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THERMAL ANALYSIS OF SPECIFIC REGIONS OF INTEREST ON CERES

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We describe the thermal behavior of some notable features, investigated by the Dawn spacecraft on the dwarf planet Ceres, using thermal infrared data acquired by the Visible and InfraRed mapping spectrometer (VIR), and comparing them with the local geology and mineralogy of those areas. Based on experience gained at Vesta, thermal information at unprecedented spatial resolution is useful in constraining thermophysical properties, which ultimately allow a comprehensive interpretation of the observed features. On Ceres, the feature that displays the largest thermal contrast, both on a regional and local scale, is the 34-km crater Haulani, located in the equatorial region and close to the prime meridian. Its central peak, rim and its nearest ejecta appear cooler than surrounding terrains observed under similar illumination conditions and local solar time. While Haulani is one of the youngest surface features of Ceres (<6 Myr), its thermal contrast is not found in other young craters like Oxo, Juling and Kupalo, making it difficult to invoke age and space weathering as the sole reason for this observational evidence. Rather, the characteristics of the impact event that generated Haulani, which triggered hydrothermal activity in the shallow subsurface, could have exposed material with higher density and/or characterized by different thermal conductivity compared to most of the other surface features.
Bright material units were discovered on Ceres by the Dawn spacecraft during approach in early 2015. The brightest cluster of spots is found in the 92-km complex Occator crater. VIR data acquired in the near infrared revealed that Cerealia Facula (the brighest spot) is made up of an outcrop of anhydrous sodium carbonate, which is the solid residue of crystallization of brines erupted from below. Despite their compositional uniqueness on Ceres, Occator's faculae do not show any substantial thermal contrast at spatial resolutions of kilometers down to a few hundreds of meters, suggesting that albedo does not strongly constrain daytime surface temperature on Ceres.
With an average height of about 4 km, Ahuna Mons is the highest mountain discovered on Ceres, believed to be cryovolcanic in origin. A thermal analysis of Ahuna Mons carried out with VIR highlights that the northern flank and the summit of Ahuna could be inherently cooler than the surrounding regions observed at the same local time. Because surface composition is quite homogeneous within Ahuna Mons, this evidence could be related to a different compactness of the surface regolith in these areas.
Dawn/VIR spectra allowed a safe identification of water ice-rich materials on the surface of Ceres. About a dozen of ice-rich units were discovered in as many craters located poleward of 30°, favored by the peculiar local topography, which allows ice to be shielded from direct sunlight for most of the Cerean day. In this respect, crater Juling is particularly interesting since the the extension of its ice-rich unit has been discovered to change with time, suggesting a potential connection with the sporadic emissions of water and hydroxyl observed from space. Because pure surficial H2O ice would sublime under current thermal conditions on Ceres, where daytime surface temperatures span the range 180-240 K, direct thermal mapping enabled by VIR infrared data can put constraints on the ice loss rate of ice-rich materials, helping us to establish their origin.