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Dawn at Ceres: A Synopsis

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Dawn has now been in orbit about Ceres for over two years. In that time, it has spiraled down to the lowest altitudes and back to the highest altitudes and on its way, performed global mapping of Ceres' surface morphology, topography, gravity, mineralogy, and elemental composition. It found a water-rich body with a temporary atmosphere that was sufficiently strong to deflect the solar wind. This atmosphere appears after the Sun produces high fluxes of very energetic protons. This time-varying association explains why 1-AU observations previously had both detected and failed to detect a water or OH atmosphere at Ceres. At global scale, the surface typically consists of a layer of phyllosilicates, including ammoniated clays, Ca-Mg carbonates and a dark but spectrally neutral component. At local scale, the Cerealia facula in Occator crater was found to be the largest known extraterrestrial accumulation of Na-carbonates. The Ernutet crater was peppered with organic molecules, possibly of internal origin, while small km square-sized regions of exposed ice were found in several places on the surface. In broad regions at high latitude, ice is just beneath the surface, and the depth to the ice table varies with latitude. Fractured crater floors suggesting stresses produced by uplift of sub-surface material were found, and the dome in the center of Occator craters' central pit was also postulated to be fractured by localized upwelling material. Ahuna mons, a 4-km high isolated mountain, further indicates the recent occurrence of cryovolcanic activity likely driven by brines. The gravity and topography data and the crater-size frequency distribution have been interpreted in terms of a rigid ice-rock shell covering a less rigid interior. Elemental data are consistent with ice-rock fractionation. The data clearly demonstrate that Ceres is a small exotic water-rich world, deserving of much attention in the next wave of planetary exploration.