A close look at the Vestan Rheasilvia basin: The Tarpeia crater

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From July 2011 to August 2012, the Dawn spacecraft orbited around Vesta [1] and the Visible InfraRed mapping Spectrometer (VIR) acquired spectra from 0.2 to 5 µm of its surface [2]. The instrument has been operative during Survey, High Altitude Mapping (HAMO), and Low Altitude Mapping (LAMO) orbits as well as during Approach and Departure phases providing an almost global coverage of the surface. Data from LAMO are those with the highest resolution. 70 m/px is the nominal resolution in this orbit in comparison with 170 m/px and 700 m/px that are the typical resolutions during HAMO and Survey, respectively. While the VIR coverage in this mission phase is limited to less than 1 % of the surface, the LAMO dataset provides a detailed view of some localized areas.

Vesta exhibits ubiquitous pyroxene absorption bands [3] with variations of band center position, band depth and other band parameters at both large and small scales [4]. In particular, there is a strong indication that the Rheasilvia basin has its own spectral characteristics: on average, the pyroxene absorption bands are deeper, wider, and their center positions are shifted towards shorter wavelengths, and the central mound has relatively low spectral diversity [5]. These spectral behaviors indicate the presence of Mg-pyroxene-rich terrains in Rheasilvia, occurrence confirmed by the Gamma-Ray and Neutron Detector [2] and the Framing Camera color data [6], the other two instruments on the Dawn spacecraft.

The focus of the present study is the analysis of compositional variations of small-scale surface features within the Rheasilvia basin. We made use of LAMO data, which have the highest resolution and provide a detailed view of some localized areas of Vesta's surface. Most of LAMO data cover the South Polar region, where the giant impact basin RheaSilvia is located. An example is Tarpeia, a crater with a diameter of about 40 km located within the Rheasilvia basin at -70°lat and 29°E-lon (Claudia Coordinate System). This crater has been chosen because spectra of this location have been acquired during all the mission phases. For this reason, it was possible to verify the consistency of measurements from the same region but acquired in different mission phases which is particularly important within the Rheasilvia basin, where the viewing geometries were unfavorable. In addition, the existence of spectral images from different mission phases make Tarpeia a good example to illustrate, how the composition diversity is better revealed with higher-resolution data. Using a method already applied to VIR spectra at larger scales [7], we identified, within Tarpeia, regions with different amounts of Fe in pyroxene. In particular, in the west side of the crater, the bottom part of the wall and part of the floor has been found to be composed of Fe-rich pyroxene. Pyroxene in the rest of the internal part of the crater as well as its surroundings have Fe content in line with the average of Vesta, while some spots in the region just outside the crater rim are enriched in Mg-rich pyroxene. Since Rheasilvia is dominated by Mg-rich pyroxenes terrains, the origin of the Fe-rich unit is still unclear. However, the presence of Fe-rich and Mg-rich pyroxene within the same topographic feature suggests a heterogeneous composition of the surface in this particular location of the surface.

Acknowledgements: The authors gratefully acknowledge the support of the Dawn Instrument, Operations, and Science Teams. This work is supported by NASA through the Dawn project and by an Italian Space Agency (ASI) grant.

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