BRIGHT SPOTS ON CERES: OCCATOR, OXO AND THE OTHERS. E. Palomba[1,2], A. Longobardo[1], M. C. De Sanctis[1], N. T. Stein[3], B. Ehlmann[3,4], A. Raponi[1], M. Ciarniello[1], E. Ammannito[1,5], E. Cloutis[6], A. Galiano[1], F. G. Carrozzo[1], M. T. Capria[1,2], F. Zambon[1], F. Tosi[1], C. A. Raymond[4], C. T. Russell[5] and the Dawn/VIR Team, [1] INAF-IAPS Istituto di Astrofisica e Planetologia Spaziali, Rome, Italy (ernesto.palomba@iaps.inaf.it), [2]ASDC-ASI, Rome, Italy, [3] Div. Geological and Planetary Sciences, California Institute of Technology, [4] Jet Propulsion Laboratory, California Institute of Technology, [5] University of California at Los Angeles, Los Angeles, CA, USA, [6] Department of Geography, University of Winnipeg, 515 Portage Avenue, Winnipeg, Manitoba, Canada.

Abstract: The dwarf planet Ceres has a very dark surface (average reflectance at 0.55 μm is 0.03 [1]) with some bright areas detected during the early phases of Dawn mission [2] and identified as "bright spots" (BS). The brightest among these are located on the floor of Occator crater, named Cerealia Facula and Vinalia Faculae. By using the hyperspectral data provided by the VIR instrument [3], a catalogue of 98 BS was obtained [4]. A spectral analysis of these BS has been performed in order to reveal if they have a common or a different origin and evolution.

BS general distribution and characteristics: BS have no preferential orientation or location, even if many of them are located on younger terrains. The highest concentration of BS is found on the Rongo [5] and the Yalode quadrangles [6] with 14 and 15 BS, respectively.

The majority of BS are features related to impacts, while the remaining ones are areal and linear features.

BS spectra are diverse. First of all, the reflectance continuum varies by a factor of three between Occator spots (reflectance at 30° phase is 0.11) and the "darkest" BS's (0.034).

Spectra of Dantu, Oxo and Occator are shown in Figure 1, representing three different cases of BS.

The Dantu (17°N 135°E) BS spectrum reveals weak, but clear, carbonate bands (3.4 and 4 μm [7]), and strong ammoniated and OH features (3.05 and 2.7 μm, respectively [8]).

The Oxo (43°N 0°E) BS spectrum exhibits very strong carbonate bands and both the 3.05 μm and the 2.7 μm features. However, the latter have a different shape from the Dantu case.

In both Occator BS (20°N; 239°E 241°E, respectively) spectra, the ammoniated feature disappears, the OH band remains strong but becomes sharper, and the carbonate band depths increase. For the first time and uniquely here there is the appearance of a weaker 2.2 μm band, due to possible ammoniated salts [8].

Bright Spots Compositional properties:

Carbonate composition. The 3.4 and 4 μm carbonate overtone band depths (BD) are an indirect measurement of carbonate abundance and in this respect the Cerealia and Vinalia Faculae, Oxo and Ezinu (61°N 221°E) are the BS's with the largest carbonate abundances (Fig.2a). Band depths of carbonate features are defined as 1-Rc/Rb, where Rb is the reflectance of band minimum after removed continuum and Rc is the reflectance of the continuum at the same wavelength of band minimum [9].

Band depth values of Cerealia and Vinalia Faculae, Oxo and Ezinu are located in the upper part of the 4 vs 3.4 μm band depth scatterplot which show an expected strong linear correlation with very few exceptions, strongly indicating that both bands are due to the same phase. As an example, the Ernutet BS shows a 3.4 μm BD overtone excess with respect to the 4 μm and this could be due to the presence in this area (even if not exactly overlapped to the bright spot) of aliphatic organics (which absorb strongly in the 3.4 μm region), as recently detected by [10]. Conversely, an excess of 4.0 μm BD is observed in some other cases, but differently from the Ernutet case. This does not imply a compositional difference and could be simply explained by the different carbonate grain size in these BS's, where one of the two absorption bands is optically saturated.

The composition of carbonates in BS's is generally similar to the average Ceres, with Mg-Ca carbonates mixed with dark components, hydrated and ammoniated compounds. However, there are particular cases in which the prevalent carbonate is Na-bearing as shown in Fig.2b.

Ammonia and OH bearing materials. Ammoniated clays are ubiquitous on Ceres and common in BS's, too. However, their abundance decreases with increasing brightness and increasing carbonate BD, and their absorption bands completely disappear on Cerealia and Vinalia Flaculae. A similar anticorrelation trend, although less strong, exists between carbonates and phyllosilicates. In particular, the Oxo and Ezinu's BSs are among the most OH-depleted and richest in carbonates.

A peculiar trend is observed for the two spots in Occator, which exhibit a moderately strong phyllosilicate 2.7 μm band, comparable with carbonate poorer BS's. A possible explanation of this behavior can be found in the different nature of hydrated materials in Occator, where Al-pyllosilicates are present instead of the Mg-phyllosilicates that are common in the rest of the BS's.

Conclusions: Most of bright spots present on the Ceres surface have very similar compositional properties in terms of carbonates, phyllosilicates and ammoniated phases. However, there are few examples of BS with larger albedo, which show important differences with respect to most of the BSs. First of all they appear to be depleted in OH and NH_4 bearing compounds. Another important difference is in the carbonate composition which moves from Mg/Ca-carbonates, common on the rest of the surface, to Na-carbonates.

The Occator Faculae complex could form a third, distinct family at least in terms of OH-bearing species, being more hydrated and exhibiting phyllosilicates of a different nature, Al-bearing versus Mg-bearing.

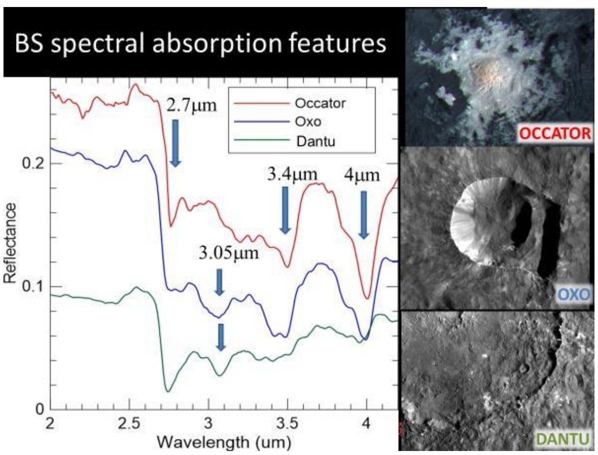
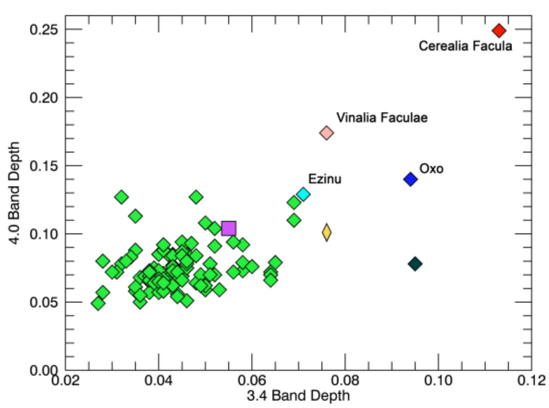


Figure 1. Three spectra of BS's representing different cases: Brightest BS (Occator, red spectrum), Intermediate albedo BS (Oxo, blue spectrum), "low" albedo BS (Dantu, green spectrum).



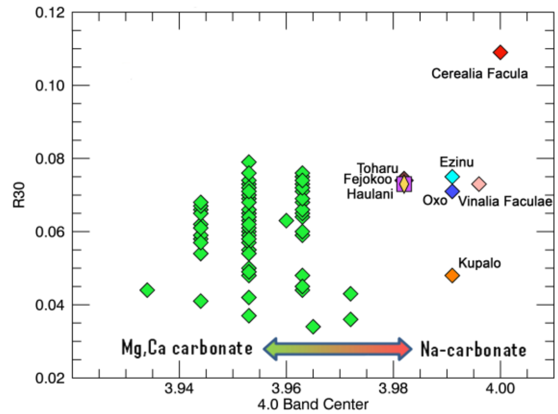


Figure 2. a) Scatterplot of 4 µm band depth versus 3.4 µm band depth; b) scatterplot of reflectance value obtained at 30° phase [11] (estimated at 1.2 µm) as a function of band center of the 4 µm band. The rhomboid symbols indicate: general BS (green), Cerealia Facula (red), Vinalia Faculae (pink), Oxo (blue), Fejokoo (jellow), Ezinu (cyan), Ernutet (dark green), Toharu (brown), Kupalo (orange). Haulani is represented by square violet symbol.

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