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A close look at the Vestan Rheasilvia basin

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Abstract

The focus of the present study is the analysis of compositional variations of small-scale surface features within the Rheasilvia basin. We considered data acquired by the Dawn Spectrometer VIR during the Low Altitude Mapping (LAMO) orbit of two craters in the southern region, Tarpeia and Severina. We analyzed their composition and we discuss our results in the general context of the composition and morphology of Vesta and Rheasilvia.

1. Introduction

From July 2011 to August 2012, Dawn spacecraft orbited around Vesta [1] and in this period of time 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 orbits respectively. While the coverage is limited to less than 1% of the surface, the LAMO dataset provides a detailed view of some localized areas.

Vesta exhibits ubiquitous BI and BII 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 centers positions at 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 (GRaND) (6) and the Framing Camera (FC) color data (7), the other two instruments on the Dawn spacecraft.

2. RheaSilvia Basin

We made use of data from LAMO orbit, 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. While Rheasilvia basin is generally uniform in composition, Tarpeia and Severina craters show lithological variations which are evident in the global maps [8]. In Fig.1 there is a lithologic map of the south hemisphere produced analyzing the position of the center of pyroxenes BI and BII [5]. Rheasilvia basin has generally an howarditic composition (cyan in the map) with an higher concentration of howarditic to diogenitic distribution in the region between 45° and 225°E-lon (yellow/green in the map). In particular, two regions have been identified for further investigations. Tarpeia (black box in the map) has an eucritic patch in the west side of the crater, the bottom part of the wall and part of the floor. Severina (purple box in the map) has some diogenitic units on the walls of the crater while the all region where this crater is located has an higher content in Mg-rich pyroxene when compared with the other locations within the basin (yellow/green regions).

2.1 Tarpeia Crater

Tarpeia is a crater with a diameter of about 40km centered at -70°lat and 29°E-lon (Claudia Prime Meridian Reference System). Within Tarpeia, we identified regions with different amount 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 by Fe-rich pyroxene (blue in the map). 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 and the east side of the crater walls are enriched in Mg-rich pyroxene.

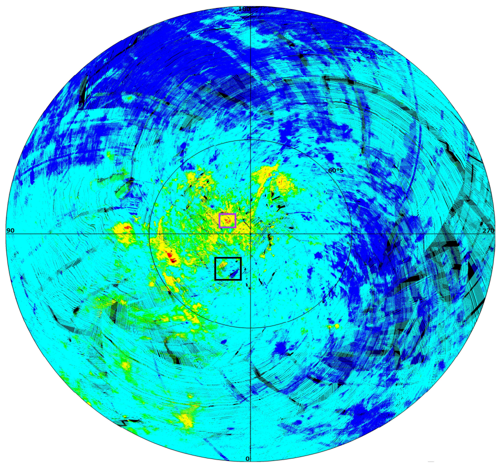

Figure 1: Stereographic Projection of Vesta's South Hemisphere. The centre of the projection is the South Pole. The black box is Tarpeia crater. The purple box is Severina crater. In this map, red are diogenite-like, green are howardite-like and blue are eucrite-like lithologies.

2.2 Severina Crater

Severina is a crater with a diameter of about 35km centered at -75°lat and 121°E-lon (Claudia Prime Meridian Reference System). Severina lies in a region with an high concentration of Mg-rich pyroxenes (yellow and green in the map in fig. 1) which, together with the Matronalia Rupes, has subunits formed by pyroxenes with the highest amount of Mg with respect to Fe (red in the map) on Vesta's surface. In particular, spectral data from all Dawn mission phases confirmed that the lithologic unit formed by Mg-rich pyroxenes is located on the crater walls towards south (red spot in the map).

3. Conclusions

Spectra of Tarpeia and Severina craters have been analyzed and within each crater variations in the composition of pyroxenes have been found. The origin of the Fe-rich unit in Tarpeia and the Mg-rich unit in Severina are still unclear, however, the presence of Fe-rich and Mg-rich pyroxene within the same topographic feature suggests an heterogeneous composition of the Vestan crust in this particular location of the surface.

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