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Preliminary Geologic Mapping of the Ac-S-1 Hemisphere of Ceres from NASA's Dawn Mission

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Abstract

NASA's Dawn spacecraft [1], launched in September 2007, spent ~1 year (2011-2012) investigating Vesta and recently (March 6, 2015) arrived at dwarf planet Ceres. The first images of Ceres' surface were acquired by Dawn's Framing Camera (FC) [2] as it made optical navigation and rotation characterization observations during the Approach phase. The Dawn Science Team will conduct a geological mapping campaign at Ceres during the Nominal Mission, which will include iterative mapping using data obtained during each orbital phase. Iterative geologic mapping was previously successfully conducted during Dawn's mission to Vesta [3,4]. This abstract describes the preliminary geologic mapping results for quadrangle Ac-S-1 (55-90°N, 0-360°E), the northern hemisphere of Ceres.

1. Geologic Mapping of Ceres

Geologic maps are research products that document the nature and distribution of surface terrains, as well as tools that help interpret the geologic history of a planetary surface. Compilation of a geologic map may utilize photogeologic, spectral and topographic analyses to organize planetary features into discrete process-related map units. These units are defined and characterized by their physical (albedo, morphology, structure, color, topography) and chemical (mineralogy) attributes related to the putative geologic processes that produced them (e.g., volcanism, tectonism, impact cratering, weathering-erosion-deposition). Relative ages of map units are determined by principles of stratigraphic relations (superposition, lateral continuity, cross-cutting, embayment, intrusion, etc.) and analyzing crater size-frequency distribution statistics.

Iterative geologic mapping of dwarf planet Ceres will be accomplished during the Nominal Mission. The goals of mapping include (1) providing increasingly improved geologic context to the full science team as FC images are acquired at increasing spatial resolution during discrete orbital phases of the mission, and (2) providing geologic context to the Visible and Infrared Spectrometer (VIR) and the Gamma-Ray and Neutron Detector (GRaND) teams to aid in interpreting their compositional information.

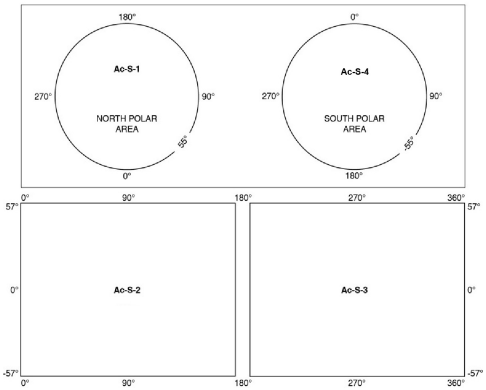

Fig 1: Hemispheric geologic mapping quadrangles for dwarf planet Ceres.

Similar to Vesta [5], the first iteration geologic map of Ceres will be a preliminary map generated from FC images acquired during the Approach and Survey orbital phases [6]. This map will provide a global assessment of Ceres' geology, including its geologic units and structures, and identification of potential surface processes. This preliminary map will be accomplished using a hemispheric 4-quadrangle

system (Fig. 1). This abstract presents an overview of the geology of Ac-S-1 (55-90°N, 0-360˚E), the northern hemisphere of Ceres.

2. First Geological Results

At the time of this writing, images for approximately two-thirds of the northern hemisphere have been acquired (currently unreleased data). Dawn FC images [7] show that the surface of the north hemisphere quadrangle (Ac-S-1) is heavily modified by impact craters (Fig. 2). In this region, the surface is densely cratered, and there are numerous examples of superposition of crater forms. Current observations of the northern hemisphere show the distribution of craters appears fairly homogeneous. Craters range in size from the limits of resolution (several kilometers at this scale) to a few hundred kilometers. Morphologically, most craters appear circular, shallow, and flat-floored, but there are some craters with polygonal shapes (generally hexagonal), which may have implications for the target material [see 8,9]. Most of the smaller-diameter craters appear to have sharp, clearly defined rims, whereas rims for larger craters, although most are clearly defined, are not as sharp and appear flattened to the level of the surrounding terrain. Numerous craters contain central peaks, and at this scale there does not appear to be any post-formation modification of crater walls, such as by slumping, terracing or mass wasting. Distinct ejecta blankets are not apparent at this resolution.

Apart from impact craters, intercrater regions appear relatively smooth at this scale, and albedo variations are not apparent. Large-scale structural features are not evident in the northern hemisphere; however, some localized ridges, scarps and other topographic high areas are visible, and could represent tectonic deformation of Ceres' crust, or the remnants of the rims of ancient impact craters/basins that have been heavily modified by subsequent processes. Some small dome-like features are also apparent, but will have to be confirmed by later imaging

3. Future Work

As data are acquired during the RC3 and Survey phases of Dawn's mission to Ceres, mosaics will be created from these data and detailed mapping of contacts, structures and other geologic features will begin.

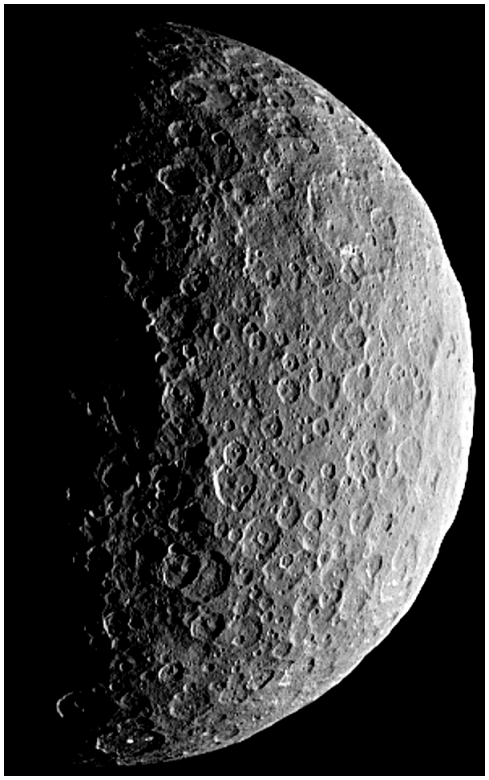

Fig. 2: Dawn FC image of Ceres looking at the northern terrain on the sunlit side. This image was acquired during Optical Navigation 7 (OpNav7) while Dawn was ~22,000 km above Ceres' northern hemisphere. Image resolution = 2.1 km/pixel; NASA/JPL-Caltech/UCLA/MPS/DLR/IDA.

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