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Preliminary Geologic Mapping of the Southern Hemispheric Quadrangle (Ac-S-4) of Ceres from NASA's Dawn Mission

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Abstract

The Dawn mission visited Vesta from 2011-2012, and arrived in Ceres orbit in March 2015. For Vesta, a global geologic map at 1:500,000 scale and quadrangle maps at 1:250,000 scale were produced by the geologic mappers of the Dawn science team. A similar mapping campaign is planned for Dawn's mission at Ceres. A global geologic map will be produced based on Approach and Survey data, which will be acquired during the time period April-July 2015. For the purpose of global geologic mapping, Ceres has been divided into four hemispheric quadrangles. In this work we map the southern hemispheric quadrangle, Ac-S-4, which is located from 55-90°S and 0-360°E.

1. Introduction

The Dawn mission [1] is a NASA Discovery class mission, which visited Vesta from 2011-2012 and arrived in Ceres orbit in March 2015. Ceres and Vesta are the two most massive objects in the main asteroid belt, and are protoplanets that survived being accreted into a planet, and survived being scattered and/or ejected out of the solar system. The Dawn mission's aim is to characterize the geological, compositional and physical properties of these unique worlds, and to use these observations to learn about the formation and evolution of our solar system.

The Dawn spacecraft has three instruments: (1) the Framing Camera (FC), which provides images of the surface from the visible to the near-infrared through a clear filter and seven color filters [2]; (2) the Visible and Infrared Spectrometer (VIR), which provides hyperspectral cubes of the surface from the near-ultraviolet to mid-infrared [3] and (3) the Gamma Ray and Neutron Detector (GRaND), which measures the gamma rays and neutrons emitted from the surface [4]. The work presented here is mainly based upon Framing Camera images.

During Dawn's mission at Vesta, data were acquired by the spacecraft in six phases: (1) Approach, (2) Survey, (3) High Altitude Mapping Orbit 1 (HAMO-1), (4) Low Altitude Mapping Orbit (LAMO), (5) High Altitude Mapping Orbit 2 (HAMO-2) and (6) Departure. Four phases are planned for Dawn's mission at Ceres: (1) Approach, (2) Survey, (3) High Altitude Mapping Orbit (HAMO), and (4) Low Altitude Mapping Orbit (LAMO).

2. Methods: geological mapping

Geological mapping is a tool that is widely used to methodically observe and interpret the surfaces of planets, moons and small bodies. Systematic observations of the morphology and physical properties of these surfaces are used to define a set of geologic units. The surface of a planetary/small body is divided into these geologic units, and relative cross-cutting relationships are used to derive the stratigraphic order of the geologic units. Interpretations are made about the processes that formed the geologic units, which sometimes include the analysis of compositional properties etc. These interpretations then lead to inferences about the properties, formation and evolution of the planetary/small body on which the geologic units are located.

3. Vesta Geologic Mapping Campaign

A global geologic map of Vesta was produced with a scale of 1:500,000 [5]. In addition, to facilitate systematic geologic mapping at a higher

scale, the surface of Vesta was divided into 15 quadrangles and 1:250,000 maps were produced for each quadrangle. A team consisting of a lead mapper and mappers from neighboring quadrangles mapped each quadrangle, and the results were presented in a special issue of Icarus [6].

4. Ceres Geologic Mapping Campaign

Following the geologic mapping campaign at Vesta, a global geologic map of Ceres will be produced based on Approach and Survey data, which will be acquired during the time period April-July 2015. Subsequently, 15 quadrangle maps of Ceres will be produced at higher scale, based on HAMO and LAMO data, which will begin to be acquired in August of 2015.

For the global geologic map, which is based on Approach and Survey data, Ceres has been divided into four hemispheric quadrangles (Figure 1). In this work we map the southern hemispheric quadrangle, Ac-S-4, which is located from 55-90°S and 0-360°E.

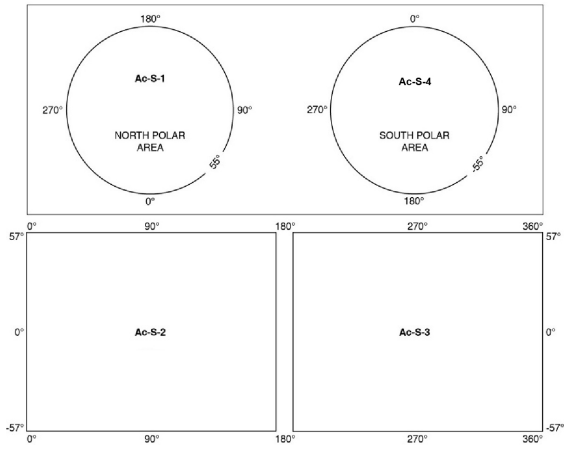

Figure 1: The four hemispheric quadrangles into which Ceres has been divided.

5. First Geological Results

As of the abstract deadline, Dawn has not yet observed Ac-S-4. Observations have been made slightly to the north of Ac-S-4, during the Rotational Characterization 2 (RC2) stage of the Approach phase (Figure 2). On the northern border of Ac-S-4, two large impact basins are visible in the RC2 data: one is located at ~43°S, ~290°E and is ~280 km in diameter, and one is located at ~45°S, ~251°E and is ~200 km in diameter. These impact basins extend into Ac-S-4 and dark lobate deposits appear to be located on their floors. There are also numerous smaller impact craters visible along the northern border of Ac-S-4. The smallest resolvable craters along this border are ~30 km in diameter. From ~45°S to ~12°N and ~236°E to ~310°E there are a set of northwest-trending grooves. It is possible that these grooves extend into Ac-S-4.

The southern hemispheric quadrangle Ac-S-4 will be observed during the Rotational Characterization 3 (RC3) stage of the Approach phase and in the Survey phase of the Dawn mission at Ceres. Based upon these data, we will construct a geologic map of this region of Ceres.

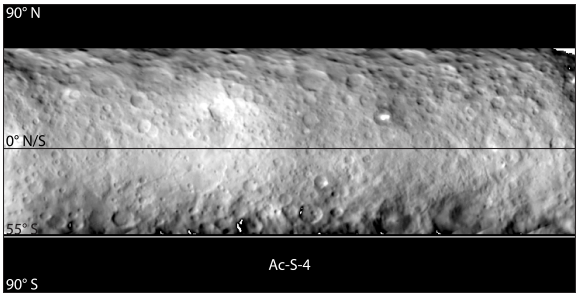

Figure 2: A Framing Camera clear filter mosaic of the surface of Ceres, obtained during RC2. The southern hemispheric quadrangle (Ac-S-4) is below the white line at 55°S. The mosaic has a simple cylindrical projection and has a resolution of ~4 km/pixel. Mosaic credit: DLR.

References

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