POTENTIAL CURVILINEAR GULLIES ON CERES: INSIGHTS INTO THE PRESENCE OF SHALLOW SUBSURFACE VOLATILES.

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Introduction: Ceres, the only dwarf planet in the inner solar system and the largest planetary body in the asteroid belt, is postulated to be rich in volatiles [1,2]. Previously reported morphological and mineralogical evidence favors the presence of shallow subsurface volatiles and ice-rich deposits mixed with regolith and plausibly located a few centimeters to meters below [1,2]. Geomorphological evidence that supports the presence of shallow subsurface water-ice on Ceres includes pitted terrain, furrows on lobate deposits, and gullies [3].

Gullies are pervasive on other planetary bodies e.g., Earth, Mars, Moon, and Vesta, though their origin contrasts whether allied to dry granular flows vis-à-vis wet flows. Based on the morphology, gullies can be categorized into two types: 1) linear gullies and 2) curvilinear gullies. On Vesta, a recent study [4] anticipated the involvement of dry granular flows in the formation of linear gullies, whereas curvilinear gullies are anticipated to form by the debris-flow process that encompasses the transient flow of liquid water. On Ceres, linear gullies are reported; however, the search for curvilinear gullies is still ongoing. Identification of curvilinear gullies on Ceres has implications for the presence of shallow subsurface volatiles and the potential occurrence of the transient flow of water on Ceres. In this context, a global survey is ongoing to identify potential curvilinear gullies on Ceres.

Data and Methods: We used individual images and LAMO clear filter global mosaic from Framing Camera (FC) on board NASA's Dawn spacecraft, having a resolution of ~35m/pixel, for the morphological and chronological analysis. We used FC HAMO global DTM, having a resolution of ~137m/pixel, to determine the topography. To derive the modeled age for the period of activities, we used the production and chronology functions by Hiesinger et al. (2016).

Results and discussion: In our survey of identifying potential curvilinear gullies on Ceres, we observed two craters of interest: Ikapati crater (Fig 1a) and Haulani crater (Fig 1b). We observed kilometer-scale fan deposits at the toe of the observed gullies (Fig 2) and an alcove at the head (Fig 2a). The gullies formed within these craters tend to be curved or sinuous (Fig 2), thus suggesting the plausible involvement of shallow subsurface volatiles on Ceres.

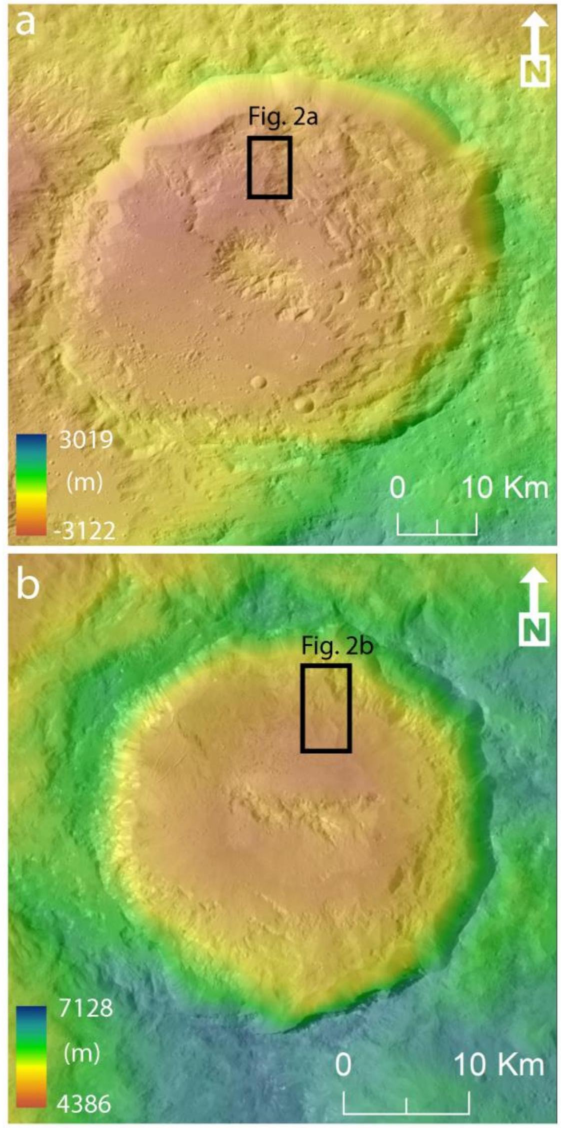

Fig. 1: *a) Ikapati crater b) Haulani crater on Ceres. HAMO global DTM overlaid LAMO FC global mosaic.*

Further, to determine the period of gully formation activity within the Ikapati crater, we determined the modeled absolute age of the crater by computing the crater-size frequency distribution of the primary craters on the two-floor units of the crater [Fig 3a]. The crater-size frequency distribution for the unnamed crater suggests an age of ~32 Ma and ~26 Ma for the preserved and modified floor units, respectively [Fig 3b]. Thus, we interpret that the potential curvilinear gully formed post to ~26 Ma on Ceres.

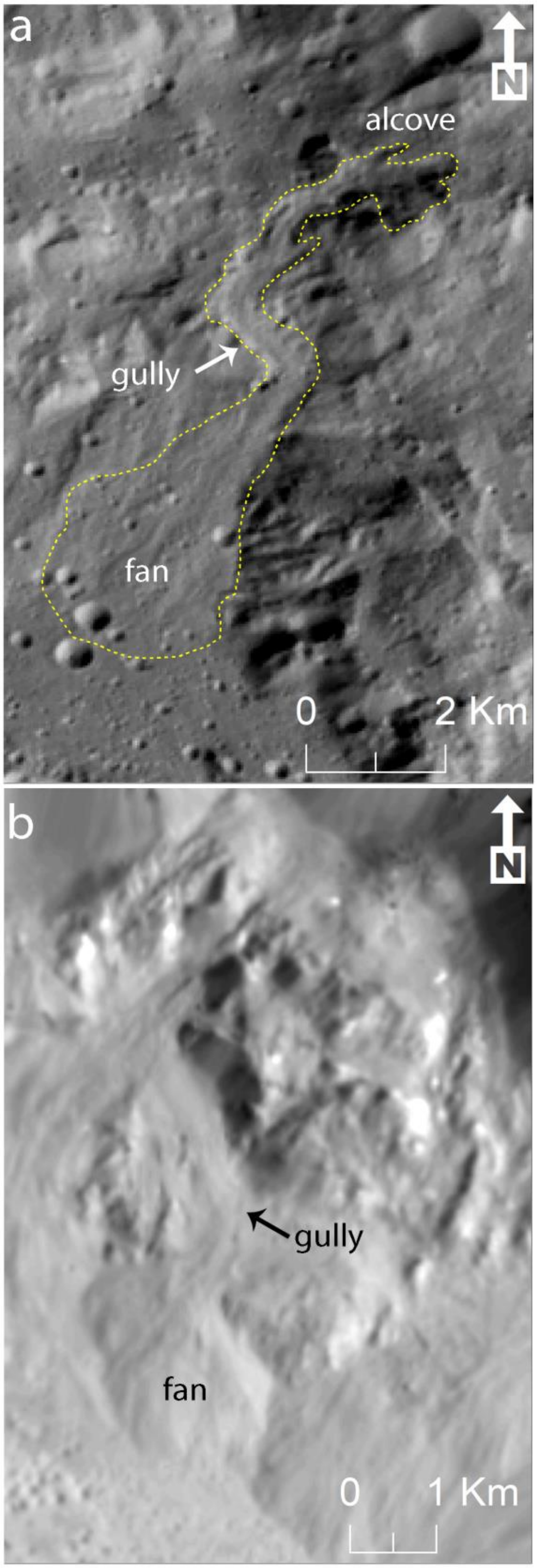

Fig. 2: *Potential curvilinear gully within a) Ikapati crater and b) Haulani crater.*

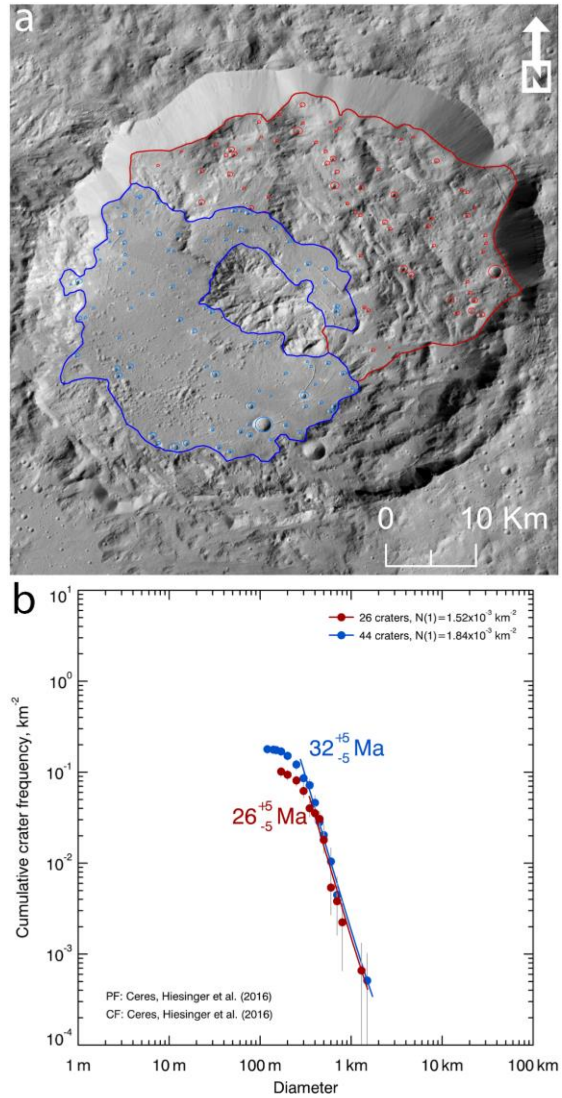

Fig. 3: *a) Counts of superposed craters over the two units of the floor of the Ikapati crater. b) CSFD plot showing the best-fit ages.*

This ongoing study suggests the plausibility of curvilinear gullies on Ceres. Initial analysis indicates that curvilinear gully-forming activity can be as young as ~26 Ma. Our preliminary results suggest the presence of localized shallow subsurface volatiles and favor the transient flow of water on Ceres.

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