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Ceres' hydrogen-rich regolith

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Low-altitude mapping of Ceres by Dawn's Gamma Ray and Neutron Detector (GRaND) began in December of 2015. GRaND will continue to acquire data for at least six months in a circular-polar orbit, at an altitude of about 0.8 body radii. Close-proximity enables global mapping of the elemental composition of Ceres' regolith, with regional-scale spatial resolution, similar to that achieved at Vesta. An initial analysis of the data shows that Ceres' regolith is rich in H, consistent with the detection of ammoniated phyllosilicates by Dawn's Visible to InfraRed (VIR) spectrometer. Global maps of neutron and gamma ray counting data reveal a strong latitude variation, with suppressed counts at the poles. Lower bound estimates of the concentration of polar H exceed that found in carbonaceous chondrites, which are the best meteorite analogs for Ceres. Thermal modeling predicts that water ice is stable near the surface at high latitudes, and, given Ceres' low obliquity, water ice and other volatile species may be concentrated in permanently shadowed regions near the poles. Excess hydrogen at high latitudes is likely in the form of water ice within the decimeter depths sensed by GRaND. Changes in the hydration state of phyllosilicates and hydrated salt minerals with temperature could also contribute to observed spatial variations. Some GRaND signatures show evidence for layering of hydrogen, consistent with ice stability models. Differences in the gamma ray spectra of Ceres and Vesta indicate that Ceres' surface is primitive (closely related to carbonaceous chondrite-like compositions), in contrast to Vesta's fractionated igneous composition. Strong gamma rays are observed at 7.6 MeV (Fe), 6.1 MeV (O), and 2.2 MeV (H). With additional accumulation time, it may be possible to quantify or bound the concentration of other elements, such as Mg, Ni, and C. Elements diagnostic of hydrothermal activity (K, Cl, and S) may be detectable if they are present in high concentrations over large portions of the surface. We will combine elemental measurements with other remote sensing observations to investigate Ceres' origins, evolution, interior structure, and chemistry.