Geophysical Research Abstracts
Vol. 19, EGU2017-13748, 2017
EGU General Assembly 2017

Geologic evolution of the dwarf planet (1) Ceres: results from geologic mapping using Dawn FC2 camera imaging data and an update in cratering model ages

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The Dawn spacecraft, in orbit around the dwarf planet (1) Ceres since March 6, 2015, has carried out global imaging with the FC2 framing camera in three orbital phases: Survey (4424 km altitude above the surface; ~400 m/pxl spatial resolution), high-altitude (HAMO; ~1475 km; ~140 m/pxl) and low-altitude mapping orbit (LAMO; ~375 km; ~30 m/pxl) [1]. In this study we combine FC images with topographic data from digital elevation models (DEMs) for geologic mapping and age determination with crater size-frequency distribution measurements. For the latter we use an updated impact chronology model [2]. Globally, Ceres' surface is characterized by ubiquitous cratered plains, separable in units with higher or lower crater frequencies at high, medium, and low topographic levels. A second major geologic unit are individual impact craters with a wide range of morphologies. Craters provide important stratigraphic markers, especially the larger ones, those with rays, or craters with specific spectral properties. A third remarkable type of surface features are mountains. Densely cratered plains occur at all three topographic levels, but no correlation between absolute mode age (AMA) and topographic position can be found. In a lunar-derived model chronology [2], AMAs are on the order of 3 – 3.4 Ga, i.e. younger than in a previous version of the model. The three large major impact features characterizing time boundaries in Ceres' geologic history, Kerwan, Yalode, and Urvara, have AMAs [2] of 1.1 $\pm$ 0.2 Ga, 540 $\pm$ 80 Ma, and 120 $\pm$ 20 Ma, respectively. Other craters whose superimposed crater frequencies were measured in Survey images show wide ranges in AMAs, such as Asari (2.8 $\pm$ 0.6 Ga), Jarovit (2.1 $\pm$ 1.0 Ga), Ghanan (980 $\pm$ 380 Ma), or Dantu (AMAs range from 65 $\pm$ 20 Ma (ejecta) to 30 $\pm$ 15 Ma (floor)). The enigmatic feature Ahuna Mons, a mountain several kilometers high, has an AMA of 2 $\pm$ 0.8 Ma measured on its summit region indicating that Ceres most likely was geologically active in the very recent past. References: [1] Russell C. T. et al. (2016), Science 353, 1008-1010. [2] Hiesinger H. et al. (2016), Science 353, doi:10.1126/science.aaf4759.