RESULTS OF THE DAWN MISSION TO CERES. C. A. Raymond[1], C. T. Russell[2], J. C. Castillo-Rogez[1] and the Dawn Science Team. [1]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91001. Email: Carol.A.Raymond@jpl.nasa.gov, [2] Institute of Geophysics and Planetary Physics, University of California, Los Angeles, 595 Charles Young Drive East, Los Angeles, CA 90095.

Introduction: The Dawn mission launched in 2007 on a history-making ion-propelled journey to visit the two most massive bodies in the main asteroid belt and learn about the conditions and processes that shaped the early solar system. Dawn entered orbit around Vesta in July 2011 and explored the protoplanet for 14 months using its framing camera (FC), visible-infrared spectrometer (0.4-5µm; VIR), gamma-ray and neutron detector (GRaND) and by mapping the topography and gravity. Dawn recently completed its comprehensive mapping of Ceres and has begun an extended mission. The main results and implications of the investigations of Ceres are described below.

Pre-Dawn Ceres: Prior to Dawn's arrival, Ceres was already known, from decades of ground- and space-based observations, to be a dark, wet dwarf planet with evidence for altered minerals [1], and water vapor emissions [2]. It was thought to be at least partially differentiated with a shell enriched in water ice [3]. Models also predicted that Ceres hosted a deep ocean early on, formed as a consequence of ^{26}Al decay heat, that survived for ~100 My, although a layer rich in supersaturated brines could remain until present [4].

Post-Dawn Ceres: Dawn arrived at Ceres in March 2015 and found a heavily-cratered, very dark surface that was punctuated by isolated, extremely bright areas [5]. This contradicted pre-Dawn model predictions of an ice-rich, viscously-relaxed smooth surface. Instead, Ceres is shown to have a mechanically strong crust and is gravitationally relaxed at long wavelengths, implying that the strong crust overlies a weaker deep interior [6, 7]. Compositionally, Ceres' surface is dominated by dark material, ammoniated Mg-phyllosilicates, and carbonates [8-10]. The ubiquitous presence of ammoniated material suggests formation in a colder environment, possibly in the outer solar system, while the overall mineralogy indicates Ceres' interior experienced pervasive alteration at the global scale. Water ice has been observed in fresh craters at high latitudes, and elemental measurements indicate a shallow ice table [11]. These observations, along with Ceres gravity field [12] confirm that Ceres at least partially differentiated providing indirect evidence for an ancient subsurface ocean (Fig. 1A). The presence of sodium-carbonates and other evaporites forming Ceres' bright areas provide additional evidence for the existence of material of oceanic origin in the near surface (Fig. 1B, C). Local morphology such as crater floor deposits, isolated mountains and the enigmatic bright areas indicate processes on Ceres that likely involved brine-driven cryovolcanism [13]. These processes may still be active, as suggested by the very recent Ahuna mons [13] or triggered by impacts that could have created local, short-lived hydrothermal environments [14].

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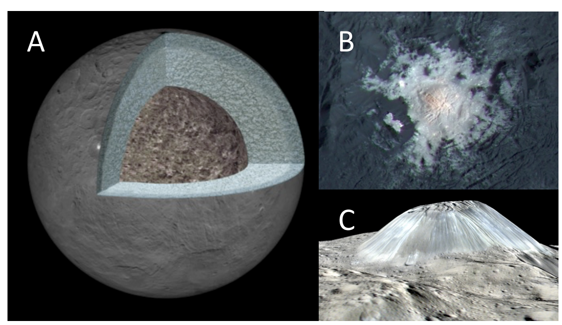

Figure 1. A) Ceres interior, inferred from Dawn's gravity and topography data [e.g., 6, 7, 12], is layered in a rocky mantle and volatile-rich crust itself divided into a strong outer layer and weaker bottom layer (thicknesses shown are notional). B) The bright central dome (Cerealia facula) within Occator crater's central pit appears to be recently emplaced and is rich in sodium carbonates. C) Steep-sided Ahuna Mons is consistent with recent eruption of brine-rich cryomagma [13]. Its bright flanks are rich in carbonate [15].