EXPOSED H_2O-RICH AREAS ON CERES DETECTED BY DAWN. J.-Ph. Combe[1], A. Raponi[2], F. Tosi[2], M.C. De Sanctis[2], E. Ammannito[2,3], F.G. Carrozzo[2], M. E. Landis[4], S. Byrne[4], U. Carsety[5], S. Schröder[5], T. Platz[6], O. Ruesch[7], K. Hughson[3], T. B. McCord[1], S. Singh[1], K. Johnson[1], F. Zambon[2], C.M. Pieters[8], C.A. Raymond[9], C.T. Russell[3], and the Dawn/VIR Team, [1]1 Bear Fight Institute, Winthrop, WA, USA. 2 INAF-IAPS Istituto di Astrofisica e Planetologia Spaziali, Rome, Italy. [3]University of California at Los Angeles, Los Angeles, CA, USA. [4]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, USA. [5]German Aerospace Center (DLR), Institute of Planetary Research, Rutherfordstrasse 2, 12489 Berlin, Germany. [6]Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany. [7]NASA/Goddard Space Flight Center, Greenbelt, MD, USA. [8]Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI, USA. [9]NASA/Jet Propulsion Laboratory and California Institute of Technology, Pasadena, CA, USA.

Introduction: H_2O-rich materials are exposed at the surface of Ceres as discovered from VIR spectra [1] on the Dawn mission [2]. Oxo crater exhibits the most diagnostic absorption bands of the H_2O molecule (Fig. 1) at 1.65 and 1.28 µm [3].

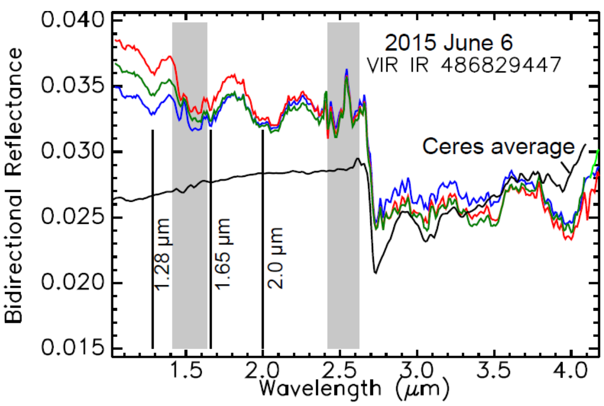

Fig. 1: (Adapted from combe et al., 2016 [3]). Dawn VIR IR observations of Oxo crater on Ceres demonstrate the detection of H2O at the surface. Reflectance spectra collected where absorption bands of H2O at 1.27, 1.65, and 2 µm are the strongest (in color) from distinct pixels within a VIR image. The average spectrumof Ceres (in black) displayed as a reference, shows no H2O absorption bands. Gray rectangles define ranges of wavelengths where the spectra are the least reliable because they are at filter junctions.

Results: These features exist in at least eight other locations [4}, and they are consistent with H_2O ice mixed with low-albedo components [3-5]. Spectra of mineral hydrates such as salts are also characterized by H_2O absorption overtones; however, they do not fit VIR observations as well as H_2O ice spectra. In order to further constrain the composition, the thermophysical and chemical stability of exposed H_2O-rich compounds on Ceres and results from chemical models of Ceres interior are being investigated. One meter of pure H_2O ice exposed to direct sunlight would sublimate within a few tens of years [6-8]. The sublimation of an H_2O ice-cemented regolith would leave a low-albedo lag deposit that would also decrease detectability and increase temperatures over time [9]. All the reported H_2O exposures occur at latitudes higher than 30°N have surface area < 7 km^2. H_2O-rich materials have been detected in different geological contexts. Several of them are present inside of fresh craters, in poorly illuminated regions (Fig. 2),while others are only associated to high-albedo materials on surfaces that do not present any distinctive type of terrain morphology (Fig. 3).

Conclusion: The exposed H_2O ice that is observed by VIR is likely due to a recent exposure event, such as an impact or a landslide. In some occurrences, high-albedo materials observed within shadowed areas by the Framing Camera (FC) are contiguous to the observed H_2O (Fig. 2); several of them could be in Permanently Shadowed Regions [10]. Since all these observations are compatible with an H_2O-rich subsurface, the replenishment of surfacic H_2O likely comes from the ice that is present underneath. In four occurrences, H_2O is detected on walls and floors of fresh impact craters, either in the shadow or adjacent to shadows, which seem to indicate that cold traps may also play a role in the concentration of H_2O in these areas. [11].

References: [1] De Sanctis M.C. et al.,2011, SSR 163. [2] Russell C. T. et al., 2011, SSR 163. [3] Combe J-Ph. et al., 2016, Science 353. [4] Combe et al., 2017, Icarus, submitted. [5] Raponi A. et al., 2016, DPS-EPSC. [6] Hayne P. O., Aharonson O., 2015, JGR 120. [7] Formisano M. et al., 2016, MNRAS 455. [8] Titus T., 2015, GRL 42. [9] Hayne P. O., Aharonson O., 2016, LPSC #2736. [10] Platz et al., 2016, Nature Astronomy 1. [11] Schorghofer et al., 2016, GRL accepted.

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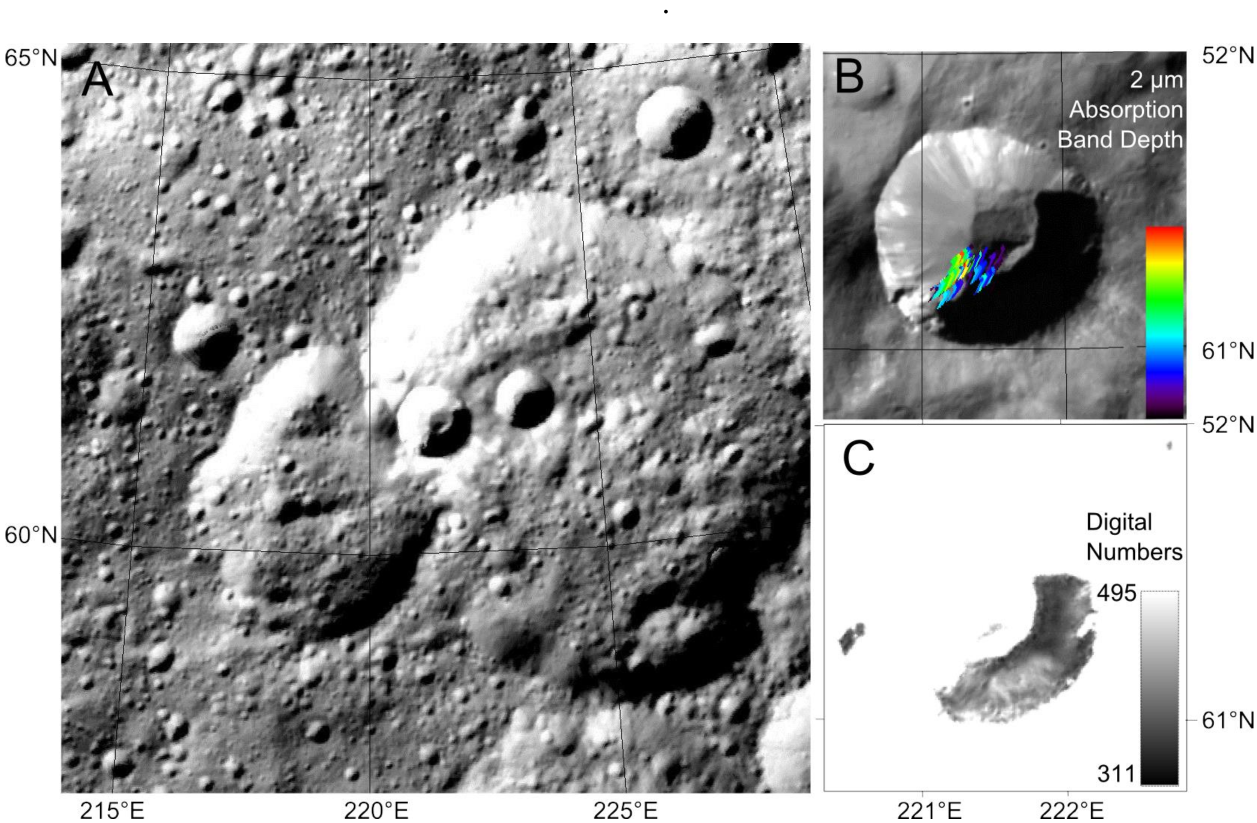

Fig. 2: FC imagery context of the H_2O-rich material area at 61.61°N, 221.06°E inside a fresh impact crater included in Messor Crater. A – Mosaic from HAMO observations displayed in Lambert conformal conic projection. The white rectangle delimits the close-up view on the right. B – Close-up view of the fresh crater from image FC21A0047863_15358091114F1G acquired from LAMO. Colored pixels are VIR H_2O detections of H_2O from LAMO. C – Same FC image as B, with brightness display is stretched in order to visualize the surface inside of the shadowed areas.

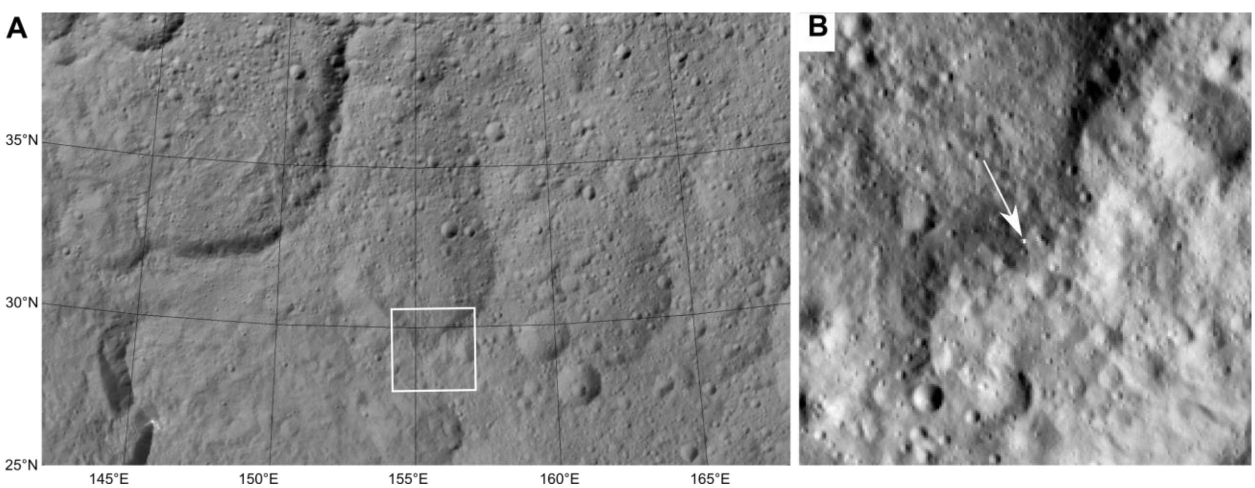

Fig. 3: H_2O-rich material area at 29.60°N, 155.08°E. A – Framing Camera clear filter mosaic used for the regional context. B – Framing Camera image from Low-altitude Maping Orbiut (LAMO) showing high albedo where H2O-rich materials have been detected by VIR (white arrow)