VESTA MINERALOGY IN THE LIGHT OF DAWN.

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Introduction: VIR-Visible InfraRed mapping Spectrometer- aboard Dawn, is the primary instrument for mapping the surface mineralogy of Vesta [1]. Vesta's spectrum has strong absorption features centered near 0.9 and 1.9 µm, indicative of Fe-bearing pyroxenes. The spectra of HED (howardite, eucrite and diogenite) meteorites have similar features. This led to the hypothesis that Vesta was the parent body of the HED clan [2,3].The data from the Dawn VIR instrument [4,5,6] characterized and mapped the mineral distribution on Vesta, strengthened the Vesta – HED linkage, discovered hydrated materials and their association with the low albedo materials, discovered olivine in an unexpected location, providing new insights into Vesta's formation and evolution.

VIR data: VIR acquired data during all the Dawn mission phases, providing very good coverage of the surface. Data of high quality, from 0.2 to 5 microns, have been acquired for a total of about 20 million spectra in 864 spectral channels. The VIR nominal pixel resolution ranges from 1.3 km (Approach phase) to 0.18-0.15 km (HAMO). The coverage obtained, allows a near global study of Vesta's surface mineralogy.

Results: Vesta spectra are dominated by pyroxene bands, but the global spectral observations of Vesta revealed several unexpected features and large variation in the pyroxenes mineralogy.

Vesta presents complex geology/topography and the mineral distribution is often correlated with geological and topographical structures. Ejecta from large craters have distinct spectral behaviors, and materials exposed in the craters show distinct spectra on floors and rims. Maps of spectral parameters show surface and subsurface unit compositions in their stratigraphic context. VIR reveals the mineralogical variation of Vesta's crustal stratigraphy on local and global scales.

The surface composition is imprinted by the huge impact that formed Rheasilvia basin. This impact excavated a large amount of material and redistributed it on Vesta's surface. Within the basin, the mineralogical composition is different, with primarily diogenites and howardites. Orthopyroxene-rich materials are present in the deepest parts of the basin and within its walls (fig. 1).

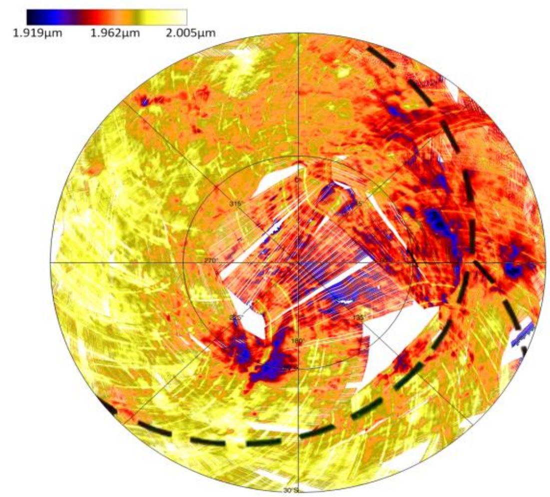

Fig.1: BII center distribution in the south polar region. The dash line represents Rheasilvia and Venenia boundaries.

Most of the VIR spectra are consistent with a surface covered by a howardite-like regolith containing varying proportions of eucrite and diogenite at different locations[5,6]. The observed distribution is suggestive of significant gardening of surface materials, consistent with a background of breccias composed of eucrite and diogenite.

Large eucrite-rich regions occur at equatorial/mid latitudes, hinting at remnants of Vesta's old crust. Diogenitic lithology, other than that within the Rheasilvia basin, is exposed in an extensive ejecta blanket produced by the Rheasilvia-forming impact. The ejecta covers a broad portion of Vesta's surface, spreading from Rheasilvia's rim far to the North.

Significant amount s of olivine are predicted by the petrogenic models and its occurrence is demonstrated by some diogenites meteorites that are rich in olivine[ref]. Nevertheless, olivine has not been firmly detected in the Rheasilvia basin. It must be recalled that spectral detection of olivine when associated with orthopyroxene is difficult.

However, olivine has been discovered in the Northern hemisphere far from the deeply excavated southern basins [7], (fig. 2).

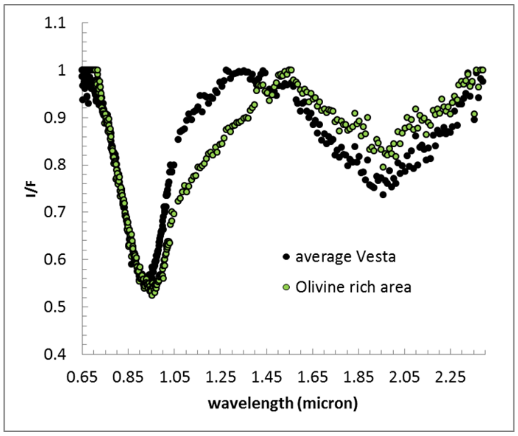

Fig. 2 Spectrum of olivine rich area in comparison with an average spectrum of Vesta.

Olivine distribution is another key detection that can help in distinguishing between competing hypothesis. The classical models foresee widespread crystallization of olivine and diogenite (magma ocean models) while other models invoke olivine and diogenite rich lithologies formed via fractionation in multiple crustal plutons. The distribution of these lithologies on Vesta can provide constraints on the formation models and on the processes that were active in the primordial solar system.

The global albedo map of Vesta [8] reveals the presence of different types of terrains: bright material (BM) and dark material (DM). The mid-southern Vestan hemisphere contains most of the bright areas, while the northern hemisphere is poor in of bright regions [9,10]. The analysis of the spectral parameters of BM shows a dependence between albedo and band depths with stronger bands corresponding to high albedo units, while no large differences in the BM mineralogy has been observed [11]. The spectral characteristics led to the interpretation that the bright areas represent fresh material excavated by recent impacts, representative of younger Vesta surface [11,12].

Dark materials are distributed unevenly, with a concentration in some regions of the equatorial belt [10]. The spectral differences among them, when present, are only subtle and suggest a composition similar to the Vestan average “material”, with a small amount of a moderately darkening agent. The spectra often present a signature at about 2.8 micron[14, 15]. The low albedo and the presence of the hydration band point to CC as one of the possible darkening agent.

The 2.8-μm OH absorption is distributed across Vesta’s surface and shows areas enriched and depleted in hydrated materials[14]. The uneven distribution of hydrated mineral phases indicates ancient processes that differ from those believed to be responsible for OH on other airless bodies, like the Moon. The origin of Vestan OH, mainly linked with the presence of carbonaceous materials, provides new insight on the delivery of hydrous materials in the main belt, and may offer new scenarios on the delivery of hydrous minerals in the inner solar system.

Vesta mineralogy is surprisingly rich of signs of its “ancient and recent” past, from the primordial formation and evolution to the more recent collisional evolution, spanning the history of the solar system.

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