ARE FLOOR-FRACTURED CRATERS ON CERES FORMED BY CRYOMAGMATISM? D.L. Buczkowski[1], H. G. Sizemore[2], M. T. Bland[3], J.E.C. Scully[4], L. C. Quick[5], K. H. G. Hughson[6], R. S. Park[4], F. Preusker[7], C.A. Raymond[4], C.T. Russell[6]. [1]JHU-APL, Laurel, MD, USA; [2]PSI, Tucson, AZ, USA; [3]USGS Astrogeology, Flagstaff, AZ, USA; [4]NASA JPL, California Institute of Technology, Pasadena, CA, USA; [5]Smithsonian, Washington, DC, USA; [6]UCLA, Los Angeles, CA, USA; [7]DLR, Berlin, Germany.

Introduction: Several of the impact craters on Ceres have sets of fractures on their floors. These fractures are morphologically similar to those found within a class of lunar craters referred to as Floor-Fractured Craters (FFCs). We present a geomorphic and topographic analysis of the cerean FFCs and propose hypotheses for their formation.

Data: Geologic analysis was performed using Dawn spacecraft [1] Framing Camera (FC) [2] mosaics from late Approach (1.3 km/px), Survey (415 m/px), the High Altitude Mapping Orbit (HAMO - 140 m/px) and the Low Altitude Mapping Orbit (LAMO – 35 m/px) orbits, including clear filter and color images and digital terrain models derived from stereo images.

Lunar floor-fractured craters: Lunar FFCs are characterized by anomalously shallow floors cut by radial, concentric, and/or polygonal fractures [3]. These FFCs have been classified into crater classes 1 through 6, based on their morphometric properties [eg. 3, 4, 5]. The depth vs. diameter (d/D) relationship of the FFCs is distinctly shallower than the same association for other lunar craters [eg. 4, 5]. Models for FFC formation have explained their shallow floors by either floor uplift due to magmatic intrusion below the crater [eg. 3, 4, 5] or floor shallowing due to viscous relaxation [e.g. 6]. However, only magmatic uplift can explain the degree of floor uplift and the asymmetric nature of the uplift present in several of the FFCs [5, 7].

Cerean floor-fractured craters: Eight cerean craters have been categorized as Class 1 FFCs, following the classification scheme designed for the Moon. Dantu and Occator have radial and concentric fractures at their centers, and concentric fractures near their walls, representing fully mature magmatic intrusions [5]; initial doming of the center due to laccolith formation causes central fracturing, and continuing outward uplift of the remaining floor results in concentric fracturing adjacent to the wall. Other large (>50 km) cerean FFCs which have only linear or radial fractures at the center of the crater are also classified as Class 1 FFCs, but likely represent a less mature magmatic intrusion, with doming of the crater floor but no tabular uplift.

Thirteen smaller craters on Ceres are more consistent with Class 4 FFCs, which are defined by their v-shaped moats, with three sub-classes characterized by interior morphology [5]. Lociyo crater is a Class 4b FFC, having a distinct ridge on the interior side of its v-shaped moat and subtle fracturing. Other small cerean craters resemble Class 4c FFCs, with a moat and a hummocky interior, but no obvious fracturing.

An analysis of the d/D ratio shows that, like lunar FFCs, the cerean FFCs are anomalously shallow compared to the average Ceres crater [8].

Discussion: The cerean FFCs may be a product of the intrusion of a cryomagma below the craters, uplifting their floors [9]. This is not inconsistent with the identification of a cryovolcanic extrusive edifice (Ahuna Mons) on Ceres [10]; other features, mapped as large domes [9], have also been proposed to be cryovolcanic edifices, although degraded ones [9, 10].

In-depth analysis of Occator crater indicated that Ceres' mantle could yield cryomagma with sufficient driving pressure to have been responsible for the FFC fractures, reaching depths in the crust of ~3 km [11]. However, none of the impact craters that host large domes are FFCs. This anti-correlation suggests that there may be a difference in crustal properties between the locations of the FFCs and the large domes.

Ceres' crust is heterogeneous. Recent models suggest that impact into a layer of low viscosity/low density (LV-LD) material could result in solid-state flow of the layer, expressed as doming into the crater wall [12]. It is possible that FFCs formed where cryovolcanism happened, while large domes formed where solid state flow occurred. However, the location of the modeled doming is also consistent with some of the fracturing that observed in some FFCs, so perhaps differences in a putative subsurface LV-LD layer account for changes in the observed surface deformation. Further modeling will need to be performed to determine which process is more consistent with the observed features and what we know of the Ceres surface and interior.

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