deep reservoir [1, 13].

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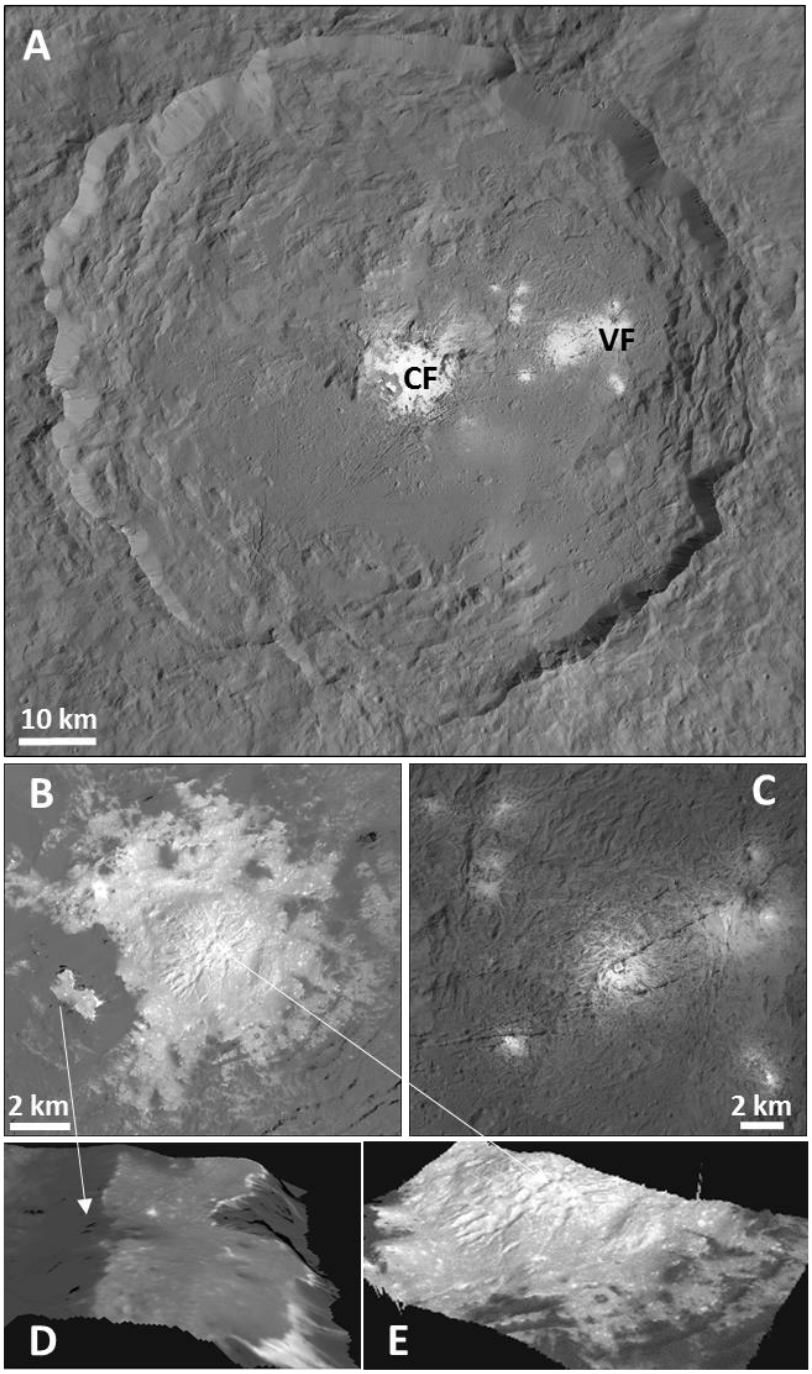

Fig. 1: *Views of Occator crater in clear filter from final orbit. (A) Full reprojected mosaic at ≤15 m pixel scale with Cerealia Facula (CF), Vinalia Faculae (VF), (B) CF at ≥3 m pixel scale, and (C) VF at ≥3 m pixel scale. (D, E) Perspective views of selected areas at ≥3 m pixel scale using topographic information derived from those images by stereophotogrammetry: (D) Mesa, (E) central pit and central dome.*