GEOLOGIC MAPPING CAMPAIGN FOR CERES FROM NASA DAWN MISSION. D.A. Williams[1], D.L. Buczkowski[2], S.C. Mest[3], J.E.C. Scully[4]. [1]School of Earth and Space Exploration, Arizona State University, Box 871404, Tempe, AZ 85287 (David.Williams@asu.edu); [2]Johns Hopkins University Applied Physics Laboratory, Laurel, MD; [3]Planetary Science Institute, Tucson, AZ; [4]NASA JPL, California Institute of Technology, Pasadena, CA.

Introduction: NASA's Dawn spacecraft arrived at the dwarf planet (1) Ceres on March 5, 2015, and as of this writing has successfully completed Approach, Survey, and High Altitude Mapping Orbits (HAMO) during 2015. The Dawn Science Team is conducting a geologic mapping campaign for Ceres, building on our experience from a similar mapping campaign for asteroid (4) Vesta in 2011-2014 [1, 2]. The purpose of this abstract is to describe our mapping campaign for Ceres and present some of our preliminary results.

Global Mapping: The Dawn Science Team began to assess the global geology of Ceres through analysis of images returned during Cruise and Approach phases through Winter 2015, including comparison with Hubble Space Telescope maps [3]. Detailed mapping began during the Survey orbit (Framing Camera (FC) spatial resolution ~415 m/pixel), in which four of us (DAW, DLB, SCM, JECS) mapped the surface using Survey-based hemispheric quadrangles supplied by DLR [4]. All geologic mapping is being done using ArcGIS™ software following current procedure as recommended by the USGS. **Figure 1** contains a unified Survey-based global geologic map derived from the 4 hemispheric quadrangles, included in *Buczkowski et al*. [5, in revision]. With the acquisition of HAMO images (spatial resolution ~140 m/px) more detailed mapping is underway to update the global map (Lead: Mest).

Quadrangle Mapping: Following guidelines in [6] we are also mapping Ceres using a 15-quadrangle system. The goal of the quadrangle mapping is to assess the geological evolution and processes that operated on Ceres using HAMO and Low Altitude Mapping Orbit (LAMO) images (spatial resolution ~35 m/px) at a greater level of detail than can be done with global mapping. At the time of this writing LAMO images are being returned, and the first two cycles of imaging covering the whole surface are nearly completely returned. Preliminary maps of all 15 quadrangles were presented at GSA 2015, Fall AGU 2015, LPSC 2016, and EGU 2016. We expect that the 15 quadrangle geologic maps will be combined variously to support studies of Ceres' major geologic features/processes as was done for Vesta.

Mapping Results: As you can see from Fig. 1, our initial Survey-based geologic mapping leads to the following initial findings:

- Ceres is dominated by cratered terrain, and its crust preserves a long-lasting record of impact cratering
- Kerwan, a 285 km diameter basin in the eastern hemisphere, is the largest preserved old impact basin. It contains and is surrounded by a 'smooth terrain' indicative of a resurfacing process perhaps related to impact melting of an icy crust or possibly cryovolacnic flows (see [6] for details).
- Urvara and Yalode, two large basins in the western hemisphere, are young and well preserved with far-reaching ejecta fields. They may be related to some linear features including fractures or crater chains in the western hemisphere (see [7, 8] for details).
- Ceres has multiple bright spots associated with craters. Some like Haulani appear to be relatively young impact craters that exposes fresh icy crustal materials (see [9] for details). Others like Occator have a more complex geology, possibly related to emplacement of salty materials by a cryovolcanic or glacial mechanism (see [10] for details).
- Ceres has several domical, positive relief edifices with distinct morphologies. One, Ahuna Mons, is suggestive of a cryovolcanic dome (see [11] for details).
- We are beginning to identify key features that mark a chronostratigraphy for Ceres. Like Vesta, the major geologic events that shaped Ceres surface are impacts, and subsequent modification. We tentatively identify Pre-Kerwan, Kerwan, Urvara-Yalode, and Occator-related terrains. LAMO data should enable final identification of Ceres major chronostratigraphic units.

Future Work: NASA's Dawn spacecraft is in its LAMO orbit, where it is acquiring its highest resolution imaging, mineralogical, elemental, and gravity data. We plan to revise our geological maps and write a series of papers discussing Ceres geological evolution and major surface features in the June 2016. Hopefully Dawn's LAMO mission will be extended depending on the availability of hydrazine fuel beyond 2016.

References: [1] Williams D.A. et al. (2014) *Icarus, 244,* 1-12. [2] Yingst R.A. et al. (2014) *PSS, 103,* 2-23. [3] Li J-Y. et al. (2006) *Icarus, 182,* 143-160. [4] Roatsch T. et al. (2016) *PSS, 121*, 115-120. [5] Buczkowski D.L. et al. (2016) *Science*, in revision. [6] Williams D.A. et al. (2016), Kerwan quad., *LPS XLVII,* Abstract 1522. [7] Sizemore H. et al. (2016),

Urvara quad., *LPS XLVII,* Abstract 1599. [8] Crown D.A. et al. (2016), Yalode quad., *LPS XLVII,* Abstract 1602. [9] Krohn K. et al. (2016), Haulani quad., *LPS XLVII,* Abstract 1977. [10] Buczkowski D.L. et al. (2016), Occator quad., *LPS XLVII,* Abstrcat 1255. [11] Ruesch O. et al. (2016), Ahuna Mons, *LPS XLVII,* Abstract 2279.

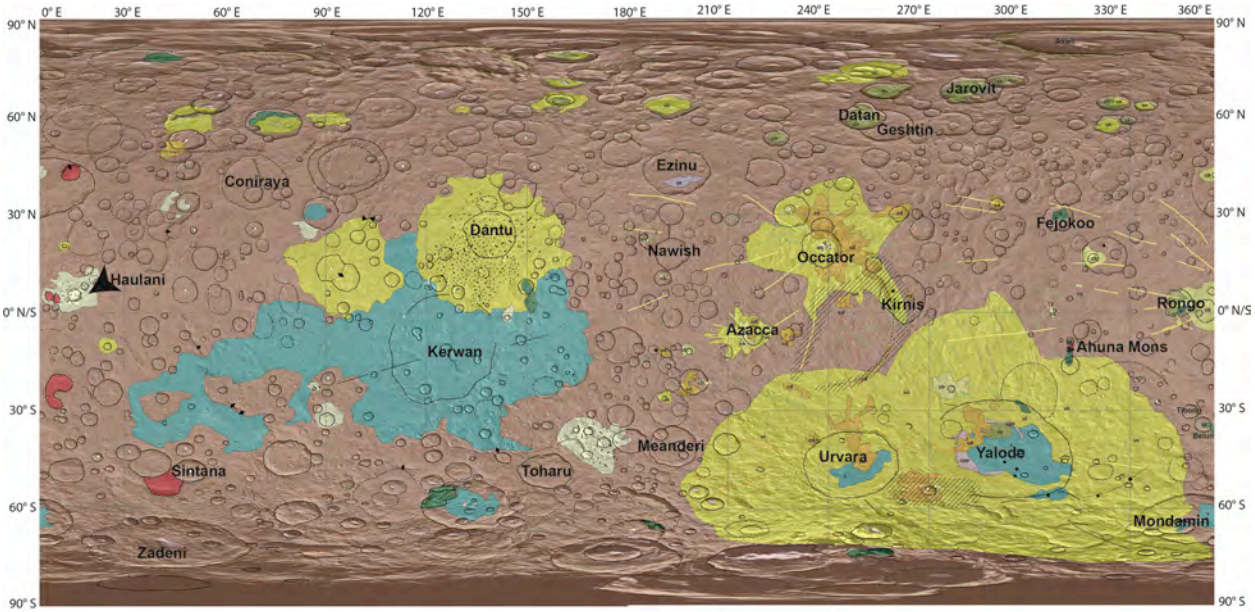

Figure 1. Survey-derived global geologic map of dwarf planet (1) Ceres (Mercator projection, center long. = 180˚). This map was produced using ArcGIS™ software through integration of 4 hemispheric quadrangle maps produced by SCM, DAW, DLB, and JECS. From *Buczkowski et al*. [5, in revision].

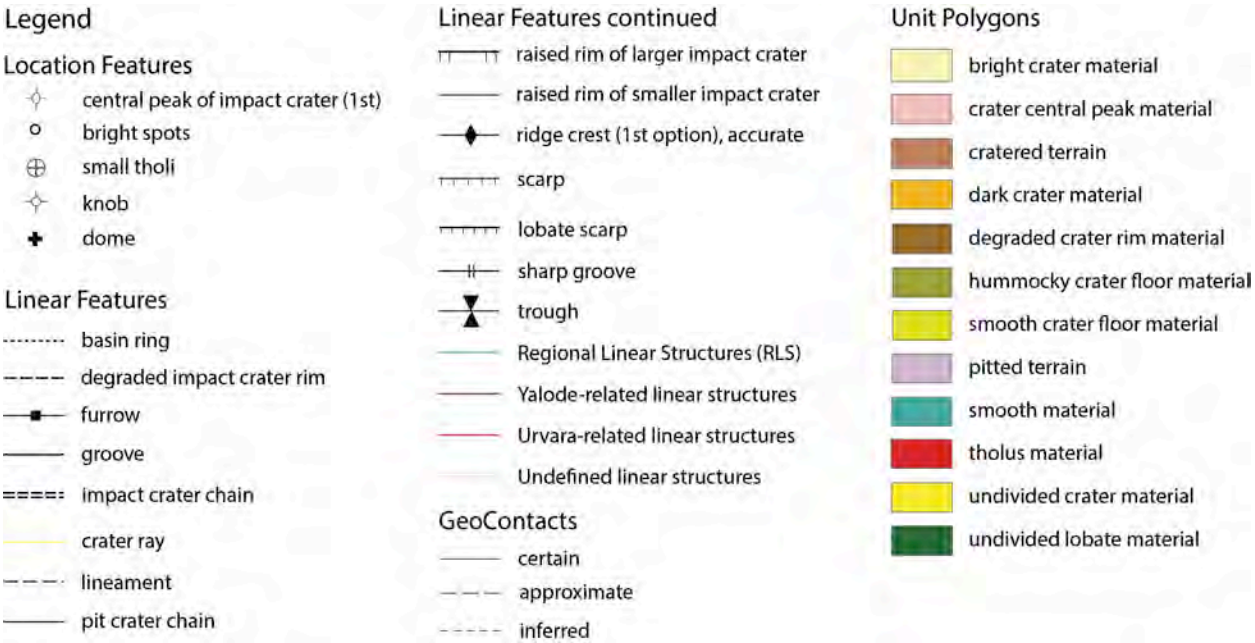

Figure 2. Legend for map in Figure 1. From *Buczkowski et al*. [5, in revision].