EPSC Abstracts
Vol. 13, EPSC-DPS2019-5-1, 2019
EPSC-DPS Joint Meeting 2019


EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

# The Geologic Mapping of Small Bodies: Results from the NASA Dawn Mission to Vesta and Ceres

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## Abstract

NASA's Dawn mission was a Discovery-class robotic mission to send an orbiter to the two most massive objects in the Main Asteroid Belt, asteroid (4) Vesta and dwarf planet (1) Ceres [1]. Dawn orbited Vesta from July 2011 to September 2012, and it remains in orbit of Ceres since it arrived in March 2015. As part of the spacecraft's nominal mission, the Dawn Science Team requested geologic mapping campaigns of both Vesta and Ceres, which included global mapping using High Altitude Mapping Orbit (HAMO) images (Vesta: 70 m/px; Ceres: 140 m/px) and quadrangle mapping using Low Altitude Mapping Orbit (LAMO) images (Vesta: 25/m/px; Ceres: 35 m/px). As part of this mapping we developed chronostratigraphies and geologic time scales for these small bodies, consistent with those developed for the Moon, Mercury, and Mars on earlier NASA missions. We describe the key results in this abstract.

## 1. Vesta mapping & chronostratigraphy

The geologic mapping of Vesta was described in [2-3] and its chronostratigraphy was given in [4]. The southern hemisphere is dominated by units associated with the two major impact events, older 400km diameter Veneneia basin superposed by younger 505km diameter Rheasilvia basin. These two impacts excavated Vesta into its current ellipsoidal shape and produced the material that falls to Earth as the Howardite-Eucrite-Diogenite (HED) family of meteorites. These impacts also produced the tectonically-disrupted ridge and trough terrains called the Divalia and Saturnalia Fossae, which occupy the equatorial and northern mid-latitudes, respectively. The north polar region hosts the oldest, heavily cratered terrain on Vesta. Superposed on all are younger crater deposits, including both light and dark mantles and rayed craters.

## 2. Ceres mapping & chronostratigraphy

The geologic mapping of Ceres was described in [5] and its chronostratigraphy is still being finalized at the time of this writing. Ceres has a globally distributed cratered terrain, with three large, ill-defined topographic depressions that could be ancient basins. Kerwan crater (285 km diameter) is the largest identifiable impact crater, infilled and surrounded by a unique smooth material that marks this oldest crater. In the southeastern hemisphere Yalode and Urvara craters mark the next two youngest basins, with complex ejecta units. Intermediate and younger aged craters, including rayed craters, are scattered across the surface. The young Occator crater (20 Ma LDM) contains fresh, bright spots (Cerealia and Vinalia Faculae) composed of Na-carbonates and salts, and is estimated to be a few Ma in age, indicative of recent cryovolcanic or hydrothermal activity.

## Acknowledgements

I acknowledge NASA and the Dawn mission for their support of this work from 2010-2019.

## References

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[4] Williams, D.A., et al.: Icarus, Vol. 244, 158-165, 2014.

[5] Williams, D.A., et al.: Icarus, Vol. 316, 1-13, 2018.

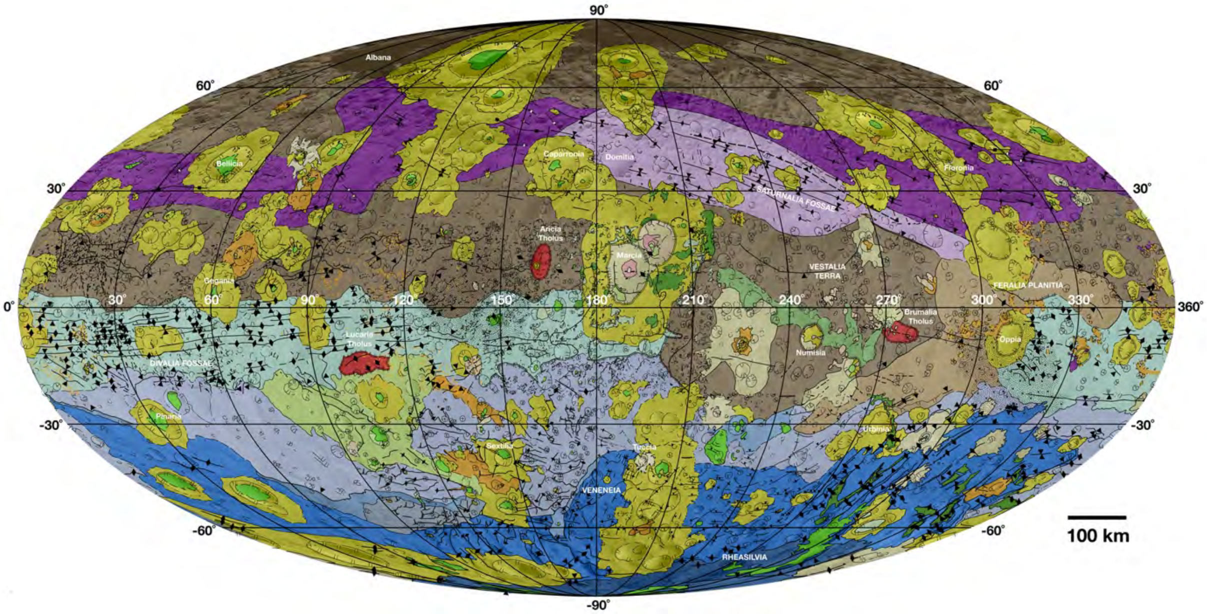


Figure 1: Unified LAMO quadrangle geologic map of (4) Vesta, scale 1:250,000. Mollweide projection, centered on 0˚, 180˚. For a description of the map see *Icarus*, *244*, December 2014.

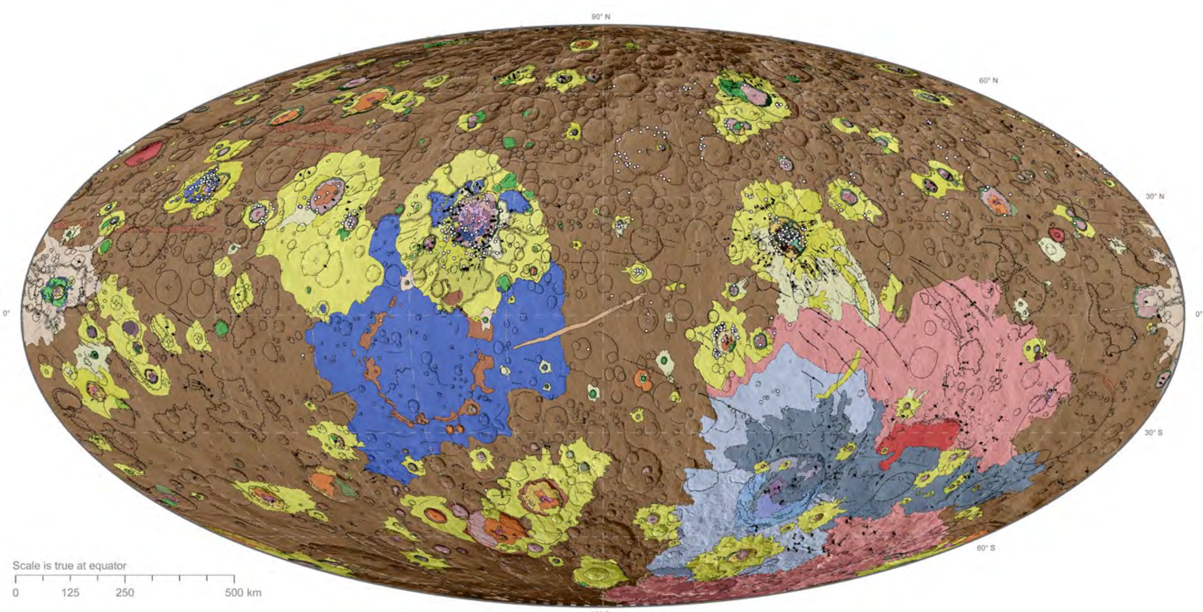


Figure 2: Unified LAMO quadrangle geologic map of (1) Ceres, scale 1:500,000. Mollweide projection, centered on 0˚, 180˚. For a description of the map see *Icarus*, *316*, December 2018.