Peculiarities of Occator crater on (1) Ceres A. Nathues[1], G. Thangjam[1], T. Platz[1], M. Hoffmann[1], N. Schmedemann[1], J. E. C. Scully[2], N. Stein[3], O. Ruesch[4] and K. Mengel[5], [1]Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077, Göttingen, Germany (nathues@mps.mpg.de), [2]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, [3]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, 91125, [4]ESA-ESTEC, Keplerlaan 1, 2201 AZ Noordwijk, The Netherlands, [5]Institute of Disposal Research, Clausthal University of Technology, Adolph-Roemer-Str. 2a, 38678 Clausthal-Zellerfeld, Germany.

Introduction: One of the most intriguing surface features on Ceres is crater Occator that exhibits a central pit and a number of bright spots on the crater floor [1, 2, 3, 4, 5, 6, 7]. These spots show a diurnal brightness variation that is possibly attributed to the appearance of haze [1, 8]. Spectral analysis revealed that the bright spots are dominated by sodium carbonate mixed with a dark material component and some phyllosilicates [9]. The bright spots are significantly younger than the impact crater itself [3, 10, 11]. The central spot is likely the result of a long lasting, periodic or episodic ascent of brine from a subsurface reservoir [3, 4, 7]. Originally triggered by an impact event, gases, possibly exsolved from a subsurface brine reservoir, enabled the material to ascend [3, 4, 10].

Occator's bright spots provide a case to understand processes that formed and modified bright spots elsewhere on Ceres [1, 5]. In addition, their study allow insights into the cerean crust, which likely harbors large reservoirs of brine or even an encompassing brine layer ('ocean at depth') [1].

Method: We used clear and color filter images, mosaics and digital terrain models of the Dawn Framing Camera for our analyses [12, 10, 13].

Geology: Occator is a ~92 km diameter complex impact crater (Fig. 1) located on an elevated region named Hanami Planum that shows a strong negative Bouguer anomaly [14]. Occator exhibits a central pit (Ø ~9 km) which is surrounded by remnants of a central peak (Fig. 2), and a flat floor bounded by a multitude of terraces [1, 7, 15]. The central pit is up to 1 km deep and hosts the Cerealia Facula bright spot (Figs 1, 2). The center of the pit is occupied by an asymmetric, fractured, and 3 - 3.5 km diameter dome, which rises up to 0.55 km above to lowest point (-1,220 m) within the pit (Fig. 2). East of Cerealia Facula a number of less bright sites, collectively known as Vinalia Faculae mantle the distal portion of the largest lobate deposit within Occator (Fig. 1).

Bright material thickness of Vinalia Faculae has been first investigated by [3]. The material is rather thin, about a few meters or less, as it mostly mantles the rough surface texture of the large lobate deposit. The largest spots of bright material are associated with fractures [3, 18]. Some fracture planes are coated with bright material and thus are potential sources. However, fractures near some smaller bright spots are not observed at LAMO resolution. The fractures associated with Vinalia Faculae are characterized by circular to elliptical depressions of up to ~0.25 km in diameter. These depressions represent pits rather than impact features since they line up like a string of pearls along the fractures, which are ~0.11 – 0.18 km wide. Most fractures are about 50 - 100 m deep and only some portions of their bottoms get illuminated during a cerean day. Several small extreme bright sites are resolved within the bright spots of Vinalia Faculae which could be volcanic vents branched from a major conduit.

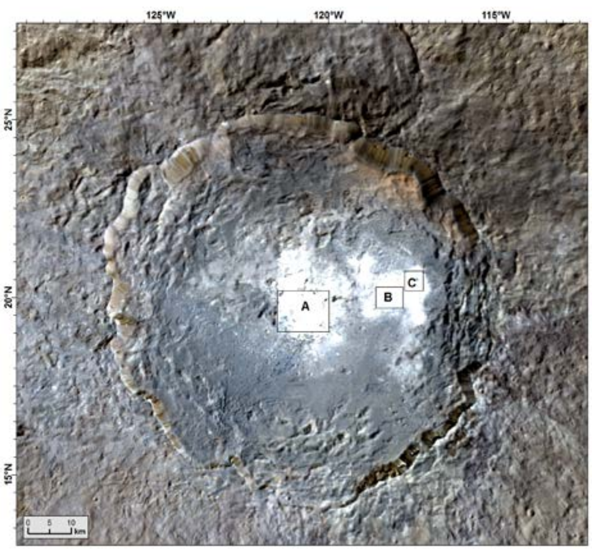

Fig. 1: *Enhanced color mosaic (R=0.96 µm, G=0.65 µm, and B=0.44 µm) of Occator crater at ~35 m/pixel resolution (LAMO). Gaps are filled by HAMO imagery. Dark floor and dark ejecta materials show higher relative reflectances at 0.44 µm and thus appear bluish. Ejecta located to the north-east are on average 1.3-times darker than typical dark material on Ceres [15]. The crater exhibits terraced walls, a large flow deposit covering most of the crater floor, a central pit containing a central bright dome (Cerealia Facula, box A), remnants of a central peak, and secondary bright spots to its north-east (Vinalia Faculae, boxes B and C). Equidistant cylindrical projection with the standard parallel at 19.5°N.*

While the Vinalia faculae are rather thin deposits of bright material, the central pit consists of vast deposits. In particular, the dome is entirely composed of bright material [3]. The formation ages of Cerealia Facula was estimated to be about 4 Ma [3]. Vinalia Faculae are entirely confined to the extent of the northeastern portion of the lobate deposit, and therefore, are younger than the deposit itself. The two largest bright sites of Vinalia Faculae (box B and C in Fig. 1) were examined for superposed impact craters. Although none were detected at highest resolution, this information can still be used to derive a first-order model age which is less than 2 MA [3].

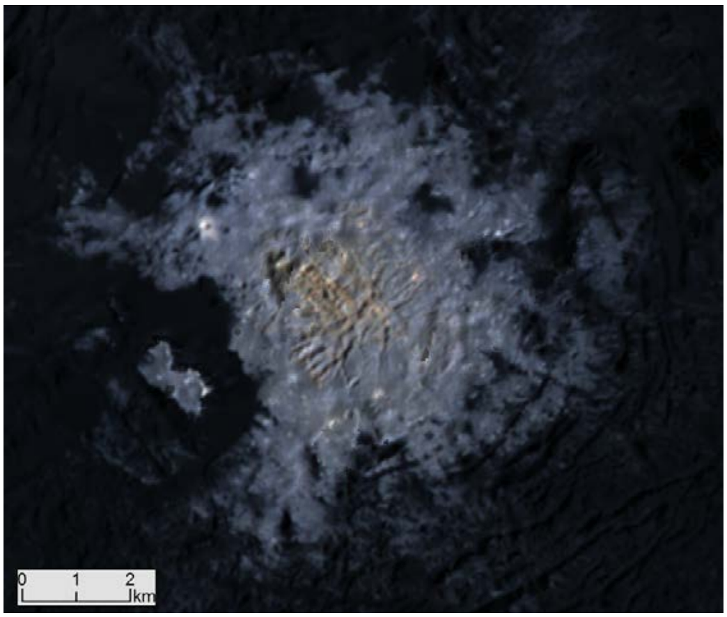

Fig. 2: *Color mosaic (R=0.96 µm, G=0.65 µm, B=0.44 µm) of Cerealia Facula at ~35 m/pixel. A significant fraction of the pit is covered with bright material which has been deposited by one or more eruptive events. Isolated bright material is located at several elevated areas. The central dome shows radial fractures. Further fractures are associated with the central pit. North is up. Equidistant cylindrical projection with the standard parallel at 19.5°N.*

The NE wall and the proximal portion of the small lobate deposit appear slightly reddish in false-color RGB images (Fig. 1). Here terrace material shows slightly different color spectra than elsewhere in Occator, which is a result of higher reflectivities longward of 0.65 µm. This spectral variation is likely not caused by compositional differences since the area is not distinct in VIR compositional maps [16].

Two large fracture systems intersect within southwestern terrace material [3, 17]. The one system extends towards the northeast across the large lobate deposit while the other system indicates a concentric pattern with individual fracture segments being oriented parallel to crater wall segments. A similar concentric fracture pattern is also observed on the crater rim and these are likely precursor fractures for future partial crater wall collapses. At the terminus of the NE-trending fracture system the two largest bright areas of Vinalia Faculae are present. Further individual fractures are associated with the central pit.

The ejecta of Occator exhibits color and reflectance dichotomies, i.e. the NE ejecta are darker, while the western is brighter and appears bluish in our RGB color mosaics. Ejecta material extends up to 140 km, in some cases to up to ~500 km from the crater center.

Haze: Recent investigations of Occator center based on data obtained during the extended mission phase confirm a unique light scattering process that was described earlier [1, 8]. Whether this is indeed due to haze or a unique surface scattering characteristic of the material is subject of ongoing investigations.

Conclusions: Occator is a complex central pit impact crater hosting intriguingly bright spots of cryovolcanic origin [3, 7], composed mainly of sodium carbonate [9, 3]. Intrusions of brine formed fractures, conduits and vents through which the material reached the surface. The central facula is located in a central pit exhibiting a central dome that shows indications of geologically recent eruptive processes.

References:

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