URVARA BASIN ON CERES: BRINE RESIDUES AND ORGANICS. A. Nathues[1], M. Hoffmann[1], N. Schmedemann[2], R. Sakar[1], G. Thangjam[3], K. Mengel[1], J. Hernandez[1], H. Hiesinger[2], and J.H. Pasckert[2]

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Introduction: The dwarf planet Ceres is the largest (~940 km diameter) object in the main asteroid belt, orbiting the Sun at a distance of ~2.8 AU. Ceres is a survivor of the earliest period of the Solar System formation and thus a detailed knowledge about its interior provides fundamental insights into the formation and evolution of volatile-rich planetary embryos.
The Urvara basin (diam. ~170 km) is the third-largest impact feature on Ceres [1]. We studied Urvara by using the highest resolution Framing Camera images (~3 m/px) of the Dawn mission [2], combined clear and color filter data with topographic information [4], and thus enabled insights into the cerean crust.

Geology: Urvara exhibits one of the lowest-lying surface areas on Ceres and may have formed within an even larger, ancient eroded basin. Its morphology is consistent with a complex, medium-aged impact crater, showing a partly preserved ejecta blanket and a continuous crater wall often with vast terraces (Fig. 1) [1, 4]. Some parts of its wall and floor are covered by smooth material (SM), which is one of the most intriguing geologic units on Ceres.

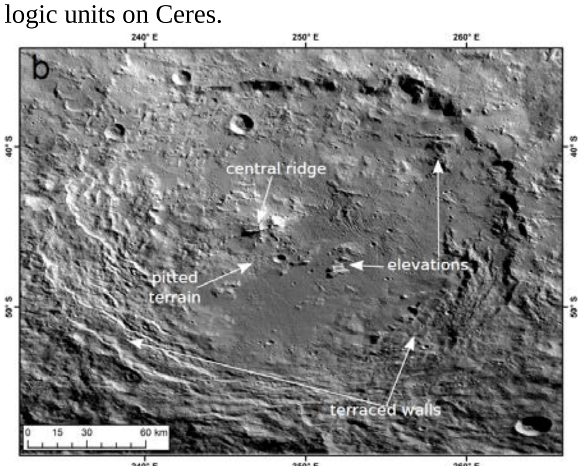

Figure 1: *Clear filter mosaic of Urvara (~35 m/px). Important surface features are labelled.*

A central ridge is located off-center and rises ~3 km above the floor. Its southern flank is steep, exposing fragmented bedrock (Fig. 2). These cliffs exhibit inclusions of bright material (BM), indicative of salts that originate from great depth. Eastward of the central ridge, we identified a central pit (~20 km diameter, 0.56 km deep), suggesting a high volatile content of the cerean crust. The pit formed close in time to the impact [4]. Linear grooves traverse the eastern and western floor, which could be indicative of post-impact movements of the SM and suggest late floor activities.
One of the deepest areas in Urvara is an undulated, irregular unit south of the central ridge, characterized by numerous shallow depressions described as a "pitted texture" [4, 5]. This terrain also indicates past outgassing of a volatile-rich subsurface. However, these pitted terrain seems to be substantially younger than the central pit.

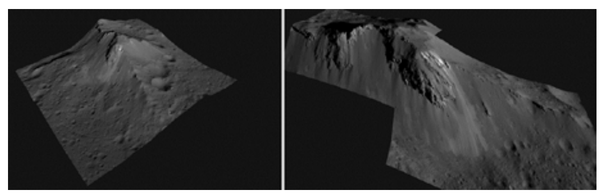

Figure 2: *Perspective views of the central ridge (at ~5 to ~15 m/px). The brightest material is found near its summit at one of the main cliffs in the north-east. The view is towards the west (left image) and north-west (right image).*

Urvara's colors: Urvara shows a distinctive spectral diversity, much greater than the neighboring Yalode basin. Figure 3 displays a false-color mosaic (RGB) in which several color units can be distinguished. An increased content of BM raises the overall reflectance of the central ridge area, the rugged terrain, and extends beyond the western crater rim.
Salty BM can be easily identified due to their characteristic spectral shape in FC colors [4, 6] and is found on the central ridge and floor. Here BM spectra are similar to the average cerean BM and thus likely of similar mineralogy. Interestingly, meter-scale concentrations of the north-eastern central ridge (Fig. 2) exhibit reflectances up to ~0.16 in clear filter. These reflectances are comparable to those measured for Vinalia Faculae in Occator crater.
Surprisingly, one site of BM on the western floor shows an overall red-sloped spectrum in FC wavelengths without the typical reflectance peak at 0.55 µm of cerean BM (Fig. 4). In addition, this site exhibits a weak 3.4 µm absorption feature in VIR data [4]. The characteristics are similar to those found for sites in

and around the Ernutet crater, which are composed of organic-rich material [7].

Dark material is mainly restricted to the eastern part of the floor, on which dark bluish material is associated with small impact craters.

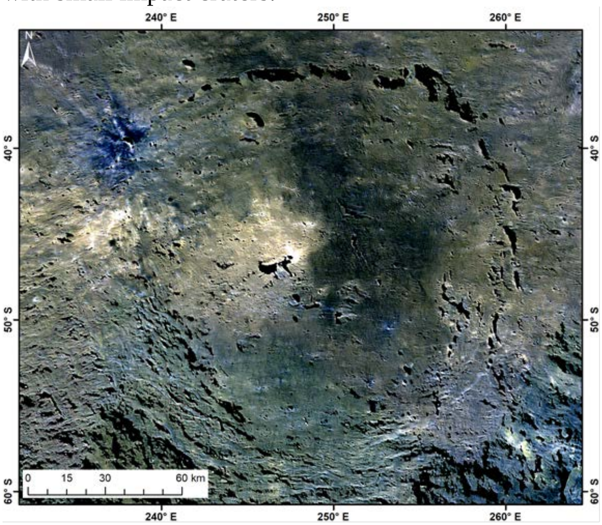

Figure 4: *Photometrically corrected color mosaic (R=0.96, G=0.75, B=0.44 µm) at ~140 m/px by using the shape model of [3]. The following color units can be identified: (1) "Central ridge area": showing the brightest ochre-colored tones and the highest reflectances; (2) "Rugged terrain": on the western floor in ochre-colored tones, which expand to the western crater rim, showing slightly higher reflectances than the remaining floor; (3) "Smooth material": mainly on the eastern floor, which is in FC spectral data similar to the average dark material of Ceres; (4) A dark bluish crater of 8 km diameter on the north-western rim; (5) Several small bluish-colored craters showing low reflectances, found on the smooth material and outside the rim; and (6) Several small bright material units on the northern crater wall, the floor, the upper central ridge, and one terrace.*

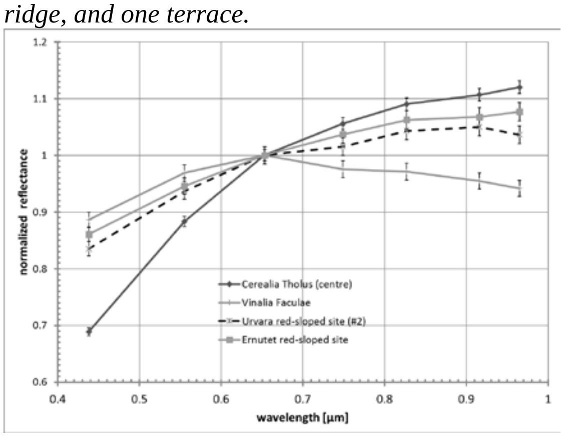

Figure 6: *Color spectrum of the organic-rich BM on a scarp of the rugged terrain. Error bars, ±1.5% (typical uncertainty)*

Ages: All major color units have been age-dated by using the CSFD (Crater size-frequency distribution) measurements [8]. Urvara is confirmed to be ~250 Myr old (LDM). Interestingly, we identified floor units, especially the southern SM, which were resurfaced ~160 Myr ago [4]. This finding is remarkable because one would expect the entire floor to show the same age, which is close or equal to the crater formation age. However, we found a difference of ~100 Myr between the crater formation age and the southern SM.

Conclusions: We report new findings that help in understanding the structure and composition of the cerean crust. Unexpectedly, we found meter-scale concentrated exposures of bright material (salts) along the crater's upper central ridge, which originate from an enormous depth, possibly from a deep-seated brine or salt reservoir. An extended resurfacing modified the southern floor ~100 Myr after crater formation, long after the dissipation of the impact-generated heat. In this resurfaced area, one floor scarp shows spectra consistent with the presence of organic material, the first such finding on Ceres beyond the vast Ernutet area. Our results strengthen the hypothesis that Ceres is and has been a geologically active world even in recent epochs, with salts and organic-rich material playing a major role in its evolution.

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