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A compositional view of Av-10 Oppia quadrangle

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Abstract

In an ongoing effort to map various quadrangles of Vesta from a compositional perspective, here we use data from the Visible and InfraRed (VIR) mapping spectrometer [1] to assess mineralogical evidences and trends across the Av-10 "Oppia" quadrangle.
We focus on features observed at the local scale, to highlight diagnostic compositional signatures and relationships with similar findings observed in other quads. Combining information from different datasets (mineralogy, geology, and topography) may ultimately help decipher the origin of these structures and properly fit them in the context of the evolution of the entire asteroid.

1. Introduction

Oppia quadrangle Av-10 is one of five quadrangles on Vesta that cover the equatorial region (Lon 288°-360°E, 78°-150°E IAU, Lat ±22°) [2,3]. The central area of Av-10 is dominated by a broad, east-west elongated basin (*Feralia Planitia*) surrounded by topographically higher cratered terrain in the northeast quadrant and a relatively smoother, faulted terrain along the southern border. Structural troughs strike through Av-10 from the northwest (*Saturnalia Fossae*) and the southeast (*Divalia Fossae*) corners. This quadrangle is named after *Oppia* (Lon 309.1°E, 99.1°E IAU, Lat 7.9°S), the second largest crater with a diameter of ~37 km. Other geologically young impact craters with diameter in the range 20-40 km in this quad are *Lepida* and *Paulina*.
Quadrangle Av-10 contains geologic mapping units that are representative of each of the vestan time-stratigraphic systems and time periods: cratered highlands terrain, cratered plains material, Saturnalia Fossae trough terrain, Divalia Fossae terrain, crater wall and ejecta, dark crater rays, and light and dark mantle [3]. The cratered highlands terrain is the oldest unit in Av-10 and represents crustal material on Vesta that was excavated to form the basin Feralia Planitia and the cratered plains unit, both of which are Pre-Veneneian in age [3]. These terrains are characterized by low reflectance at visible wavelengths and shallow pyroxene bands. The most notable feature of quadrangle Av-10 is the Oppia crater, which is associated with broad, spectrally distinct ejecta and shows large spectral variations within the crater walls and floor. The ejecta blanket of Oppia is mapped as 'dark mantle material' because it appears dark orange in the Framing Camera (FC) 'Clementine' color-ratio image (**Fig. 1**) and has a diffuse, gradational contact distributed to the south across the rim of Rheasilvia.
Hereafter we summarize the main points of interest related to mineralogical mapping of Oppia quad:

1. We use spectral indices derived from VIR data to assess broad HED trends across the entire quadrangle. Our analysis shows that the northeastern part of Av-10 (older) is dominated by howardite/eucrite-rich material, while the southwestern part (younger), including Oppia and its ejecta blanket, is eucritic (**Fig. 2**). The association of the mineralogical map with the geologic map and also a topographic map allows us to highlight relationships between the age of the main formations observed in this quadrangle and their composition.
2. Compared to previous works focused on the composition of the 'orange' material on Vesta [4], we put more emphasis on mineralogy of the whole Av-10 quad as inferred from VIR spectra. Moreover, VIR data are used to infer the composition of other geologic features defined in the geologic map of Av-10 [3], to emphasize relations existing between their surface composition and their age dating. We carried out spectral unmixing on specific features of interest, as well as the evaluation of their thermal properties [5] (**Fig. 3**), which is an advancement over past works.

3. A major point of interest in Av-10 is the signature of hydrous materials in the ejecta blanket west of Oppia crater, which can be highlighted by using VIR data combined with FC data so as to enable a clear correlation with specific geologic features. Our analysis shows that hydrous material is particularly associated with the 'light mantle material' seen at the local scale. In this case, we investigate the similarity of the OH signature observed at the local scale in this quad compared to the regional distribution of OH on Vesta, already discussed in previous works [6].

2. Figures

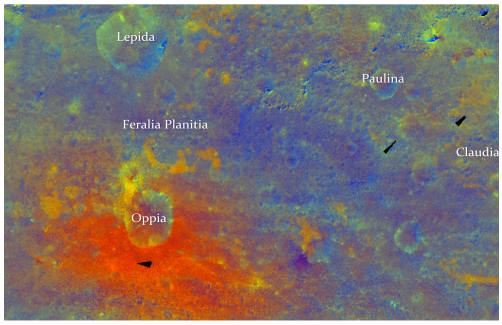

Figure 1. RGB composite of the Av-10 Oppia quadrangle made from FC color ratios: R = 438nm/749nm, G = 749nm/917nm, B = 749nm/438nm ("Clementine" colors). Color ratios may enhance differences in material and composition and shed light on the lithology. Combined with the visible albedo of Vesta's surface, this color-ratio composite shows: 1) bright material in yellow/green, 2) dark material in blue/violet, and 3) spectrally distinct ejecta in red/orange.

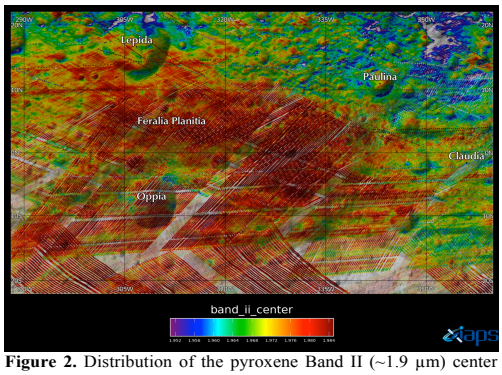

Figure 2. Distribution of the pyroxene Band II (~1.9 μm) center across the Oppia quadrangle, superimoposed to a FC optical mosaic of the same region. The overall mineralogy spans from howarditic (blue) to eucritic (red).

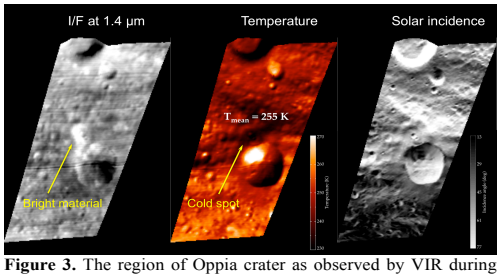

Figure 3. The region of Oppia crater as observed by VIR during the Survey phase of the mission at Vesta (resolution 0.68 km/px). The three panels from left to right show, respectively: the scene as observed at the near-infrared wavelength of 1.4 μm, a temperature map of the same area as inferred at wavelengths >4.5 μm, and a map of solar incience angle. Bright material associated with a small unnamed crater in the northern rim of Oppia displays a distinct thermal behavior compared to the surroundings.

Acknowledgements

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