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High-resolution Stereo Mapping of Endogenic Features on Impact Deposits at Occator Crater, Ceres

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Abstract

Dawn extended mission stereo imaging and digital terrain models (DTMs) of Occator floor deposits at scales down to 3.5 m reveal crater-wide mantling by impact melts and widely scattered endogenic pits, sinuous troughs, and perhaps periglacial landforms. These features result from melting and mobilization of crustal water ice into ice- and salt-rich muddy slurries during impact and subsequent recrystallization and volatile release. Bright Na-carbonate deposits at Vinalia Faculae formed as surficial coatings of precipitates from brine effusion at many individual sites, coalescing in several larger centers. The unique morphologies contrast with those seen in large fresh craters on the Moon and Mars, and are related to lower impact velocities and the mixed ice-salt-silicate crustal composition of Ceres.

1. Introduction

Impact deposits and structures and carbonate deposits at the well-preserved 92-km Occator crater (the "Tycho of the Asteroid Belt") reveal the influence of Ceres' unique mixed ice-salt-silicate crustal composition on impact processes. A prime objective was to map the surface in detail to test hypotheses derived from higher altitude imaging [1,2], and elucidate the mechanisms by which these deposits were emplaced. Here we focus on the nearly complete mapping coverage in stereo at 3.5 to <10 m pixel scales over the eastern half of the crater (with additional coverage over the western portions), and high-resolution DTMs derived from the same data. In many cases, these stereo images can be mosaicked together to provide stereo strips in a N-S direction from rim to rim (Fig. 1).

1.1 Geomorphology of Floor Features

A rich variety of unusual features are observed in the XM2 high-resolution imaging and stereo (Fig. 2, 3). These include extensive mantling by (likely) impact 'melt' deposits (consisting of melted water with suspended and dissolved silicates, carbonates and salts), curvilinear scarps and troughs, narrow fractures, large irregular mounds, small rounded knobs (some with bright flanks or crest pits), and widely scattered irregular non-impact pits (some with bright deposits). All are indicative of impact related deposits that formed promptly but also underwent extensive post-emplacement chemical and physical evolution leading to dissociation of some phases and local surface modification of the cooling and solidifying deposits.

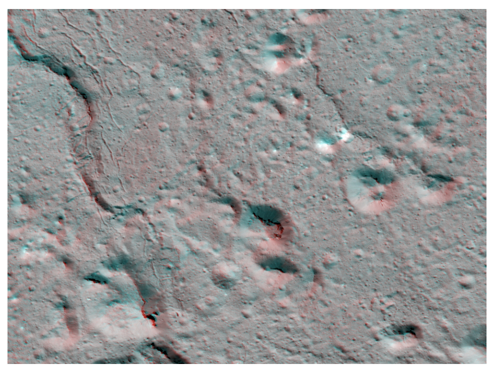

Figure 1: Small portion of 126-frame rim-to-rim stereo mosaic across Occator crater, featuring curvilinear scarps, mounds, crested mounds, pits, and rounded domes.

The bright carbonate deposits in Vinalia Faculae (Fig. 2) formed as multitudes of small discrete spots <25 m across and large extended contiguous deposits. Most line but do not fill closed topographic depressions within the floor deposits, and only at 2 sites do we observe small putative constructional edifices of carbonate material. Relief of these materials is extremely low. The stereo observations are consistent with the deposition of carbonate materials via the extensive seepage of subsurface fluids onto the surface where dissolved carbonates precipitate as solids during outflow or localized fountaining.

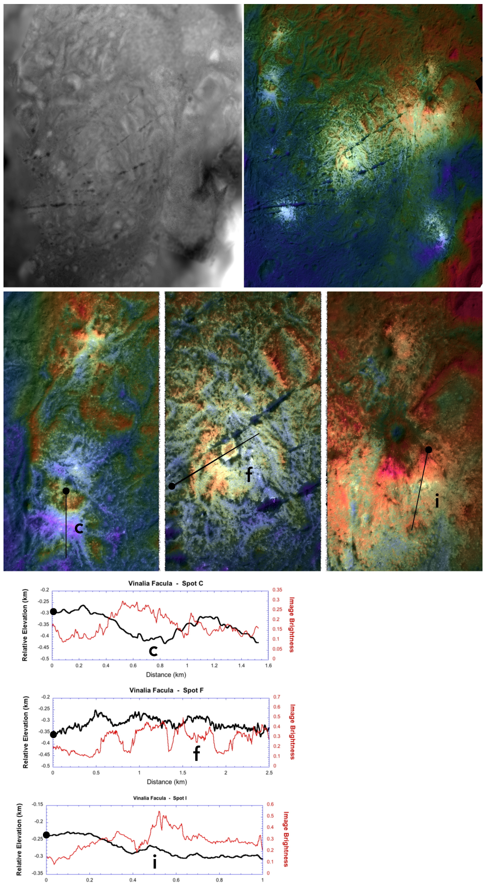

Figure 2. Stereogrammetric DTM (top left) and XM2 mosaic color-coded with DTM (top right) of lobate floor deposits featuring Vinalia Faculae carbonate deposits. Middle row shows major bright spots featuring low topography and two possible constructional features (f, i), with profiles at bottom.

2. Comparisons to Moon and Mars

Differences in surface morphology of impact deposits at Occator with those on the Moon and Mars may be related to impact conditions and/or crustal composition. The shallow small pits and pit clusters, thick lobate flow margins, and sinuous troughs observed at Occator are either not common or are different in expression in both lunar and Mars craters. On the other hand, the absence at Occator of the pervasively pitted terrains observed on Mars and Vesta and to some degree in some large craters on Ceres is curious considering the likely higher volatile content of Ceres (up to 60% ice and clathrates v. ≤10% ice for Mars [3, 4]). Variations in floor morphology across Ceres and on Mars may reflect regional composition variations or impact conditions. Ceres differs from Mars in its ~40°K cooler surface (and even cooler internal) temperatures, ~15x lower surface gravity, and ~2x lower mean impact velocities. All these conspire to produce lower heating rates for a given size projectile on Ceres [5], mitigated in part by the latent heat of Ceres' greater water ice content. Low-temperature crustal components may be more easily volatilized or more explosively released on Mars than on Ceres, or water may be sequestered differently on Ceres than on Mars (where perhaps <3 wt% is inferred to be in hydrated minerals [4]).

Acknowledgements

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References

[1] Scully, J.E.C., and 8 others: Ceres' Occator crater and its faculae explored through geologic mapping. *Icarus, 320*, 7-23, http://doi.org/j.icarus.2018.04.014, 2019.

[2] Schenk, P, and 12 others: The central pit and dome at Cerealia Facula bright deposit and floor deposits in Occator crater, Ceres: Morphology, comparisons and formation, Icarus, 320, 159-187, 2019.

[3] Ermakov, A. I., et al.: Constraints on Ceres' internal structure and evolution from its shape and gravity measured by the Dawn spacecraft. Journal of Geophysical Research: Planets 122, 2267-2293, 2017.

[4] Mustard, J.; in *Volatiles in the martian crust,* eds. J. Filiberto and S. Schwenzer, Elsevier Press, 2019.

[5] Bowling T. J., and 6 others: Post-impact thermal structure and cooling timescales of Occator crater on asteroid 1 Ceres, Icarus 320, 110-118, doi: 10.1016/j.icarus.2018.08.028, 2019.