AHUNA MONS: A GEOLOGICALLY-YOUNG EXTRUSIVE DOME ON CERES.

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Introduction: The Framing Camera (FC) onboard the Dawn spacecraft acquired 140 m/pixel images of the entire Ceres surface [3]. These observations revealed a ~4.5 km high isolated mountain (10.4°S, 316.2°E) named Ahuna Mons. The size, shape and morphology of the mountain are unique and distinct from other topographic rises scattered across Ceres's surface. Here we use FC clear-filter and color images as well as digital elevation models from stereo-photogrammetry to derive a photo-geological map of the Ahuna Mons region. Crater size-frequency distribution (CSFD) measurements are used to derive absolute model ages. Topographic profiles across the mons are investigated and compared to physical models of dome emplacement.

Photo-geological mapping: The regional context of Ahuna Mons is characterized by a cratered terrain with rare subdued troughs. The mountain is associated with a broader topographic rise ~30 km wide (tholus unit, Fig. 2). A smooth, less cratered unit (Fig. 1) surrounds the mountain. Its origin could be related to the crater unit adjacent to the mountain. CSFD measurements of the geologic units predating Ahuna Mons indicate an emplacement age younger than 72-850 Ma for the mountain. The large range of the age stems from the use of two independent chronology functions, however, both indicate Ahuna Mons formed in the geologically recent past.

Ahuna Mons has a 21×13 km elliptical base and reaches ~4.5 km above the surrounding terrains, leading to an aspect ratio (height/basal diameter) of 0.28. The topographic profile (cross section) is concave downward. Two main morphological units can be distinguished: a talus and a summit unit. The talus unit has 30°-40° slopes and contains brighter and darker downslope lineations (+15% and -5% difference relative to global albedo), which are interpreted as gravitationally driven rock falls. These lineations are spectrally distinct relative to the rest of the mountain and the surrounding terrains, and are characterized by a negative (blue) slope in the visible wavelength range. The

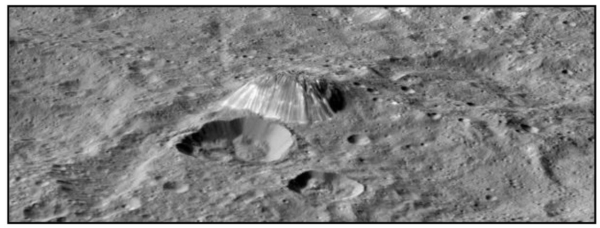

Figure 1. Perspective view of Ahuna Mons and surrounding cratered terrains derived from FC clear-filter 140 m/pixel images and digital terrain model (scene is 70 km wide, looking south-east).

contact between the talus unit and the smooth unit is sharp as accumulated debris at the base of the talus is minor. The summit unit is formed by ~1.5 km long ridges and troughs in a subradial pattern. The center of the summit is slightly depressed topographically. A

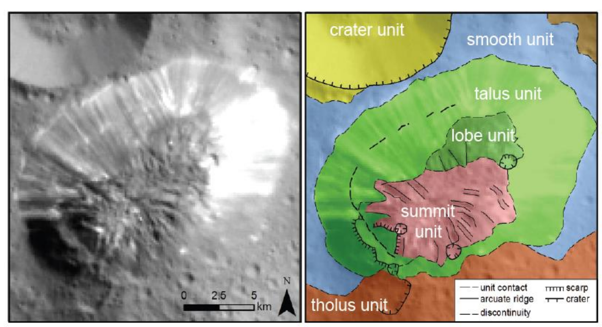

Figure 2. Left: Framing Camera image (140 m/pixel) of Ahuna Mons. Right: morphological units described in the text.

darker lobate unit, possibly representing mass wasting, is present on the northeast flank of the mountain. All these morphologically fresh-appearing features support the young age of the mountain.

These observations point to a formation by extrusion of viscous material. The high aspect ratio [4] and absence of flow fronts suggest a relatively viscous material.

Models of dome profiles: Several physical models have been developed for the formation of extrusive viscous domes [5, 6]. Here we consider a model that describes the spreading of a viscous material under the effect of gravity [6]. The model is based on the Boussinesq equation for the spreading of a Newtonian fluid with an upper unbounded surface, a time-dependent viscosity and a constant fluid volume in a cylindrical geometry. An exponential increase in viscosity with time is used to simulate the effect of cooling. Here we use an emplacement time of 10^3 years based on radiative cooling [7, 8]. The dimensions of Ahuna Mons (average diameter and height) as well as the concave downward topographic profile are reproduced with an initial apparent kinematic viscosity of 10^{13} Pa s. This apparent viscosity represents an upper estimate, as the effect of a carapace in halting the spreading is not considered. Nevertheless this estimate is consistent with a moderately viscous material inferred from morphological observations.

Discussion and Conclusion: Morphological and morphometric observations of Ahuna Mons suggest an origin as an extrusive dome of viscous material, analogous to a volcanic dome. Ascent through the crust and extrusion onto the surface required a lower density of the material relative to the crust. Given Ceres's low density (~2.1) [1], water was a probable component of the material. The geologically recent formation (<1 Ga) of Ahuna Mons and the apparent absence of prolonged surface endogenic activity preceding its formation (surrounding cratered terrains) represent strong constraints for Ceres's thermal and chemical evolution.

The Dawn spacecraft reached a low altitude orbit (LAMO) in mid December 2015, and the FC is currently acquiring images at 35 m/pixel. We will report on further characterizing and modeling this feature with these higher resolution images.

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