Paradigm Shift In The Main Belt: Dawn Reveals A Once Frozen Ocean World

Christopher RUSSELL[1#+], Carol RAYMOND[2], Julie CASTILLO-ROGEZ[2], Andreas NATHUES[3], Maria Cristina DE SANCTIS[4], Thomas PRETTYMAN[5,6], Harry MCSWEEN[7], Ralf JAUMANN[8], Carle PIETERS[9], Michael TOPLIS[10], Debra BUCZKOWSKI[11], David WILLIAMS[12], Harald HIESINGER[13], Ryan PARK[2], Jian-Yang LI[5], Eleonora AMMANNITO[1]

[1] University of California, Los Angeles, United States, [2] California Institute of Technology, United States, [3] Max-Planck Institute for Solar System Research, Germany, [4] National Institute for Astrophysics (INAF), Italy, [5] Planetary Science Institute, United States, [6] University of New Mexico, United States, [7] University of Tennessee at Knoxville, United States, [8] German Aerospace Center, Germany, [9] Brown University, United States, [10] National Centre of Scientific Research, France, [11] Johns Hopkins University, United States, [12] Arizona State University, United States, [13] University of Münster, Germany

[#]Corresponding author: ctrussel@igpp.ucla.edu [+]Presenter

Discovered on January 1, 1801, and celebrated as the missing planet predicted by the Titius-Bode's law, Ceres has had a very checkered history. Very quickly, Ceres was demoted to minor planet status when many more small bodies were found, no matter that Ceres was larger than all of them combined. In 1970 T. B. McCord and co-workers reported that Ceres' sister asteroid, Vesta, was the parent of numerous meteorites that had traveled to Earth. Vesta was a dry, basaltic asteroid, deepening the image of the asteroid belt as the graveyard of dry planetary embryos. Following its arrival in 2011, Dawn confirmed that Vesta had supplied those meteorites to Earth, but it also found evidence for transient water flow on Vesta's surface. Ceres, in contrast, had sent the Earth few decipherable signals. Distant gravity measurements (from Mars!) and telescopic observations revealed Ceres had a density more than twice that of water. This was a clue that Ceres had to be very wet, but the state of that water was unknown. Was it free water in hydrothermal systems? Was it bound water in hydrated silicates or clathrates? On approach to Ceres, Dawn saw bright spots, now called Cerealia and Vinalia Faculae, whose diagnostic spectra revealed sodium carbonate, possibly deposited on the surface from a hydrothermal system below. When Dawn achieved its lowest altitude at 400 km above the surface it saw neutrons signaling water ice below the surface. Infrared spectra revealed multiple small patches of water ice on the surface. Gravity and topography data revealed a hard solid crust about 50 km thick with the rigidity and density of a rock-ice-hydrates mixture. Ceres' surface may have rested beneath a frozen ocean later eroded by meteor impacts. Ceres may have once been an ocean world, similar to Jupiter's moons, Europa and Ganymede.