UNDERSTANDING CRYOVOLCANISM ON DWARF PLANET CERES. G. Thangjam[1], A. Nathues[1], N. Schmedemann[1], K. Mengel[2], H.G. Sizemore[3], R. Strom[4], E.A. Cloutis[5], T. Prettyman[3], T. Platz[1], M. Hoffmann[1]. [1]Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077, Göttingen, Germany, [2]IELF, TU Clausthal, Adolph-Roemer-Straße 2A, 38678, Clausthal-Zellerfeld, Germany, [3]Planetary Science Institute, 1700 East Fort Lowell, Tucson, AZ 85719-2395, USA, [4]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ 85721-0092, USA, [5]University of Winnipeg, MB R3B 2E, Canada. (thangjam@mps.mpg.de).

Introduction: (1) Ceres is the largest asteroid and the only dwarf planet in the inner Solar System located at ~2.8 AU. The three instruments onboard Dawn spacecraft (i.e., Framing Camera/FC, Visible and Infrared Spectrometer/VIR, Gamma Ray and Neutron Detector/GRaND) have been exploring the geologic insights of this body. Among the important discoveries from Dawn, the finding of potential cryovolcanic features and processes on Ceres is of significant scientific interest [1-5]. However, the cryovolcanism and its processes are not well understood, and need detailed investigation to characterize and define such activities on Ceres. Therefore, we here present the current scenario and understanding, as well as our work in progress investigating potential cryovolcanic and cryogenic features and their processes using both FC color (0.4-0.96 µm) and VIR spectral (1.0-4.2 µm) data.

Cryovolcanism on Ceres: Multiple features and processes that are likely of cryovolcanic origin are reported, e.g., the discovery of Ahuna Mons as a potential cryovolcanic dome formed by the extrusion and inflation of cryomagma [1]. Then, the bright material in Occator crater, i.e., Cerealia Facula and Vinalia Faculae featuring the brightest cerean material on the center of the crater floor and a cluster of the second brightest cerean material on the north-eastern crater floor, suggesting a cryovolcanic origin formed by the extrusion of a brine reservoir at depth [4]. Recent or still ongoing activity at Occator has been reported [2, 6]. In addition, several sites on Ceres exhibit cryogenic flows and visco-elastic ice flows [3, 7]. Numerous craters exhibit crater floor fractures [8] that are likely formed by the upwelling of cryomagmas and subsequently freezing/dilatation mechanism.

A detailed mapping of these surface features is presented using both, FC clear filter data and FC-derived topography (Fig. 1). The global distribution of Mons/Tholi and local topographic highs (green cicrcles) as well as cryogenic/ice-like flows (red stars) and floor fractured craters (yellow stars) are presented in Fig. 1A. A possible clustering of mons-like features is observed in and around Ahuna Mons and Liberalia Mons as is shown in Fig. 1A and also by [9]. The spatial clustering of the mons could be of interest in the context of the cryovolcanism and reveal geologic conditions in the subsurface. Fig. 1B shows the global distribution of bright and dark material [10]. A comparison of the spatial distribution of the potential cryovolcanic features and that of the bright and dark material could bring further insights, particularly with the bright sites, because they are suggested to represent the surface as well as subsurface composition [10-11]. The surface and subsurface composition derived from the FC color and VIR data will complement our study.

The FC color data from HAMO orbit (~140 m/pixel) and LAMO orbit (~35 m/pixel) are used to derive spectral characteristics because of the relatively higher spatial resolution of FC color data. The VIR data from HAMO orbit (~275 m/pixel) are used for detailed mineralogical investigation. Note the differences in spatial resolution that require attention during analysis and interpretation. The VIR data used here is the level 1B radiance data archived at the NASA/PDS. The level 1B data are processed at MPS using the standard multi-step iteration processes: (1) artifact removal adapted from VIR and VIRTIS team's procedure for artifact removal [13-15], (2) thermal removal [16-17], (3) photometric correction [15, 18].

Figure 1E shows FC color spectra (normalized at 0.65 µm) of Occator crater and Ahuna Mons compared with average HAMO spectrum. Fig. 1F shows VIR spectra of those corresponding sites. Iterative steps of VIR data processing is an ongoing work. The spectra presented here are not photometrically corrected.

A detailed analysis for all potentially cryovolcanic sites on Ceres is in progress combining available information from the morphology, topography and composition.

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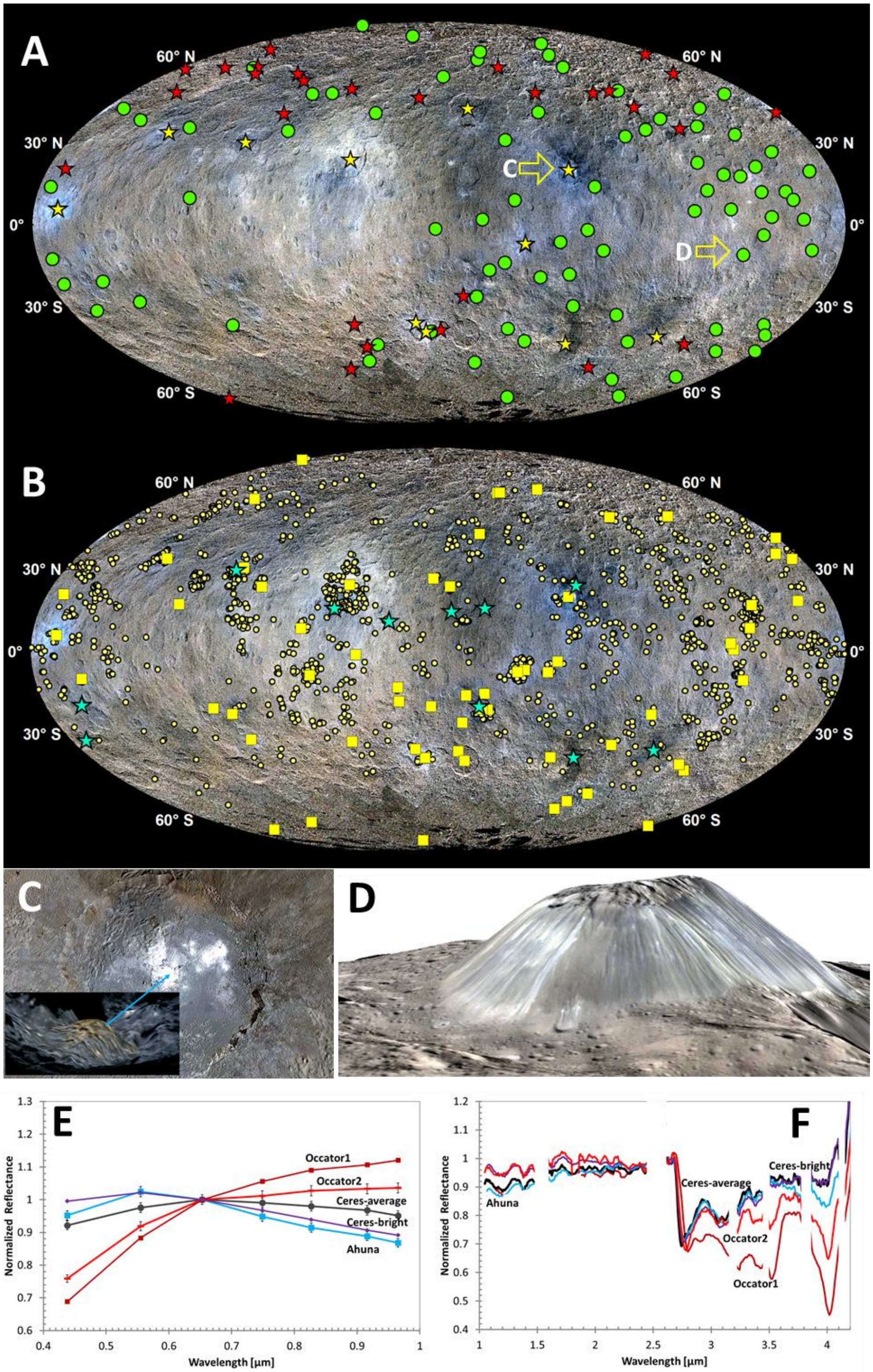

Fig. 1: (A) Global RGB mosaic of Ceres from FC color data (R=0.96 µm, G=0.65 µm, B=0.44 µm) in Mollweide projection centered at 180º longitude. Potential cryovolcanic sites including Occator crater (C) and Ahuna Mons (D) are highlighted (Symbols: green filled circles - mons/tholus, red stars - cryogenic/ice-like flows, yellow star - floor fractured craters). (B) Global RGB mosaic highlighting bright material (yellow squares mark large craters with diameter >10 km; yellow circle- small craters with diameters < 5 km; star – dark material [10]). (C) RGB of Occator crater, and perspective view of the central dome (inset). (D) Perspective view of Ahuna Mons draped over by RGB. (E, F) Normalized spectra of Ceres bright (typical [10]) material, Occator bright material and Ahuna Mons bright material from FC color (E) and VIR IR (F).