DAWN AT CERES: WHAT WE HAVE LEARNED. C. T. Russell[1], C.A. Raymond[2], M.C. DeSanctis[3], A. Nathues[4], T.H. Prettyman[5], J. Castillo-Rogez[2], H.A McSween[6], C.M. Pieters[7], R. Jaumann[8], D. Buczkowski[9], E. Ammannito[1], H. Hiesinger[10], M. Toplis[11], J.Y. Li[5], R.S. Park[2]. [1]UCLA, Earth, Planetary and Space Sciences, 603 Charles Young Drive, Los Angeles, CA 90095-1567, USA; ctrussell@igpp.ucla.edu, [2]Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109, USA, [3]Istituto di Astrofisica e Planetologia Spaziali, Via Fosso del Cavaliere 100, 00133, Roma, [4]Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Gottingen, Germany, [5]Planetary Science Institute, 1700 E. Fort Lowell Road, Tucson, AZ 85719, USA, [6]University of Tennessee, Knoxville, TN 37996, USA, [7]Brown University, Providence, RI 02912, USA, [8]German Aerospace Center, 51147 Koln, Germany, [9]Johns Hopkins University Applied Physics Laboratory, 11100 Johns Hopkins Road, Laurel, MD 20723, USA, [10]University of Muenster, Schlossplatz 2, 48149 Muenster, Germany, [11]Institut de Recherche en Astrophysique et Planetologie, 14 Avenue Edouard Belin, 31400 Toulouse, France.

Ceres, the largest body in the main belt, had been the subject of extensive telescopic observation, since its discovery on January 1, 1801, to the present, at which time a broad spectrum of remote sensing instrumentation is available. The Earth's atmosphere limits what we see, and the amount of time available on space-based telescopes is limited. The vast distance to Ceres also limits the spatial resolution. The arrival of Dawn at Ceres enabled much to be both learned and unlearned. The topography and gravity were consistent with a rigid, about 40-km crust. This crust supported crater formation and retention similar for small craters to those on silicate bodies like Vesta. The crust was composed of an intimate mixture of rock and ice. Below 40 km depth, the rigidity of the material lessened. The surface was cratered but very large craters were absent. It also had mountains, like Ahuna Mons [Fig. 1], that is most probably a cryovolcanic construct.

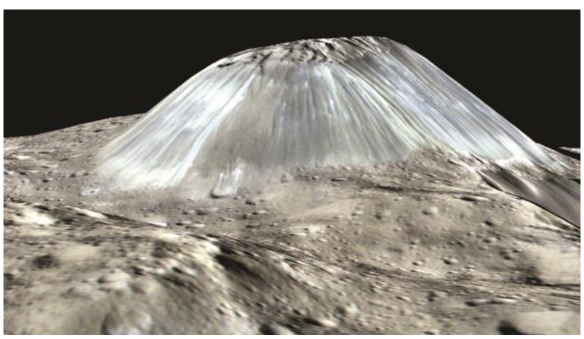

Figure 1. Ahuna Mons that is best explained in a cryo volcano.

The surface showed uniformity of composition but varying abundance. Ammoniated phyllosilicates covered the surface, the ammonia suggesting a cold origin, but there also was in Occator crater the largest accumulation of carbonate in the solar system other than on Earth [Fig. 2].

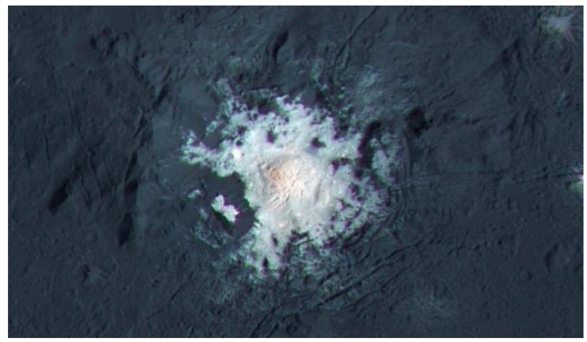

Figure 2. The dome of Cerealia fossa in Occator is fractured as if it were pushed up from below.

The distribution of the material on the Occator crater suggested that this material was produced inside Ceres in brine-fed hydrothermal systems that brought this material to the surface. And clearly the surface had been tectonically active [Fig. 3].

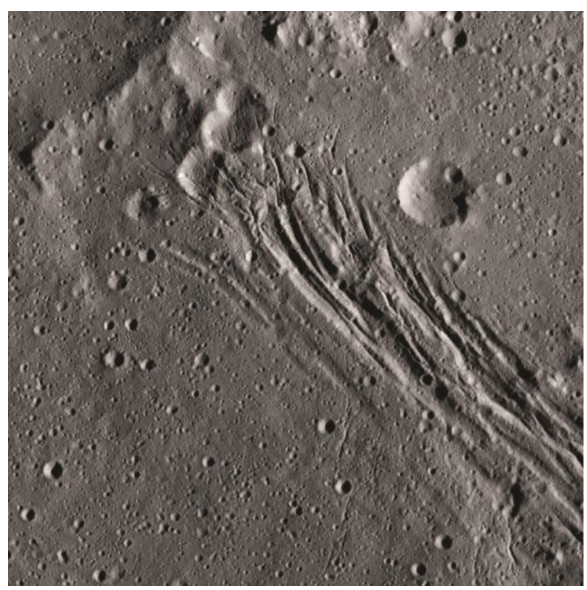

Figure 3. Surface structure near Yalode crater.

There were long flows associate with impacts, fractured crater floors, and crater domes, and pits indicative of volatile degassing. While the surface is almost uniformly ammoniated phyllosilicate, there are exceptional regions such as the colorful Haulani crater [Fig. 4], in which the crater has unearthed a very contrasty material.

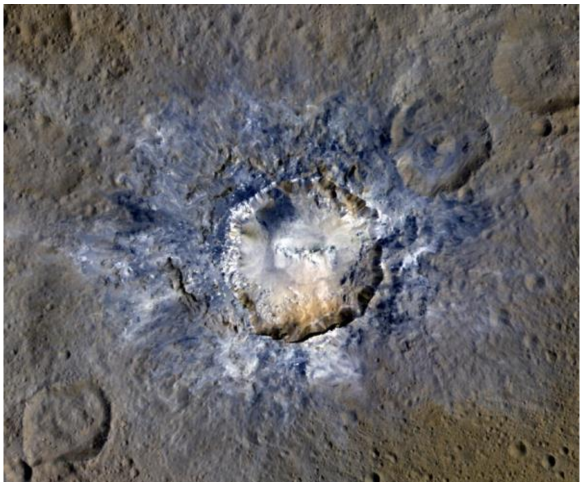

Figure 4. Haulani crater.

Furthermore, even though the surface is exposed to the vacuum of space and any exposed ice must sublimate, we do see ice patches such as in the crater Oxo [Fig. 5]. Perhaps our biggest surprise is the time variation of Ceres atmosphere. From the time of the first observations of OH with IUE, there have been both clean positive and negative detections of water vapor. No atmosphere was observed with VLT in 2007. HSO had positive and negative H_2O sightings. When Dawn arrived, it found times when Ceres interacted with the solar wind and times when it did not. There are no vents or plumes on Ceres, but when highly energetic solar protons are present, apparently water deposited in or on the surface is liberated.

Figure 5. Water ice exposed in Oxo crater.

At high resolution, the composition of the surface revealed ice patches such as in Oxo [Fig. 5] and organic molecules at Ernutet. The surface was scoured for evidence of temporal variation, but no clear evidence was found for a changing surface.

The surface has been mapped completely by Dawn's geology team, and these maps are now available to the community. Data are available to all through the Planetary Data System for all phases of the Dawn prime mission. Dawn is now completing its extended mission phases at high altitude where it can both observe Ceres optically and gather background data to enable cosmic ray background to be removed from the Gamma Ray and Neutral Detector count rates.