

**SPECTRAL INVESTIGATION OF QUADRANGLE Ac-H-3 OF THE DWARF PLANET CERES - THE REGION OF IMPACT CRATER DANTU.** K. Stephan<sup>1</sup>, R. Jaumann<sup>1,2</sup>, F. Zambon<sup>3</sup>, F. G. Carrozzo<sup>3</sup>, M. C. De Sanctis<sup>3</sup>, F. Tosi<sup>3</sup>, E. Ammannito<sup>4</sup>, A. Longobardo<sup>3</sup>, E. Palomba<sup>3</sup>, L. A. Mc Fadden<sup>5</sup>, K. Krohn<sup>1</sup>, D. Williams<sup>6</sup>, A. Raponi<sup>3</sup>, M. Ciarnello<sup>3</sup>, J.-P. Combe<sup>7</sup>, A. Frigeri<sup>3</sup>, T. Roatsch<sup>1</sup>, K.-D. Matz<sup>1</sup>, F. Preusker<sup>1</sup>, C. A. Raymond<sup>8</sup>, C.T. Russell<sup>4</sup>. <sup>1</sup>DLR, Institute of Planetary Research, Berlin, Germany; <sup>2</sup>Free University of Berlin, Germany; <sup>3</sup>INAF-IAPS, Rome, Italy; <sup>4</sup>UCLA, Institute of Geophysics and Planetary Physics, Los Angeles, CA; <sup>5</sup>NASA Goddard Space Flight Center, Greenbelt, MD, USA; <sup>6</sup>Arizona State University, Tempe, AZ, USA; <sup>7</sup>Bear Fight Institute, Winthrop, WA, USA; <sup>8</sup>NASA-JPL Pasadena, CA, USA. (Katrin.Stephan @dlr.de)

**Introduction:** In this study we explore the surface composition in the Ac-H 3 quadrangle of Ceres' surface named after its dominating surface feature Dantu. This 126 km large complex impact crater with its extended ejecta blanket is situated in the southern portion of this quadrangle. It is not only an impressive geological feature, but it is also spectrally unique. Its investigation offers a key to further our understanding about the compositional and geological evolution of Ceres' crust.

**Data basis:** Our study has been performed on data acquired by the VIR instrument [1], which detects Ceres' surface between 0.25 and 1.05 $\mu\text{m}$  (VIS) and between 1.0 and 5.1  $\mu\text{m}$  (IR), allowing the identification and mapping of Ceres' major spectral signatures. The spectral mapping has been performed as described in detail by [2]. In order to study the spectral characteristics of the Ceres spectra at wavelength longer than 3 $\mu\text{m}$  a correction of the thermal signal has been performed as described in [3].

Images acquired by the Framing Camera (FC) [4] offer the geologic context for our spectral investigation but also spectral information due to its 7 color filters, which are sensitive in a wavelength range between 0.4 and 1.1 $\mu\text{m}$ . Although, these images do not offer a continuous spectrum like the VIR observation, they are useful to see changes in the visible albedo and spectral slope at a much higher spatial resolution – revealing correlations between composition and geology at a local scale.

**Geological setting:** The Ac-H-3 quadrangle includes Ceres' surface located between 21° and 66°N as well as 90° and 180°E north of the prominent impact basin Kerwan [5,6]. The northern and southeastern parts of the quadrangle are characterized by cratered terrain while the southern and southwestern parts are dominated by the partially smooth ejecta blankets of craters Dantu (d $\approx$ 126 km) and impact crater Gaue (d $\approx$ 80 km) (Fig. 1). Most parts of the area, especially the impact crater Dantu, lie in a large-scale depression named Vendimia Planitia.

Dantu has a quite complex morphology with a central pit, pitted terrain and fractures on its floor, formed during the impact event or by post impact processes [6]. Several bright spots appear on the crater floor but

also at the crater wall and outside the crater as part of the ejecta blanket. High-resolution measurements of crater size-frequency distributions (CSFDs) by [6] indicate a formation/modification age of  $\sim$ 72-150 Ma (based on the lunar derived model). Superimposed onto the crater floor are two small fresh impact craters. FC images reveal smooth flow-like material associated to Dantu, which has been interpreted as impact melt superimposing the intra crater fractures [6]. Other lobate features are associated to small impact craters such as Jaja and Xochipili.

**Major surface composition:** The VIR-derived spectral characteristics of the Dantu region in general reflect the average surface composition of Ceres [7]. Ammoniated phyllosilicates with the diagnostic absorptions at 2.7 and 3.1 $\mu\text{m}$  appear in every VIR spectrum. On the other hand, relatively deep absorptions at 3.4 and 3.9 $\mu\text{m}$ , which have been related to carbonates [8], appear only locally.

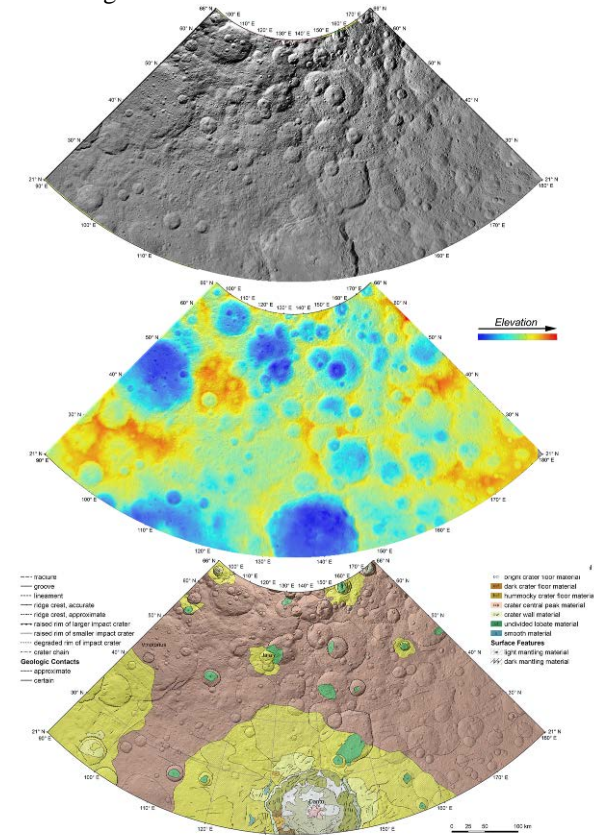
**Distribution of the spectral units:** In the spectral parameter maps as well as the spectral slope maps two major areas can be distinguished (Fig. 2). Similar to what can be seen in the geological map produced by [6] the southern portion of our region of interest is dominated by the spectral signature of the impact crater Dantu and its ejecta blanket, which is characterized by a generally higher visible albedo and a red-to-neutral visible spectral slope. Intriguingly, Dantu exhibits unusually deep absorptions at 2.7 and 3.1  $\mu\text{m}$ .

The northern region shows a higher variegation in the spectral properties. The absorptions at 2.7 and 3.1 $\mu\text{m}$  are distinctly weaker than in the vicinity of Dantu with the weakest absorptions associated with a bluish visible slope as well as a bluish color in the RGB color composite in the vicinity of small fresh impact craters like the impact crater Ialonus in the northeastern portion of the quadrangle (Fig. 2), for example. The remaining cratered terrain exhibits a reddish visible slope similar to Dantu's central collapsed peak. However, unlike Dantu's peak the cratered terrain exhibits a reddish color in the color composite of the Dantu region and a relatively low visible albedo.

Changes in the appearance and/or abundance of carbonates do not occur on a global/regional scale.

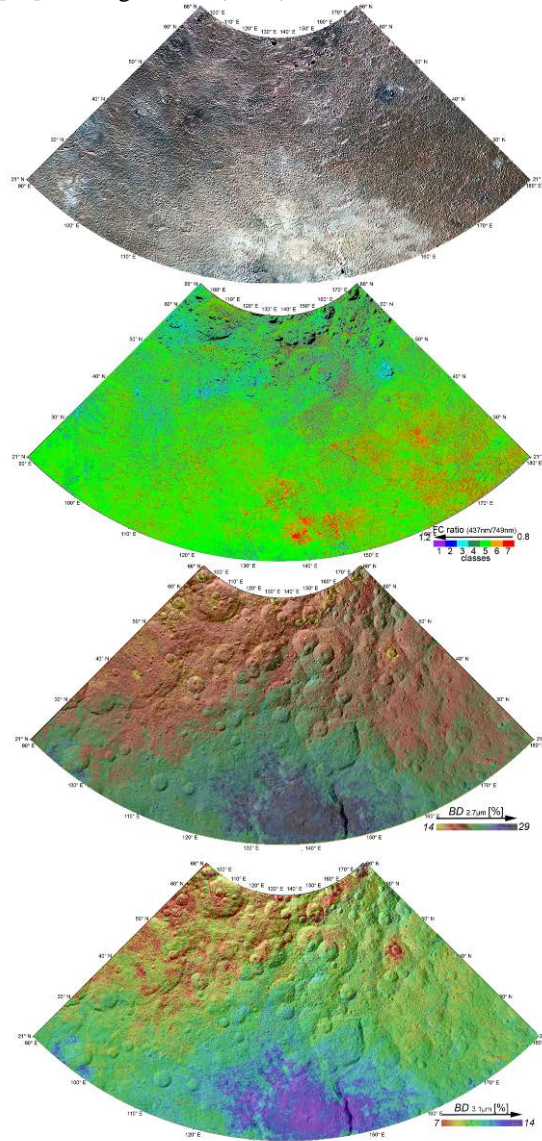
Only locally a few small bright spots can be detected in that show a strong carbonate signature [9].

**Discussion:** Usually, fresh craters show a blue slope and weak absorptions at 2.7 $\mu\text{m}$  and 3.1 $\mu\text{m}$ . With increasing age the blue slope turns red and the phyllosilicate absorptions become stronger [10,11]. Dantu’s spectral properties, however, do not fit to this trend. Dantu’s visible slope is generally rather red-to-neutral, which could be explained by its age. Furthermore, Dantu exhibits the deepest phyllosilicate absorptions measured on Ceres. The area of the enhanced signature of phyllosilicates also includes Kerwan – the oldest impact basin on Ceres [5]. Both impact features lie in the large-scale depression Vendimia Planitia, a strongly degraded huge impact basin formed early in Ceres’ history [11]. Subsequent impacts in this basin reach deep into Ceres’ crust. Thus, differences in the spectral signature of Dantu could be explained by variations in the composition due to the excavation of material from stratigraphically deeper-lying regions of Ceres’ crust. Because Dantu is the youngest of the large impact features located in this basin the phyllosilicate absorptions are strongest here.



**Figure 1:** (a) Clear filter image, (b) digital elevation model, and (c) geological map (from Kneissl et al., 2016) of Ceres’ Ac-H-3 quadrangle.

**References:** [1] De Sanctis, M. C. et al. (2011) *SSR*, 163, 329-369; [2] Ammannito E. et al. (2016) *Science*, 353, 6303; [3] Raponi, A. et al. (2015) *EPSC*, #537; [4] Sierks H. (2011) *SSR*, 163, 263-327; [5] Williams et al. (2016) *Icarus*, in press; [6] Kneissl, T. et al. (2016) *LPSC*, #1967; [7] De Sanctis, M. C. et al. (2015) *Nature*, 528, 241-244; [8] De Sanctis M. C. (2016) *Nature*, 536, 54-57; [9] Palomba et al. (2016) *LPSC* #2197; [10] Stephan K. et al. (2017) *GRL*, submitted; [11] Schmedemann et al. (2016) *GRL* in press; [12] Hiesinger et al. (2016) *Science*, 353.



**Figure 2:** Spectral maps of the Ac-H-3 quadrangle: (a) enhanced color mosaic of the color filters 5, 2 and 8 in RGB, (b) classification of the visible spectral slope (ratio of the FC filters 8 and 3 sensitive at 440 and 750nm), the band depth maps of the absorptions at (c) 2.7 and (d) 3.1 $\mu\text{m}$ .