EPSC Abstracts
Vol. 10, EPSC2015-715, 2015
European Planetary Science Congress 2015

Correlation between the mineralogic and geologic maps of Vesta: spatial analysis and perspectives towards the mapping of Ceres

A. Frigeri[1] , M.C. De Sanctis [1] , E. Ammannito [2] , R. A. Yingst [3] , D. A. Williams [4], F. Capaccioni [1] ,F. Tosi [1] , E. Palomba [1] , F. Zambon [1] , R. Jaumann [5] , C.M. Pieters [6] , C.A. Raymond [7] , C.T. Russell [2] and the Dawn Team;

[1] Istituto di Astrofisica e Planetologia Spaziali, Istituto Nazionale di Astrofisica, via del Fosso del Cavaliere, 00133 Roma, Italy (alessandro.frigeri@iaps.inaf.it); [2] Institute of Geophysics and Planetary Physics, University of California at Los Angeles, Los Angeles, California, USA; [3] Planetary Science Institute, Tucson, Arizona, USA; [4] Arizona State University, Tempe, AZ; [5] DLR, Berlin, Germany; [6] Department of Geological Sciences, Brown University, Providence, Rhode Island, USA; [7] NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, USA;

1. Introduction

Between July 2011 and September 2012, the NASA/Dawn mission has mapped the surface of Vesta with images from the Framing Camera (FC [1]), spectral data from the Visible and Infrared Mapping Spectrometer (VIR [2]), and elemental data from the Gamma Ray and Neutron Detector (GRaND [3]). The successful acquisition of imagery from FC and VIR allowed us to produce global image mosaics reaching 20 meters per pixel and global mineralogic maps at 100 meters per pixel. A global geologic map of Vesta has been recently published [4,5]. Geologic units and structures have been identified and put into their stratigraphic context using FC image-mosaic and the digital terrain model derived from stereo image processing. The VIR spectra have been synthesized into spectral parameters or indicators [6] that have been used to produce quadrangle and global maps showing the mineralogic diversity across Vesta, through the variation of the compositional and the physical state of the pyroxene-rich lithologies, which are typical of Vesta[7]. Herein we present the work done to explore the spatial correlation between the mineralogic and geologic map of Vesta (Figure 1).

2. Geoprocessing

We have designed a Geographic Information System (GIS) approach to spatially correlate the geologic map and the spectral parameters maps of Vesta. For this work the mineralogic and geologic maps of Vesta have been imported into a widely-used Free Open Source GIS (the Geographic Resources Analysis Support System, or GRASS[8]) using a common coordinate reference system. The digital GIS maps are stored in a Open Gis Consortium (OGC) compatible format to facilitate interoperability between different GIS packages. Within the GIS environment, specialized tools allow us to spatially correlate different maps, do statistical analyses and

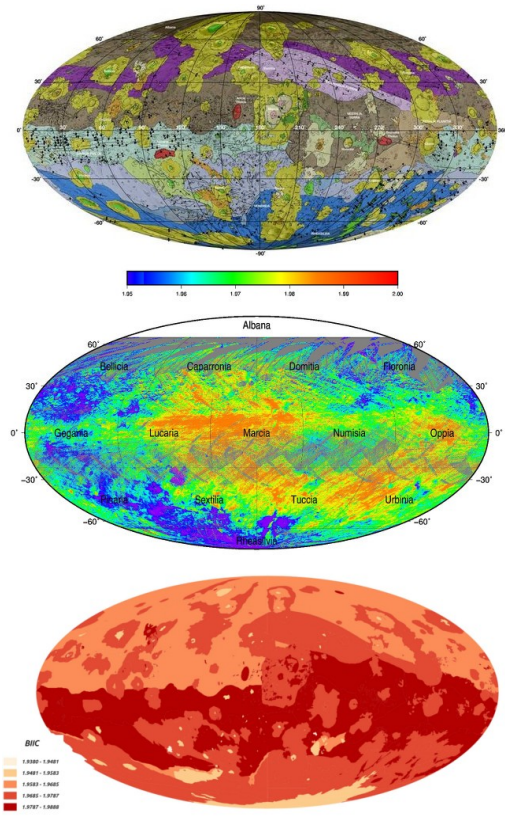

Figure 1: Top: the geologic map of Vesta. Middle: the pyroxene-related Band II center spectral parameter map. Bottom: the geologic units classified on the basis of Band II center.

develop specific geoprocessing pipelines involving different types of geospatial data.

Figure 1-bottom shows the map resulting from the correlation of the geologic map and the pyroxene-related spectral parameters Band II center, which is the position of the absorption band around 2 microns. Lowest values are found for the Rheasilvia related units at the south pole, mid-values are found within the northern emisphere, while higher values are typical of equatorial units.

3. Discussion and New Perspectives

This work of comparison of the geologic map of Vesta and the mosaics of spectral parameters extracted from VIR data aims to explore the level of spatial correlation between two kind of maps made with different approaches. The geologic map is the result of an interpretative process, while the spectral parameters map is the result of an automated processing. The basic element of a geologic map is the geologic unit. Geologic units are made up of bodies of rock that are interpreted to have been formed by a particular process or set of related processes over a discrete interval of time, so the morphology and the topography are the primary sources for the crafting of a geologic map. Spectral parameter maps are the result of a data reduction process made by experienced spectroscopists and allow the non-spectroscopists to focus on the spatial variation of a single aspects of a complex spectra, representing a perfect element for the study of the spatial correlation with other dataset, as the gelogic map of this study. Figure 1 shows that although globally there is no one-to-one correlation between geologic units and spectral parameters, the re-classification of the geologic units on the base of their spectral fingerprint (Figure 1, bottom) represent an additional way to explore the geologic characteristic of Vesta. The availability of global geologic and mineralogic maps published in late 2014 / early 2015 represents the first opportunity to observe the spatial correlation globally for Vesta, using the most up-to-date dataset. Dawn is currently collecting data from Ceres, and the first geologic mineralogic maps are being prepared. Our study made on Vesta is going to be replicated on Ceres, but this time we can apply our experience early in the mapping process, providing new views for a more detailed interpretation of the geologic history of the dwarf planet Ceres.

References

[1] Sierks, H. et al. The Dawn Framing Camera.*Space Science Reviews*, 163:263-327, Dec. 2011.

[2] De Sanctis et al. The VIR Spectrometer. *Space Science Reviews*, 163:329-369, December 2011.

[3] Prettyman et al. Dawn's Gamma Ray and Neutron Detector. Space Science Reviews 163, 371–459. doi:10.1007/s11214-011-9862-0, 2011

[4] Williams et al. Introduction: The geologic mapping of Vesta. Icarus 244, 1 – 12. 2014

[5] D. A. Williams et al., LPSC Abstract #1126. 2015

[6] Ammannito, et al. 2013. Vestan lithologies mapped by the visual and infrared spectrometer on Dawn. Meteoritics & Planetary Science 48, 2185–2198. 2013

[7] McCord, T.B. et al. Asteroid Vesta: Spectral Reflectivity and Compositional Implications. Science 168, 1445–1447. 1970

[8] M. Neteler and H. Mitasova (2008), Open Source GIS: A GRASS GIS Approach. Third edition. Springer, New York.