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Thermal behaviour of unusual local-scale surface features on Vesta

F. Tosi (1), M.T. Capria (1), M.C. De Sanctis (1), E. Palomba (1), D. Grassi (1), F. Capaccioni (1), E. Ammannito (1), J.-Ph. Combe (2), J.M. Sunshine (3), T.B. McCord (2), J.-Y. Li (3), T.N. Titus (4), C.T. Russell (5), C.A. Raymond (6), D.W. Mittlefehldt (7), M.J. Toplis (8), O. Forni (8), and M.V. Sykes (9)

(1) INAF-IAPS Istituto di Astrofisica e Planetologia Spaziali, Rome, Italy (federico.tosi@ifsi-roma.inaf.it), (2) Bear Fight Institute, Winthrop, USA, (3) Department of Astronomy, University of Maryland at College Park, USA, (4) Astrogeology Science Center, U.S. Geological Survey, Flagstaff, USA, (5) Institute of Geophysics and Planetary Physics, University of California at Los Angeles, Los Angeles, USA, (6) NASA/Jet Propulsion Laboratory and California Institute of Technology, Pasadena, USA, (7) NASA/Johnson Space Center,
Houston, USA, (8) Institut de Recherche en Astrophysique et Planétologie (UMR 5277), Toulouse, France, (9) Planetary Science Institute, Tucson, USA

On Vesta, the region of the infrared spectrum beyond ~3.5 μm is dominated by the thermal emission of the asteroid's surface, which can be used to determine surface temperature by means of temperature-retrieval algorithms. The thermal behavior of areas of unusual albedo seen at the local scale can be related to physical properties that can provide information about the origin of those materials. Dawn's Visible and Infrared Mapping Spectrometer (VIR) hyperspectral cubes are used to retrieve surface temperatures, with high accuracy as long as temperatures are greater than ~180 K.

Data acquired in the Survey phase (23 July through 29 August 2011) show several unusual surface features: 1) high-albedo (bright) and low-albedo (dark) material deposits, 2) spectrally distinct ejecta, 3) regions suggesting finer-grained materials. Some of the unusual dark and bright features were re-observed by VIR in the subsequent High-Altitude Mapping Orbit (HAMO) and Low-Altitude Mapping Orbit (LAMO) phases at increased pixel resolution.

To calculate surface temperatures, we applied a Bayesian approach to nonlinear inversion based on the Kirchhoff law and the Planck function. These results were cross-checked through application of alternative methods. Here we present temperature maps of several local-scale features that were observed by Dawn under different illumination conditions and different local solar times.

Some bright terrains have an overall albedo in the visible as much as 40% brighter than surrounding areas. Data from the IR channel of VIR show that bright regions generally correspond to regions with lower thermal emission, i.e. lower temperature, while dark regions correspond to areas with higher thermal emission, i.e. higher temperature. This behavior confirms that many of the dark appearances in the VIS mainly reflect albedo variations. In particular, it is shown that during maximum daily insolation, dark features in the equatorial region may rise to temperatures greater than 270 K. However, individual features may show different thermal behaviours, as a result of differences in composition and/or structure (e.g, average grain size of the surface regolith, porosity, etc.).

To complement the temperature and near-infrared emissivity derived from the infrared spectra, a separate work is devoted to calculate thermal inertia and other thermal properties using theoretical models which solve the heat equation for airless bodies, and model the distribution of temperatures due to surface roughness variations.