EPSC Abstracts
Vol. 8, EPSC2013-1084, 2013
European Planetary Science Congress 2013

The Atlas of Vesta Spectral Parameters derived from Dawn/VIR data

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Introduction

The Dawn mission mapped Vesta from three different orbital heights during Survey orbit (2700 km altitude), HAMO (High Altitude Mapping Orbit, 700 km altitude), and LAMO (Low Altitude Mapping Orbit, 210 km altitude) [1]. From these orbits the Dawn's Visible and Infrared Mapping Spectrometer (VIR) acquired infrared and visible spectra from 0.2 to 5 microns, sampled in 864 channels with a spatial resolution reaching about 150 m/pixel.

Studies of the comparison of spectra from remote sensed data and spectra from laboratory allows to synthesize spectral parameters, which can be combined to identify specific physical and compositional states.

VIR spectra of Vesta, stored in about 4300 Planetary Data System (PDS) cubes, have been analyzed to derive spectral parameters, each of which is diagnostic of the associated mineralogy on the surface of the asteroid being observed [2].

Maps of spectral parameters show terrain units compositions in their stratigraphic context. Band centers and band depths are among the most important diagnostic parameters of the mineralogy in a spectrum. In most pyroxenes and in the basaltic achondrites there is a strong correlation between the position of BI center and BII center and the associated mineralogy. For example, orthopyroxene bands shift towards longer wavelengths with increasing amounts of iron, whereas clinopyroxene bands shift towards longer wavelengths with increasing calcium content. Band depth is related to scattering effects, thus can be related to the physical state of the material.

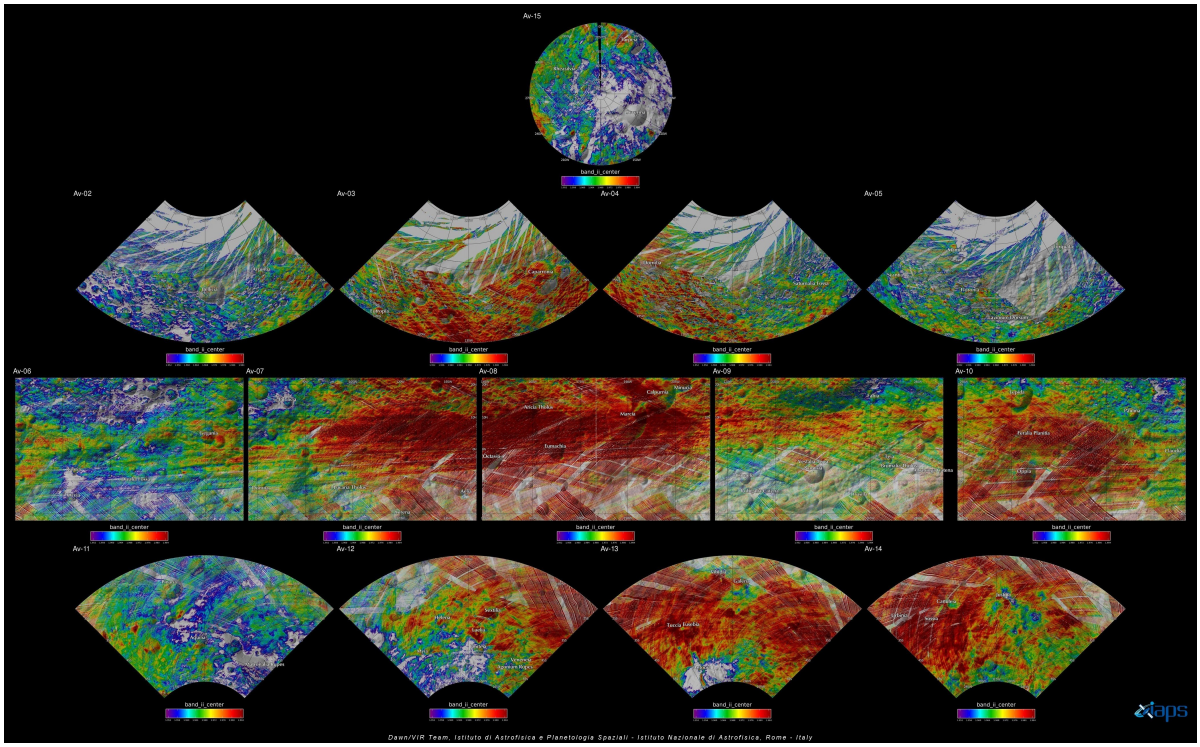
Data processing

VIR data is stored in form of data cubes as PDS and ENVI files. Spectral parameters are computed from calibrated VIR data and put into multi band data cubes. Geometric information are computed using the latest version of the SPICE toolkit [3], which includes a shape model of Vesta and stored into geometric cubes. Spectral parameters and geometric cubes are used to produce geo-referred and orthorectified Geographic Information System (GIS) data files into GRASS GIS, which allows to process big volumes of data thanks to its scripting capabilities [4].
Spectral parameters maps are produced at a resolution of 70 meters per pixel within the GIS environment and exported as Geotiffs and ENVI files, following a 15 tiles quadrangle scheme commonly used for medium sized planetary bodies [5], and matching the Framing Camera Atlas of Vesta [6]. Graphical rendition of the spectral parameters have been produced as images from the GIS data, adding a shaded relief obtained from the digital terrain model produced by DLR and the official IAU nomenclature. This visualization allows to identify the general morphologic setting and correlate the mineralogy to the the main topographic features of every quadrangle.

Example: Band II Center quads

The 14 maps displaying Band II center are reported in Figure 1. While the overall spatial distribution of spectral parameters has been already studied as Dawn was still observing Vesta [7], the availability of those hight resolution maps will allow more detailed studies at a greater scale. Within the Dawn science team the single high-resolution quadrangles are being studied individually by small groups of researchers with different backgrounds in geology and spectroscopy.

Figure 1: En excerpt from the VIR Spectral Parameters Atlas of Vesta, showing the color coded spatial distribution of the pyroxene Band II center. Quadrangle Av-1 (Albana) is missing because of the limited coverage at the north pole with poor illumination conditions.



Current status, future work

The Atlas of Spectral Parameters represents a synthesis of all the observations made by VIR, thus it is averaging data of different resolution and quality. We are incrementally improving the map, detecting and filtering out possible artifacts on specific observational sessions. Herein we present the first version of the complete Atlas, which includes 6 spectral parameter per quadrangle, for a total of 84 digital maps at a resolution of 70 meters per pixel.

Acknowledgements

Dawn Science, Instrument, and Operations Teams. This work was supported by ASI and NASA's. A portion of this work was performed at the JPL NASA. VIR is funded by the Italian Space Agency–ASI and was developed under the leadership of INAF-Istituto di Astrofisica e Planetologia Spaziali, Rome-Italy. The instrument was built by Selex-Galileo, Florence-Italy. The authors acknowledge the support of the Dawn Science, Instrument, and Operations Teams. This work was supported by ASI and NASA's. A portion of this work was performed at the JPL NASA.

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