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Distribution of phyllosilicates on Ceres

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Studies of the dwarf planet Ceres using ground-based and orbiting telescopes proposed a variety of possible surficial composition including water in clay minerals [1], ammoniated phyllosilicates [2], or a mixture of brucite, $Mg2CO_3$ and iron-rich serpentine [3, 4]. But the lack of spectral data in the 2.5 to 2.9 μm interval has precluded definitive identifications. The Dawn spacecraft has been acquiring spectra of the surface of Ceres since January 2015 [5, 6, 7]. The average thermally corrected reflectance spectrum of Ceres shows that the 2.6–4.2μm region is characterized by a broad asymmetric feature, characteristic of H_2O/OH bearing materials, with several distinct narrower absorption bands [8]. This spectrum is compatible with the presence on the surface of a mixture of ammoniated-phyllosilicates, Mg-phyllosilicates, carbonates, and dark materials [8]. A strong 2.7-μm absorption dominates the overall spectral properties, and it has been attributed to OH-stretching vibrations in phyllosilicates [9] while the weaker 3.05 μm absorption has been attributed to the presence of NH4+ in phyllosilicates [10].
The spectral parameters of the absorption features at 2.7 and 3.05 μm have been computed to study their position and intensity.
The computed spectral position of both absorption features is remarkably homogeneous. The average values are 2.727$\pm$0.005 and 3.061$\pm$0.005 μm respectively. Since the position of both features is sensitive to the chemical composition of the phyllosilicates, we conclude that the composition of phyllosilicates does not significantly change across the mapped portion of Ceres' surface. The computed values are indicative of Mg-OH phases, like antigorite (Mg-serpentine) or saponite (Mg-smectite) [9]. The presence of Mg-, rather than Fe-serpentine on Ceres may be interpreted as an indication that alteration had been extensive, while the lack of geochemical variation indicates that this is true throughout the exposed upper layer with no significant compositional gradients.
The computed spectral intensity of both absorption features shows some variability. For the 2.7 absorption, the average value is 0.251$\pm$0.006, while the range of variability is between 0.20 and 0.29. For the 3.05 absorption, the average value is 0.055$\pm$0.012, while the range of variability is between 0.03 and 0.09. Interestingly, the distributions of the intensities of the two bands broadly match. Among several possibilities, the most likely explanation for the variability in intensity is a changing abundance of phyllosilicates within the assemblage forming the surface of Ceres.
In conclusion, while the chemical composition of the phyllosilicates is remarkably constant, their abundance is variable. The compositional homogeneity characterized by the pervasive presence of Mg- and NH4-bearing phyllosilicates indicates endogenous formation by a globally widespread and extensive alteration processes while the variations in the amount of phyllosilicate suggest the existence of a vertically stratified upper crust.
References: [1] Lebofsky, L. et al. (1981) Icarus, 48, 453–459. [2] King T. et al. (1992) Science, 255, 1551–1553. [3] Rivkin A.S. et al. (2006) Icarus, 185, 563–567. [4] Milliken R.E. and Rivkin A.S. (2009) Nature Geosci., 2, 258–261. [5] Russell C.T. and Raymond C.A. (2011) Space Sci. Rev., 163, 3–23. [6] Russell C.T. et al. (2015) EPSC. [7] De Sanctis M.C. et al. (2011) Space Sci. Rev., 163, 329–369. [8] De Sanctis M.C. et al. (2015) Nature. [9] Bishop J.L. et al. (2008) ClayMiner., 43, 35–54. [10] Bishop J.L. et al. (2002) Planet. Space Sci., 50.