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Preliminary Geologic Mapping of the Ac-S-3 Hemisphere of Ceres from NASA's Dawn Mission

D.L. Buczkowski (1), R.A. Yingst (2), D.A. Williams (3), J.E.C. Scully (4), S.C. Mest (2), D.A. Crown (2), R. Jaumann (5), C.T. Russell (4), C.A. Raymond (6), P.M. Schenk (7), S. Marchi (8), D.P. O'Brien (2), A. Nathues (9), M. Hoffmann (9), M. Schäfer (9), T. Platz (9), T. Roatsch (5), E. Kersten (5), F. Preusker (5) K. Stephan (5), M.C. De Sanctis (10), A. Frigeri (10).

(1) Johns Hopkins University Applied Physics Laboratory, Laurel, MD, USA (Debra.Buczkowski@jhuapl.edu); (2) Planetary Science Institute, Tucson, AZ, USA; (3) School of Earth & Space Exploration, Arizona State University, Tempe, AZ, USA; (4) UCLA, Institute of Geophysics, Los Angeles, CA, USA; (5) Institute of Planetary Research, German Aerospace Center (DLR), Berlin, Germany; (6) NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA; (7) Lunar and Planetary Institute, Houston, TX, USA; (8) Southwest Research Institute, Boulder, CO, USA; (9) Max Planck Institute for Solar System Research, Göttingen, Germany; (10) Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale de Astrofisica, Rome, Italy.

Abstract

NASA's Dawn spacecraft [1] was captured into orbit by the dwarf planet (1) Ceres on March 6, 2015. During the Approach phase capture was preceded and followed by a series of optical navigation and rotation characterization observations by Dawn's Framing Camera (FC) [2], which provided the first images of Ceres' surface. As was done at Vesta [3], the Dawn Science Team will conduct a geological mapping campaign at Ceres during the Nominal Mission, including iterative mapping using data obtained during each orbital phase. In this presentation we will describe the approach of the Ceres Mapping Campaign and discuss the preliminary geological mapping of the Ac-S-3 (180-360˚E) hemisphere of Ceres.

1. Introduction

Geologic mapping is an investigative process that organizes planetary features into discrete process-related map units, thus going beyond first-order photogeologic analysis. These units are defined and characterized based on specific physical attributes such as albedo, morphology, structure, color, and topography. These units are related to the putative geologic processes that produced them, such as volcanism, tectonism, impact cratering, deposition, weathering and/or erosion. The application of basic stratigraphic principles, including superposition, lateral continuity, cross-cutting, embayment, intrusion, etc., is used to determine the chronologic order of the map units. The map units can then be grouped into geologic formations, from which the geologic timescale and geologic history are determined. Thus, geologic maps are tools to help interpret the geologic history of a planetary surface.

2. Ceres Geologic Mapping Campaign

Following on from our successful campaign to map the surface of asteroid Vesta [3, 4], the Dawn Science Team will conduct a geologic mapping campaign for dwarf planet Ceres during the Nominal Mission. The goals of this campaign are two-fold: 1) to provide geologic context to the full science team of our ever-improving knowledge of the geology of Ceres with increasing FC spatial resolution during discrete orbital phases of the mission; and 2) to provide 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.

The first step of the Ceres mapping campaign is to construct a preliminary geologic map using images obtained during the Approach and Survey orbital phases. The purpose of this map is to assess the geology of Ceres at the global scale, to identify global map units and structural features, and determine the geologic processes that have affected Ceres globally. To accomplish this we will map Ceres using a hemispheric four-quadrangle system (Fig. 1).

Observations of the four hemispheric quadrangles have been considered (see section 3 below) and preliminary global map units have been contemplated. These may include, but are not restricted to, Cratered Plains material, Smooth Plains material, Lobate material, Bright-rayed crater material, Crater floor

material, and Central peak material. At present spatial resolution is too low to actually map out contacts and structural features, but we expect to be able to begin constructing the maps using Rotation Characterization #3 and Survey mosaics, to be acquired in May and June 2015.

3. First Geological Results

In this presentation we will present an overview of the geology of the Ac-S-3 (180-360˚E) hemisphere of Ceres. This region is a heavily cratered terrain, with both fresh-looking and putatively-relaxed craters evident (Fig. 2). Linear structures are also evident, but determining whether they are formed due to impact stresses or by internal activity of Ceres will require higher-resolution imaging than is available at the time of writing. Also evident in Ac-S-3 is the feature known as Spot 5; although the brightest of the "bright spots" on Ceres it is not currently observable in infrared images, unlike some of the other spots [5]. Color data (Fig. 2, bottom) indicates compositional diversity in the Ac-S-3 hemisphere, specifically around Spot 5, as well as around some of the other craters and associated with some of the linear structures. Variations in crater abundance in different parts of this hemisphere suggest that some type of resurfacing might be occurring. Domical, positive relief features may also be present in some of the craters (such as the crater to the southeast of Spot 5 that is also cut by a linear structure) but higher resolution imaging is required before they can be confirmed.

References:

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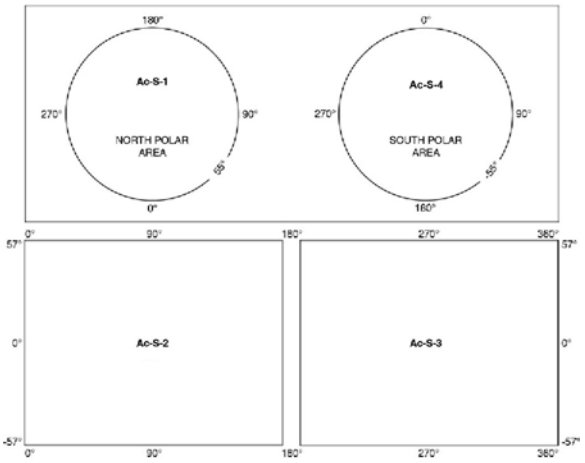

Fig 1: Hemispheric geologic mapping quadrangles for dwarf planet Ceres during the Approach and Survey orbital phases. Proposed quadrangle names have not yet been approved by the IAU.

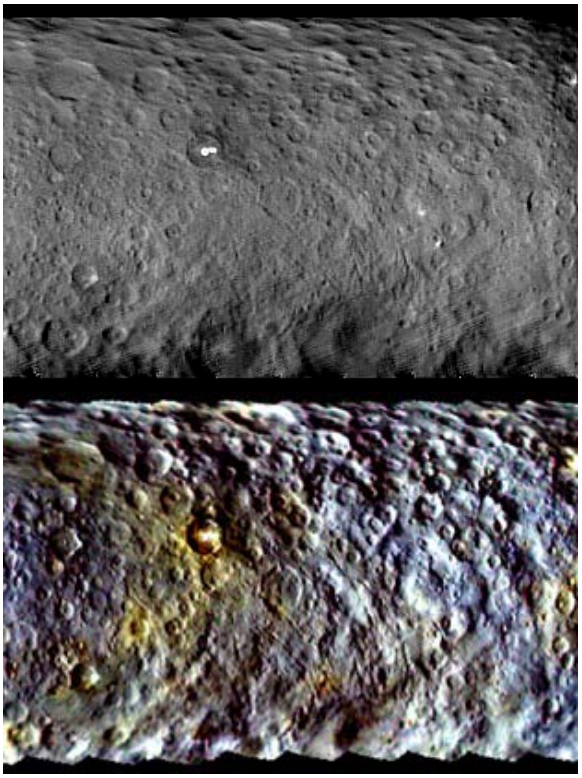

Fig 2: Dawn FC mosaic (top) and color composite image (bottom) of the Ac-S-3 (180-360˚) quadrangle of Ceres. Obtained during Approach phase, Rotation Characterization 2 observation, ~4 km/pixel spatial resolution. Color composite RGB is 0.96-0.75-0.44 μm. Image processing by the MPI for Solar System Research,Germany.