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GEOLOGIC MAPPING OF THE Ac-H-6 QUADRANGLE OF CERES FROM NASA's DAWN MISSION: CHANGES IN COMPOSITION

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Introduction: NASA's Dawn spacecraft arrived at Ceres on March 5, 2015, and has been studying the dwarf planet through a series of successively lower orbits, obtaining morphological & topographical image, mineralogical, elemental, and gravity data. The Dawn Science Team is conducting a geologic mapping campaign for Ceres similar to that done for Vesta [1,2], including production of a Survey- and High Altitude Mapping Orbit (HAMO)-based global map, and a series of 15 Low Altitude Mapping Orbit (LAMO)-based quadrangle maps [3]. In this abstract we discuss the geologic evolution of the Ac-H-6 Haulani Quadrangle.

Mapping Data: At the time of this writing LAMO images (35 m/pixel) are just becoming available. Thus, our geologic maps are based on HAMO images (140 m/pixel) and Survey (400 m/pixel) digital terrain models (for topographic information). Dawn Framing Camera (FC) color images are also used to provide context for map unit identification. The maps to be presented as posters will be updated from analyses of LAMO images.

Results: Ac-6 Haulani quadrangle is located between -22-22˚ and 0-72˚E. Figure 1 shows the geological map of Ac-6. Primary geologic features of this region include: bright crater ray / Haulani material, cratered terrain, smooth material, tholus material, undivided lobate material and undivided crater material. Furthermore, the quadrangle is affected by numerous flow fronts, swirled crater floors, grooves, channels, troughs, ridges and a set of furrows. Linear depressions cross the quadrangle in W-E direction, with a slight tendency to NW.

This quadrangle is dominated by the 31 km diameter Haulani crater, which is one of the brightest features on Ceres. Haulani shows a smooth bright crater floor with some cracks in the northwestern part parallel to the rim and a hummocky mountainous ridge in the center with flows running downslope the crest. The floor is laced with pits and flows. The bright ejecta material of Haulani exhibits a high albedo compared to the surrounding terrain in the FC images as well as an unusual bluish signature in the FC color filters 5 (965nm), 2 (555nm) and 8 (440nm). The crater walls show different textures. The western part shows thin rock slices. The northwestern part shows a steep fresh crater wall with little lobate landslide material, mostly covered by crater floor material. The northern and eastern part show a steep smooth wall at the top and a slumped down blocks forming smaller and larger steps with smoother lobate landslide material. The southern part shows a steep crater wall with flows running down to the center covering the floor material. The slope angle of the wall has an average of 25-30°. The crater flanks are affected by multiple flow events radiating from the crater and breakages. The flows occur as very smooth fine-grained lobes with well-defined margins and as smooth undifferentiated streaky flows covering the adjacent surface. The fine-grained flows partly building islands around solid blocks. Next to Haulani, there are two tholi: Dalien Tholus and an unnamed one. The bulge of the adjacent impact crater and the fact that the tholus is not cut by the impact indicates that Dalien Tholus was formed after the impact. Dalien Tholus also defines the border to the ejecta material of Haulani in the east.

Discussion: The color ratio of Haulani indicates compositional differences and possible time variable effects related to cryo-processes, either volcanic or glacial [4,5]. The elongated well-defined sharp ridge is unusual. The ridge is not surrounded by swirls, thus, we can exclude a formation due to impact melt.

Recent studies suggest ice occurrences within the Cerean crust [6] as well as possible salts incorporated into a regolith layer [6,7,8]. This corresponds with the detected temperature of Haulani, which is cooler than the surrounding regions [9]. These observations indicate similar geological processes as seen on other icy bodies. The smooth morphology and the cold temperature indicate a cryogenic formation process for the flows at Haulani. Pits on Vesta are thought to be formed through degassing of volatile-bearing material heated by the impact [10]. But rapid release of volatiles from viscous flows can also form such pits [11], which is consistent with the location of the pits on flows within Haulani.

Moreover, results from thermal models [6,7] and from compositional studies [8] indicate the possibility of cryovolcanic processes on Ceres.

Future work: Key goals of the ongoing mapping are to analyze the origin of the bright/bluish material of Haulani crater, and to analyze the formation process of the flows, pits and the mountainous ridge in order to prove the cryo-volcanic theory.

Future work also includes more detailed definition and characterization of surface units and estimates of their compositional variations through study of color images and Visible and Infrared spectrometer data, and application of crater statistical techniques to obtain model ages of surface units.

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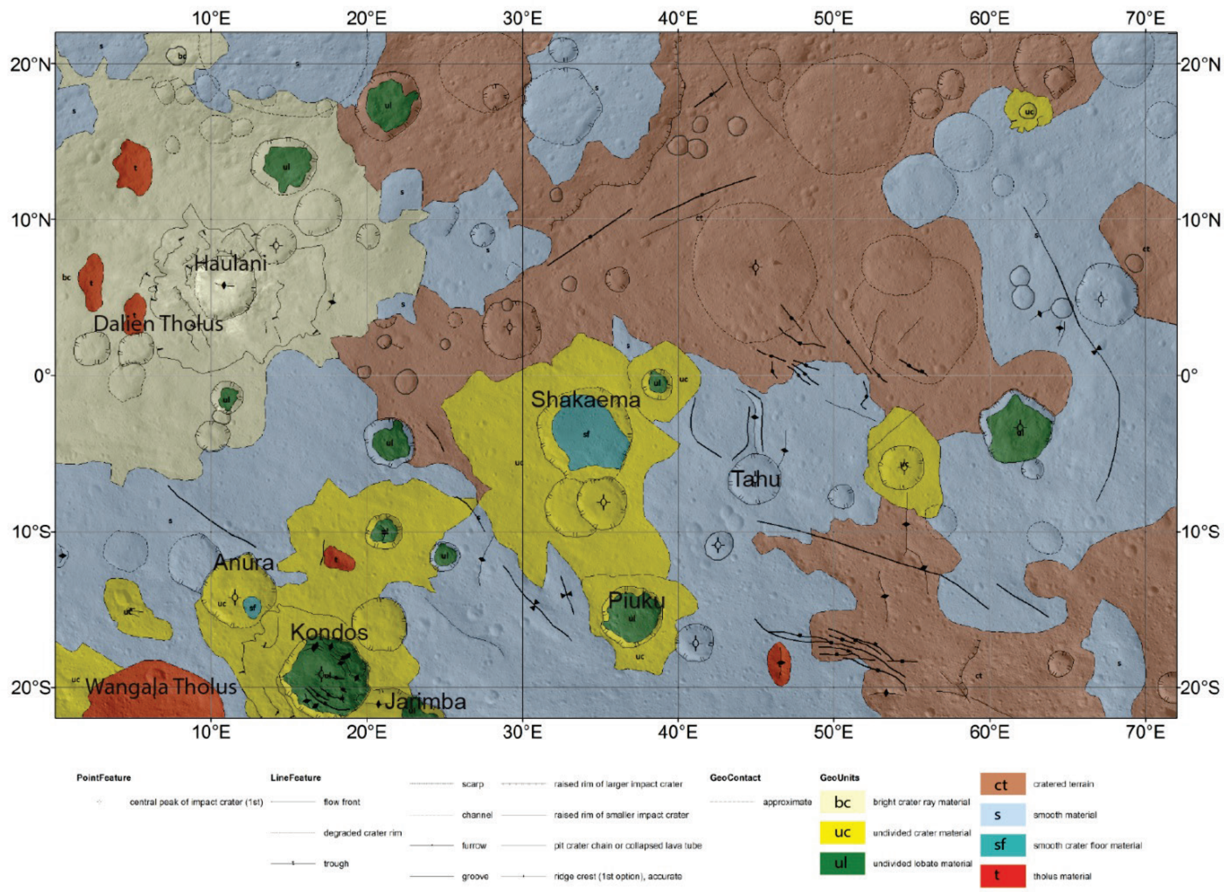

Figure 1: Geologic map of the Ac-H-6 Haulani Quadrangle of dwarf planet Ceres. Mapping base is Dawn FC HAMO mosaic (courtesy DLR).